Waterford County Council

Environmental Risk Assessment for Unregulated Waste Disposal Site

Tier 2 Exploratory Investigation

Townspark East, Lismore Landfill

Final Issue	**Name**	**Position**	**Date**
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Approved by	G Hynes	Senior Engineer	December 2011

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1.0 Introduction

The 'Code of Practice Environmental Risk Assessment for Unregulated Waste Disposal Sites (COP)' was issued by the EPA in April 2007. This document gives direction to local authorities in the investigation of old landfill sites that operated between 1977 and 1997 without the proper permitting and authorising system (i.e. in accordance with the Waste Framework Directive 75/442/EEC).

Waterford County Council has undertaken an inventory and preliminary risk assessment of all unregulated waste disposal sites within the county (as per the COP). A number of Tier 1 desk studies and reports have been completed and Waterford County Council has been included in a second round of pilot projects in conjunction with the South East Region for proceeding to the next phase (Tier 2) for a particular site located at Townspark East, Lismore, Co. Waterford.

1.1 Background:

Waterford County Council completed a Tier 1 risk assessment of the historic landfill site in November 2008. Risk screening and prioritisation includes a preliminary investigation of the site using a desk top study and site inspection, and the preliminary risk assessment. This outlines the different Source-Pathway-Receptor (S-P-R) linkages and thereby provides the information for the risk screening element.

Following this procedure, the Tier 1 risk assessment for historic landfill located on lands at Townspark East, Lismore was classified as a *Class C - Low Risk site*.

In September 2009, the EPA prepared guidance on the completion of Tier 2 Site investigations in which it was recommended that the investigations be completed in two phases. Phase 1 should consist of Exploratory Works, following which the initial Tier 1 assessment should be revised and the need for and/or extent of a Phase 2 Detailed Site Investigation.

1.2 Definition of Class C site:

Class C sites are defined as sites where any of the site specific Source-Pathway-Receptor (S-P-R) linkages have a score between 0% and 40% and site investigations are required to verify the risk status. Class C sites; therefore, have to apply for a regularisation through a Certificate of Authorisation process implemented by the EPA following the completion of the Site Investigation.

1.3 Scope of Works:

As per the EPA's code of practice, an exploratory investigation shall be carried out to confirm the initial conceptual site model prior to designing the main investigation programme. The exploratory investigation shall investigate the landfill gas regime and leachate regime, the investigation may consist of trial holes, landfill gas sampling at the nearest receptors and also some landfill gas and leachate monitoring within the waste body. It is also recommended to take some water (surface water & groundwater) sampling as to ascertain whether there is any evidence of impacts from the waste body.

As a result of information obtained and provided from the Tier 1 risk assessment, a site inspection and internal staff meeting and having regard to the *EPA Matrix Guidance for Preliminary &*

Exploratory Investigation for all Un-regulated Waste Disposal Sites; Waterford County Council decided that the following shall be carried out for the Exploratory Investigation:

- Topographic Survey
- Trial Pit Survey
- Waste Characterisation
- Soil & Waste analysis
- Leachate sampling
- Surface water sampling
- Groundwater Sampling
- Gas Monitoring

It was anticipated, following the information and results provided from the exploratory investigation that Waterford County Council could re-design its conceptual site model as developed from the Tier 1 risk assessment previously. This, therefore, then would provide the necessary information for developing a detailed site investigation (Tier 2 main site investigation).

2.0 Exploratory Investigation:

2.1 Topographic Survey:

Waterford County Council compiled a topographic survey of the historic landfill site at Townspark East, Lismore, Co. Waterford on 30th November 2010. This particular topographic survey was compiled using in-house Geographical Information Systems (G.I.S) in conjunction with vertical mapping for the production of ordnance survey contours on the said lands.

The topographic survey drawing can be viewed in Appendix A. The topographic survey indicates that the site slopes down gradient in a North to South direction from approximately 31m to 25m OD. The River Owbeg is located further down gradient approximately 120m from the site.

2.2 Trial Pit Survey:

2.2.1 Trial Pits 1 – 8:

The trial pit survey was undertaken on Thursday 2rd September 2010. The Environment Section hired a 12ton Komatsu track mounted 360° excavator and operator which was suitable for travelling on uneven terrain and with a reach of 6-8 mbgl. Figure 2.1, gives an indication of the civic amenity facility and site located at Townspark East, Lismore and also highlights the trees and woodland in the background.

Figure 2.1: Historic Landfill, Townspark East, Lismore

From the preliminary investigation which is an integral part of the Tier 1 of the Code of Practice which comprises of a desk study and site inspection (including a walkover survey), it highlighted that this particular site would be complex and difficult for carrying out a uniform trial pit survey across the entire site. This is as a result of uneven terrain and the density of trees which were

planted adjacent to the civic amenity facility following closure of the landfill. Since the Tier 1 assessment was carried out, the Civic Amenity Site is now closed to the public also.

The trial pit locations can be viewed in Appendix B. Waterford County Council arranged to excavate 8 trial pits for the survey to obtain details in relation to the extent and nature of waste materials. The excavation was supervised by Waterford County Council technical staff including both engineering and scientific backgrounds and each pit was logged in accordance with BS5930 (see Appendix C).

2.2.2 Lateral Extent of the Waste:

As stated previously, lands adjoining the site appear to be primarily used for agriculture purposes and mainly grassland. There are a number of residential dwellings in close proximity to the site. To the south, one dwelling is located approximately 20m from the site. To the north, three dwellings are present at approximately 50m from the site. To the east, one dwelling is lies approximately 50m from the site. To the west, two dwellings are located approximately 150m & 200m from the site.

Wastes were encountered in trial pits from 1 - 7 throughout the site. Only the edge of the waste body was visible in Trial Hole 1 (north west) and also no waste was encountered in Trial Pit 8 (west) at the front of the site. It appears that most of the waste was deposited at the middle and rear of the site. Unfortunately due to the restrictiveness of the site, Waterford County Council was unable to determine the lateral extent of the waste body to the northern, eastern and southern boundaries. Further intrusive and geophysical investigations will be required to determine the lateral extent of the landfill area.

2.2.3 Vertical Extent of the Waste:

The waste material is covered by an impermeable layer in the civic amenity section and a thin layer of topsoil throughout the rest of the site. These capping layers ranged from 0.3m (TP-3) to 0.6m (TP-7) in thickness. This capping layer comprised mainly of sandy clay and gravelly clay fill materials. The capping layer was underlain by waste material which ranged in thickness from 0.3m (TP-4) to 3.7m (TP-4). The average thickness of waste materials across the trial pit survey is approximately 2.25m. The deepest trial pit was 3.7m (TP-4). No bedrock was identified in any of the trial pits except Trial Pit 8. The digging of trial pits was restricted to the machinery used and the stability of the trial pits themselves. While soil was encountered at the bottom of most trial pits, it is unclear if this marked the extent of the vertical depth of the waste body. Again, further intrusive and geophysical investigations will be required to determine the vertical extent of the landfill area.

2.2.4 Waste Characterisation:

The waste encountered in the trial pits ranged from damp to dry with wet zones towards the base of each trial pit. It comprised a mix of residual waste, plastics, glass, timber, steel, construction & demolition waste, tyres, mechanical parts, concrete piping, etc. It is assumed that the sandy clay layer was used to cover the waste material when the site was operational.

During the trial pit survey, technical staff interestingly located a section of the Irish Independent newspaper dated the 29th May, 1991. Figure 2.2 highlights this particular discovery. Leachate was

encountered in the following trial pits, TP-3, TP-5 & TP-7. Please see appendix C in relation to laboratory results.

Figure 2.2: Irish Independent 1991

2.3 Surface Water Sampling

2.3.1 Description

As stated previously, the River Owbeg is located approximately 120m in a southern direction from the site. The River Owbeg is not designated as a Special Area of Conservation. The flow of the river is from west to east. Two surface water samples were taken – one upstream SW-1 approximately 130 meters from site and one downstream SW-2 approximately 140 meters from site. The surface water samples by Environment Section technical staff members, Ms. Aoife O' Flaherty, Executive Engineer and Mr. Liam Ahearn, Assistant Engineer. The surface water sampling locations can be viewed in Appendix B.

2.3.2 Laboratory Analysis

The samples were analysed for a range of organic and inorganic parameters including Biological Oxygen Demand, Chemical Oxygen Demand, pH, Ammonia, Chloride, Nitrate and Phosphate.

These surface water results suggest that water quality was satisfactory in surface water samples. There was no measurable effect from the historic landfill.

2.4 Waste & Soil Analysis

Based on field observations and field screening, the waste appeared to be generally consistent across the site. Three soil/waste samples (Tp-1, Tp-3 & Tp-7) and one leachate (capping layer TP 5) were selected for analysis.

These samples were sent to an accredited scientific laboratory for analysis.

The site leachate sample was compliant with threshold groundwater values for cyanide, cadmium, copper, lead, mercury and phenols. Exceedances were noted for the following groundwater thresholds; arsenic, boron, chromium, nickel and PAH.

The NRA leachate samples showed compliance with threshold groundwater values for cyanide, cadmium, chromium, copper, led, mercury, PAH and phenols. Slight exceedances of threshold groundwater values for sulphate, arsenic, nickel and boron.

2.5 Gas Monitoring

Although, the results of the Tier 1 risk assessment highlighted that there was no risk of landfill gas as per the S-P-R linkages, Waterford County Council decided to perform a gas monitoring for completeness. During the excavations of each of the trial pits, the Environment Section technical staff monitored for gas (methane) occurrence using an in-house gas meter. Each of the trial pits (TP1-8) recorded 0% of methane gas presence.

2.6 Groundwater Sampling

Directly south west of the historic landfill site boundary is a natural groundwater well/spring. This particular groundwater spring is locally referred to as 'Holy Well' and is located approximately 500m south west from the historic landfill. Please refer to Appendix B.

Waterford County Council Environment Section technical staff obtained groundwater sample from this particular well/spring on the 18th November 2010. This sample was tested at Environmental Laboratory Services (ELS). Please refer to appendix D for results.

The groundwater sample was satisfactory for the following parameters; pH, ammonia, phosphate, chloride, nitrate, BOD and COD. It was concluded that there was no measurable effected noted from the historic landfill.

2.7 Laboratory Analysis

All of the field samples were collected in accordance with Waterford County Council and EPA protocols and were placed in suitable containers and stored in a cooler. Field measurements including GPS readings of sample location and observations were recorded at the time of the sample taking.

3.0 Conceptual Site Model:

3.1 Revised CSM

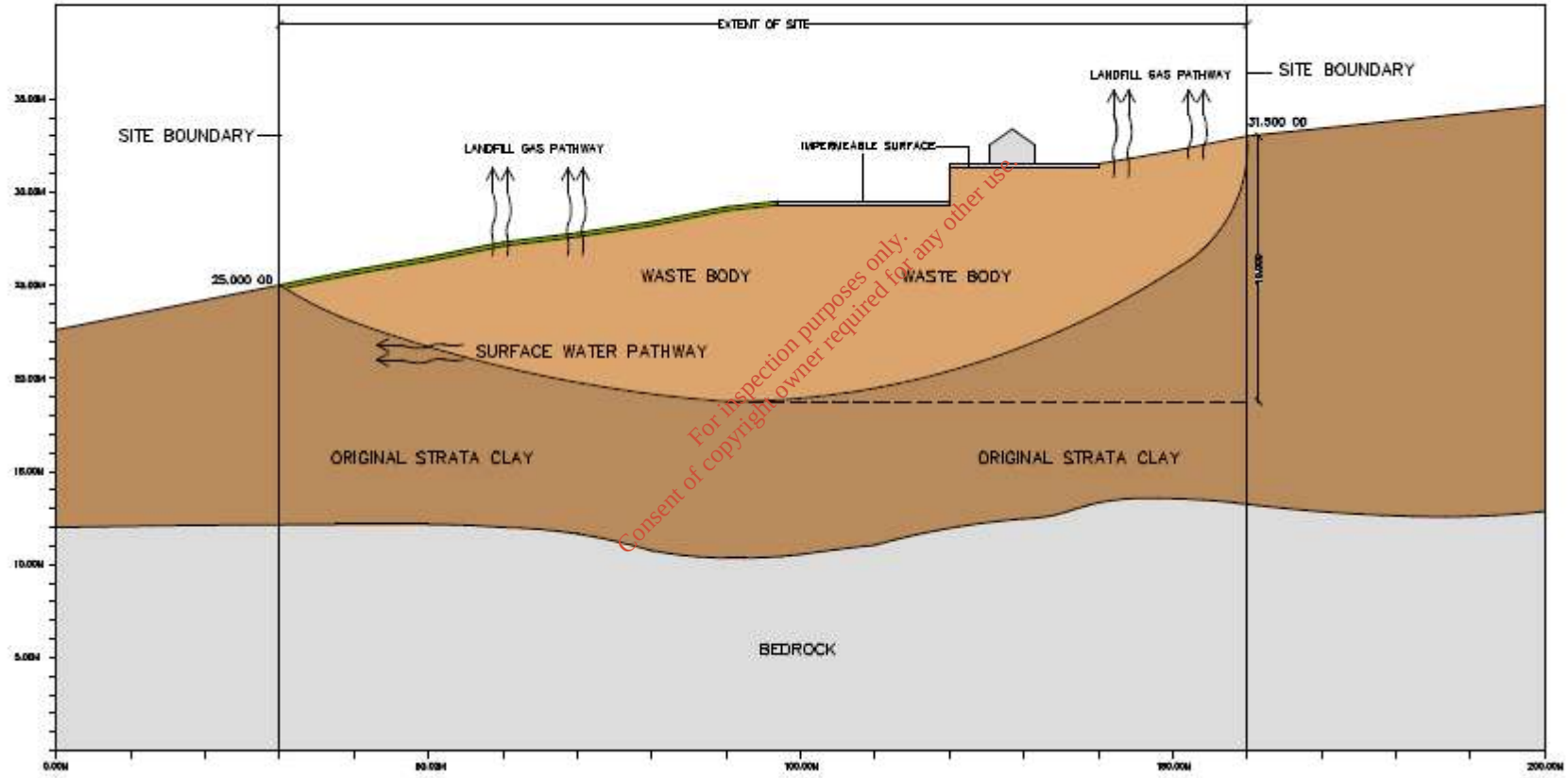
From the information obtained and results provided from the exploratory site investigation, Waterford County Council revised the conceptual site model from that previously produced at the Tier 1 Risk Assessment stage.

The revised conceptual site model illustrates the known depth of the waste material (up to 3.7m) in the landfill which correlates with the reported depth of waste material to be between 5-10m which was obtained at the preliminary investigation stage from local knowledge. However it was not possible to determine the exact extent of the waste body as the excavator could only reach a maximum dept of 3.7m. This will be clarified when drilling borewells as part of the intrusive investigation and from the geophysical surveys proposed to be undertaken on site.

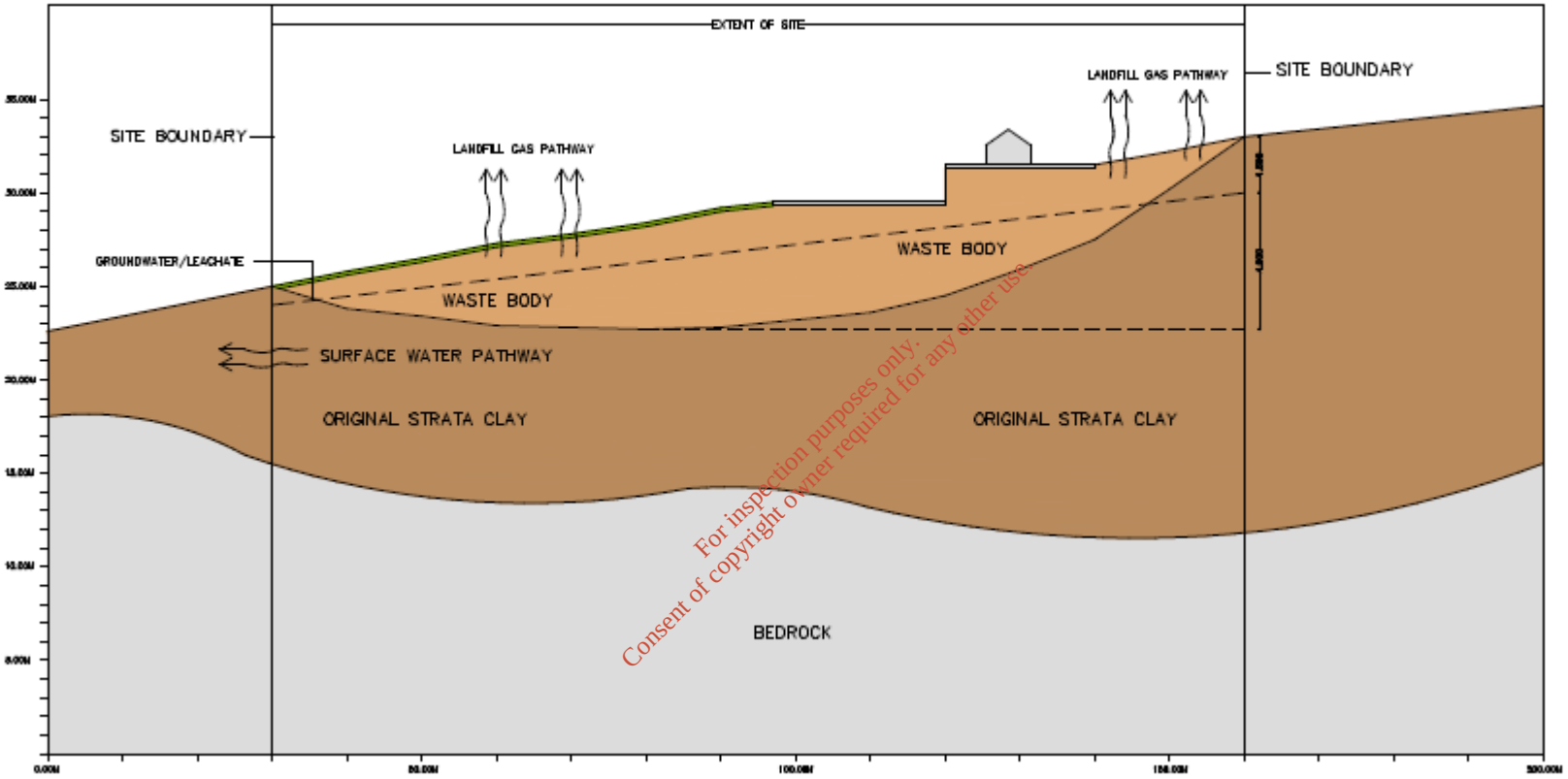
In addition, the revised model showed that the landfill gas potential from the landfill is minimal and no methane gas was detected in any of the trial pits (TP1-7). The revised conceptual site model determines that the groundwater/leachate depth appears to be in region of 1.5 to 2 meters and is located within the waste body.

The two Conceptual Site Models are shown overleaf.

FORMER LANDFILL SITE - TOWNSPARK EAST, LISMORE - CONCEPTUAL SITE MODEL - TIER ONE RISK ASSESSMENT



FORMER LANDFILL SITE - TOWNSPARK EAST, LISMORE - CONCEPTUAL SITE MODEL EXPLORATORY RISK ASSESSMENT



4.0 Conclusions & Recommendations:

4.1 Conclusions

The exploratory investigation provides significant information in relation to possible environmental pollution to potential receptors from the historic landfill located on lands at Townspark East, Lismore, Co. Waterford. The Tier 1 risk assessment for the said lands classified the historic landfill as a *Class C – Low Risk site.* Therefore, the risk assessment linkages (source-pathway-receptor) highlighted that there was possibly minimal impact resulting from the presence of the historic landfill. This risk assessment was compiled using the "Code of Practice Environmental Risk Assessment for Unregulated Waste Disposal Sites (COP)" issued by the EPA in April 2007.

The waste material is covered by a layer of topsoil ranging from approximately 300 – 600mm in depth; this sandy clay/gravelly clay layer was underlain by waste material which range in thickness from 0.3m (TP-4) to 3.7m (TP-4). The waste material was characterised by Municipal Solid Waste and fill material.

Surface water samples were taken from the River Owbeg which is located approximately 120m south from the historic landfill. Surface water results received from the ELS laboratories highlight that it appears there may be no direct connection of leachate migration to the River Owbeg. There was no measureable effect within these results.

Landfill gas monitoring was undertaken during the exploratory investigation. During the excavations of each of the trial pits, landfill gas monitoring was carried out using a gas meter. Each trial pit recorded 0% for methane gas presence.

The groundwater monitoring results from the natural groundwater well/spring 'Holy Well' indicate that there is no direct connection of contamination from the historic landfill as results for Ammonia, Manganese and Iron were low.

4.2 Recommendations

Waterford County Council recommends that a main Tier 2 site investigation including a detailed risk assessment be initiated on the historic landfill located at Townspark East, Lismore, Co. Waterford. This detailed site investigation should primarily focus on the potential risk of leachate migration to surface water (River Owbeg) and groundwater. Also further gas monitoring within and outside the landfill would be beneficial. Taking on board the guidance set out in the *EPA Code of Practice* and the M*atrix Guidance for Preliminary & Exploratory Investigation for all Unregulated Waste Disposal Sites*, the following works are proposed:

4.2.1 Geophysical Survey

A Geophysical Survey is proposed to be carried out to locate various subsurface features and geological layers that may be present including buried waste/debris, soil and bedrock types.

It is proposed to use conductivity and resistivity geophysical methods across the site. Conductivity survey shall be used to establish the extent of the waste body and possibly highlight any buried metal material. Resistivity survey shall be used to provide information on the thickness of waste and identify areas of possible leachate.

4.2.2 Groundwater Boreholes

It is proposed that cable percussion boring (*shell & auger drilling*) shall be undertaken for the installation of the 3 no. groundwater monitoring boreholes. See Appendix B for proposed boreholes locations. The drilling works will be supervised and logged by a competent person with suitable technical qualifications. This intrusive site investigation will involve taking and analysing of soil & groundwater to further determine the extent of any contamination which may potentially be present.

4.2.3 Leachate Borehole

It is proposed that cable percussion boring (*shell & auger drilling*) shall be undertaken for the installation of the 2 no. leachate monitoring borehole. The drilling works will be supervised and logged by a competent person with suitable technical qualifications. This intrusive site investigation will involve taking and analysing of soil & groundwater to further determine the extent of any contamination which may potentially be present.

It is proposed that a gas tap shall be placed on 2 no. leachate borehole located within the landfill. The landfill gas levels in the wells should be monitored weekly intervals over a suitable timeframe. The monitoring will include methane, carbon dioxide and hydrogen sulphide pressure and flow rates.

4.2.4 Laboratory Analysis

Groundwater samples be to collected and analysed for the core parameters as stated in the Interim Guideline Values published by the EPA. The suite of parameters for groundwater will include the following: faecal coliforms, total coliforms, electrical conductivity, temperature, total organic carbon, colour, pH, alkalinity, ammonia, bicarbonate, carbonate, chloride, dissolved oxygen, hardness, nitrate, nitrite, orthophosphate, sulphate, aluminium, calcium, iron, magnesium, manganese, potassium, sodium, arsenic, boron, cadmium, chromium, copper, mercury, nickel, zinc, total oxidised nitrogen, TPH and diesel range organics.

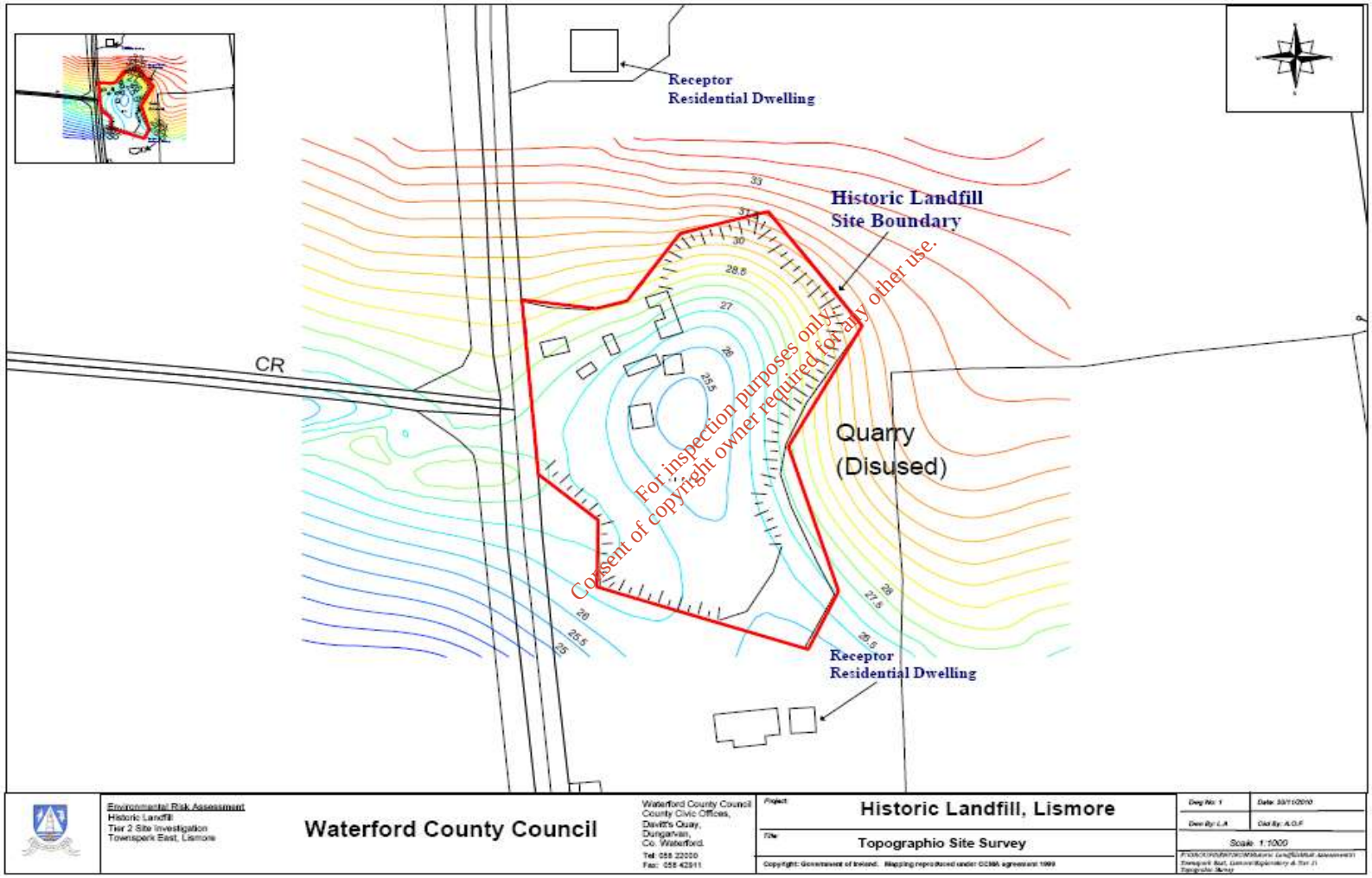
Base layer soil samples to be collected and analysed using "leachability testing" which will provide information to assess the potential for contaminated soils and material in and around the waste body to 'leach' contaminants to the surrounding environment. It is proposed to use the NRA test for this analysis. Soil samples will also be analysed using permeability and strength tests.

4.2.5 Ecological Assessment

Screening for an Appropriate Assessment is also recommended to be carried out which will be undertaken by Waterford County Council's Heritage Officer.

Appendix A

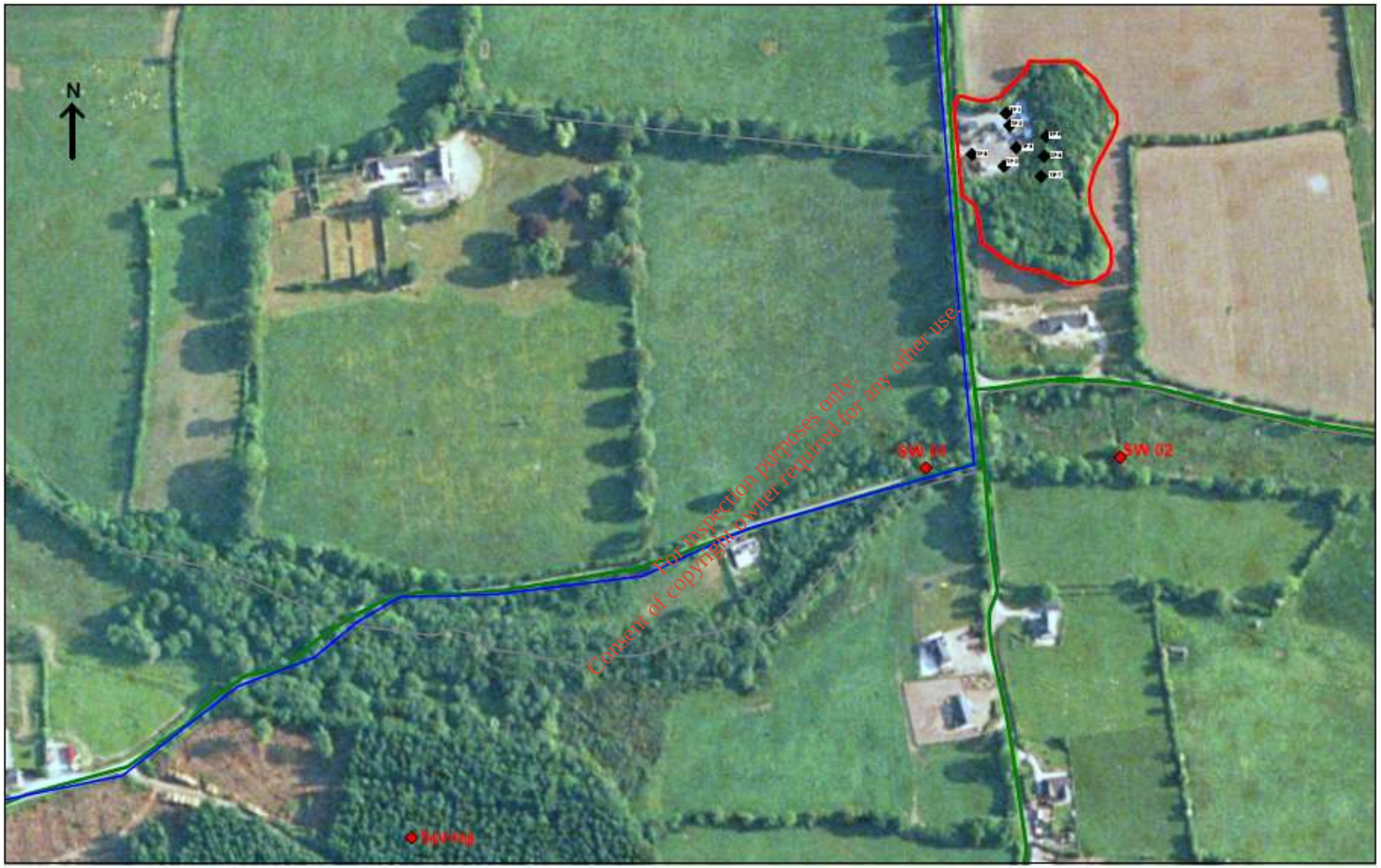
(Topographic Survey)



Appendix B

(Trial pits, surface water, groundwater & gas monitoring locations)

Environment Section Aoife O'Flaherty Executive Engineer	**Waterford County Council** **Historic Landfill Lismore**	Waterford County Council, Davitt's Quay, Dungarvan, Co. Waterford.	Map Title Trial Pit Locations



Environment Section Aoife O'Flaherty Executive Engineer	**Waterford County Council** **Historic Landfill Lismore**	Waterford County Council, Davitt's Quay, Dungarvan, Co. Waterford.	**Map Title** **Surface Water Sampling Locations**

Environment Section Aoife O'Flaherty Executive Engineer	**Waterford County Council** **Historic Landfill Lismore**	Waterford County Council, Davitt's Quay, Dungarvan, Co. Waterford.	Map Title Bore Hole Locations

Appendix C

(Geotechnical Logs per Trial Pits)

Waterford County Council Environment Section		Trial Pit No. 1
Project **Lismore Historic Landfill** **Exploratory Investigation**	**Co- Ordinates** **IX 04549** **ITM 96465**	**Date** **2nd September 2010**
Location **Townspark East, Lismore**	**Dimensions** **1.7x3.9x1.5m**	**Method/ Plant** **12 Tonne 360° Hitachi Excavator**

Samples & In Situ Testing					Strata Description
Depth (m)	**Type/ Sample**	**Depth (m)**	**Water (m)**	**Legend**	
		0.25		-------- -------- --------	**Concrete Pad (0.0 – 0.25m)**
0.5				~ ~ ~ -------- ~ ~ ~~ -------	
1.0				~ ~ ~ -------- ~ ~ ~~ -------	**Mainly bedrock and sandy soil. Edge of waste body visible.**
1.5		1.5		~ ~ ~ -------	**End of trial hole**
2.0				_-_-_-_- _-_-	**Original strata clay…….**
2.5					
3.0					
Remarks:					**Logged By: Aoife O'Flaherty E.E.** **Liam Ahearne A.E.** **Daniel Devine**

Waterford County Council Environment Section		Trial Pit No. 2
Project **Lismore Historic Landfill** **Exploratory Investigation**	**Co- Ordinates** **IX 04479** **ITM 96397**	**Date** **2nd September 2010**
Location **Townspark East, Lismore**	**Dimensions** **3.7x2.1x3.1m**	**Method/ Plant** **12 Tonne 360° Hitachi Excavator**

Samples & In Situ Testing					Strata Description
Depth (m)	**Type/ Sample**	**Depth (m)**	**Water (m)**	**Legend**	
		0.3		-------- --------	**Concrete Pad (0.0 – 0.3m)**
0.5		0.6		~ ~ ~ --------	**Fill Material** **Start of Waste**
1.0				~ ~ ~ ------- ~ ~ ~ --------	
1.5				~ ~ ~ -------- ~ ~ ~	**(Fill Material Consisting of Domestic Waste, Plastic, Steel & Glass Bottles)**
2.0				~ ~ ~~ ------- ~ ~ ~~	
2.5		2.5		------- ~ ~ ~ --------	**End of Waste**
3.0		3.1		~ ~ ~ --------	**Underlying material** **End of trial hole**
				-_-_-_- -_-_-_-	
Remarks:					**Logged By: Aoife O'Flaherty E.E.** **Liam Ahearne A.E.** **Daniel Devine**

Waterford County Council Environment Section		Trial Pit No. 3
Project **Lismore Historic Landfill** **Exploratory Investigation**	**Co- Ordinates** **IX 04513** **ITM 96454**	**Date** **2nd September 2010**
Location **Townspark East, Lismore**	**Dimensions** **4.3x1.7x3.18m**	**Method/ Plant** **12 Tonne 360° Hitachi Excavator**

Samples & In Situ Testing					Strata Description
Depth (m)	**Type/ Sample**	**Depth (m)**	**Water (m)**	**Legend**	
		0.15		--------	**Tarmac Surface (0.0 – 0.15m)**
0.5		**0.63**		~ ~ ~ -------- ~ ~ ~ ------- ~ ~ ~ -------	**Hardcore Fill Material** **Start of Waste**
1.0		**1.0**	**1.0**	~ ~ ~ -------- ~ ~ ~ ------- ~ ~ ~ -------	**Leachate: 1.0m**
1.5				~ ~ ~ ------- ~ ~ ~~ ------- ~ ~ ~~ -------	**(Waste consists of Steel, Timber, Plastic and Construction and Demolition material)**
2.0				~ ~ ~ -------- ~ ~ ~~ ------- ~ ~ ~ --------	
2.5		**2.65**		~ ~ ~~ ------- ~ ~ ~ ------- ~ ~ ~~ -------	**End of Waste**
3.0		**3.18**		~ ~ ~ ------- ~ ~ ~	**Underlying material** **End of trial hole**
				_-_-_-_- _-_-	
Remarks:					**Logged By: Aoife O'Flaherty E.E.** **Liam Ahearne A.E.** **Daniel Devine**

Waterford County Council Environment Section		Trial Pit No. 4
Project **Lismore Historic Landfill** **Exploratory Investigation**	**Co- Ordinates** **IX 04527** **ITM 96468**	**Date** **2nd September 2010**
Location **Townspark East, Lismore**	**Dimensions** **1.5x2.5x3.7m**	**Method/ Plant** **12 Tonne 360° Hitachi Excavator**

Samples & In Situ Testing					Strata Description
Depth (m)	**Type/ Sample**	**Depth (m)**	**Water (m)**	**Legend**	
		0.3		-------- --------	**Topsoil (0.0 – 0.3m)**
0.5				~ ~ ~ -------- ~ ~ ~ ------- ~ ~ ~ ------- ~ ~ ~ -------- ~ ~ ~ -------- ~ ~ ~ ------- ~ ~ ~~ ------- ~ ~ ~~ ------- ~ ~ ~ -------- ~ ~ ~ -------- ~ ~ ~ -------- ~ ~ ~	**Start of Waste**
1.0					
1.5					
2.0					**(All Domestic Waste, ELV's and Tyres)**
2.5					
3.0					
		3.7		--------	**End of trial hole**
				-_-_-_- -_-_-_-	
Remarks:					**Logged By: Aoife O'Flaherty E.E.** **Liam Ahearne A.E.** **Daniel Devine**

Waterford County Council Environment Section		Trial Pit No. 5
Project **Lismore Historic Landfill** **Exploratory Investigation**	**Co- Ordinates** **IX 04513** **ITM 96485**	**Date** **2nd September 2010**
Location **Townspark East, Lismore**	**Dimensions** **1.5x2.5x2.5m**	**Method/ Plant** **12 Tonne 360° Hitachi Excavator**

Samples & In Situ Testing					Strata Description
Depth (m)	**Type/ Sample**	**Depth (m)**	**Water (m)**	**Legend**	
0.5		**0.5**		-------- -------- -------- -------- --------	**Topsoil (0.0 – 0.5m)**
1.0				~ ~ ~ -------- ~ ~ ~	**Start of Waste**
1.5				------- ~ ~ ~ -------	**(All Domestic Waste – Largely consisting of Plastic and Timber)**
2.0				~ ~ ~~ ------- ~ ~ ~	
2.5		**2.5**	**2.5**	-------- ~ ~ ~~ ------- ~ ~ ~~	**End of Trial Hole**
3.0				-_-_-_- -_-_-_- -_-_-_-	**Leachate: 2.5m**
Remarks:					**Logged By: Aoife O'Flaherty E.E.** **Liam Ahearne A.E.** **Daniel Devine**

Waterford County Council Environment Section		Trial Pit No. 6
Project **Lismore Historic Landfill** **Exploratory Investigation**	**Co- Ordinates** **IX 04547** **ITM 96469**	**Date** **2nd September 2010**
Location **Townspark East, Lismore**	**Dimensions** **1.5x4.0x3.0m**	**Method/ Plant** **12 Tonne 360° Hitachi Excavator**

Samples & In Situ Testing					Strata Description
Depth (m)	**Type/ Sample**	**Depth (m)**	**Water (m)**	**Legend**	
		0.3		-------- --------	**Topsoil (0.0 – 0.3m)**
0.5				~ ~ ~ -------- ~ ~ ~	**Start of Waste**
1.0				------- ~ ~ ~ ------- ~ ~ ~	
1.5				-------- ~ ~ ~ -------- ~ ~ ~	
2.0				------- ~ ~ ~~ ------- ~ ~ ~~	**(All Domestic Waste)**
2.5				------- ~ ~ ~ -------- ~ ~ ~	
3.0		2.8		--------	**End of trial hole**
				-_-_-_- -_-_-_- -_-_-_-	
Remarks:					**Logged By: Aoife O'Flaherty E.E.** **Liam Ahearne A.E.** **Daniel Devine**

Waterford County Council Environment Section		Trial Pit No. 7
Project **Lismore Historic Landfill** **Exploratory Investigation**	**Co- Ordinates** **IX 04552** **ITM 96458**	**Date** **2nd September 2010**
Location **Townspark East, Lismore**	**Dimensions** **3.5x1.5x3.0m**	**Method/ Plant** **12 Tonne 360° Hitachi Excavator**

Samples & In Situ Testing					Strata Description
Depth (m)	**Type/ Sample**	**Depth (m)**	**Water (m)**	**Legend**	
0.5		**0.6**		-------- -------- -------- -------- -------- --------	**Topsoil (0.0 – 0.6m)**
1.0				~ ~ ~ -------- ~ ~ ~ ------- ~ ~ ------- ~ ~ ~ ------- ~ ~ ~~ ------- ~ ~ ~ -------- ~ ~ ~~ ------- ~ ~ ~~ ------- ~ ~ ~~	**Start of Waste** **(All Domestic Waste – mainly plastic)**
1.5					
2.0					
2.5		**2.5**			
3.0		**3.0**			**End of Trial Hole**
				-_-_-_- -_-_-_-	
Remarks:					**Logged By: Aoife O'Flaherty E.E.** **Liam Ahearne A.E.** **Daniel Devine**

2.2 — **Leachate: 2.2m**

Waterford County Council Environment Section		Trial Pit No. 8
Project **Lismore Historic Landfill** **Exploratory Investigation**	**Co- Ordinates** **IX 04501** **ITM 96452**	**Date** **2nd September 2010**
Location **Townspark East, Lismore**	**Dimensions** **N/A**	**Method/ Plant** **12 Tonne 360° Hitachi Excavator**

Samples & In Situ Testing					Strata Description
Depth (m)	**Type/ Sample**	**Depth (m)**	**Water (m)**	**Legend**	
				-_-_-_- -_-_-_- -_-_-_-	**300 mm concrete pad** **Natural Bedrock**
0.5					
1.0					
1.5					
2.0					
2.5					
3.0					
Remarks:					**Logged By:** **Aoife O'Flaherty E.E.** **Liam Ahearne A.E.** **Daniel Devine**

Appendix D

(Laboratory Results)

REPORT OF TESTING OF LEACHATE AND SOLID WASTE AT LISMORE LANDFILL

Method.

A leachate sample was taken from Trial Hole No. 5 at the Lismore landfill site on 2/9/10. Additionally, Soil/Waste samples were taken from three Trial Holes (Nos. 1, 3 and 7).

The solid samples were subjected to the UK National Rivers Authority (NRA) leachability test. This is a test that uses distilled water being shaken with the waste material at a liquid:solid ratio of 10:1 for 24 hrs. The resulting liquid portion is filtered and tested for a range of relevant parameters.

Results of testing of the site leachate sample and the three NRA leachate samples are presented in table below and attached appendix. The results are compared to **threshold groundwater values** under the European Communities Environmental Objectives (Groundwater) Regulations 2010, S.I. No. 9/2010. "Threshold values" have been established for pollutants that are causing a risk to groundwater bodies. Exceedance of a relevant threshold value at a representative monitoring point triggers further investigation to confirm whether the criteria for poor groundwater chemical status are being met.

Results

Table 1. Results of analysis of site leachate and NRA Test leachate from solid samples from trial holes at Lismore landfill.

			Results			
Parameter Name	Units	Threshold Values for Groundwater	Leachate from Trial Hole 5	NRA leachate test on soil from Trial Pit 1	NRA leachate test on soil from Trial Pit 3	NRA leachate test on soil from Trial Pit 7
Cyanide	mg/l	0.0375	<0.05	<0.5	<0.5	<0.5
Sulphates	mg/l	187.5	NT	290	450	250
Arsenic (dissolved)	ug/l	7.5	31	12	43	20
Boron	ug/l	750	1000	200	900	800
Cadmium (dissolved)	ug/l	3.75	0.14	0.2	<0.2	<0.2
Chromium (dissolved)	ug/l	37.5	800	30	30	20
Copper (dissolved)	ug/l	1500	14	5	10	13
Iron	ug/l	N/A	360	1200	1900	7600
Lead (dissolved)	ug/l	18.75	3.2	<3	14	11
Manganese (dissolved)	ug/l	N/A	14000	NT	NT	NT
Mercury (dissolved)	ug/l	0.75	0.4	<0.5	<0.5	<0.5
Nickel (dissolved)	ug/l	15	170	<10	10	20
PAHs	ug/l	0.075	5	<0.1	<0.1	<0.1
Phenols	ug/l	0.1	<0.5	<5	<5	<5

Notes

1. Under the European Communities Environmental Objectives (Groundwater) Regulations 2010, S.I. No. 9/2010, "Threshold values" have been established for pollutants that are causing a risk to groundwater bodies. Exceedance of a relevant threshold value at a representative monitoring point triggers further investigation to confirm whether the criteria for poor groundwater chemical status are being met.

Discussion of results

The site leachate sample was:

- **compliant** with threshold groundwater values for cyanide, cadmium, copper, lead, mercury and phenols.
- **Slightly in exceedance** of threshold groundwater values for arsenic and boron.
- **Significantly in exceedance** of threshold groundwater values for chromium, nickel and PAH.

The NRA leachate samples were:

- **compliant** with threshold groundwater values for cyanide, cadmium, chromium, copper, lead, mercury, PAH and phenols.

- **Slightly in exceedance** of threshold groundwater values for sulphate, arsenic, nickel and boron.

Paul Carroll Dec 13th 2011

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Sample ID: 91093

Description: Leachate sample No. 1 taken 02.09.10 from test hole No. 5

Ref No:

ID	Test	SOP	Results
91093	Dissolved Lead as Pb mg/l	Subcontracted	0.0032
91093	Dibenzo(ah)Anthracene ug/l	Subcontracted	0.03
91093	Chrysene ug/l	Subcontracted	0.16
91093	Benzo(b/k)Fluoranthene ug/l	Subcontracted	0.30
91093	Benzo a pyrene ug/l	Subcontracted	0.17
91093	Anthracene ug/l	Subcontracted	0.15
91093	Dissolved Nickel as Ni mg/l	Subcontracted	0.170
91093	Dissolved Mercury as Hg mg/l	Subcontracted	0.00040
91093	Dissolved Arsenic as As mg/l	Subcontracted	0.031
91093	Magnesium as Mg, mg/l	STM-C-23.1.0	78
91093	Indeno(123-cd)Pyrene ug/l	Subcontracted	0.11
91093	Iron as Fe mg/l	Subcontracted	0.36
91093	Fluoride as F, mg/l	Subcontracted	0.07
91093	Cyanide mg/l	Subcontracted	<0.05
91093	Dissolved Copper as Cu mg/l	Subcontracted	0.014
91093	Dissolved Chromium as Cr mg/l	Subcontracted	0.800
91093	Calcium as Ca, mg/l	STM-C-22.1.0	310
91093	Dissolved Cadmium as Cd mg/l	Subcontracted	0.00014
91093	Boron as B mg/l	Subcontracted	1.0
91093	Dissolved Manganese as Mn mg/l	Subcontracted	14.00
91093	Sodium as Na, mg/l	STM-C-33.1.0	87
91093	BOD, mg/l	STM-C-10.2.0	insuf. Sample

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☐	91093	Orthophosphate as PO4, mg/l	STM-C-20.2.0	insuf. Sample
☐	91093	Sulphates as SO4, mg/l	STM-C-18.2.0	insuf. Sample
☐	91093	Total Oxidised Nitrogen, mg/l	STM-C-30.1.0	insuf. Sample
☐	91093	Ammonia as NH3-N, mg/l	STM-C-7.2.04	insuf. Sample
☐	91093	Conductivity, uS/cm @ 20°C	STM-C-4.1.00	insuf. Sample
☐	91093	pH value	STM-C-3.1.00	insuf. Sample
☐	91093	Acenaphthene ug/l	Subcontracted	0.75
☐	91093	Fluoranthene ug/l	Subcontracted	0.54
☐	91093	Total Phenols as C6H5OH ug/l	Subcontracted	<0.5
☐	91093	Naphthalene, ug/l	Subcontracted	0.83
☐	91093	Potassium as K, mg/l	STM-C-32.1.0	120
☐	91093	Benzo(ghi)perylene ug/l	Subcontracted	0.17
☐	91093	Benzo(a)Anthrancene ug/l	Subcontracted	0.15
☐	91093	Fluorene ug/l	Subcontracted	0.41
☐	91093	Pyrene ug/l	Subcontracted	0.47
☐	91093	Phenanthrene ug/l	Subcontracted	0.67
☐	91093	Acenaphthylene ug/l	Subcontracted	0.05
☐	91093	COD mg/l	STM-C-11.2.0	insuf. Sample
☐	91093	Polyaromatic Hydrocarbons (PAH's) mg/l *	Subcontracted	5.0

* PAH should be just units as per individual results - pc.

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Report Authorised By: Peter O'Byrne Peter O'Byrne Chem. Lab. Manager

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Sample ID: 91095

Description: Lismore Soil sample Trial Pit 1 02/09/10

Ref No:

ID	Test	SOP	Results
91095	Dissolved Mercury as Hg mg/l	Subcontracted	<0.0005
91095	Dissolved Zinc as Zn mg/l	Subcontracted	0.03
91095	Polyaromatic Hydrocarbons (PAH's) mg/l *	Subcontracted	<0.1
91095	Sulphur (Free) mg/l	Subcontracted	<100
91095	Sulphide mg/l	Subcontracted	<0.5
91095	Sulphates as SO4 mg/l	STM-C-18.2.0	290
91095	Selenium as Se mg/l	Subcontracted	0.051
91095	Dissolved Arsenic as As mg/l	Subcontracted	0.012
91095	Dissolved Nickel as Ni mg/l	Subcontracted	<0.01
91095	Phenanthrene ug/l	Subcontracted	<0.1
91095	Dissolved Lead as Pb mg/l	Subcontracted	<0.003
91095	Iron as Fe mg/l	Subcontracted	1.2
91095	Cyanide mg/l	Subcontracted	<0.5
91095	Dissolved Copper as Cu mg/l	Subcontracted	0.005
91095	Dissolved Chromium as Cr mg/l	Subcontracted	0.03
91095	Dissolved Cadmium as Cd mg/l	Subcontracted	0.0002
91095	Boron as B mg/l	Subcontracted	0.2
91095	Phenols, ug/l	Subcontracted	<5
91095	Benzo(b/k)Fluoranthene ug/l	Subcontracted	<0.1
91095	pH value	STM-C-3.1.00	insuf. Sample
91095	Conductivity, uS/cm @ 20°C	STM-C-4.1.00	insuf. Sample
91095	Chloride as Cl, mg/L	STM-C-5.2.07	insuf. Sample

* PAH should be µg/L as per individual results -PC

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☐	91095	COD mg/l	STM-C-[illegible].2.0	insuf. Sample
☐	91095	Fluorene ug/l	Subcontracted	<0.1
☐	91095	Fluoranthene ug/l	Subcontracted	<0.1
☐	91095	Dibenzo(ah)Anthracene ug/l	Subcontracted	<0.1
☐	91095	Indeno(123-cd)Pyrene ug/l	Subcontracted	<0.1
☐	91095	Benzo(ghi)perylene ug/l	Subcontracted	<0.1
☐	91095	Naphthalene, ug/l	Subcontracted	<0.1
☐	91095	Benzo a pyrene ug/l	Subcontracted	<0.1
☐	91095	Benzo(a)Anthrancene ug/l	Subcontracted	<0.1
☐	91095	Anthracene ug/l	Subcontracted	<0.1
☐	91095	Acenaphthylene ug/l	Subcontracted	<0.1
☐	91095	Acenaphthene ug/l	Subcontracted	<0.1
☐	91095	Pyrene ug/l	Subcontracted	<0.1
☐	91095	Ammonia as NH3-N, mg/l	STM-C-7.2.04	insuf. Sample
☐	91095	Chrysene ug/l	Subcontracted	<0.1

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Sample ID: 91094

Description: Lismore Soil sample Trial Hole 3 02/09/10

Ref No:

ID	Test	SOP	Results
91094	Indeno(123-cd)Pyrene ug/l	Subcontracted	<0.1
91094	Dissolved Arsenic as As mg/l	Subcontracted	0.043
91094	Anthracene ug/l	Subcontracted	<0.1
91094	Acenaphthylene ug/l	Subcontracted	<0.1
91094	Acenaphthene ug/l	Subcontracted	<0.1
91094	Dissolved Zinc as Zn mg/l	Subcontracted	0.05
91094	Pyrene ug/l	Subcontracted	<0.1
91094	Benzo(a)Anthracene ug/l	Subcontracted	<0.1
91094	Naphthalene, ug/l	Subcontracted	<0.1
91094	Dissolved Chromium as Cr mg/l	Subcontracted	0.03
91094	Fluorene ug/l	Subcontracted	<0.1
91094	Fluoranthene ug/l	Subcontracted	<0.1
91094	Dibenzo(ah)Anthracene ug/l	Subcontracted	<0.1
91094	Chrysene ug/l	Subcontracted	<0.1
91094	Benzo(ghi)perylene ug/l	Subcontracted	<0.1
91094	Benzo(b/k)Fluoranthene ug/l	Subcontracted	<0.1
91094	Benzo a pyrene ug/l	Subcontracted	<0.1
91094	Phenanthrene ug/l	Subcontracted	<0.1
91094	Phenols, ug/l	Subcontracted	<5
91094	pH value	STM-C-3.1.00	insuf. Sample
91094	Conductivity, uS/cm @ 20°C	STM-C-4.1.00	insuf. Sample
91094	Chloride as Cl, mg/L	STM-C-5.2.07	insuf. Sample

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☐	91094	COD mg/l	STM-C-11.2.0	insuf. Sample
☐	91094	Ammonia as NH3-N, mg/l	STM-C-7.2.04	insuf. Sample
☐	91094	Sulphur (Free) mg/l	Subcontracted	<100
☐	91094	Sulphide mg/l	Subcontracted	<0.5
☐	91094	Boron as B mg/l	Subcontracted	0.9
☐	91094	Selenium as Se mg/l	Subcontracted	0.010
☐	91094	Dissolved Cadmium as Cd mg/l	Subcontracted	<0.0002
☐	91094	Dissolved Nickel as Ni mg/l	Subcontracted	0.01
☐	91094	Dissolved Mercury as Hg mg/l	Subcontracted	<0.0005
☐	91094	Dissolved Lead as Pb mg/l	Subcontracted	0.014
☐	91094	Iron as Fe mg/l	Subcontracted	1.9
☐	91094	Cyanide mg/l	Subcontracted	<0.5
☐	91094	Dissolved Copper as Cu mg/l	Subcontracted	0.010
☐	91094	Polyaromatic Hydrocarbons (PAH's) mg/l *	Subcontracted	<0.1
☐	91094	Sulphates as SO4, mg/l	STM-C-18.2.0	450

* PAH should be µg/l as per individual results -PC.

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Sample ID: 91096

Description: Lismore Soil sample Trial Pit 7 02/09/10

Ref No:

ID	Test	SOP	Results
91096	Dissolved Mercury as Hg mg/l	Subcontracted	<0.0005
91096	Dissolved Zinc as Zn mg/l	Subcontracted	0.26
91096	Polyaromatic Hydrocarbons (PAH)* mg/l *	Subcontracted	<0.1
91096	Sulphur (Free) mg/l	Subcontracted	<100
91096	Sulphide mg/l	Subcontracted	<0.5
91096	Sulphates as SO4, mg/l	STM-C-18.2.0	250
91096	Selenium as Se mg/l	Subcontracted	<0.005
91096	Dissolved Arsenic as As mg/l	Subcontracted	0.020
91096	Dissolved Nickel as Ni mg/l	Subcontracted	0.02
91096	Anthracene ug/l	Subcontracted	<0.1
91096	Dissolved Lead as Pb mg/l	Subcontracted	0.011
91096	Iron as Fe mg/l	Subcontracted	7.6
91096	Cyanide mg/l	Subcontracted	<0.5
91096	Dissolved Copper as Cu mg/l	Subcontracted	0.013
91096	Dissolved Chromium as Cr mg/l	Subcontracted	0.02
91096	Dissolved Cadmium as Cd mg/l	Subcontracted	<0.0002
91096	Boron as B mg/l	Subcontracted	0.8
91096	Phenols, ug/l	Subcontracted	<5
91096	Fluoranthene ug/l	Subcontracted	<0.1
91096	pH value	STM-C-3.1.00	insuf. Sample
91096	Conductivity, uS/cm @ 20°C	STM-C-4.1.00	insuf. Sample
91096	Chloride as Cl, mg/L	STM-C-5.2.07	insuf. Sample

* PAH should be mg/L
as per individual results - PC

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☐	91096	COD mg/l	STM-C-11.2.04	insuf. Sample
☐	91096	Pyrene ug/l	Subcontracted	<0.1
☐	91096	Phenanthrene ug/l	Subcontracted	<0.1
☐	91096	Naphthalene, ug/l	Subcontracted	<0.1
☐	91096	Acenaphthene ug/l	Subcontracted	<0.1
☐	91096	Fluorene ug/l	Subcontracted	<0.1
☐	91096	Acenaphthylene ug/l	Subcontracted	<0.1
☐	91096	Dibenzo(ah)Anthracene ug/l	Subcontracted	<0.1
☐	91096	Chrysene ug/l	Subcontracted	<0.1
☐	91096	Benzo(ghi)perylene ug/l	Subcontracted	<0.1
☐	91096	Benzo(b/k)Fluoranthene ug/l	Subcontracted	<0.1
☐	91096	Benzo a pyrene ug/l	Subcontracted	<0.1
☐	91096	Benzo(a)Anthrancene ug/l	Subcontracted	<0.1
☐	91096	Ammonia as NH3-N, mg/l	STM-C-7.2.04	insuf. Sample
☐	91096	Indeno(123-cd)Pyrene ug/l	Subcontracted	<0.1

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KILMEADEN,
COUNTY WATERFORD
PHONE: 051-384393
FAX: 051-384238

LABORATORY REPORT: SURFACE & GROUND WATERS

Old Lismore Landfill Water Testing

INTRODUCTION

Samples were taken on 18/11/10 of surface water (upstream and downstream) and a nearby groundwater adjacent to a closed landfill at Lismore in order to determine possible impact on water quality. Results of physicochemical tests are presented in table below. [Refer to main investigation report for details and locations of landfill and water sampling sites.]

RESULTS –

Sample location	*Surface water upstream old landfill, Lismore*	Surface water downstream old landfill, Lismore	Groundwater near old landfill, Lismore
Sampling date	18/11/10	18/11/10	18/11/10
Sampler	L Ahearne	L Ahearne	L Ahearne
pH	6.90	7.01	6.02
Ammonia mg/l NH4	0.02	0.01	<0.01
Phosphate mg/l P	0.04	0.04	<0.01
Chloride mg/l	17.9	17.95	21.7
Nitrate mg/l N	2.5	2.8	4.4
BOD mg/l	<1	<1	<1
COD mg/l	9	12	2

COMMENTS

Water quality was satisfactory in surface and groundwater samples. There was no measurable effect from the landfill.

Signed: *Paul Carroll*

Date: 17/12/10

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Acorn Business Campus,
Mahon Industrial Park,
Blackrock,
CorkTel: 021-4536141
Fax: 021-4536149

Analysis Report

Attention:		**Report No:**	19905
Paul Carroll			
Waterford County Council		**Date of receipt:**	26/11/2010
Water Laboratory		**Date Started:**	01/12/2010
Kilmeaden			
County Waterford			
Fax No:		**Issue Date:**	17/12/2010
Tel No:	051-384393	**Page**	1 **of** 4
	086-8210414		
PO Number:	400117608	**Delivery Mode**	Courier
Sample Type	Drinking Water	**No. of Samples**	3
Condition on receipt	Satisfactory	**Client Ref:**	Below

QN2314 Drinking Water-Metals,VOC,PAH

SIGNED **(17/12/2010)**

Technical Manager (or Deputy)
Brendan Murray

Report Number 19905 Page 2 of 4

Method		ICPMS								GCMS		Purge and Trap			
Method Number		EM130								EO129		EO025			
Parameter		As	Cd	Cr	Hg	Ni	Pb	Sb	Cu	Benzo(a) Pyrene	PAH	1,2-diCl ethane	Benzene	Tetra- TriCl ethene	TPH Sum
Units		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Limit of Detection		0.2	0.1	1.0	0.20	0.5	0.3	0.1	0.003	0.003	0.01	0.1	0.1	0.2	5.0
Parametric Value		10.0	5.0	50.0	1.00	20.0	25	5.0	2.000	0.01	0.10	3.0	1.0	0.2	100
Date Testing Initiated		03/12								28/11		01/12			
ELS Ref	Client Ref														
19905-1	Samshire Upstream (Bottles reference: 1)	0.80	0.2	<1.0	<0.2	0.9	0.4	<0.1	<0.003	<0.003	<0.01	<0.1	<0.1	<0.2	<5.0
19905-2	Samshire Downstream(Bottles reference: 2)	0.90	0.2	<1.0	<0.2	1.4	0.5	<0.1	<0.003	<0.003	<0.01	<0.1	<0.1	<0.2	<5.0
19905-3	Samshire Groundwater(Bottles reference: 3)	0.9	<0.1	<1.0	<0.2	0.6	0.3	<0.1	<0.003	<0.003	<0.01	<0.1	<0.1	<0.2	<5.0

NOTES
1 Sub-contract analysis denoted by: *
2 ND = Concentration was below the limit of detection

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Pesticides and PAH

PAH	Parametric Value	LOD	19905-1	19905-2	19905-3
Naphthalene	-	0.01	<0.01	<0.01	<0.01
Acenaphthylene	-	0.01	<0.01	<0.01	<0.01
Acenaphthene (Note 3)	-	0.01	<0.01	<0.01	<0.01
Fluorene	-	0.01	<0.01	<0.01	<0.01
Phenanthrene	-	0.01	<0.01	<0.01	<0.01
Anthracene	-	0.01	<0.01	<0.01	<0.01
Fluoranthene	-	0.01	<0.01	<0.01	<0.01
Pyrene	-	0.01	<0.01	<0.01	<0.01
Chrysene	-	0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	-	0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	-	0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	-	0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	-	0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene (Note 3)	-	0.01	<0.01	<0.01	<0.01
PAH (Sum of 4 above)	0.1	-	<0.01	<0.01	<0.01

NOTES
1. ND = Concentration was below the limit of detection
2. Limit of detection for some parameters updated arising from recent NATA audit
3. Result is non accredited due to QC Breach, retest not possible due to lack of sample

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Volatile Organic Compounds and THM's

No.	Analyte	Parametric Value (ug/l)	LOD (ug/l)	19763-1	19905-1	19905-2	19905-3
61	Bromoform	-	1.0	<1.0	<1.0	<1.0	<1.0
43	Bromodichloromethane	-	2.0	<2.0	<2.0	<2.0	<2.0
31	Trichloromethane/ Chloroform	-	1.0	<1.0	<1.0	<1.0	<1.0
53	Dibromochloromethane	-	1.0	<1.0	<1.0	<1.0	<1.0
	Total THM's	100	5.0	<5.0	<5.0	<5.0	<5.0
50	Tetrachloroethylene/ Tetrachloroethene	-	0.1	<0.1	<0.1	<0.1	<0.1
39	Trichloroethylene/ Trichloroethene	-	0.1	<0.1	<0.1	<0.1	<0.1

NOTES
1. ND = Concentration below limit of detectioon

Appendix E: Walkover Survey Checklist

INFORMATION	CHECKED	COMMENT
1. What is current Land Use?	Yes	Closed Civic Amenity Site
2. What are the neighbouring Land Uses?	Yes	Agricultural
3. What is the size of the site?	Yes	2 acres
4. What is the topography?	Yes	Falling down gradient from north to south
5. Are there potential	Yes	
receptors (if yes, give details)?		Yes
Houses		1 within 20-30m to south 1 within 50m to north 2within 100m to north 2 within 100m to wesst
Surface water features (if yes, give details	Yes	No
Any wetland or protected areas	Yes	No
Public Water Supplies	Yes	Yes
Private Wells	Yes	None in use
Services	Yes	ESB, Public Water Scheme running past site
Other buildings	Yes	Civic Amenity Office Building on site . No longer in use
Other	Yes	
	Yes	
6. Are there any potential sources of contamination (if yes, give details)?	Yes	Yes. Leachate & gas from waste body
Surface waste (if yes, what type?)	Yes	
	Yes	
7. *Are there any outfalls to surface water?* (If yes, are there discharges and what is the nature of the discharge?)	Yes	None from the site
8. Are there any signs of impact on the environment? (If yes, take photographic evidence)	Yes	No
Vegetation die off, bare ground	Yes	No
Leachate seepages	Yes	No

Odours	Yes	No
Litter	Yes	No
Gas bubbling through water	Yes	No
Signs of settlement, subsidence water logged areas	Yes	No
Drainage or hydraulic issues	Yes	No
9. Are there any indications of remedial measures? (Provide details)	Yes	
Capping	Yes	Yes 200-300 topsoil
Landfill gas collection	Yes	No
Leachate collection	Yes	No
	Yes	
10. Describe fences and security features (if any)	Yes	Security fence along entire perimeter. 2 locked gates at front of site.
Any other relevant information?		

Waterford County Council

Environmental Risk Assessment for Unregulated Waste Disposal Site

Tier 1

Desk Study on Closed Landfill:

Townspark East, Lismore

	Name	**Position**	**Date**
Prepared By	L Ahearn	Assistant Engineer	December 2008
Checked By	A O' Flaherty	Executive Engineer	December 2008
Approved by	G Hynes	Senior Engineer	December 2008

1.0 Lismore Landfill:

This closed landfill is located in the Townland of Townspark East, approximately 1km from Lismore town. The site is currently being operated as civic amenity site by Waterford County Council's Environment Section. This civic amenity site accepts waste such as domestic waste, recycling bags, glass, electronic goods, fluorescent tubes, waste cooking oils and garden waste. This civic amenity has being in operation since 1991.

The GPS co-ordinates of the site are 204,520 (x) & 96,400 (y). The lands on which the site is located are zoned for agricultural use/development (White Lands – to provide for the development of agriculture, to protect and improve rural amenity, and to distinguish general agricultural landuse). Residential zoning extends to 1.2km from the northern boundary of the site.

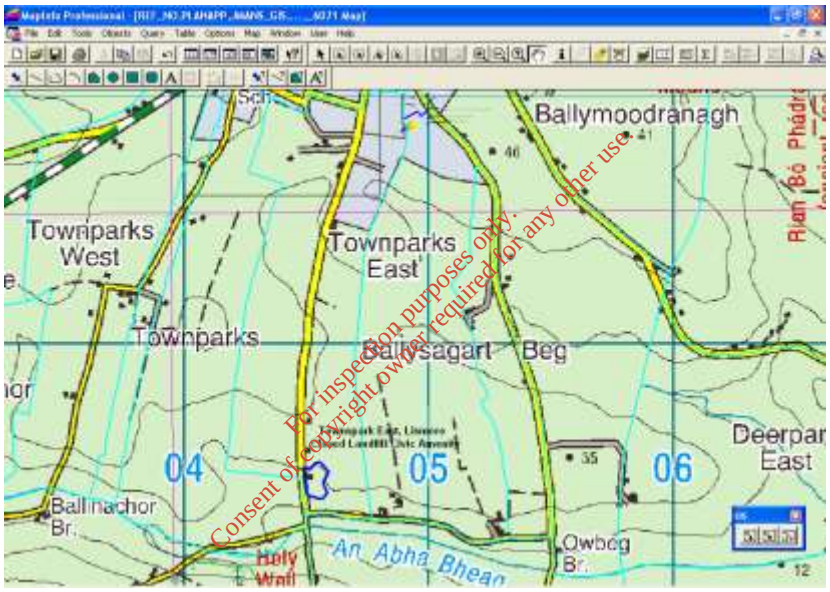


Figure 1: Site Location

The Lismore site was used as a municipal landfill site, and from local knowledge it was determined that the site operated as a landfill from circa 1972 and closed in 1991. The site was owned and operated by Waterford County Council. The size of the site is 2 acres approximately. Before Waterford County Council owned and operated the site, it was previously used as a limestone quarry which had been exhausted and then purchased by the council.

The lands adjoining the site appear to be primarily used for agriculture purposes and mainly grassland. There are a number of residential dwellings in close proximity to the site. To the south, one dwelling is present and approximately 20m from the site. To the north, three dwellings are present and approximately 50m from the site. To the east, one dwelling is present and approximately 50m from the site. To the north, two dwellings are present and approximately 150m & 200m from the site.

The Lismore landfill accepted domestic and commercial and possibly a small quantity of industrial waste, although sources of industrial waste are unknown. The site is reported to be 5 – 10m deep. At closure, the landfill was capped with approximately 0.3m of topsoil and it was also decided to plant the majority of the old landfill site with trees.

1.1 Scope of the Risk Assessment:

For the risk assessment the material deposited at this site during the period of operation will be included within the scope of the risk assessment.

1.2 Geographical Information Systems (MapInfo):

A detailed analysis of the site location was compiled before commencing a walk over inspection. This analysis was compiled using Waterford County Councils geographical information systems software MapInfo. An aerial photograph of the area was located as to provide information on the surrounding land uses.

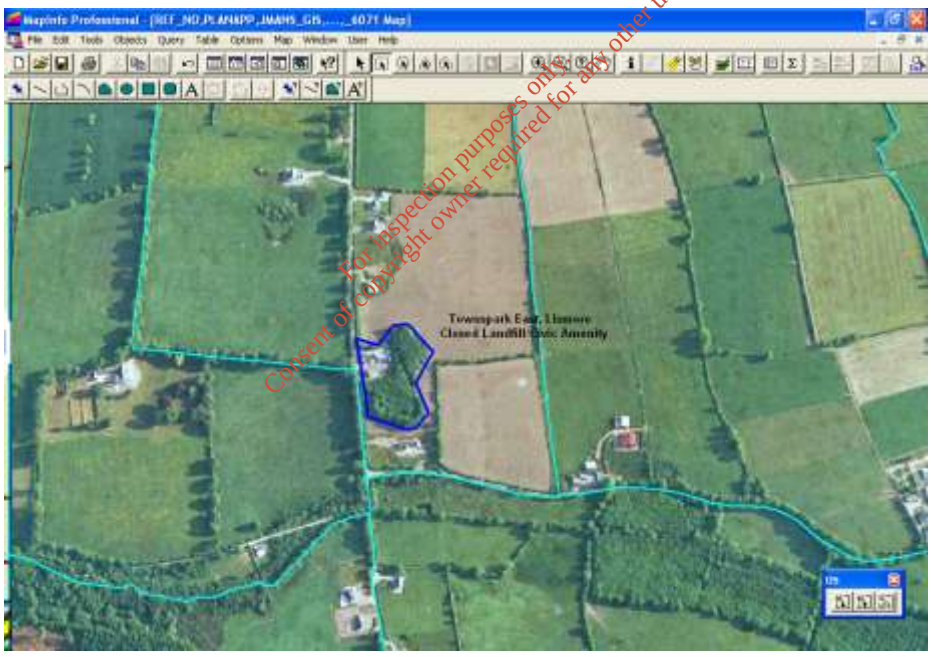


Figure 2: Aerial Photo of site

The aquifer type and vulnerability were also determined from MapInfo. The northern part of the site was deemed to lie over an aquifer of extreme vulnerability. The southern half of the site lies over an aquifer of high vulnerability.

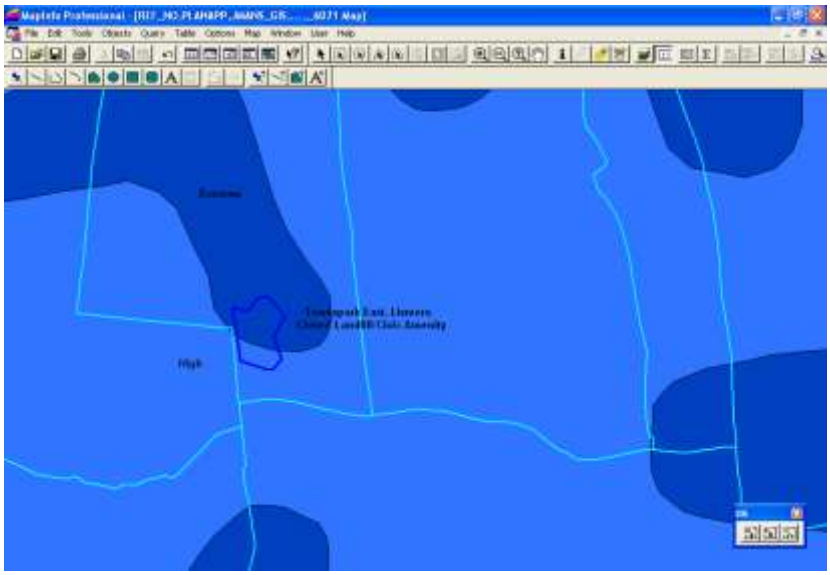


Figure 3: Aquifer Vulnerability

The site overlies an aquifer which is classed as Regionally Important Karst aquifer type. Also, it can be viewed from figure 4 below that an aquifer which is classed as Locally Important Moderately Productive is in close proximity to the site.

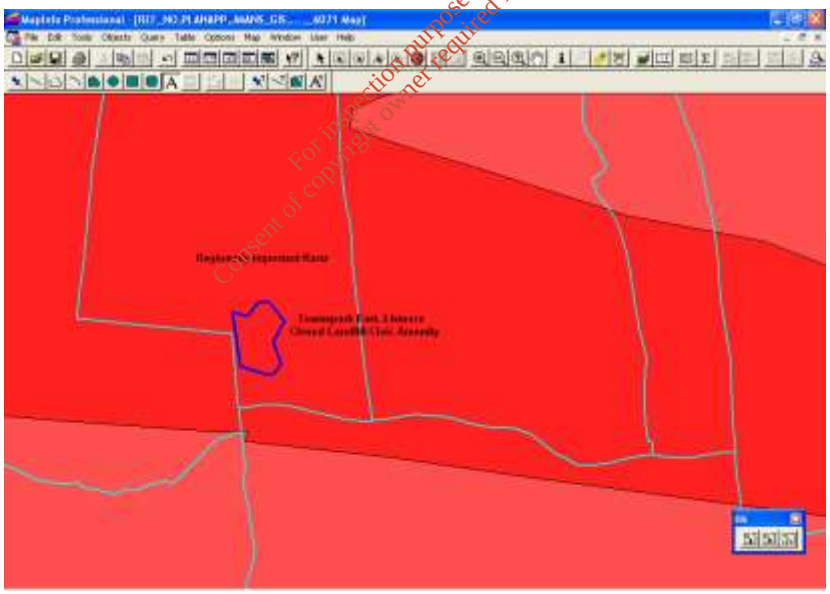


Figure 4: Aquifer Type

The geology characteristics of the area are a vital component for compiling the risk assessment especially in determining the value for table 2d & 2e. The Environmental Protection Agency website was used for obtaining this information. The site location and adjacent lands were determined to have a soil characteristic of Acid Brown Earths/Brown Podzolics. Although the geology characteristics were determined for the site, it is

important to note that this particular site was an exhausted limestone quarry before commencement of landfilling in 1972.Therefore; for the purpose of the risk assessment a geology characteristic of Bedrock was used.

Figure 5: Geology Characteristics

The site and area was also researched on the MapInfo as to determine whether any SPA, SAC, NHA were present. This site does not lie within or adjacent to any Special Areas of Conservation, Special Protection Areas of Proposed Natural Heritage Area. It was noted that the River Owbeg was within 130m of the site. Also it was found that the water main is located along the road outside the civic amenity boundary. Although, it is important to note that the source of this public water supply is greater than 1km from the site but does overlie a Karst Aquifer.

1.3 Walk-over Inspection:

Waterford County Council, Environment Section completed a walk-over inspection on the 3rd December 2008. As previously stated the closed landfill site is currently being been operated as Civic Amenity by Waterford County Council and is open to the public from 9:00 – 17:00 Mon-Fri and 9:00 -13:00 Sat. The Civic Amenity accepts waste such as domestic waste, recycling bags, glass, electronic goods, fluorescent tubes, waste cooking oils and garden waste.

The site comprises of an impermeable surface for the civic amenity area which also consists of a split level design. There is a caretaker on-site at all times and the civic amenity also includes a site office and toilet facilities for the staff. In 1991, the landfill ceased operation and as part of capping, it was decided to plant the area with evergreen trees. Therefore, the site appears as natural woodland and there does not appear to be any evidence of vegetation die-off. Also there was no evidence of leachate ponding on-site and the site was dry underfoot.

1.4 Lismore - Risk Screening

The risk assessment methodology outlined in the Code of Practice Manual is based on the principle of linkages between the Source, Pathway, and Receptor. Refer to Chapter 4 of the Manual for the Risk Score Tables.

Table 2

Ref	**Source**	*Score*	*Max*	*Rational*
1a	Leachate	5	10	▪ <1 hectare ▪ Waste included both municipal & commercial wastes
1b	Gas	5	10	▪ <1 hectare ▪ Highest rating given as proportion of municipal: industrial wastes are not known.

Table 3

Ref	**Pathways**	*Score*	*Max*	*Rational*
2a	Groundwater vulnerability	3	3	▪ GSI data states that part of site is rated as having extreme vulnerability.
2b	Groundwater flow regime	1	5	▪ Bedrock type present ▪ (Poorly Productive Bedrock- Taken From EPA Risk Rating Report)
2c	Surface water drainage	0	2	▪ Landfill is not directly connected to adjacent surface water bodies.
2d	Landfill gas lateral migration	3	3	▪ Residence within 250m of closed landfill ▪ Sand and gravel, made ground, urban, karst
2e	Landfill gas vertical migration	5	5	▪ Civic Amenity located & in operation on the site including a site office ▪ Sand and gravel, made ground, urban, karst

Table 4

Ref	**Receptors**	*Score*	*Max*	*Rational*
3a	Human presence (leachate)	2	3	▪ House with private well <250m from landfill
3b	Protected areas	0	3	▪ No designated sites in the vicinity of the landfill.
3c	Aquifer category	5	5	▪ Regionally Important Karstified Aquifer (Rk)
3d	Public water supply	3	7	▪ >1 km from the source ▪ Karst Aquifer
3e	Surface water bodies	2	3	▪ River Owbeg is >50m but <250m from the site boundary
3f	Human presence (gas)	5	5	▪ House within 50m of site

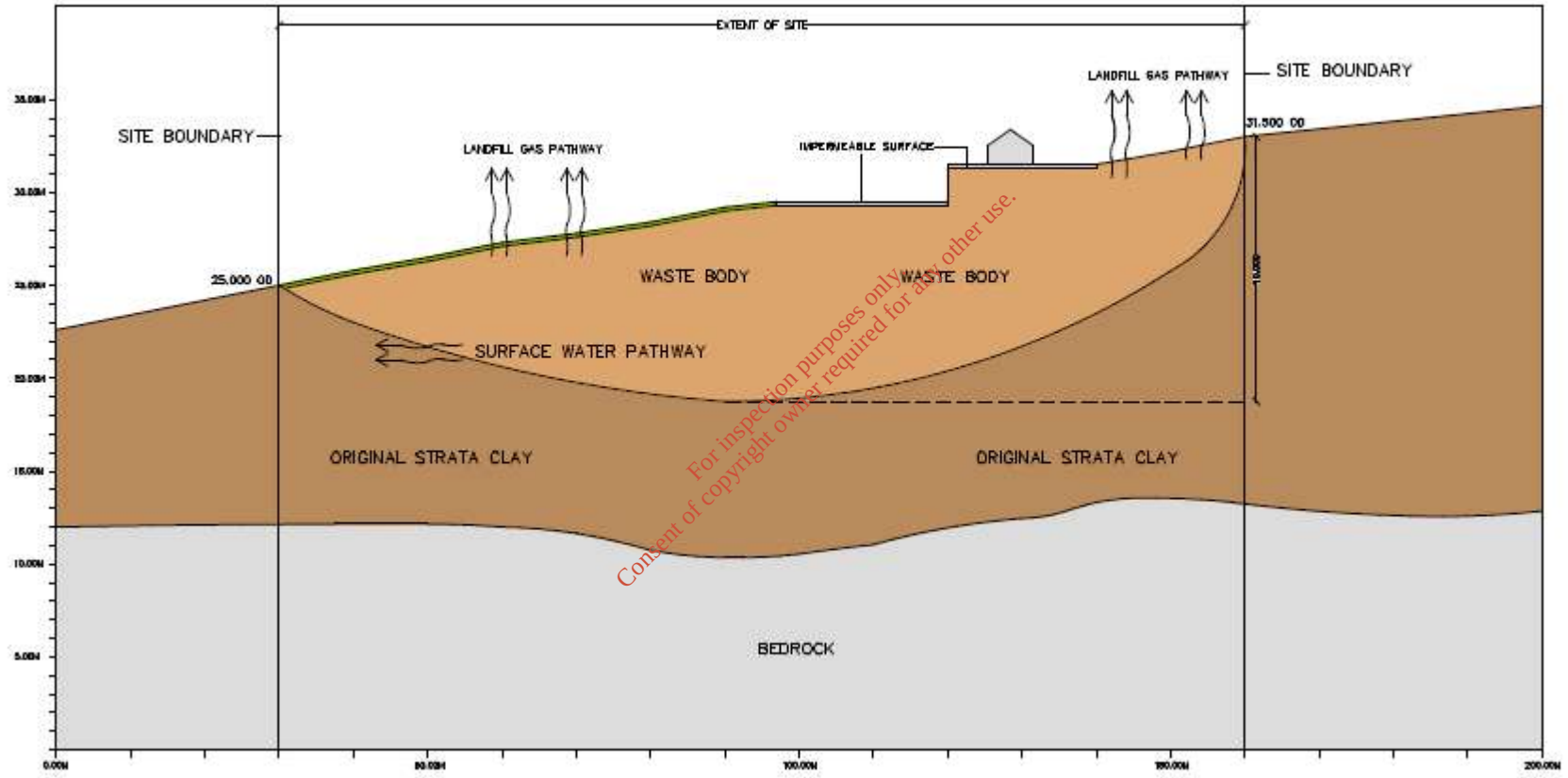
1.5 Lismore – Risk Classification

Table 5

S-P-R Linkage Score		**Max Score**	**Actual Score**	**Normalised Score**	**Risk Classification**
SPR 1	Leachate migration to surface waters through combined groundwater and surface water pathways	300	1a x (2a + 2b + 2c) x 3e = 40	13.33%	Class C – Lowest risk
SPR 2	Leachate migration to protected areas through combined groundwater and surface water pathways	300	1a x (2a + 2b + 2c) x 3b = 0	0%	Class C – Lowest risk
SPR 3	Leachate migration to human receptors via groundwater	240	1a x (2a + 2b) x 3a = 400	16.67%	Class C – Lowest risk
SPR 4	Leachate migration to protected areas via groundwater	240	1a x (2a + 2b) x 3b = 0	0%	Class C – Lowest risk
SPR 5	Leachate migration to bedrock via groundwater	400	1a x (2a + 2b) x 3c = 100	25%	Class C – Lowest risk
SPR 6	Leachate migration to public water sources via groundwater	560	1a x (2a + 2b) x 3d = 60	10.71%	Class C – Lowest risk
SPR 7	Leachate migration to surface water via groundwater	240	1a x (2a + 2b) x 3e = 40	16.67%	Class C – Lowest risk
SPR 8	Leachate migration to surface water via surface water	60	1a x 2c x 3e = 0	0%	Class C – Lowest risk
SPR 9	Leachate migration to protected area via surface water	60	1a x 2c x 3b = 0	0%	Class C – Lowest risk
SPR 10	Gas migration to human receptors via subsoil – lateral	150	1b x 2d x 3f = 45	30%	Class C – Lowest risk
SPR 11	Gas migration to human receptors via subsoil – vertical	250	1b x 2e x 3f = 75	30%	Class C – Lowest risk
Overall Site Classification: Class C – Lowest risk					

1.6 Conceptual Site Model

FORMER LANDFILL SITE - TOWNSPARK EAST, LISMORE - CONCEPTUAL SITE MODEL - TIER ONE RISK ASSESSMENT



Tier 2 Landfill Assessment

Townspark East, Lismore, Co. Waterford

20 August 2012
Final

Issue No 3
49341903

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Issue No: 3	Name	Signature	Date	Position
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1	21 December 2010	Original issue
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Section **Page No**

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the services. The results of any measurements taken may vary spatially or with time and further confirmatory measurements should be made after any significant delay in using this Report.

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1. INTRODUCTION & BACKGROUND

URS Ireland Ltd (URS) is pleased to present Waterford County Council (WCC) with this report summarising the results and findings from a Tier 2 assessment of a former unregulated landfill located at Townspark East, Lismore, Co. Waterford (the site).

The site location is presented in Figure 1 and the site boundary is shown outlined in red on Figure 2.

Regulations were introduced in 2008[1] to address a gap in the transposition of waste licensing legislation in that (pre 1996) Local Authorities were not required to have authorisation for their waste management activities. As a result, the Environmental Protection Agency (EPA) has prepared a code of practice (CoP)[2] to assist local authorities in meeting the requirements of these regulations. With regard to the EPA CoP, a Tier 1 risk assessment was completed by WCC[3]. The Tier 1 assessment identified the site as being *'Class C – Low Risk Site'*, with the most significant source-pathway-receptor (SPR) linkages as follows:

- Risk to protected areas via migration of leachate to groundwater; and
- Risk to bedrock aquifer via migration of leachate.

The works reported herein formed part of "Step 3" of the approach outlined in the EPA CoP and consisted of an "exploratory investigation" (as outlined in Section 5.3.3 of the CoP).

2. OBJECTIVES

The objectives of the works reported herein were as follows:

- Confirm, through investigation, the preliminary conceptual site model (CSM) developed by WCC during the Tier 1 assessment, in particular to confirm the source-pathway-receptor (SPR) pollutant linkages identified;
- Characterise the waste body; and
- Collect data to inform a quantitative risk assessment (QRA) for the site should a Tier 3 assessment be required ("Step 4" of the EPA CoP).

---

[1] S.I. No. 524 of 2008, *Waste Management (Certification of Historic Unlicensed Waste Disposal and Recovery Activity) Regulations 2008*

[2] Environmental Protection Agency, Office of Environmental Enforcement, *Code of Practice, Environmental Risk Assessment for Unregulated Waste Disposal Sites*, April 2007

[3] Waterford County Council, *Environmental Risk Assessment for Unregulated Waste Disposal Sites, Desk Study on Closed Landfill: Townspark East, Lismore Landfill*

3. SCOPE OF WORKS

3.1 Geophysics Survey

A geophysics survey was undertaken by Minerex Geophysics Limited (MGX) on 8 November 2010. The survey consisted of acquiring EM31 Ground Conductivity and 2D Resistivity datasets. The final Minerex report is presented in Appendix A.

3.2 Intrusive Site Investigation

Site works were carried out between 17 and 22 November 2010.

The scope of work undertaken by URS during the assessment was based on the Tender Brief provided by WCC[4] and included the following:

- Initial site walkover with WCC Engineers (Ms. Aoife O'Flaherty and Mr. Liam Ahearn) on 22 October 2010;
- Drilling of five (5) boreholes to depths ranging from 6.5m below ground level (bgl) to 22m bgl;
- 'In-situ' geotechnical measurements during drilling of boreholes;
- Collection of soil / waste samples at nominal 2m depth intervals during drilling;
- Screening of these samples using a photo ionisation detector (PID) to inform selection of samples for laboratory analysis;
- Completion of each of the five (5) boreholes as 50mm diameter dual purpose ground gas and groundwater monitoring wells;
- Measurement of groundwater elevations in each of the wells on 22 November 2010;
- Collection of groundwater samples from four (4) of the installed monitoring wells (samples were not collected from the fifth well as it was dry); and
- Monitoring of landfill gases in the five monitoring wells.

The relative elevation of monitoring wells was surveyed by WCC and groundwater elevations were measured by WCC again on 4 January 2011. 17 January 2011 and 18 October 2011.

Surface water samples were collected from the Owbeg River and from the Tobar na Glóire spring by WCC on 18 November 2010.

Soil / waste and groundwater samples were analysed by Jones Environmental Laboratories (JEL) in the UK. Water sample parameters with a short holding time (BOD,

[4] Waterford County Council, *Brief for Tender Required for the Site Investigation Works at the Historic Landfill Site at Townspark East, Lismore, Co. Waterford*, 3 August 2010

COD, coliforms) were analysed by Microchem Laboratories in Dungarvan, Co. Waterford. Particle size distribution (PSD) analysis was undertaken by Testconsult Ireland Ltd in Portlaoise, Co. Laois.

WCC samples were analysed in their laboratory in Kilmeaden, Co. Waterford and by Environmental Laboratory Services in Cork.

Soil / waste samples were analysed for the following parameters:

Analyte	Bulk Analysis	Soil Leachate Analysis
TPH Criteria Working Group (CWG) Analysis	5	4
Benzene, toluene, xylene, ethylbenzene (BTEX) compounds	5	4
Total Organic Carbon (TOC)	5	4
Polycyclic Aromatic Hydrocarbons (PAHs)	5	0
Polychlorinated Biphenyls (PCBs)	5	0
Metals*	5	4
Chloride, fluoride, sulphate	0	4
Dissolved Organic Carbon (DOC)	0	4
Phenols	0	4
Total dissolved solids	0	4
Inorganics**	0	2
Particle size distribution	3	0
Moisture content	3	0
Atterburg limit	3	0

* Metals include aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium and zinc

** Inorganics include alkalinity, ammonia (as N), bicarbonate, calcium, carbonate, chloride, hardness (as CaCO3), Iron, Magnesium, Manganese, Nitrate, Nitrite, total oxidised nitrogen, orthophosphate, potassium and sodium

Groundwater / leachate samples were analysed for the following parameters:

Analyte	No. of Samples
TPH CWG	4
PAHs	1
TOC	4
Biochemical Oxygen Demand (BOD)	5
Chemical Oxygen Demand (COD)	5
Faecal coliforms	3
Inorganics*	4
Metals**	5

*Inorganics include alkalinity, ammonia (as N), bicarbonate, calcium, carbonate, chloride, hardness (as CaCO3), Iron, Magnesium, Manganese, Nitrate, Nitrite, total oxidised nitrogen, orthophosphate, potassium, sodium and sulphate

** Metals include aluminium, antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium and zinc

Surface water samples collected by WCC were analysed by WCC for the following parameters:

Analyte	No. of Samples
Volatile Organic Compounds (VOCs)*	2
Trihalomethanes (THMs)**	2
Metals***	2
Biochemical Oxygen Demand (BOD)	2
Chemical Oxygen Demand (COD)	2
Inorganics****	2

*VOCs include benzene, tetrachloroethene and trichloroethene

**THMs include bromoform, bromodichloromethane, chloroform and dibromochloromethane

*** Metals include antimony, arsenic, cadmium, chromium, copper, lead, mercury and nickel

****Inorganics include ammonia, chloride, nitrate and orthophosphate

4. SITE DESCRIPTION AND ENVIRONMENTAL SITE SETTING

4.1 Site History

It is understood that the site originally consisted of a limestone quarry which, following closure, was used by WCC for the disposal of municipal waste between 1972 and 1991. The site operated on a dilute-and-disperse principle, with no impermeable membrane present between the waste body and the underlying limestone bedrock.

On completion of landfilling activities, it is understood that the site was capped with 0.3m of topsoil and the eastern portion of the site was planted with trees. Based on the findings of the URS intrusive investigation and the MGX geophysics survey, the approximate volume of the waste body is estimated at 95,000m^3.

4.2 Site Setting

The site is located 1.5km south of the town of Lismore in the townland of Townspark East and occupies an area of approximately 0.95 hectares (9,500m^2) (see Figure 1).

The site is located in a predominantly agricultural setting and is understood to be owned by WCC. The site comprises a wooded area and a former civic amenity site. The lands on which the site is located are zoned for agricultural use. Residential zoning extends to 1.2km from the northern site boundary.

4.3 Physical Setting

The physical setting of the site is summarised in the table below.

Physical Feature	Comments
Surface of Site	Approximately 25% of the site is occupied by the former civic amenity site, the surface of which consists of a mixture of tarmac and concrete. The remainder of the site was planted with trees on closure of the landfill in 1991.
Topography	According to OSI Discovery Series 1:50,000 Map 81 the site lies at an elevation of approximately 30m above Ordnance Datum and slopes to the south. It is understood that the site operated as a limestone quarry before landfilling activities commenced. Following closure of the landfill in 1991, the site was profiled in line with the surrounding topography.
Regional Geology	According to the GSI the geology beneath the site comprises Waulsortian Mudbank Limestone overlain by till derived predominantly from Devonian sandstone. The Owbeg River to the south flows along an east-west trending fault line.

Physical Feature	Comments
Regional Hydrogeology and Aquifer Classification	The aquifer beneath the site is classed by the GSI as regionally important and karstified, and is classed by the GSI as extremely vulnerable. The limestone beneath the site is understood to be underlain by Devonian Kiltorcan-type Sandstone, which is considered by the GSI to be a considerable groundwater bearing body. This aquifer is expected to contribute a relatively high baseflow to rivers and streams directly underlain by rock[5].
Nearby Surface Water Bodies	The nearest surface water bodies to the site are the Owbeg River located 130m south, the River Blackwater located approximately 2.5km to the North and the River Bride located approximately 3km to the south. The Owbeg River flows into the River Blackwater approximately 4.5km east of the site.
Nearby Surface Water Abstractions	It is understood that there are no surface water abstractions in the area.
Nearby Groundwater Abstraction Wells	According to the GSI database, there are a number of groundwater wells within 1km of the site, with two wells noted as having agricultural and domestic uses. WCC also reported a dwelling with a groundwater abstraction well within 250m of the site. Ordnance Survey maps also show two groundwater springs in the vicinity of the site. Tobar na Glóire is a spring fed 'Holy Well' located approximately 500m southwest of the site. There is also a spring noted approximately 50m south of the site.
Inferred groundwater flow	Based on groundwater elevation data from monitoring wells outside the waste body (screened in bedrock), inferred groundwater flow direction is to the northwest towards the River Blackwater.
Waste type	Information provided by WCC suggests the landfill material consists of domestic and commercial waste, with a possibility of a small quantity of industrial waste. Sources of industrial waste were not known.

[5] GSI, *Cappoquin Kiltorcan GWB Description*, 1st Draft, 13 February 2004

4.4 Adjacent Land Use

The land use adjacent to the site are summarised in the table below:

Site Boundary	Land Use
North	Agricultural, with three residential properties located approximately 50m from the site.
South	Agricultural, with a residential property approximately 20m from the site.
West	Agricultural, with a residential property approximately 300m from the site.
East	Agricultural, with residential houses located approximately 250m from the site.

4.5 Protected Areas

According to the National Parks and Wildlife Service, the River Blackwater (located approximately 2.5km north of the site) is a designated Special Area of Conservation (SAC), Special Protection Area (SPA) and Proposed Natural Heritage Area.

The River Bride located approximately 3km south of the site is a designated SAC and Proposed Natural Heritage Area.

The River Blackwater and lower part of the Owbeg River are listed in the Water Framework Directive (WFD) Register of Protected Areas as being nutrient sensitive.

There are no designated Groundwater Dependant Terrestrial Ecosystems (GWDTE) within 1km of the site.

5. METHODOLOGY

The fieldwork was conducted under a site-specific health and safety plan and with reference to the information provided by WCC, the EPA CoP[2], the EPA landfill manuals[6] and BS10175:2001[7].

5.1 Geophysics Survey

MGX carried out a geophysical survey including EM31 ground conductivity and 2D-Resistivity. The methodology used in the survey is outlined in Section 2 of the MGX report (presented in Appendix A).

5.2 Borehole Drilling and Monitoring Well Installation

Three of the five boreholes (BH01 – BH03) were drilled into bedrock on the periphery of the site to depths ranging from 15m bgl to 22m bgl.

The other two boreholes (BH04 and BH05) were advanced through the waste body, terminating on bedrock at depths of 6.5m bgl and 10.5m bgl respectively.

Boreholes BH01 to BH03 targeted groundwater units within the bedrock while boreholes BH04 and BH05 were installed to target leachate within the waste body.

Drilling was undertaken using a combination of hollow stem auger and air rotary drilling techniques. Each location was scanned using a cable avoidance tool prior to drilling.

All five (5) boreholes were completed as dual purpose ground gas and groundwater monitoring wells, with a 50mm diameter HDPE standpipe with a 1mm slot size. The lower section of the well was screened across bedrock / waste to allow ingress of groundwater / leachate for sampling. The screened section was surrounded by a washed gravel filter pack. A bentonite seal was placed at the surface to minimise the potential for surface water entry. Following installation, the wells were developed to remove any materials that may have been introduced during drilling. The wells were finished using upright metal covers and protective bollards.

Monitoring well locations are presented on Figure 2.

5.3 Soil / Waste Sampling

Soil / waste samples were collected from each investigation location and placed into laboratory supplied sample jars. The sample containers were labelled with a unique sample number and placed in a suitable container for transportation. The field engineer wore single-use disposable nitrile gloves for each sampling event.

[6] Environmental Protection Agency, *Landfill Manuals: Landfill Monitoring (2nd Edition)*, 2003

[7] British Standards Institution, *Investigation of Potentially Contaminated Sites – Code of Practice, BS10175:2001,* 2001

The sampled material was visually examined for evidence of contamination and screened using a Photoionisation Detector (PID) for the presence of volatile compounds. Arisings were visually inspected for the presence of potentially hazardous materials (such as oils, asbestos etc.). The field engineer noted the borehole location on a plan and noted the sample depth and the sample number(s).

5.4 Groundwater Sampling

On completion, each well was developed to remove any material introduced during drilling. Prior to sample collection a water level meter was used to monitor the depth to groundwater in each of the monitoring wells. Monitoring well BH04 was dry; therefore a groundwater sample was not collected at this location.

At least three well volumes were purged from each of the wells (BH01 – BH03 and BH05) prior to sampling. The wells were purged using dedicated Waterra tubing and footvalves.

In-situ water quality parameters (temperature, pH, electrical conductivity, redox potential and dissolved oxygen) were recorded both during purging and prior to sampling.

Standard environmental sampling techniques were adopted to minimise the risk of cross contamination between sampling locations and risk of volatile losses during transport the laboratory.

The sampled water was placed directly into laboratory supplied sample containers appropriate to the proposed analytes (field filtered and with appropriate preservatives if required).

All sample bottles were labelled with a unique sample number for each monitoring well and placed in a chilled cool box dedicated for water samples.

5.5 Landfill Gas Monitoring

All five (5) groundwater monitoring wells were sealed with a gas tap to allow for monitoring of landfill gases.

Landfill gas composition (methane, carbon dioxide, oxygen and atmospheric pressure) was recorded at each of the wells using a portable landfill gas analyser (GA2000).

6. GENERIC QUANTITATIVE RISK ASSESSMENT

A generic quantitative risk assessment (GQRA) was carried out using the analytical data collected during the site works. The screening levels used for each sample medium are described below.

6.1 Soil / Waste Quality

Soil and waste laboratory results were compared against Stage 2 generic assessment criteria (GAC) protective of human health.

URS GAC are risk-based concentrations protective of chronic risks to human health for a broad range of site conditions and different generic land-uses. They represent the first stage of assessment (also commonly called "screening values"). If applied correctly to a site with a broadly consistent conceptual exposure model, it is recommended that an exceedance of a URS GAC triggers a need for further assessment of some form, such as a re-evaluation of the applicability of the conceptual site model relative to the GAC, further site investigation, more detailed quantitative risk assessment (also known as a DQRA), and potentially remedial action, subject to tests of cost-benefit, practicability and reasonableness.

Central to the development of land-use specific conceptual exposure models (CEMs) is data contained within the UK Environment Agency's SC050021/SR3, which provides available data on UK exposure for four standard land-uses. These standard land uses take into account reasonable and typical land-use patterns in the UK, based on social studies and the professional judgement of policy makers to provide CEMs suitable for generic site conditions. Standard exposure pathways have been developed for residential (with and without plant uptake), commercial and allotment land-uses. It is assumed that typical land-use patterns assumptions for the UK are valid for Ireland.

Appropriate GAC for a particular site are collated with consideration of the general site conditions encountered (soil conditions such as soil-type and Total Organic Carbon content) and the generic land-use. In this case, commercial/industrial land-use was selected in the absence of a more appropriate generic land-use. For commercial land-use, it is assumed that the critical receptor is a female worker and the duration of exposure covers a working adult lifetime of 49 years. With regard to the site, it is expected that exposure duration will be significantly less than this and as such, selected GAC may be considered conservative given the current use of the site. Therefore, it is considered that assessment for onsite commercial users is suitably protective of users of the site and potential controlled waters receptors (such as groundwater).

Where concentrations of the analysed parameters in soil or water are found to be above the assessment criteria, the possible need for a quantitative risk assessment (QRA) is identified. This process is generally acceptable to the Irish EPA in the previous experience of URS and is considered to be in line with the EPA CoP (as outlined in Section 6.2.2).

For comparison with background levels the results for metals were also compared with background data (where available) for Irish soil published by the Environmental

Protection Agency (EPA)[8]. The published data was based on test samples collected from across the Republic of Ireland and to remove the effect of statistical outliers, the 95th percentile values were used as the preliminary screening guidelines. It should be noted that this 95th-percentile guideline represents an Irish background level only and results exceeding these guidelines do not necessarily indicate environmental risk.

6.2 Groundwater / Leachate Quality

Groundwater and leachate analytical results were compared to the EPA Interim Guideline Values (IGVs)[9] and threshold values from the Groundwater Regulations 2010[10] that indicate the chemical status of a groundwater body.

The IGVs were developed using a number of existing water quality guidelines in use in Ireland including existing national Environmental Quality Standards (EQSs), proposed common indicators for the EU Groundwater Directive, Drinking Water Standards and GSI trigger values.

The groundwater regulations were developed to give effect to measures needed to achieve the objectives of the Water Framework and Groundwater Directives.

6.3 Surface Water Quality

Surface water analytical results were compared to EPA environmental quality standards (EQS[11]) and the Surface Water Regulations[12].

The EPA EQS values were developed to provide a potential basis for the establishment of quality objectives for the aquatic environment.

The surface water regulations were developed to give effect to measures needed to achieve the objectives of the Water Framework and Dangerous Substances Directives.

[8] Environmental Protection Agency, *Towards a National Soil Database (2001-CD/S2-M2)*, 2007

[9] Environmental Protection Agency, Towards setting guideline values for the protection of groundwater in Ireland (Interim Report).

[10] S.I. No. 9 of 2010, European Communities Environmental Objectives (Groundwater) Regulations 2010

[11] Environmental Protection Agency, Draft Environmental Quality Standards (Draft EQS) for surface waters, *"Environmental Quality Objectives and Environmental Quality Standards, The Aquatic Environment, A Discussion Document"*, EPA 1997

[12] S.I. No. 272 of 2009, European Communities Environmental Objectives (Surface Waters) Regulations 2009

7. RESULTS

Soil / waste results are presented in Tables 1 to 3. Soil leachate results are presented in Tables 4 to 6. Groundwater analytical results are presented in Tables 7 to 12. Surface water results are presented in Tables 13 to 15. Landfill gas measurements are presented in Table 16. Laboratory reports are presented in Appendix B.

Field observations and a factual summary of the analytical results are presented below.

7.1 Geophysics Survey

Detailed results and graphical outputs of the geophysics survey are contained in the MGX report in Appendix A.

The survey showed that there is a large landfill / waste body under the central part of the survey area. The extent of the waste body was inferred by MGX to be up to 115m x 48m with a maximum thickness of approximately 18m. The deepest part may contain some leachate into rock. The estimated volume of the waste body was 100,000m^3.

The inferred stratigraphy beneath the site was as follows:

Depth to stratum (m bgl)	Inferred Geology
0 – 18m	**Waste Body,** underlain by a possible layer of leachate into bedrock
9 – 23m	**Limestone Bedrock.** Where the limestone was previously excavated to create the old quarry the depth is now 9.0 – 23.0m.

7.2 Field Observations

7.2.1 Soil

The materials encountered during the intrusive assessment are described in the logs presented in Appendix C. A cross section showing the typical profile observed beneath the site is presented in Figure 3.

It was apparent that minimal engineering works had been undertaken on the landfill since closure, with no engineered cap (potentially allowing percolation of rainwater vertically through the waste to form a head of leachate and also allowing the escape of landfill generated gas) or basal liner (potentially allowing leachate to percolate vertically into the underlying superficial deposits) in place.

The material covering the waste body comprised sandy / gravelly clay and was reported by WCC to be approximately 0.3m thick across the waste body. The drilling returns indicated that the waste materials were deposited directly onto bedrock. Bedrock was encountered at depths ranging from 4.7m bgl in BH02 to 10.5m bgl in BH05.

The typical profile encountered beneath the site was as follows:

Depth to stratum (m bgl)	Geology
0 – 1	**Made Ground** comprising sandy clay and gravelly clay fill materials. It is likely that this material was used to cap the waste materials.
1 – 10	**Waste Body** comprising plastics and general waste materials mixed with gravelly clay. The waste materials appeared to be quite decomposed being black in colour with strong sweet odours.
10 -	**Limestone Bedrock**

Overall, the findings of the intrusive investigation were consistent with the findings of the geophysics survey.

No potentially hazardous materials (as defined by the EPA European Waste Catalogue and Hazardous Waste List 2002) were observed in the borehole arisings.

The maximum depth of waste of 10.5m bgl was encountered in borehole BH05 located in the northern portion of the waste body.

7.2.2 Groundwater

Water strikes were encountered in bedrock at depths of 8m bgl and 20m bgl in boreholes BH03 and BH01 respectively. The groundwater level readings taken in each of the monitoring wells following installation are presented in Appendix D. Groundwater elevation contours for bedrock wells are presented in Figure 2.

The water level measurements from across the site show the highest groundwater elevations in well BH02 (located to the east of the site) and the lowest elevations in well BH01 (located to the south of the site). Consequently, shallow groundwater flow direction beneath the site is inferred to be northwest towards the River Blackwater, with an average hydraulic gradient of 0.031.

Given the observed depth of the waste body and the reported groundwater conditions, it is likely that the waste body is in direct contact with the unconfined bedrock aquifer beneath the site during periods of high water table conditions.

The results for the in-situ water quality parameters recorded during sampling of groundwater / leachate are presented in the Table 7. With the exception of electrical conductivity, all water quality parameters recorded in the field (conductivity, pH, redox dissolved oxygen and temperature) were below their respective guideline values where available. The measured field parameters can be summarised as follows:

- Measured conductivity values in groundwater ranged from 700µS/cm in BH03 to 959µS/cm in BH01. The conductivity value measured in BH05 (7,517µS/cm) was above the IGV of 1,000µS/cm and is considered to be indicative of leachate contamination.

- Measured pH values in groundwater ranged from 7.08 to 7.13, indicating neutral groundwater beneath the site.
- Redox values in groundwater ranged from 99.8mV to 124.6mV, indicating an oxygenated groundwater system.
- Measured dissolved oxygen values in groundwater ranged from 2.36mg/l to 3.80mg/l.

7.2.3 Landfill Gas

Strong odours were observed wherever waste was encountered (i.e. in both BH04 and BH05). The odours were described as a 'sweet rotting smell'.

Concentrations of landfill gases recorded during the intrusive works are presented in Table 12. Concentrations of methane and carbon dioxide were recorded at monitoring well BH04, with concentrations of 1.2% and 0.8 recorded respectively on 22 November 2010. Methane and carbon dioxide were not detected at any other monitoring point during the assessment.

Concentrations of volatile compounds recorded using the PID were below 5ppm at all locations.

7.3 GQRA Findings

7.3.1 Soil Analytical Results (BH03)

Analytical results for soil sample BH03_0.5 are presented in Tables 1 to 3. TPH, BTEX and PAH concentrations in soil were below the respective laboratory method detection limits (MDLs).

The concentrations of all parameters analysed were below the GACs protective of human health.

There were some exceedances of the EPA background (95 percentile) values for cadmium and zinc.

7.3.2 Waste Analytical Results (BH04 and BH05)

Analytical results for the four waste samples collected are presented in Tables 1 to 3. The concentrations of all parameters analysed were below the GACs protective of human health. Results of the waste analysis are summarised below.

TPH

TPH concentrations in waste ranged from 383mg/kg to 2,912mg/kg.

BTEX & MTBE

BTEX concentrations of 1.35mg/kg and 0.288mg/kg were detected in samples BH05_2.0 and BH05_4.0 respectively. BTEX compounds were not detected in waste samples BH04_4.2 and BH04_5.9m.

MTBE compounds were not detected (above the MDL) in the soil samples analysed and the GACs were not exceeded.

PAHs

PAHs were detected in all four of the waste samples analysed, with sum of 17 PAH compounds ranging from 2.63mg/kg (BH05_2.0) to 7.66mg/kg (BH04_4.2).

Metals

There were some exceedances of the EPA background (95 percentile) values for cadmium, copper, mercury, lead, zinc and antimony.

Geotechnical Laboratory Results

Particle size distribution (PSD) sieve test was carried out on two samples of the shallow capping material and one sample of the base material overlying bedrock, as outlined in the following table. The PSD laboratory report is presented in Appendix B.

Location	Depth (m)	Stratum	Description	Plasticity Index (%)
BH04	0.3 - 0.6	Capping Material	Sandy Gravel	28
BH04	6.0	Base Material	Sandy Gravel	14
BH05	0.5	Capping Material	Sandy Gravel	21

All samples recorded a high gravel content.

The Atterburg limit test was carried out on eight selected samples. The samples analysed recorded a Plasticity Index ranging between 14% and 28%.

7.3.3 Waste Leachate Analytical Results

Analytical results for the four waste leachate samples generated by the laboratory are presented in Tables 4 to 6. Results of the waste leachate analysis are summarised below.

TPH

TPH concentrations of 143µg/l, 1,827µg/l and 11,264µg/l were detected in samples BH05_4.0, BH04_4.2 and BH05_2.0 respectively. The hydrocarbon compounds detected were predominantly in the C_{21}-C_{35} carbon fraction range. These concentrations were above the IGV for TPH of 10µg/l.

BTEX & MTBE

Benzene and toluene were not detected in the waste leachate samples analysed.

Concentrations of ethylbenzene (17µg/l) and xylene (78µg/l) in BH05_2.0 and xylene (24µg/l) in BH05_4.0 were found to be above their respective assessment criteria.

MTBE compounds were not detected (above the MDL) in the waste leachate samples analysed; hence the adopted guideline criteria were not exceeded.

Metals

Concentrations of arsenic in waste leachate exceeded the adopted guideline criteria of 7.5µg/l in samples BH04_4.2 and BH05_2.0.

There was one exceedance of the lead criteria (18.75µg/l) in sample BH04_5.9.

Concentrations of aluminium were elevated in all four waste leachate samples, with concentrations ranging from 507µg/l in sample BH05_4.0 to 1,928µg/l in sample BH04_4.2.

Concentrations of other metals were below their respective assessment criteria where present.

Miscellaneous

There were exceedances of the assessment criteria for ammonium, iron, manganese, orthophosphate and potassium in samples BH04_4.2 and BH05_2.0. In addition, the phenol concentration detected in sample BH05_4.0 (0.39mg/l) was above the assessment criteria of 0.0005mg/l.

Concentrations of the other parameters analysed were below their respective assessment criteria where present.

7.3.4 Groundwater Analytical Results

Groundwater analytical results from wells BH01 to BH03 are presented in Tables 7 to 12.

Hydrocarbon compounds (including BTEX and MTBE) were not detected in any of the three groundwater samples analysed.

Concentrations of arsenic, boron, cadmium, chromium, lead, zinc and barium were detected above the laboratory detection limit, however all concentrations detected were below their respective assessment criteria. No other metals were detected in groundwater.

The sample collected from Tobar na Glóire spring was analysed for PAHs, with all fifteen PAH compounds below the laboratory detection limit.

Ammonium concentrations of 0.085mg/l and 0.731mg/l were detected in upgradient groundwater wells BH02 and BH03. This exceeded the assessment criteria for ammonium of 0.065mg/l.

Concentrations of iron, nitrate, nitrite and potassium were also elevated when compared against the groundwater assessment criteria.

Faecal coliforms were detected in groundwater samples BH02 and BH03.

7.3.5 Leachate Analytical Results

Leachate analytical results from well BH05 are presented in Tables 7 to 12.

A TPH concentration of 1,186µg/l was detected in BH05. BTEX and MTBE compounds were not detected in this sample.

A number of elevated metals were detected in BH05, with concentrations of boron (1,691µg/l) and nickel (18µg/l) found to be above their respective assessment criteria.

An ammonium concentration of 0.224mg/l was detected in BH05. This exceeded the assessment criteria for ammonium of 0.065mg/l.

Concentrations of iron, magnesium, manganese, orthophosphate, potassium and sodium were also elevated when compared against the groundwater assessment criteria.

BOD and COD were found to be elevated in leachate, with concentrations of 65,100mg/l and 35,300mg/l detected respectively.

7.3.6 Surface Water Analytical Results

Surface water analytical results from upstream (SW01) and downstream (SW02) are presented in Tables 13 to 15.

VOCs, THMs and PAHs were not detected in the surface water samples analysed.

Ammonia concentrations of 0.02mg/l and 0.01mg/l were recorded in samples SW01 and SW02 respectively. These concentrations were below the assessment criteria of 0.14mg/l.

Concentrations of other inorganic parameters phosphate, chloride and nitrate were also below the assessment criteria.

The metals arsenic, cadmium, nickel and lead were detected above the laboratory detection limit, however all concentrations detected were below their respective assessment criteria. No other metals were detected in surface water.

BOD was below the limit of detection in both surface water samples, while COD ranged from 9mg/l in SW01 to 12mg/l in SW02.

8. CONCEPTUAL SITE MODEL UPDATE

An update to each element of the SPR risk scoring matrix and SPR linkages are outlined below.

8.1 SPR Risk Scoring Matrix Update

Risk Screening	Input	Assessment Update	Updated Score
Leachate Source (Table 1a) **Tier 1 Score –** 5	Age: 1972 - 1991 Type: Municipal Waste Footprint: 0.95ha	The intrusive assessment confirmed the waste type to be municipal and commercial. The approximate waste footprint was found to be approximately 0.95 hectares. Hazardous materials were not observed within the waste body and the GACs protective of human health were not exceeded in any of the samples analysed. The soil / waste analysis indicated that there is a potential risk to controlled waters from hydrocarbon compounds, PAHs and some metals. It is likely that the hydrocarbon concentrations detected are due to the production of fatty acids from breakdown of the waste. PAH and metal concentrations were low, with most metal concentrations (with the exception of zinc in sample BH05_4.0) either below or in line with EPA background soil concentrations. The waste leachate analysis indicated that elevated levels of TPH, some metals and ammonia were likely to leach from the waste body. This was consistent with the findings of the leachate analysis from BH05. Overall, the findings of the assessment indicate that a leachate source is present.	5
Landfill Gas Source (Table 1b) **Tier 1 Score –** 5	Age: 1972 - 1991 Type: Municipal Waste Footprint: 0.95ha	As above. Methane gas concentrations recorded during the assessment were below the lower explosive limit of 5% in all wells and was only detected in well BH05 at a concentration of 1.2%. There was no evidence of landfill gas egress on the surface of the site. This indicates that the waste body is generating relatively low levels of landfill gas. The waste body was found to be quite decomposed and displayed a strong sweet odour. Overall, the findings of the assessment indicate that, while there is a potential source of landfill gas present, it is not likely to be significant. This will need to be confirmed through further monitoring works.	5

Risk Screening	Input	Assessment Update	Updated Score
Leachate Migration Pathways (Table 2a) **Tier 1 Score –** 3	Groundwater Vulnerability (Vertical Pathway): Extreme	The assessment confirmed that groundwater beneath the site is extremely vulnerable to contaminants released from the former landfill due to the lack of engineered controls or basal materials overlying weathered and karstified limestone and the predominantly granular basal and top cover layers. Leachate generation is likely both from rainfall percolating through the waste body and from groundwater flow leaching contaminants from the waste.	3
Leachate Migration Pathways (Table 2b) **Tier 1 Score –** 3	Groundwater Vulnerability (Horizontal Pathway): Extreme	As above. Given that the GSI indicate that the aquifer is karstified, a maximum score of 5 has been applied.	5
Leachate Migration Pathways (Table 2c) **Tier 1 Score –** 0	Surface Water Drainage: No Direct Connection	The nearest surface water body to the site (Owbeg River) is located approximately 130m to the south. No direct connection was identified during the assessment and groundwater flow is inferred to be to the northwest, away from the Owbeg River. It should be noted that, according to the GSI, basal flow to rivers in the area is common and, given the fault located beneath the Owbeg River, may be possible.	0
Landfill Gas Pathways (Table 2d) **Tier 1 Score –** 2	Landfill Gas Lateral Migration Potential: Sand and Gravel / Karst	The geology encountered beneath the site is expected to be continuous beneath the nearest residential property located 20m south of the site, indicating that the conditions for lateral migration of landfill gas through sandy / clayey gravel are present. Therefore a maximum score of 3 has been applied.	3
Landfill Gas Pathways (Table 2e) **Tier 1 Score –** 3	Landfill Gas Vertical Migration Potential: Sand and Gravel / Karst	The findings of the assessment indicate that the conditions for landfill gas to migrate vertically are present, given the lack of and engineered cap and the granular nature of the material at the surface of the waste body. However, the Civic Amenity site is no longer operational therefore there are no receptors present.	N/A

Risk Screening	Input	Assessment Update	Updated Score
Leachate Migration Receptors (Table 3a) **Tier 1 Score –** 1	Human Presence (Potential for Private Wells):	As outlined above, the findings of the assessment indicate that a leachate source is present in the waste body. Groundwater is inferred to flow towards the northwest, meaning that sampled well BH01 is downgradient of the waste body. WCC report a house with a groundwater abstraction well approximately 250m to the south (upgradient) of the site, however it is understood that this well is not in use and this dwelling is connected to mains water. The GSI database notes two wells used for agricultural and domestic use within 1km of the site (both cross-gradient). There are a number of wells located approximately 1km northwest (downgradient) of the site, the use of which is not known. With the exception of nitrite (which may be attributed to sewage or agricultural sources), no other parameters were detected at concentrations above the available guideline criteria in the downgradient monitoring well BH01. This indicates that leachate breakout is not occurring and that the site is not impacting on groundwater quality downgradient of the site. There was no evidence of impact in the Tobar na Glóire spring located 500m southwest of the site. Overall, it appears that leachate breakout is not occurring from the site.	1
Leachate Migration Receptors (Table 3b) **Tier 1 Score –** 3	Protected Areas: No protected areas within 1km of the site	The River Blackwater (located approximately 2.5km north of the site) is a designated Special Area of Conservation (SAC), Special Protection Area (SPA) and Proposed Natural Heritage Area. The River Bride located approximately 3km south of the site is a designated SAC and Proposed Natural Heritage Area. The River Blackwater and lower part of the Owbeg River are listed in the Water Framework Directive (WFD) Register of Protected Areas as being nutrient sensitive. There are no designated Groundwater Dependant Terrestrial Ecosystems (GWDTE) within 1km of the site. URS understands that there are no undesignated sites in the vicinity of the landfill.	0
Leachate Migration Receptors (Table 3c) **Tier 1 Score –** 5	Aquifer Category: Regionally Important Karstified Aquifer	The aquifer beneath the site is understood to be regionally important, with the GSI identifying a number of wells in the area. Information from the GSI indicates that a significant aquifer in the form of the Kiltorcan Sandstones underlies the limestone beneath the site, with the two formations likely to be in hydraulic conductivity.	5

Risk Screening	Input	Assessment Update	Updated Score
Leachate Migration Receptors (Table 3d) **Tier 1 Score –** 3	Public Water Supplies: Greater than 1km (karst aquifer)	There are understood to be no public water supplies within 1km of the site, however bedrock aquifer is karstified. There are two public supply wells located approximately 6km to the east of the site near Cappoquin. The site is understood to be located well outside the source protection areas of these wells.	3
Leachate Migration Receptors (Table 3e) **Tier 1 Score –** 2	Surface Water Bodies: Greater than 50m but less than 250m	The Owbeg River lies approximately 130m to the south of the site (upgradient) and flows eastward along an east-west trending fault. The assimilative capacity of the Owbeg River was not considered during this assessment. Laboratory analysis of samples collected from the Owbeg River upstream and downstream of the site indicated that leachate from the site was not impacting on surface water quality. The assessment criteria were not exceeded in either of the samples analysed.	2
Landfill Gas Receptors (Table 3f) **Tier 1 Score –** 5	Human Presence: Within 50m of site boundary	The nearest residential property is located approximately 20m south of the site boundary. Landfill gas was not detected in ambient air during the assessment and there was no evidence of landfill gas egress at the site surface. It is understood that there have been no complaints of odours from residents in the vicinity of the site.	5

8.2 SPR Linkage Update

SPR1 - Leachate=>Groundwater & Surface Water =>Surface Water Body

Tier 1 Risk Classification – C / Low Risk

Updated Classification – C / Low Risk

The assessment found that TPH, PAH and metal concentrations within the waste body represent a risk to groundwater and surface water bodies.

Overall, groundwater quality was found to be good in the vicinity of the site, with no indications that leachate breakout was occurring.

The potential risk to surface water is low considering inferred groundwater flow direction, proximity of the site to the Owbeg River and the nature of the geology beneath the site. In addition, the surface water analytical results indicate that the site is not impacting on water quality in the river.

Further monitoring of the Owbeg River should be undertaken to assess possible impact from the site and seasonal fluctuations in surface water quality.

SPR2 - Leachate=> Groundwater & Surface Water => Protected Area

Tier 1 Risk Classification – C / Low Risk

Updated Classification – C / Low Risk

There are no protected areas within the vicinity of the site; therefore it is considered that this risk does not need to be assessed further.

SPR3 - Leachate => Groundwater => Human Presence

Tier 1 Risk Classification – C / Low Risk

Updated Classification – C / Low Risk

The findings of the assessment indicate that a leachate source is present within the site.

The analytical results found that groundwater quality downgradient of the site was not impacted by leachate. There were some exceedances of the adopted assessment criteria in groundwater for nitrate, nitrite, ammonia and phosphate, however most of these exceedances were detected in wells BH02 and BH03 upgradient of the site. Sewage effluent and agricultural practices, such as fertiliser application and spreading of organic wastes, are potential sources of these contaminants.

WCC report a house with a groundwater abstraction well within 250m to the south (upgradient) of the site, however it is understood that this well is not in use and this dwelling is connected to mains water.

URS recommends that further monitoring of groundwater beneath the site should be undertaken to assess possible impact from the site and seasonal fluctuations in groundwater quality. In addition, a well survey of houses in the vicinity of the site should be considered to identify potential receptors. Samples should be collected from any abstraction wells identified.

Measures should be put in place to manage the risk associated with potential future groundwater abstractions in the vicinity of the site.

SPR4 - Leachate => Groundwater => Protected Areas

Tier 1 Risk Classification – C / Low Risk

Updated Classification – C / Low Risk

There is understood to be no groundwater dependant terrestrial ecosystems (GWDTE) within the vicinity of the site, therefore it is considered that this risk does not need to be assessed further.

SPR5 – Leachate => Groundwater => Aquifer

Tier 1 Risk Classification – C / Low Risk

Updated Classification – B / Moderate Risk

The analytical results indicate that groundwater quality downgradient of the site is not impacted by leachate. Given that the aquifer is considered by the GSI to be regionally important and the absence of engineering controls, it is considered that the impact of the site on the aquifer should be assessed through further monitoring.

SPR6 – Leachate => Groundwater => Public Supply

Tier 1 Risk Classification – C / Low Risk

Updated Classification – C / Low Risk

There is understood to be no public water supply source within the vicinity of the site, therefore it is considered that further assessment of this risk is not required.

SPR 7 – Leachate =>Groundwater => Surface Water Body

Tier 1 Risk Classification – C / Low Risk

Updated Classification – C / Low Risk

Surface water analytical results indicate that the site is not impacting on surface water quality. However, given the proximity of the site to the Owbeg River, further monitoring of water quality in the river should be undertaken.

SPR8 – Leachate =>Surface Water => Surface Water Body

Tier 1 Risk Classification – C / Low Risk

Updated Classification – C / Low Risk

No direct surface water pathways were identified between the site and the Owbeg River and groundwater flow is inferred to be to the northwest, away from the river. It should be noted that, according to the GSI, basal flow to rivers in the area is common and, given the fault located beneath the Owbeg River, may be possible.

As outlined in SPR 1 and SPR 7, further monitoring of water quality in the river should be carried out.

SPR9 – Leachate =>Surface Water => Protected Area

Tier 1 Risk Classification – C / Low Risk

Updated Classification – C / Low Risk

There is understood to be no protected areas within the vicinity of the site, therefore it is considered that further assessment of this risk is not required.

SPR10 – Landfill Gas => Lateral Migration => Human Presence

Tier 1 Risk Classification – C / Low Risk

Updated Classification – B / Moderate Risk

The findings of the assessment indicate that, while there is a potential source of landfill gas present, it is not likely to be significant. This should be confirmed through further monitoring works given the proximity of residential houses to the site.

SPR11 – Landfill Gas => Vertical Migration => Human Presence

Tier 1 Risk Classification – C / Low Risk

Updated Classification – C / Low Risk

Methane gas concentrations recorded during the assessment indicate that the waste body is generating relatively low levels of landfill gas. Given that there is unlikely to be any receptors impacted by the vertical migration of landfill gas, it is considered that further assessment of this SPR linkage is not required.

9. CONCLUSIONS

Based on the Tier 2 assessment, URS has drawn the following conclusions:

- The assessment found the extent of the waste body to be 5,500m^2 with a maximum thickness of approximately 18m. The estimated volume of the waste body was 100,000m^3.
- Hazardous materials were not observed within the waste body and the GACs protective of human health were not exceeded in the soil / waste samples analysed.
- The assessment confirmed that there is no impermeable cap on the surface and no impermeable basal liner beneath the site, meaning that there is no impediment to leachate migration both vertically and laterally towards receptors.
- The assessment found that, while there is a potential source of landfill gas present, it is not likely to be significant. This should be confirmed through further monitoring works given the proximity of residential houses to the site.
- The risk screening exercise found that the overall risk classification for the site is moderate, with the following SPR linkages identified as posing a risk to identified receptors:
    - SPR 5 – Leachate => Groundwater => Aquifer
    - SPR 10 – Landfill Gas => Lateral Migration => Human Presence

The findings of the GQRA were as follows:

- Concentrations of all parameters analysed in soil were below the GAC protective of human health.
- Concentrations of all parameters analysed in the surface water sample collected from the Owbeg River were below their respective GAC, indicating that the site is not impacting on surface water quality.
- With the exception of nitrite, there were no exceedances of the GAC for groundwater in downgradient monitoring well BH01. This indicates that the waste body is not impacting on groundwater quality downgradient of the site and there is no pollutant linkage between the leachate source and the groundwater aquifer beneath the site.
- There were exceedances of the GAC for ammonia, nitrate, nitrite, potassium and coliforms in groundwater samples collected from upgradient monitoring wells BH02 and BH03. Given that these wells are located hydraulically upgradient of the waste body, it is considered that sewage effluent and agricultural practices (such as fertiliser application and spreading of organic wastes) could act as potential sources of these contaminants.

- Concentrations of electrical conductivity, hydrocarbons, metals, phenols, ammonia and other inorganic parameters in leachate (including soil leachate samples) were elevated against their respective GAC. These parameters are typical landfill leachate contaminants.

10. RECOMMENDATIONS

SPR 5

The findings of the GRQA indicate that leachate is not impacting on the groundwater aquifer beneath the site. Ongoing monitoring of both groundwater and surface water is recommended to assess for seasonal variations in water quality in the vicinity of the site.

If future monitoring events indicate a potential risk to controlled waters then a DQRA may be required.

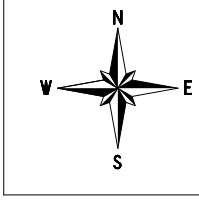
In addition, WCC should consider putting measures in place to manage the risk associated with potential future groundwater abstractions in the vicinity of the site.

SPR 10

The findings of the assessment indicate that, while there is a potential source of landfill gas present, it is not likely to be significant. This should be confirmed through further monitoring works given the proximity of residential houses to the site.

Figures

North



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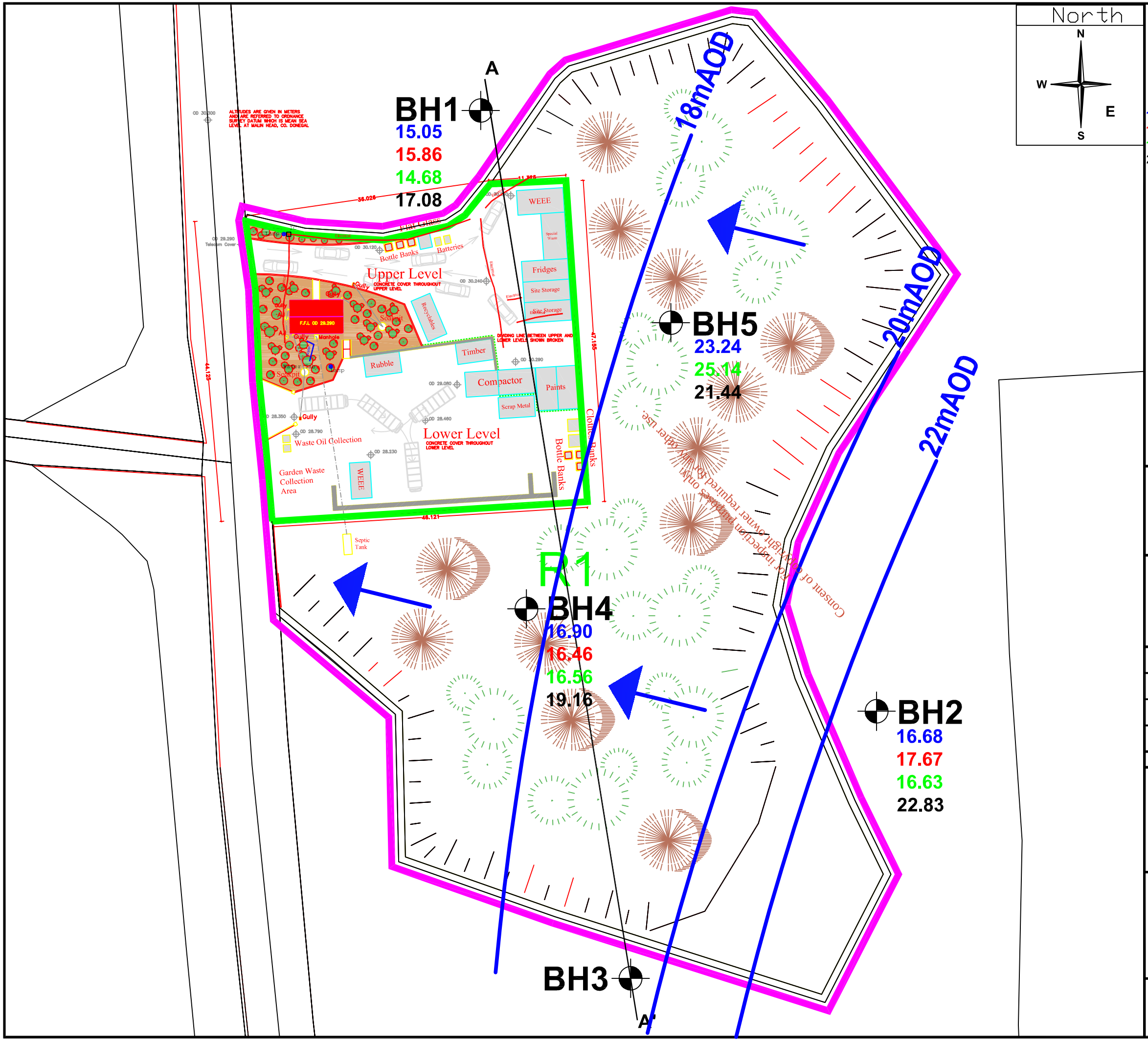
CLIENT
WATERFORD COUNTY COUNCIL

PROJECT LOCATION
LISMORE LANDFILL, CO. WATERFORD
TIER 2 ASSESSMENT OF FORMER LANDFILL

DRAWING TITLE
FIGURE 1 - SITE LOCATION PLAN

ENVIRONMENTAL CONSULTANTS
URS
Iveagh Court, 6–8 Harcourt Road, Dublin2
TEL +353 1 4155100 FAX +353 1 4155101

DRAWN	TRACED	CHECKED	APPROVED	DATE
SML		DM	DM/DUB	09.12.10
SCALE	Job No.			REV.
1:50,000	49341903			A



North

N
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S

KEY:

- MONITORING WELL LOCATIONS
- A A' CONCEPTUAL SITE MODEL LOCATION
- 16.68 RELATIVE WATER LEVELS(m) NOV 2010
- 17.67 RELATIVE WATER LEVELS(m) 4 JAN 2011
- 16.63 RELATIVE WATER LEVELS(m) 17 JAN 2011
- 22.83 RELATIVE WATER LEVELS(m) OCT 2011
- GROUNDWATER CONTOURS
- INFERRED GROUNDWATER FLOW DIRECTION

Client

WATERFORD COUNTY COUNCIL

CONSULTING ENGINEERS

URS

4th Floor Iveagh Court, 6-8 Harcourt Rd, Dublin 2. Tel: 00353 (1) 4155100

Office of Origin			
DUBLIN			
Designed	Date	Checked	Date
SML	15.11.10	DM	14.12.10
Drawn	Date	Approved	Date
SML	14.12.10	DM	14.12.10
Original Scale		Original Size	
		A3	

DIMENSIONS IN mm UNLESS STATED OTHERWISE. DO NOT SCALE

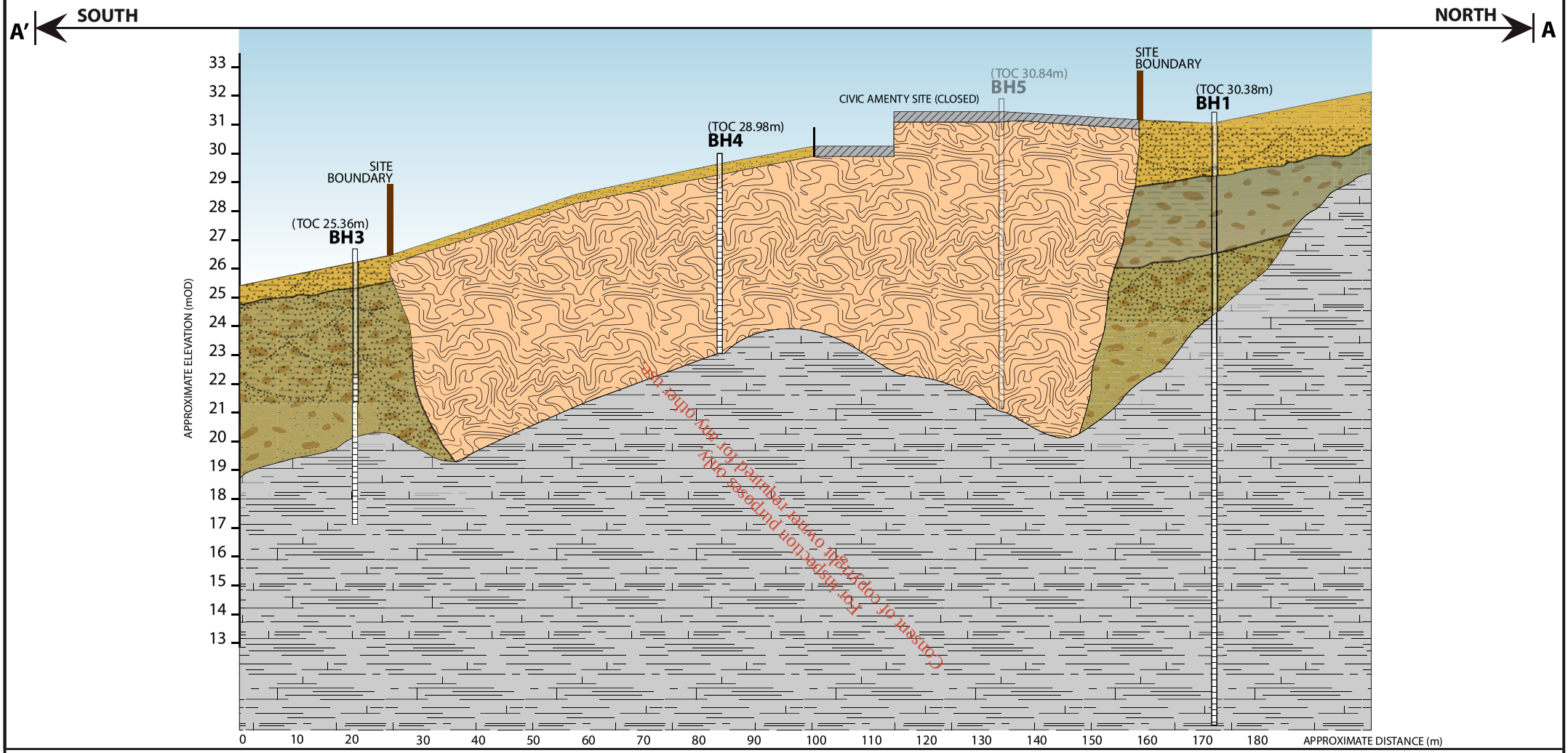
Contract

LISMORE LANDFILL, CO. WATERFORD
TIER 2 ASSESSMENT OF FORMER LANDFILL

Drg. Title

FIGURE 2 _ MONITORING WELL LOCATIONS AND GROUNDWATER CONTOURS

Drg. No.	Rev.	Sheet No.
49341903		



CLIENT

WATERFORD COUNTY COUNCIL

PROJECT

LISMORE LANDFILL, CO. WATERFORD
TIER 2 ASSESSMENT OF FORMER LANDFILL

DRAWING TITLE

FIGURE 3 - CONCEPTUAL SITE MODEL - GEOLOGICAL CROSS SECTION

SOURCES

- SANDY CLAY
- HARDSTANDING
- GRAVELLY CLAY
- SANDY/CLAYEY GRAVEL
- LIMESTONE BEDROCK
- WASTE BODY

DRAWN	TRACED	CHECKED	APPROVED	DATE
SML		DM	DM/DUB	21.12.10

SCALE	Job No:	REV
N.T.S	49341903	A

ENVIRONMENTAL CONSULTANTS

URS

Iveagh Court, 6–8 Harcourt Road, Dublin2
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Tables

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 1: Soil Analytical Results: Hydrocarbons
Land use: Commercial/Industrial

Sample Type				Soil	Soil	Soil	Soil	Soil
Sample ID				BH03	BH04	BH04	BH05	BH05
Sample Depth				0.5	4.2	5.9	2.0	4.0
Date Sampled				18-Nov-10	19-Nov-10	19-Nov-10	19-Nov-10	19-Nov-10
Parameters	**Units**	**MDL**	**Human Health GAC - Soil**					
Hydrocarbons								
Aromatics								
C5-C7	mg/kg	0.1	24,500	-	-	-	-	-
C7-C8	mg/kg	0.1	61,000	-	-	-	-	-
C8-C10	mg/kg	0.1	4,540	-	-	-	1.3	0.2
C10-C12	mg/kg	0.2	20,000	-	-	-	15	9
C12-C16	mg/kg	4	36,700	-	-	-	20	20
C16-C21	mg/kg	7	28,300	-	40	-	129	140
C21-C35	mg/kg	7	28,400	-	330	148	812	935
Total Aromatics	mg/kg	19	nv	-	370	148	977	1104
Aliphatics								
C5-C6	mg/kg	0.1	3,540	-	-	-	-	-
C6-C8	mg/kg	0.1	9,790	-	-	-	0.1	0.3
C8-C10	mg/kg	0.1	2,670	-	0.1	-	10.2	2.1
C10-C12	mg/kg	0.2	12,900	-	-	-	83	24
C12-C16	mg/kg	4	68,200	-	-	-	-	30
C16-C21	mg/kg	7	1,640,000	-	-	-	27	133
C21-C35	mg/kg	7	1,640,000	-	419	235	164	1619
Total Aliphatics (MO)	mg/kg	19	nv	-	419	235	284	1808
Total TPH	mg/kg	38	nv	-	789	383	1261	2912
BTEX								
Benzene	mg/kg	0.005	24.9	-	-	-	-	-
Toluene	mg/kg	0.005	61,000	-	-	-	0.048	0.021
Ethylbenzene	mg/kg	0.005	18,100	-	-	-	0.294	0.08
Total Xylene	mg/kg	0.01	7,520	-	-	-	1.008	0.187
BTEX	mg/kg	0.005	nv	-	-	-	1.35	0.288
MTBE	mg/kg	0.005	5,740	-	-	-	-	-
TOC	%	0.2	nv	0.3	1.3	1	3.4	5.6

xx	Exceeds Human Health Generic
MDL	Method Detection Limit
-	Less than MDL
na	Not Analysed
nv	No Value

Prepared By: DM
Checked By: EF

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co.
Job No: 49341903
Table 2: Soil Analytical Results: PAHs
Land use: Commercial/Industrial

Sample Type				Soil	Soil	Soil	Soil	Soil
Sample ID				BH03	BH04	BH04	BH05	BH05
Sample Depth				0.5	4.2	5.9	2.0	4.0
Date Sampled				18-Nov-10	19-Nov-10	19-Nov-10	19-Nov-10	19-Nov-10
Parameters	**Units**	**MDL**	**Human Health GAC - Soil**					
PAHs								
Naphthalene	mg/kg	0.04	230	-	-	-	-	0.2
Acenaphthylene	mg/kg	0.03	91,000	-	-	-	-	0.04
Acenaphthene	mg/kg	0.05	90,600	-	0.060	0.06	0.08	0.1
Fluorene	mg/kg	0.04	66,600	-	0.070	0.06	0.07	0.11
Phenanthrene	mg/kg	0.03	22,300	-	0.530	0.4	0.25	0.59
Anthracene	mg/kg	0.04	534,000	-	0.170	0.12	0.08	0.14
Fluoranthene	mg/kg	0.03	22,700	-	1.34	0.78	0.42	0.75
Pyrene	mg/kg	0.03	54,400	-	1.210	0.66	0.41	0.59
Benz(a)anthracene	mg/kg	0.06	95.2	-	0.79	0.45	0.17	0.27
Chrysene	mg/kg	0.02	142	-	0.690	0.38	0.22	0.33
Benzo[bk]fluoranthene	mg/kg	0.07	144	-	1.08	0.49	0.39	0.47
Benzo(a)pyrene	mg/kg	0.04	14.4	-	0.69	0.33	0.24	0.28
Indeno(123cd)pyrene	mg/kg	0.04	61.4	-	0.45	0.23	0.16	0.2
Dibenzo(ah)anthracene	mg/kg	0.04	13.0	-	0.16	0.07	-	0.05
Benzo(ghi)perylene	mg/kg	0.04	662	-	0.42	0.2	0.14	0.21
Coronene	mg/kg	0.04	nv	-	-	-	-	-
Total 17 EPA PAHs	mg/kg	0.64	nv	-	7.66	4.23	2.63	4.33

xx	Exceeds Human Health Generic
MDL	Method Detection Limit
-	Less than MDL
na	Not Analysed
nv	No Value

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 3: Soil Analytical Results: Heavy Metals & PCBs
Land use: Commercial/Industrial

Sample Type					Soil	Soil	Soil	Soil	Soil
Sample ID					BH03	BH04	BH04	BH05	BH05
Sample Depth					0.5	4.2	5.9	2.0	4.0
Date Sampled					18-Nov-10	19-Nov-10	19-Nov-10	19-Nov-10	19-Nov-10
Parameters	**Units**	**MDL**	**Human Health GAC - Soil**	**EPA Background**					
Heavy Metals									
Arsenic	mg/kg	0.5	640	21.9	6.8	9	14.3	9	8.1
Cadmium	mg/kg	0.1	230	1.652	**9.1**	0.7	0.6	0.6	2.8
Chromium	mg/kg	0.5	34.8	86.8	9.6	13.5	12.9	16.3	15.7
Copper	mg/kg	1	71,700	45.9	14	17	14	36	**58**
Mercury	mg/kg	0.1	21	0.237	0.2	0.1	0.1	-	**0.9**
Nickel	mg/kg	0.7	1,800	50	22.8	22.9	22	20	18.1
Lead	mg/kg	5	6,010	61.9	38	47	**192**	52	**113**
Selenium	mg/kg	1	13,000	2.67	-	-	-	-	1
Zinc	mg/kg	5	665,000	144.7	**459**	**168**	**163**	**160**	**6066**
Boron	mg/kg	0.1	200,000	nv	0.5	1.6	1.2	5.8	7.8
Barium	mg/kg	1	22,100	454.5	36	84	112	81	144
Aluminium	mg/kg	50	990,000	66500	6568	8463	7875	7927	5853
Antimony	mg/kg	1	7,550	1.54	1	1	**2**	1	**3**
Molybdenum	mg/kg	0.1	17,700	3.29	0.7	0.6	0.5	1.5	0.9
PCB Congerers									
PCB 28	mg/kg	0.005	13.4	nv	-	-	-	-	-
PCB 52	mg/kg	0.005	12.9	nv	-	-	-	-	-
PCB 101	mg/kg	0.005	15.0	nv	-	-	-	-	-
PCB 118	mg/kg	0.005	77.8	nv	-	-	-	-	-
PCB 138	mg/kg	0.005	15.2	nv	-	-	-	-	-
PCB 153	mg/kg	0.005	15.3	nv	-	-	-	-	-
PCB 180	mg/kg	0.005	15.3	nv	-	-	-	-	-
Total 7 PCBs	mg/kg	0.035	nv	nv	-	-	-	-	-

xx	Exceeds Human Health Generic
xx	Exceeds EPA Background Concentrations
MDL	Method Detection Limit
-	Less than MDL
na	Not Analysed
nv	No Value
IR	Insignificant risk to identified potential

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 4: Soil Leachate Analytical Results: Hydrocarbons

Sample Type				Soil Leachate	Soil Leachate	Soil Leachate	Soil Leachate
Sample ID				BH04	BH04	BH05	BH05
Sample Depth				4.2	5.9	2.0	4.0
Date Sampled				19-Nov-10	19-Nov-10	19-Nov-10	19-Nov-10
Parameters	**Units**	**MDL**	**GW Regs / IGV**				
Hydrocarbons							
Aromatics							
C5-C7	µg/l	5	nv	-	-	-	-
C7-C8	µg/l	5	nv	-	-	-	-
C8-C10	µg/l	5	nv	-	-	95	31
C10-C12	µg/l	5	nv	-	-	120	-
C12-C16	µg/l	10	nv	-	-	-	-
C16-C21	µg/l	10	nv	-	-	78	-
C21-C35	µg/l	10	nv	605	-	1,269	-
Total Aromatics	µg/l	10	nv	605	-	1,562	31
Aliphatics							
C5-C6	µg/l	5	nv	-	-	-	-
C6-C8	µg/l	5	nv	-	-	-	-
C8-C10	µg/l	5	nv	-	-	272	112
C10-C12	µg/l	5	nv	-	-	1,754	-
C12-C16	µg/l	10	nv	-	-	151	-
C16-C21	µg/l	10	nv	-	-	298	-
C21-C35	µg/l	10	nv	1,222	-	7,827	-
Total Aliphatics (MO)	µg/l	10	nv	1,222	-	9,702	112
Total TPH	µg/l	10	10	**1,827**	-	**11,264**	**143**
BTEX							
Benzene	µg/l	5	0.75	-	-	-	-
Toluene	µg/l	5	10	-	-	-	-
Ethylbenzene	µg/l	5	10	-	-	**17**	7
Total Xylene	µg/l	10	10	-	-	**78**	**24**
BTEX	µg/l	10	nv	-	-	95	31
MTBE	µg/l	5	30	-	-	-	-

xx	GW Regs = EC Environmental Objectives (Groundwater) Regulations, 2010, S.I. No. 9 of 2010
	IGV = Interim Guideline Value (Towards Setting Guideline Values for the Protection of Groundwater in Ireland – Interim Report, EPA)
MDL	Method Detection Limit
-	Less than MDL
na	Not Analysed
nv	No Value

Prepared By: DM
Checked By: EF

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 5: Soil Leachate Analytical Results: Heavy Metals

Sample Type				Soil Leachate	Soil Leachate	Soil Leachate	Soil Leachate
Sample ID				BH04	BH04	BH05	BH05
Sample Depth				4.2	5.9	2.0	4.0
Date Sampled				19-Nov-10	19-Nov-10	19-Nov-10	19-Nov-10
Parameters	**Units**	**MDL**	**GW Regs / IGV**				
Heavy Metals							
Arsenic	µg/l	2.5	7.5	**10.8**	5.3	**8.2**	8
Boron	µg/l	12	750	64	47	177	323
Cadmium	µg/l	0.5	3.75	-	-	-	-
Chromium	µg/l	1.5	37.5	4.2	2.7	2.2	2.3
Copper	µg/l	7	30	7	7	-	-
Mercury	µg/l	1	0.75	-	-	-	-
Nickel	µg/l	2	15	4	3	7	11
Lead	µg/l	5	18.75	6	18	-	-
Selenium	µg/l	3	nv	-	-	-	-
Zinc	µg/l	3	100	18	18	11	15
Aluminium	µg/l	20	150	**1928**	**980**	**883**	**507**
Barium	µg/l	3	100	17	26	26	25
Antimony	µg/l	2	nv	3	2	2	5
Molybdenum	µg/l	2	nv	15	25	25	39

xx	GW Regs = EC Environmental Objectives (Groundwater) Regulations, 2010, S.I. No. 9 of 2010
	IGV = Interim Guideline Value (Towards Setting Guideline Values for the Protection of Groundwater in Ireland – Interim Report, EPA)
MDL	Method Detection Limit
-	Less than MDL
na	Not Analysed
nv	No Value
IR	Insignificant risk to identified potential

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 6: Soil Leachate Analytical Results: Miscellaneous

Sample Type				Soil Leachate	Soil Leachate	Soil Leachate	Soil Leachate
Sample ID				BH04	BH04	BH05	BH05
Sample Depth				4.2	5.9	2.0	4.0
Date Sampled				19-Nov-10	19-Nov-10	19-Nov-10	19-Nov-10
Parameter	**Units**	**MDL**	**GW Regs / IGV**				
Anions and Cations							
Fluoride	mg/l	0.3	1	-	-	-	-
Total Dissolved Solids	mg/l	35	1000	223	178	283	343
Total Phenols HPLC	mg/l	0.15	0.0005	-	-	-	**0.39**
DOC	mg/l	2	nv	19	14	32	77
Total Alkalinity as $CaCO_3$	mg/l	1	nac	125	na	204	na
Ammonia (as ammonium)**	mg/l	0.03	0.065	**8.32**	na	**21.86**	na
Biocarbonate Alkalinity as $CaCO_3$	mg/l	1	nac	125	na	175	na
Calcium	mg/l	0.2	200	31.9	na	36.4	na
Carbonate Alkalinity as $CaCO_3$	mg/l	1	nac	-	na	29	na
Chloride	mg/l	0.3	187.5	8.7	7.4	19.1	34.7
Total Hardness	mg/l	1	nv	97	na	120	na
Iron	mg/l	0.02	0.2	**1.229**	na	**0.539**	na
Magnesium	mg/l	0.1	50	4.3	na	7	na
Manganese	mg/l	0.002	0.05	**0.083**	na	**0.381**	na
Nitrate	mg/l	0.2	25	0.7	na	0.3	na
Nitrite	mg/l	0.02	0.1	0.03	na	-	na
Total Oxidised Nitrogen	mg/l	0.05	nac	-	na	-	na
Orthophosphate	mg/l	0.06	0.03	**0.88**	na	**0.06**	na
Sodium	mg/l	0.1	150	5.5	na	14.9	na
Potassium	mg/l	0.1	5	**17.9**	na	**21.7**	na
Sulphate	mg/l	0.05	200	31.05	41.55	44.00	23.38

xx GW Regs = EC Environmental Objectives (Groundwater) Regulations, 2010, S.I. No. 9 of 2010

IGV = Interim Guideline Value (Towards Setting Guideline Values for the Protection of Groundwater in Ireland – Interim Report, EPA)

MDL Method Detection Limit
\- Less than the MDL
na Not Analysed
nac No abnormal change
nv No Value
* Measured in the field
** Conversion factor of 1.286 used to convert ammoniacial nitrogen (as N) to ammonium (NH_4)

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 7: Groundwater Field Parameters

Sample ID		BH01	BH02	BH03	BH05	Tobar na Gloire Spring
	GW Regs / IGV					
Temp. (°C)	25	10.23	11.42	11.66	na	na
pH	>6.5 - <9.5	7.13	7.08	7.11	7.97	6.02
EC (uS/cm)	1875	959	770	700	**7517**	na
Redox (mV)*	nv	123.6	124.6	99.8	na	na
Dissolved Oxygen (mg/l)	nac	3.80	3.09	2.36	na	na
Comments	nv	Sampled water was slightly silty. NEC.	Sampled water was silty and brown in colour. Recovery poor. NEC.	Sampled water was clear. NEC.	Leachate, black, strong odour.	na

xx	GW Regs = EC Environmental Objectives (Groundwater) Regulations, 2010, S.I. No. 9 of 2010
	IGV = Interim Guideline Value (Towards Setting Guideline Values for the Protection of Groundwater in Ireland – Interim Report, EPA)
nv	No Value
na	Not Analysed
NEC	No Evidence of Contamination
*	Redox value corrected by adding 200 mV to the field reading in accordance with manufacturer instructions.
NAC	No abnormal change

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 8: Groundwater Analytical Results: Hydrocarbons

Sample Type				Groundwater	Groundwater	Groundwater	Leachate	Groundwater
Sample ID				BH01	BH02	BH03	BH05	Tobar na Gloire Spring
Date Sampled				22-Nov-10	22-Nov-10	22-Nov-10	22-Nov-10	18-Nov-10
Parameter	**Units**	**MDL**	**GW Regs / IGV**					
Aliphatics								
C5-C6	ug/l	5	nv	-	-	-	-	na
C6-C8	ug/l	5	nv	-	-	-	-	na
C8-C10	ug/l	5	nv	-	-	-	-	na
C10-C12	ug/l	5	nv	-	-	-	-	na
C12-C16	ug/l	10	nv	-	-	-	-	na
C16-C21	ug/l	10	nv	-	-	-	-	na
C21-C35	ug/l	10	nv	-	-	-	-	na
Total Aliphatics	ug/l	10	nv	-	-	-	-	na
Aromatics								
C5-C7	ug/l	5	nv	-	-	-	-	na
C7-C8	ug/l	5	nv	-	-	-	-	na
C8-C10	ug/l	5	nv	-	-	-	-	na
C10-C12	ug/l	5	nv	-	-	-	5	na
C12-C16	ug/l	10	nv	-	-	-	1,167	na
C16-C21	ug/l	10	nv	-	-	-	14	na
C21-C35	ug/l	10	nv	-	-	-	-	na
Total Aromatics	ug/l	10	nv	-	-	-	1,186	na
TPH	ug/l	10	10	-	-	-	**1,186**	na
MTBE	ug/l	5	30	-	-	-	-	na
Benzene	ug/l	5	0.75	-	-	-	-	-
Toulene	ug/l	5	10	-	-	-	-	na
Ethylbenzene	ug/l	5	10	-	-	-	-	na
Xylenes	ug/l	10	10	-	-	-	-	na

xx GW Regs = EC Environmental Objectives (Groundwater) Regulations, 2010, S.I. No. 9 of 2010

IGV = Interim Guideline Value (Towards Setting Guideline Values for the Protection of Groundwater in Ireland – Interim Report, EPA)

MDL Method Detection Limit
\- Less than the MDL
na Not Analysed
nv No Value

Prepared By: DM
Checked By: EF

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 9: Groundwater Analytical Results: Heavy Metals

Sample Type				Groundwater	Groundwater	Groundwater	Leachate	Groundwater
Sample ID				BH01	BH02	BH03	BH05	Tobar na Gloire Spring
Date Sampled				22-Nov-10	22-Nov-10	22-Nov-10	22-Nov-10	18-Nov-10
Parameters	**UNITS**	**MDL**	**GW Regs / IGV**					
Metals								
Arsenic	ug/l	2.5	7.5	-	-	-	6.5	0.9
Boron	ug/l	12	750	93	77	53	**1691**	na
Cadmium	ug/l	0.5	3.75	-	-	0.8	-	-
Chromium	ug/l	1.5	37.5	3.2	14.8	-	16.6	-
Copper	ug/l	7	30	-	-	-	-	-
Mercury	ug/l	1	0.75	-	-	-	-	-
Nickel	ug/l	2	15	-	-	-	**18**	0.6
Lead	ug/l	5	18.75	-	-	-	-	0.3
Selenium	ug/l	3	nv	-	-	-	-	na
Zinc	ug/l	3	100	21	46	99	21	na
Aluminium	ug/l	20	150	-	-	-	25	na
Barium	ug/l	3	100	24	11	11	84	na
Antimony	ug/l	2	nv	-	-	-	7	-
Molybdenum	ug/l	2	nv	-	-	-	53	na

xx	GW Regs = EC Environmental Objectives (Groundwater) Regulations, 2010, S.I. No. 9 of 2010
	IGV = Interim Guideline Value (Towards Setting Guideline Values for the Protection of Groundwater in Ireland – Interim Report, EPA)
MDL	Method Detection Limit
-	Less than the MDL
na	Not Analysed
nv	No Value

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 10: Groundwater Analytical Results: PAHs

Sample Type				Groundwater
Sample ID				Tobar na Gloire Spring
Date Sampled				18-Nov-10
Parameter	**Units**	**MDL**	**GW Regs / IGV**	
PAHs				
Naphthalene	ug/l	0.01	1	-
Acenaphthylene	ug/l	0.01	nv	-
Acenaphthene	ug/l	0.01	nv	-
Fluorene	ug/l	0.01	nv	-
Phenanthrene	ug/l	0.01	nv	-
Anthracene	ug/l	0.01	10000	-
Fluoranthene	ug/l	0.01	1	-
Pyrene	ug/l	0.01	nv	-
Chrysene	ug/l	0.01	nv	-
Dibenzo(ah)anthracene	ug/l	0.01	nv	-
Benzo(b)fluoranthene	ug/l	0.01	0.05*	-
Benzo(k)fluoranthene	ug/l	0.01	0.05*	-
Benzo(ghi)perylene**	ug/l	0.01	0.05	-
Indeno(123cd)pyrene**	ug/l	0.01	0.05	-
Benzo(a)pyrene	ug/l	0.003	0.0075	-
Sum 4 PAHs	ug/l	nv	0.1	-
Sum 16 PAHs	ug/l	nv	0.075	-

xx	GW Regs = EC Environmental Objectives (Groundwater) Regulations, 2010, S.I. No. 9 of 2010 IGV = Interim Guideline Value (Towards Setting Guideline Values for the Protection of Groundwater in Ireland – Interim
MDL	Method Detection Limit
-	Less than the MDL
na	Not Analysed
nv	No Value
*	Laboratory results are presented as a sum of the 2 compounds. Consequently, the lower IGV of 0.05mg/l for
**	Included in sum of 4 PAHs

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 11: Groundwater Analytical Results: Various

Sample Type				Groundwater	Groundwater	Groundwater	Leachate	Groundwater
Sample ID				BH01	BH02	BH03	BH05	Tobar na Gloire Spring
Date Sampled				22-Nov-10	22-Nov-10	22-Nov-10	22-Nov-10	18-Nov-10
Parameter	**Units**	**MDL**	**GW Regs / IGV**					
Total Organic Carbon	mg/l	1	nac	4	6	5	35	na
Total Alkalinity as $CaCO_3$	mg/l	1	nac	495	1845	339	3238	na
Ammonia (as ammonium)**	mg/l	0.03	0.065	0.044	**0.085**	**0.731**	**0.224**	-
Biocarbonate Alkalinity as $CaCO_3$	mg/l	1	nac	495	1845	339	3238	na
Calcium	mg/l	0.2	200	160.6	122.7	134.3	79.5	na
Carbonate Alkalinity as $CaCO_3$	mg/l	1	nac	-	-	-	-	na
Chloride	mg/l	0.3	187.5	21.4	38.6	19.0	77.3	21.7
Total Hardness	mg/l	1	nv	437	358	358	544	na
Iron	mg/l	0.02	0.2	-	0.067	-	**0.838**	na
Magnesium	mg/l	0.1	50	8.5	12.4	5.4	**82.3**	na
Manganese	mg/l	0.002	0.05	0.009	0.016	0.002	**0.483**	na
Nitrate	mg/l	0.2	25	2.6	**35.2**	**29.2**	0.5	4.4
Nitrite	mg/l	0.02	0.1	**0.387**	**1.754**	-	-	na
Total Oxidised Nitrogen	mg/l	0.05	nac	0.71	8.48	6.60	0.10	na
Orthophosphate	mg/l	0.06	0.03	-	-	-	**2.27**	-
Potassium	mg/l	0.1	5	3.8	**6.9**	2.9	**321.8**	na
Sodium	mg/l	0.1	150	10.2	21.0	6.8	**190.5**	na
Sulphate	mg/l	0.05	200	16.40	32.39	13.19	93.31	na
Organics								
Bromoform	ug/l	1	nv	na	na	na	na	-
Bromodichloromethane	ug/l	2	nv	na	na	na	na	-
Chloroform	ug/l	1	12	na	na	na	na	-
Dibromochloromethane	ug/l	1	nv	na	na	na	na	-
Total Trihalomethanes	ug/l	5	75	na	na	na	na	-
1,2-Dichloroethane	ug/l	0.1	2.25	na	na	na	na	-
Tetrachloroethene	ug/l	0.1	7.5	na	na	na	na	-
Trichloroethene	ug/l	0.1	7.5	na	na	na	na	-
Total Tetrechloroethene & Trichloroethene	ug/l	0.1	7.5	na	na	na	na	-

xx	GW Regs = EC Environmental Objectives (Groundwater) Regulations, 2010, S.I. No. 9 of 2010 IGV = Interim Guideline Value (Towards Setting Guideline Values for the Protection of Groundwater in Ireland – Interim Report, EPA)
MDL	Method Detection Limit
-	Less than the MDL
na	Not Analysed
nac	No abnormal change
nv	No Value
*	Measured in the field
**	Conversion factor of 1.286 used to convert ammoniacial nitrogen (as N) to ammonium (NH_4)

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 12: Groundwater Analytical Results: Biological

Sample Type				Groundwater	Groundwater	Groundwater	Leachate	Groundwater
Sample ID				BH01	BH02	BH03	BH05	Tobar na Gloire Spring
Date Sampled				22-Nov-10	22-Nov-10	22-Nov-10	22-Nov-10	18-Nov-10
Parameter	**Units**	**MDL**	**GW Regs / IGV**					
Biological								
Biological Oxygen Demand (BOD)	mg/l	1	nv	6	34	2	65,100	-
Chemical Oxygen Demand (COD)	mg/l	7	nv	1,800	5,995	120	35,300	2
Faecal Coliforms	cfu/100ml	3	0	-	**7**	**4**	na	na

xx	GW Regs = EC Environmental Objectives (Groundwater) Regulations, 2010, S.I. No. 9 of 2010
	IGV = Interim Guideline Value (Towards Setting Guideline Values for the Protection of Groundwater in Ireland – Interim Report, EPA)
MDL	Method Detection Limit
-	Less than the MDL
na	Not Analysed
nv	No Value

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 13: Surface Water Analytical Results: Various

Sample ID				SW01 (Upstream)	SW02 (Downstream)
Date Sampled				18/11/10	18/11/10
Sample Matrix				Surface Water	Surface Water
Parameters	**Units**	**MDL**	**Surface Water Regs / EQSs**		
VOCs					
Benzene	µg/l	0.1	10	-	-
Tetrachloroethene	µg/l	0.1	10	-	-
Trichloroethene	µg/l	0.1	10	-	-
THMs					
Bromoform	µg/l	1	nv	-	-
Bromodichloromethane	µg/l	2	nv	-	-
Chloroform	µg/l	1	2.5	-	-
Dibromochloromethane	µg/l	1	nv	-	-
Inorganics					
pH	pH Units	nv	6 - 9	6.9	7.01
Ammonia	mg/l	0.01	0.14	0.02	0.01
Phosphate	mg/l	0.01	0.075	0.04	0.04
Chloride	mg/l	Not Known	250	17.9	17.95
Nitrate	mg/l	Not Known	50	2.5	2.8
BOD	mg/l	1	2.6	-	-
COD	mg/l	Not Known	nv	9	12

xx	SW Regs = EC Environmental Objectives (Surface Waters) Regulations, 2009, S.I. No. 272 of 2009
	EQS = Environmental Quality Standards, EPA 1997)
MDL	Method Detection Limit
-	Less than MDL
na	Not Analysed
nv	No Value

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 14: Surface Water Analytical Results: PAHs

Sample ID				SW01 (Upstream)	SW02 (Downstream)
Date Sampled				18/11/10	18/11/10
Sample Matrix				Surface Water	Surface Water
Parameters	**Units**	**MDL**	**Surface Water Regs / EQSs**		
PAHs					
Naphthalene	µg/l	0.01	2.40	-	-
Acenaphthylene	µg/l	0.01	nv	-	-
Acenaphthene	µg/l	0.01	nv	-	-
Fluorene	µg/l	0.01	nv	-	-
Phenanthrene	µg/l	0.01	nv	-	-
Anthracene	µg/l	0.01	0.10	-	-
Fluoranthene*	µg/l	0.01	0.10	-	-
Pyrene	µg/l	0.01	nv	-	-
Chrysene	µg/l	0.01	nv	-	-
Dibenzo(ah)anthracene	µg/l	0.01	nv	-	-
Benzo(b)fluoranthene*	µg/l	0.01	0.03	-	-
Benzo(k) fluoranthene*	µg/l	0.01	0.03	-	-
Benzo(ghi)perylene*	µg/l	0.01	0.002	-	-
Indeno(123cd)pyrene*	µg/l	0.01	0.002	-	-
Benzo(a)pyrene*	µg/l	0.003	0.05	-	-
Sum 6 PAHs	µg/l	0.195	0.2	-	-
Sum 16 PAHs	µg/l	0.195	nv	-	-

xx	SW Regs = EC Environmental Objectives (Surface Waters) Regulations, 2009, S.I. No. 272 of 2009 EQS = Environmental Quality Standards, EPA 1997)
MDL	Method Detection Limit
-	Less than the MDL
na	Not Analysed
nv	No Value
*	Included in sum of 6 PAHs

Client: Waterford County Council
Project: Tier 2 Investigation
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 15: Surface Water Analytical Results: Metals

Sample ID				SW01 (Upstream)	SW02 (Downstream)
Date Sampled				22/10/10	22/10/10
Sample Matrix				Surface Water	Surface Water
	MDL	**UNITS**	**Surface Water Regs / EQSs**		
Metals					
Arsenic	0.2	µg/l	20	0.8	0.9
Cadmium	0.1	µg/l	5	0.2	0.2
Chromium	1	µg/l	3.4	-	-
Copper	0.000003	µg/l	5	-	-
Mercury	0.2	µg/l	1	-	-
Nickel	0.5	µg/l	20	0.9	1.4
Lead	0.3	µg/l	7	0.4	0.5
Antimony	0.1	µg/l	20	-	-

xx	SW Regs = EC Environmental Objectives (Surface Waters) Regulations, 2009, S.I. No. 272 of 2009 EQS = Environmental Quality Standards, EPA 1997)
MDL	Method Detection Limit
-	Less than MDL
na	Not Analysed
nv	No Value

Client: Waterford County Council
Project: Tier 2 Assessment
Location: Townspark East, Lismore, Co. Waterford
Job No: 49341903
Table 16: Landfill Gas Readings

Field Identification	Date	CH_4 (%)	O_2 (%)	CO_2 (%)	Atmospheric Pressure (mB)
BH01	22/11/2010	0.00	20.60	0.10	998
BH02	22/11/2010	0.00	20.90	0.10	1001
BH03	22/11/2010	0.00	20.60	0.10	994
BH04	22/11/2010	0.00	20.80	0.10	1008
BH05	22/11/2010	1.20	19.50	0.80	1004

Appendix A - Geophysics Survey

Lismore Landfill Site

Co. Waterford

Geophysical Survey

Report Status: Final

MGX Project Number:5507

MGX File Ref: 5507f-005.doc

12th December 2010

Confidential Report To:

URS / Scott Wilson Ireland
Iveagh Court
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Report submitted by :
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Minerex
Geophysics Limited

Subsurface Geophysical Investigations

EXECUTIVE SUMMARY

- Minerex Geophysics Ltd. (MGX) carried out a geophysical survey consisting of EM31 ground conductivity and 2D-Resistivity for assessment of a former landfill site at Townspark East, Lismore, County Waterford.
- The main objectives of the survey were to determine the ground conditions under the site, the location and extent of waste bodies and areas of leachate.
- The survey showed that there is a landfill / waste body (Layer 1) under the central part of the survey area.
- The landfill body covers an area of approx. 9500 m^2 and this area is inside the wooded/civic amenity area, within the magenta line shown on the maps. No waste or fill material was detected outside this line.
- This body is up to 115m in length and reaches a maximum thickness of about 18m. The deepest part may contain some leachate into rock. The waste body has an approximate volume of 95,000m^3 which is based on an average fill and leachate thickness of 10m.
- Layer 3 contains topsoil, gravelly clay or possible weathered and fractured rock and has a thickness of 0.5m – 13.0m. This layer forms the surface layer external to the area occupied by the landfill / waste body.
- Layer 4 is limestone with some clean sand/gravel at the top and the depth to the top of this layer is very variable between 0.5m and 23.0m below ground level.
- External to the backfilled area the depth to the top of layer 4 is shallow, between 0.5m and 5.0m.
- Where the limestone was previously excavated to create the old quarry the depth is now 9.0 – 23.0m. The lower part of these low resistivity zones may be caused by leachate into rock.
- The geophysical results were confirmed in the drilling programme and the boreholes locations and abbreviated borehole logs are indicated on the maps and figures.

CONTENTS

List of Tables, Maps and Figures:

1. INTRODUCTION

1.1 Background

Minerex Geophysics Ltd. (MGX) carried out a geophysical survey for assessment of a former landfill at Townspark East to the south of the village of Lismore in County Waterford. The survey consisted of acquiring EM31 Ground Conductivity and 2D Resistivity datasets. The survey was commissioned by URS / Scott Wilson Ireland. The geophysical survey was selected as a fast, reliable and non-intrusive method to investigate the site.

1.2 Objectives

The main objectives of the geophysical survey were:

- To determine the ground conditions under the site
- To determine the location and extent of the landfill / waste body
- To determine the presence of leachate plumes

1.3 Site Description

The site covers approximately 0.95Ha and was operated as a municipal landfill between circa 1972 and 1991. The facility mainly accepted domestic and commercial waste but some industrial waste of an unknown origin may also be present on site. The landfill previously operated as a limestone quarry and is expected to be ~5 – 10m deep. The site is now capped with ~0.3m of topsoil. There is a slight rise in elevation from south – north.

1.4 Geology

The bedrock geological map of East Cork - Waterford indicates that the site is underlain by Carboniferous lithologies of Waulsortian Limestone – a massive unbedded lime mudstone (GSI 1995).

1.5 Report

This report includes the results and interpretation of the geophysical survey. Maps, figures and tables are included to illustrate the results of the survey. More detailed descriptions of geophysical methods and measurements can be found in GSEG (2002), Milsom (1989) and Reynolds (1997).

The client provided a map of the site which was used as the background map in this report.

The interpretative nature and the non-invasive survey methods must be taken into account when considering the results of this survey and Minerex Geophysics Limited, while using appropriate practice to execute, interpret and present the data, give no guarantees in relation to the existing subsurface.

2. GEOPHYSICAL SURVEY

The methodology consisted of EM31 Ground Conductivity and 2D-Resistivity profiles.

EM31 was done on a nominal 2 x 5 m grid to determine the ground conductivities, anomalous zones and to obtain a zonation of the site. Where the central part of the site was overgrown no EM31 data was acquired. Data was acquired over an area of ~0.95Ha. The data was positioned and the measured conductivities are displayed on a contour map (Map 2). The locations were measured with a SERES DGPS system attached to the EM31 and all data was jointly stored in a data logger. The conductivity meter was a GEONICS EM31 with Allegro data logger and NAV31 data acquisition software. The instrument was checked at a base station and no drift occurred.

EM31 ground conductivity determines the bulk conductivity of the subsurface over a typical depth between 0 and 6 m bgl. and over a radius of approx. 5m around the instrument. When looking for clay, silt and water infill within rock occurring at relatively shallow depth the EM31 can find anomalous rock zones with a vertical extent of approx. 3m. The measurements are disturbed by metal and other conductive objects within the range of the instrument and therefore no geological interpretations can be made in the vicinity of such man-made objects.

During 2D-Resistivity surveying data is acquired in the form of linear profiles using a suite of metal electrodes. A current is injected into the ground via a pair of electrodes while a potential difference is measured across a second pair of electrodes. This allows for the recording of the apparent resistivity of the earth system which can be used for office based digital processing. The generated model resistivity values and their spatial distribution can then be related to typical values for different geological materials.

2D-Resistivity profiles with electrode spacing of 3m and up to 64 electrodes per set-up were surveyed at the locations shown on Map 1. Two profiles were acquired with 64 electrodes, giving a profile length of 189m, and two profiles were acquired with 32 electrodes, giving a profile length of 93m. A maximum depth penetration of 25m is achieved at the centre of the long profile set up. The readings were taken with a Tigre Resistivity Meter and Imager Cables.

All EM31 locations were surveyed to Irish National Grid and the elevations have an accuracy of 2 - 3m. These are used in Map 2 only for visualisation purposes. The elevations for the 2D-Resistivity Profiles were surveyed with an RTK-GPS resulting in an accuracy of a few centimetres. The elevations used are in mOD Malin Head datum.

2D-Resistivity has proven zones of anomalous overburden/rock with lateral extents of 5 m and more.

3. RESULTS AND INTERPRETATION

The interpretation of geophysical data was carried out utilising the known response of geophysical measurements, typical physical parameters for subsurface features that may underlay the site, and the experience of the authors.

3.1 EM31 Ground Conductivity

The EM31 ground conductivity values were merged into one data file for the survey area and contoured and gridded with the SURFER contouring package. The contours are created by gridding and interpolation and care must therefore be taken when using the data. The contours are overlaid over the location map (Map 2) and the values in milliSiemens/metre (mS/m) are colour coded.

Low conductivities would indicate either shallow bedrock or sandy and gravely overburden while higher conductivities would indicate clay-rich overburden, water saturation or made ground. The site proved to be very homogeneous with low conductivities, of < 6mS/m representing almost the entire site. Two exceptions are small areas in the northwest and northeast part of the site where localised highs of 7 – 10 mS/m indicate some clay enrichment.

There is a strong correlation between the areas of low ground conductivity values and areas of high model resistivity values.

The highest values in the EM31 ground conductivity dataset are seen along the eastern fringe of the site. These are likely caused by the proximity to the field boundary with fencing.

The EM31 data collected from outside of the landfill site boundary does not suggest the presence of a leachate plume or waste/fill material within the detection depth (6m) of the instrument.

3.2 2D-Resistivity Profiles

The 2D-Resistivity data was positioned and inverted with the RES2DINV inversion package. The programme uses a smoothness constrained least-squares inversion method to produce a 2D model of the subsurface model resistivities from the recorded apparent resistivity values. Three variations of the least squares method are available but for this project the Jacobian Matrix was recalculated for the first two iterations and then a Quasi-Newton approximation was used for subsequent iterations. Each dataset was inverted using five iterations resulting in a typical RMS error of < 2.5%. The resulting models were colour contoured and they are displayed as cross sections (Figure 1).

An interpretation for the 2D-Resistivity datasets is shown in Figure 2. The resistivities under the site cover a very large range from < 5 Ohm.m to > 6,000 Ohm.m.

The data is subdivided into four layers. Layer 1 has a very low range of model resistivity values from < 5 Ohm.m to 100 Ohm.m. These values cover the central part of the site and this layer has a significant thickness of up to 18m towards the south of the site. Within these lowest resistivities some leachate into the

ground may be included. This layer is most extensive on profile R4 (see Figure 2). The low model resistivity values represent the area of the former quarry which has been backfilled with waste material.

Layer 2 has a general model resistivity range of 100 – 350 Ohm.m. This layer has a thickness range of 0.5m – 8.0m and is seen as a continuous layer below layer 1 on the two long South – north profiles (R1 & R2). This layer is likely to consist of leachate into the underlying rock strata.

Layer 3 has a similar data range to layer 2 (100 – 350 Ohm.m) but represents a different lithological structure. This layer is seen adjacent to but external to layers 1 and 2. It is a layer 0.5m – 13.0m thick and contains topsoil, gravelly clay and possible weathered rock close to its base. This layer forms a thin covering along the entire length of R3, in the far south, away from the backfilled area. On R3 a deeper seated resistivity range matching this layer has been initially noted as possible leachate but was confirmed by drilling to be fractured limestone containing water with a low conductivity.

Layer 4 has model resistivity values > 450 Ohm.m and is a limestone layer. The very highest recorded values of 2000 - >6000 Ohm.m indicate areas of very clean limestone. The depth to the top of this layer varies between 0.5m and 23m below ground level. Where the limestone occurs outside the backfilled ground the depth to the top of the layer is generally 0.5m – 5.0m. In the backfilled areas of the old quarry the layer is in the range 9.0m – 23.0m.

Table 1 summarises the interpretation of the resistivity data.

Table 1: Summary of Results and Interpretation

Layer	**General Model Resistivity Range (Ohmm)**	**Interpretation**
1	< 100	Landfill / Waste Body
2	100 - 350	Possible Leachate (mainly into Rock)
3	100 - 350	Topsoil / Gravelly Clay / Weathered Rock
4	> 450	Limestone Rock

Boreholes confirmed the geophysical results where they are located near the resistivity lines. The borehole locations are indicated on the maps and the abbreviated borehole logs are shown in the figures.

4. REFERENCES

1. **GSEG 2002.** Geophysics in Engineering Investigations. Geological Society Engineering Geology Special Publication 19, London, 2002.

2. **GSI, 1995.** Geological Map of East Cork - Waterford. Geological Survey of Ireland 1995.

3. **Milsom, 1989.** Field Geophysics. John Wiley and Sons.

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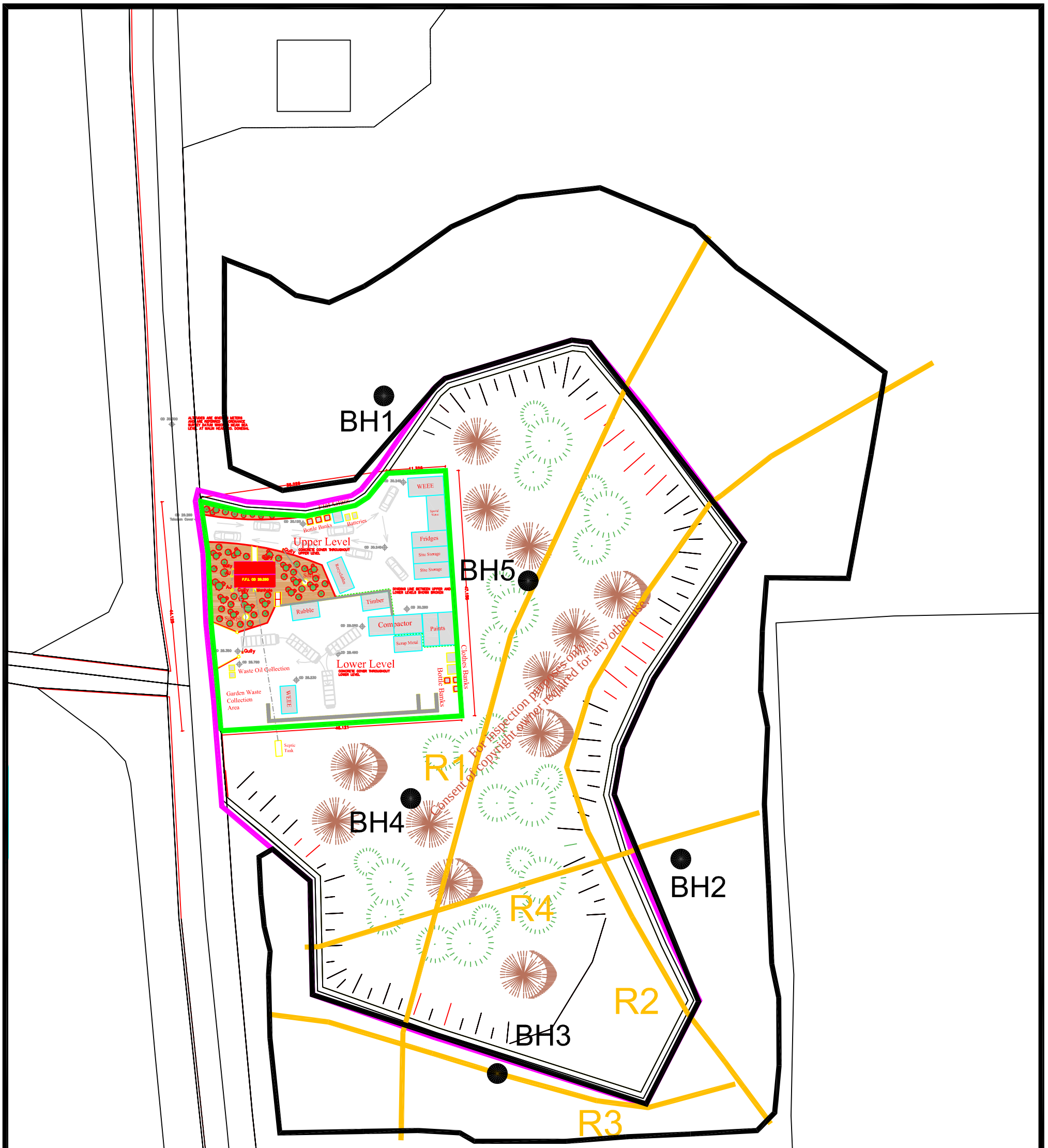

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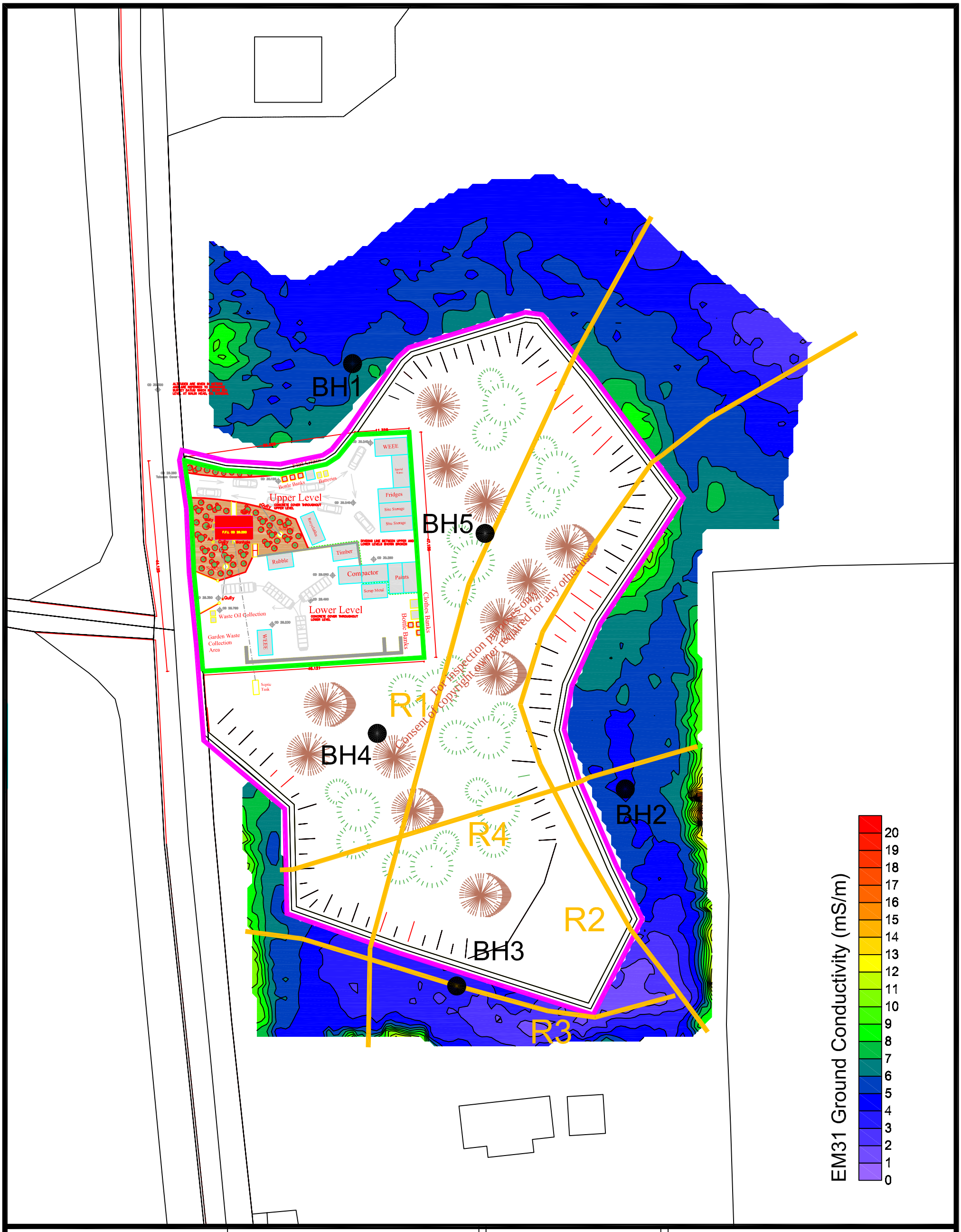
CLIENT	URS/Scott Wilson Ireland
PROJECT	Lismore Landfill Site Geophysical Survey
TITLE	Map 1: Location Map

SCALE:	1:750 @ A3
PROJECT:	5507
DRAWN:	POH
DATE:	11/11/2010
MGX FILE:	5507f_Maps.dwg
STATUS:	Final

LEGEND:
- 2D-Resistivity Profile
- Landfill Boundary
- EM31 Ground Conductivity Survey Area
- Recycling Centre
- Borehole



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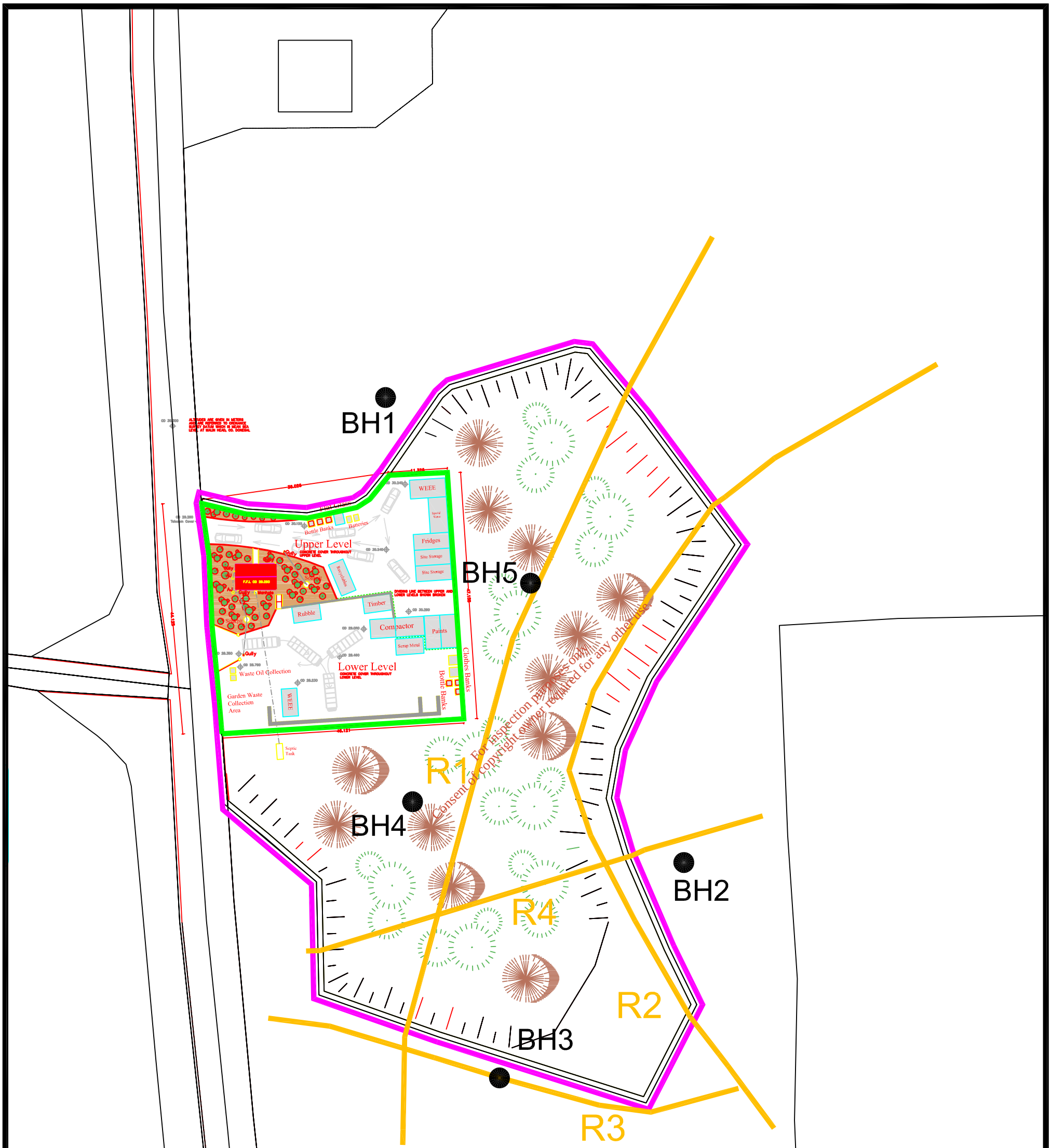
Web: www.mgx.ie

CLIENT	URS/Scott Wilson Ireland
PROJECT	Lismore Landfill Site Geophysical Survey
TITLE	Map 2: EM31 Ground Conductivity Contour Map

SCALE:	1:750 @ A3
PROJECT:	5507
DRAWN:	POH
DATE:	11/11/2010
MGX FILE:	5507f_Maps.dwg
STATUS:	Final

LEGEND:
- 2D-Resistivity Profile
- Landfill Boundary
- EM31 Ground Conductivity Survey Area
- Recycling Centre
- Borehole



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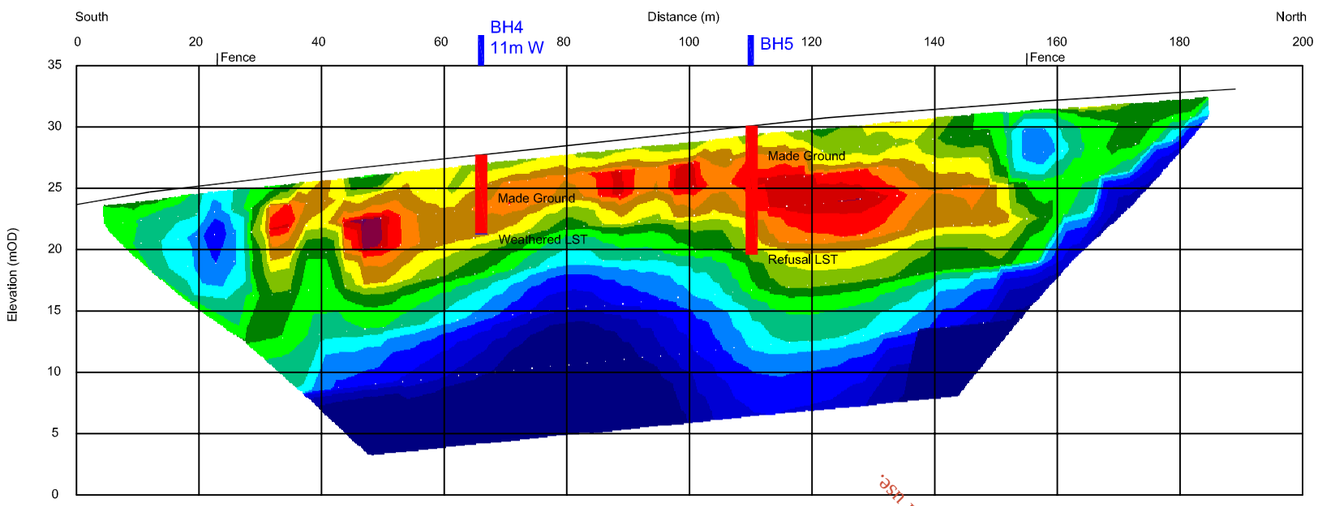
CLIENT	URS/Scott Wilson Ireland
PROJECT	Lismore Landfill Site Geophysical Survey
TITLE	Map 3: Summary Interpretation

SCALE:	1:750 @ A3
PROJECT:	5507
DRAWN:	POH
DATE:	11/11/2010
MGX FILE:	5507f_Maps.dwg
STATUS:	Final

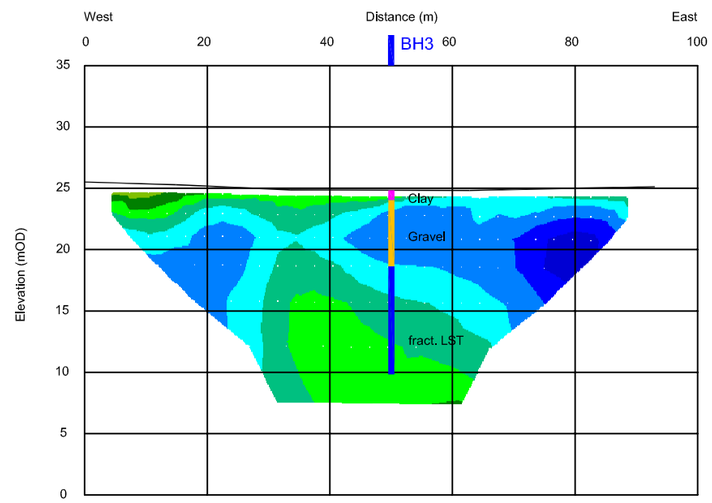
LEGEND:

- 2D-Resistivity Profile
- Landfill Boundary
- EM31 Ground Conductivity Survey Area
- Recycling Centre
- Borehole

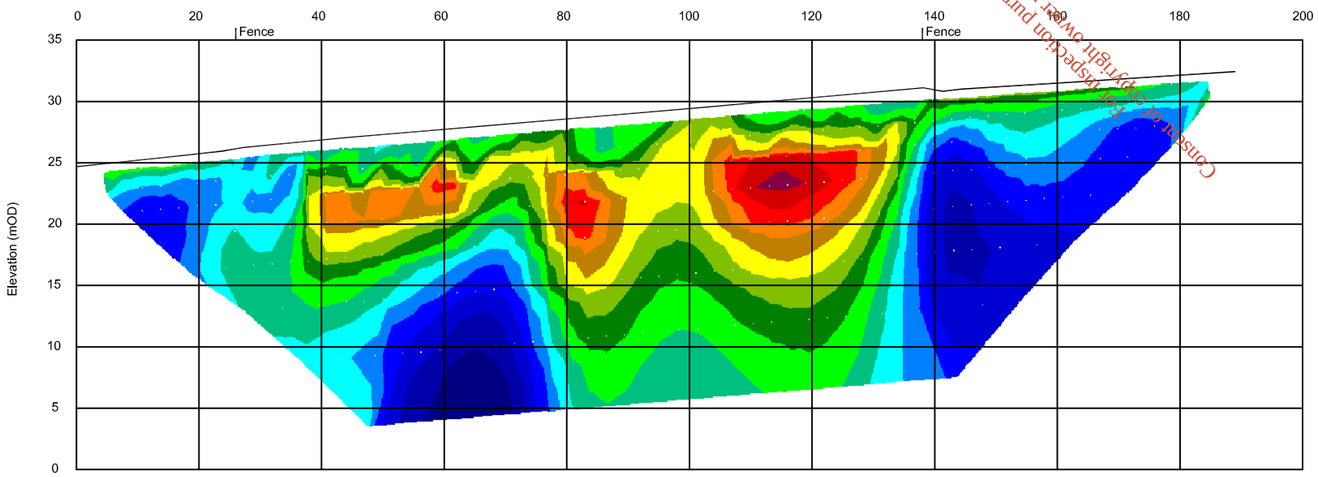
2D-Resistivity Profile R1



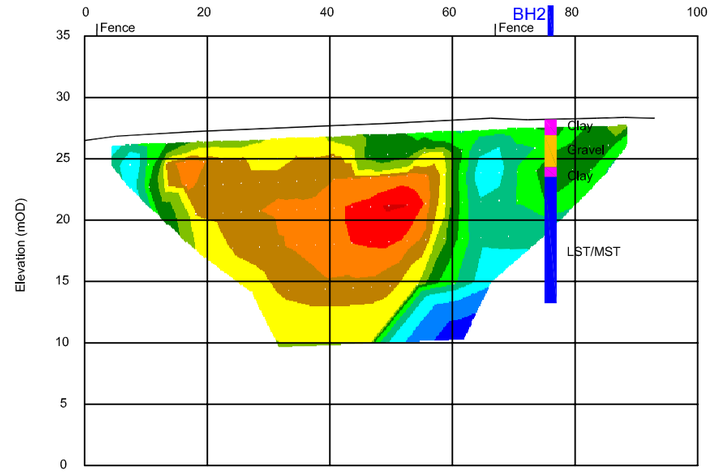
2D-Resistivity Profile R3



2D-Resistivity Profile R2



2D-Resistivity Profile R4



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CLIENT	URS/Scott Wilson Ireland
PROJECT	Lismore Landfill Site Geophysical Survey
TITLE	Figure 1: Results of 2D-Resistivity Survey

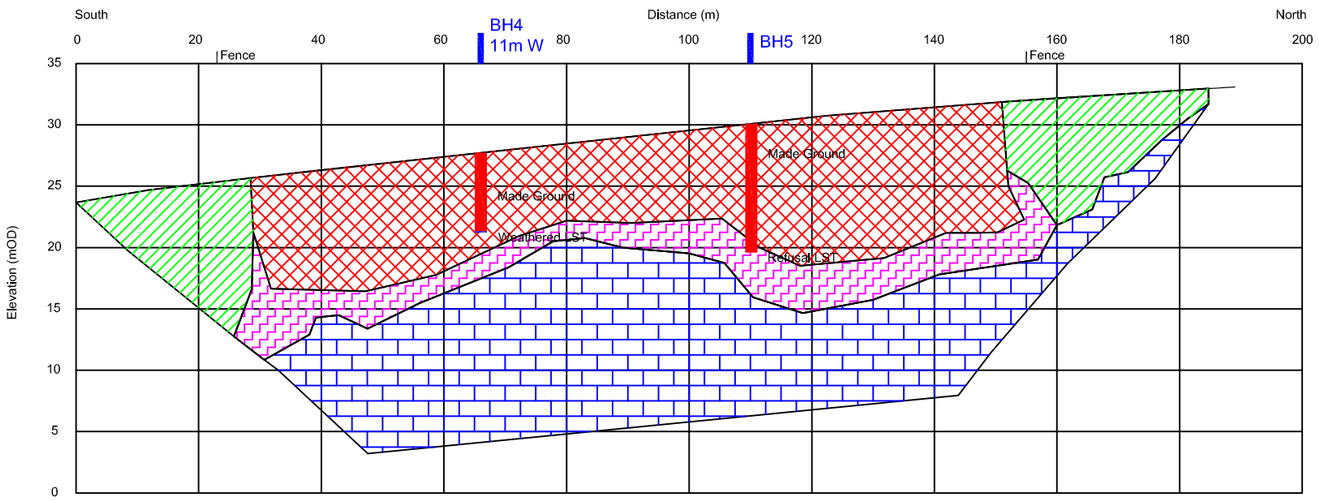
SCALE:	1:1000 @A3, 2x VE
PROJECT:	5507
DRAWN:	HK
DATE:	11/11/2010
MGX FILE:	5507f_Figs.dwg
STATUS:	Final

LEGEND: Abbreviated borehole logs are indicated on the sections

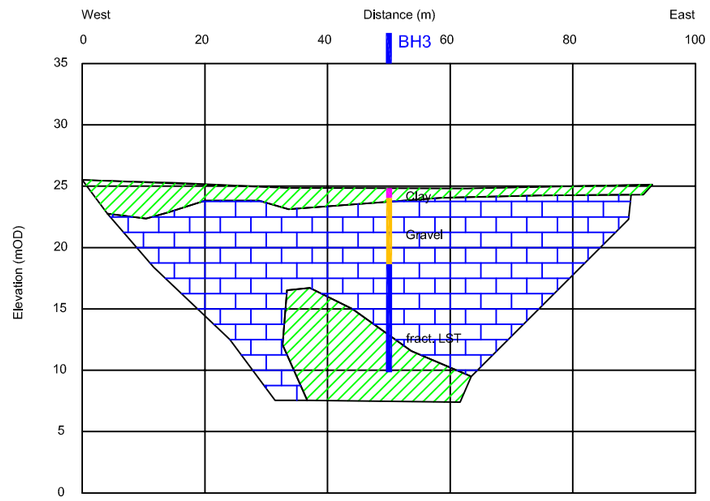
Model Values 2D-Resistivity (Ohmm)

2.0 6.3 20.0 63.2 200 632 2000 6325

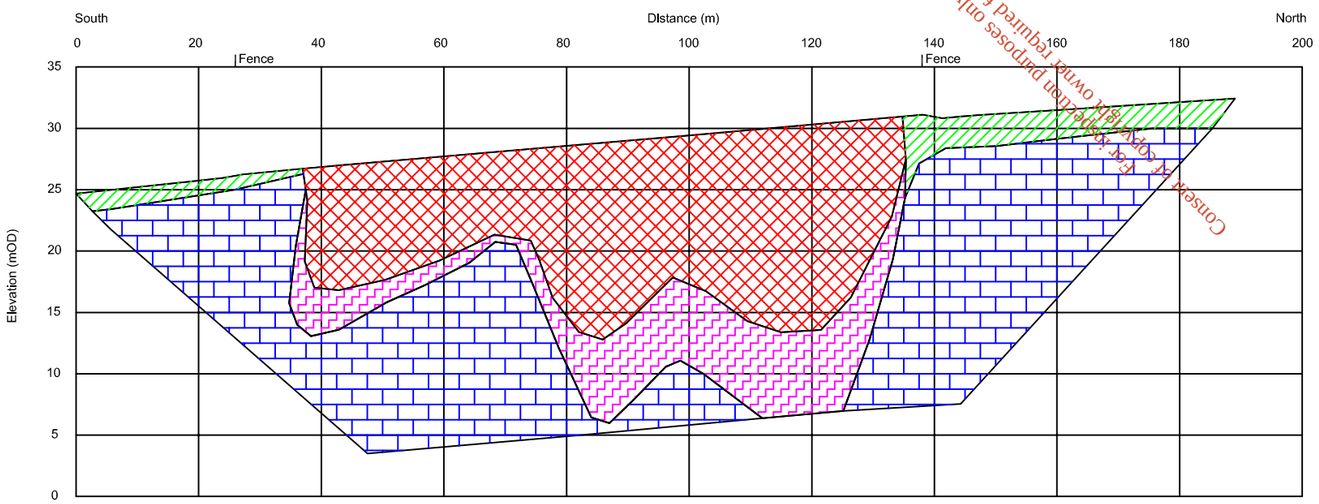
2D-Resistivity Profile R1



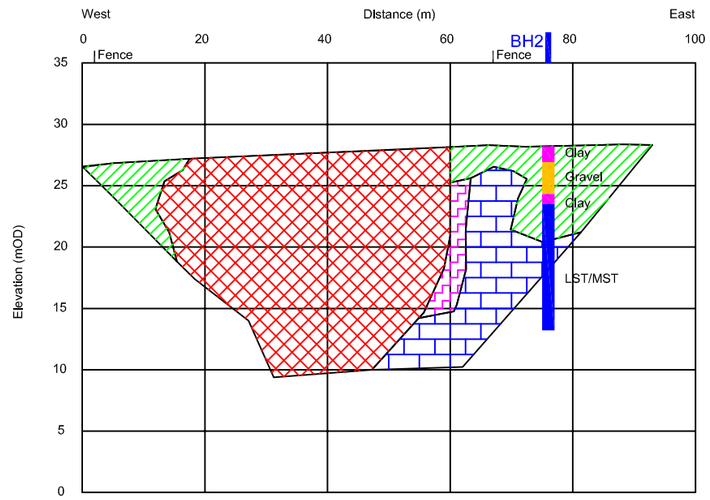
2D-Resistivity Profile R3



2D-Resistivity Profile R2



2D-Resistivity Profile R4



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CLIENT	URS/Scott Wilson Ireland
PROJECT	Lismore Landfill Site Geophysical Survey
TITLE	Figure 2: Interpretation of 2D-Resistivity Survey

SCALE:	1:1000 @A3, 2x VE
PROJECT:	5507
DRAWN:	HK
DATE:	11/11/2010
MGX FILE:	5507f_Figs.dwg
STATUS:	Final

LEGEND:

Interpretation:

Abbreviated borehole logs are indicated on the sections

1 Landfill/Waste Body (<100 Ohmm)

2 Possible Leachate mainly into Rock (100 - 350 Ohmm)

3 Topsoil / Gravelly Clay / Weathered Rock (100 - 350 Ohmm)

4 Limestone Rock with some clean Gravel at top of layer

Appendix B - Laboratory Reports

Jones Environmental Laboratory

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Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

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Fax: +44 (0) 1244 833781

URS Corporation
4th Floor Iveagh Court
6/8 Harcourt Road
Dublin 2

UKAS TESTING
No.4225

Attention :	David Mullan
Date :	13th December 2010
Your reference :	49341903
Our reference :	Test Report 10/5485
Location :	Lismore Landfill
Date samples received :	24/11/10
Status :	Final Report
Issue :	2

Sixteen samples were received for analysis on 24th November 2010 which was completed on 13th December 2010. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced.
All interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

J W Farrell- Jones CChem FRSC
Chartered Chemist

Jones Environmental Laboratory

Client Name:	URS Corporation	**Report :**	**Solid**
Reference:	49341903		
Location:	Lismore Landfill	**Solids:** V=60g VOC jar, J=250g glass jar, T=plastic tub	
Contact:	David Mullan		
JE Job No.:	10/5485		

J E Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30	Please see attached notes for all abbreviations and acronyms		
Sample ID	BH01	BH01	BH01	BH01	BH02	BH02	BH02	BH03	BH03	BH04			
Depth	0.4	1.9	4.1	6.2	0.6	2.1	4.0	0.5	4.1	0.5			
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T			
Sample Date	17/11/10	17/11/10	17/11/10	17/11/10	18/11/10	18/11/10	18/11/10	18/11/10	18/11/10	19/11/10			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Batch Number	1	1	1	1	1	1	1	1	1	1	**LOD**	**Units**	**Method No.**
Date of Receipt	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10			
TPHCWG - Aliphatics													
>C5-C6 #	~	~	~	~	~	~	~	<0.1	~	~	<0.1	mg/ kg	TM3/PM12
>C6-C8 #	~	~	~	~	~	~	~	<0.1	~	~	<0.1	mg/ kg	TM3/PM12
>C8-C10	~	~	~	~	~	~	~	<0.1	~	~	<0.1	mg/ kg	TM3/PM12
>C10-C12#	~	~	~	~	~	~	~	<0.2	~	~	<0.2	mg/ kg	TM5/PM8
>C12-C16#	~	~	~	~	~	~	~	<4	~	~	<4	mg/ kg	TM5/PM8
>C16-C21#	~	~	~	~	~	~	~	<7	~	~	<7	mg/ kg	TM5/PM8
>C21-C35#	~	~	~	~	~	~	~	<7	~	~	<7	mg/ kg	TM5/PM8
Total aliphatics C5-35#	~	~	~	~	~	~	~	<19	~	~	<19	mg/ kg	
TPHCWG - Aromatics													
>C5-EC7 #	~	~	~	~	~	~	~	<0.1	~	~	<0.1	mg/ kg	TM3/PM12
>EC7-EC8 #	~	~	~	~	~	~	~	<0.1	~	~	<0.1	mg/ kg	TM3/PM12
>EC8-EC10 #	~	~	~	~	~	~	~	<0.1	~	~	<0.1	mg/ kg	TM3/PM12
>EC10-EC12#	~	~	~	~	~	~	~	<0.2	~	~	<0.2	mg/ kg	TM5/PM8
>EC12-EC16#	~	~	~	~	~	~	~	<4	~	~	<4	mg/ kg	TM5/PM8
>EC16-EC21#	~	~	~	~	~	~	~	<7	~	~	<7	mg/ kg	TM5/PM8
>EC21-EC35#	~	~	~	~	~	~	~	<7	~	~	<7	mg/ kg	TM5/PM8
Total aromatics C5-35#	~	~	~	~	~	~	~	<19	~	~	<19	mg/ kg	TM5/PM8
Total aliphatics and aromatics(C5-35)#	~	~	~	~	~	~	~	<38	~	~	<38	mg/kg	
BTEX/MTBE# GC-FID													
MTBE #	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM31/PM7
Benzene #	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM31/PM7
Toluene #	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM31/PM7
Ethyl benzene #	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM31/PM7
m/p-Xylene #	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM31/PM7
o-Xylene #	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM31/PM7
Total Xylenes	~	~	~	~	~	~	~	<10	~	~	<10	µg/ kg	TM31/PM7
TOC#	~	~	~	~	~	~	~	0.3	~	~	<0.2	%	TM21

Jones Environmental Laboratory

Client Name: URS Corporation

Reference: 49341903

Location: Lismore Landfill

Contact: David Mullan

JE Job No.: 10/5485

Report : **Solid**

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

J E Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30			
Sample ID	BH01	BH01	BH01	BH01	BH02	BH02	BH02	BH03	BH03	BH04			
Depth	0.4	1.9	4.1	6.2	0.6	2.1	4.0	0.5	4.1	0.5			
COC No / misc											Please see attached notes for all abbreviations and acronyms		
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T			
Sample Date	17/11/10	17/11/10	17/11/10	17/11/10	18/11/10	18/11/10	18/11/10	18/11/10	18/11/10	19/11/10			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Batch Number	1	1	1	1	1	1	1	1	1	1			
Date of Receipt	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	LOD	Units	Method No.
PAH 17 MS													
Naphthalene #	~	~	~	~	~	~	~	<0.04	~	~	<0.04	mg/kg	TM4/PM8
Acenaphthylene	~	~	~	~	~	~	~	<0.03	~	~	<0.03	mg/kg	TM4/PM8
Acenaphthene #	~	~	~	~	~	~	~	<0.05	~	~	<0.05	mg/kg	TM4/PM8
Fluorene #	~	~	~	~	~	~	~	<0.04	~	~	<0.04	mg/kg	TM4/PM8
Phenanthrene #	~	~	~	~	~	~	~	<0.03	~	~	<0.03	mg/kg	TM4/PM8
Anthracene #	~	~	~	~	~	~	~	<0.04	~	~	<0.04	mg/kg	TM4/PM8
Fluoranthene #	~	~	~	~	~	~	~	<0.03	~	~	<0.03	mg/kg	TM4/PM8
Pyrene #	~	~	~	~	~	~	~	<0.03	~	~	<0.03	mg/kg	TM4/PM8
Benz(a)anthracene #	~	~	~	~	~	~	~	<0.06	~	~	<0.06	mg/kg	TM4/PM8
Chrysene #	~	~	~	~	~	~	~	<0.02	~	~	<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	~	~	~	~	~	~	~	<0.07	~	~	<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	~	~	~	~	~	~	~	<0.04	~	~	<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene #	~	~	~	~	~	~	~	<0.04	~	~	<0.04	mg/kg	TM4/PM8
Dibenzo(ah)anthracene #	~	~	~	~	~	~	~	<0.04	~	~	<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	~	~	~	~	~	~	~	<0.04	~	~	<0.04	mg/kg	TM4/PM8
Coronene	~	~	~	~	~	~	~	<0.04	~	~	<0.04	mg/kg	TM4/PM8
PAH 17 Total	~	~	~	~	~	~	~	<0.64	~	~	<0.64	mg/kg	TM4/PM8
PCB (7 congeners)											<5	µg/ kg	TM076 S
PCB 28	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM076 S
PCB 52	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM076 S
PCB 101	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM076 S
PCB 118	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM076 S
PCB 138	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM076 S
PCB 153	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM076 S
PCB 180	~	~	~	~	~	~	~	<5	~	~	<5	µg/ kg	TM076 S
Total 7 PCBs	~	~	~	~	~	~	~	<35	~	~	<35	µg/ kg	TM076 S
Arsenic #	~	~	~	~	~	~	~	6.8	~	~	<0.5	mg/kg	TM030
Cadmium #	~	~	~	~	~	~	~	9.1	~	~	<0.1	mg/kg	TM030
Chromium #	~	~	~	~	~	~	~	9.6	~	~	<0.5	mg/kg	TM030
Copper #	~	~	~	~	~	~	~	14	~	~	<1	mg/kg	TM030
Mercury #	~	~	~	~	~	~	~	0.2	~	~	<0.1	mg/kg	TM030
Nickel #	~	~	~	~	~	~	~	22.8	~	~	<0.7	mg/kg	TM030
Lead #	~	~	~	~	~	~	~	38	~	~	<5	mg/kg	TM030
Selenium #	~	~	~	~	~	~	~	<1	~	~	<1	mg/kg	TM030
Zinc #	~	~	~	~	~	~	~	459	~	~	<5	mg/kg	TM030
Water Soluble Boron #	~	~	~	~	~	~	~	0.5	~	~	<0.1	mg/kg	TM074
Barium #	~	~	~	~	~	~	~	36	~	~	<1	mg/kg	TM030
Aluminium	~	~	~	~	~	~	~	6568	~	~	<50	mg/kg	TM030
Antimony	~	~	~	~	~	~	~	1	~	~	<1	mg/kg	TM030
Molybdenum #	~	~	~	~	~	~	~	0.7	~	~	<0.1	mg/kg	TM030

Jones Environmental Laboratory

Client Name:	URS Corporation	**Report :**	**CEN 10:1 Leachate**
Reference:	49341903		
Location:	Lismore Landfill	**Solids:** V=60g VOC jar, J=250g glass jar, T=plastic tub	
Contact:	David Mullan		
JE Job No.:	10/5485		

J E Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30			
Sample ID	BH01	BH01	BH01	BH01	BH02	BH02	BH02	BH03	BH03	BH04			
Depth	0.4	1.9	4.1	6.2	0.6	2.1	4.0	0.5	4.1	0.5			
COC No / misc											Please see attached notes for all abbreviations and acronyms		
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T			
Sample Date	17/11/10	17/11/10	17/11/10	17/11/10	18/11/10	18/11/10	18/11/10	18/11/10	18/11/10	19/11/10			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Batch Number	1	1	1	1	1	1	1	1	1	1			
Date of Receipt	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	**LOD**	**Units**	**Method No.**
Fluoride	~	~	~	~	~	~	~	~	~	~	<0.3	mg/l	TM027W
Sulphate	~	~	~	~	~	~	~	~	~	~	<0.05	mg/l	TM038W
DOC	~	~	~	~	~	~	~	~	~	~	<2	mg/l	TM060W
Speciated Phenols by HPLC													
Resorcinol	~	~	~	~	~	~	~	~	~	~	<0.01	mg/l	TM26
Catechol	~	~	~	~	~	~	~	~	~	~	<0.01	mg/l	TM26
Phenol #	~	~	~	~	~	~	~	~	~	~	<0.01	mg/l	TM26
m/p-cresol	~	~	~	~	~	~	~	~	~	~	<0.02	mg/l	TM26
o-cresol	~	~	~	~	~	~	~	~	~	~	<0.01	mg/l	TM26
Total cresols #	~	~	~	~	~	~	~	~	~	~	<0.03	mg/l	TM26
Xylenols #	~	~	~	~	~	~	~	~	~	~	<0.06	mg/l	TM26
1-naphthol	~	~	~	~	~	~	~	~	~	~	<0.01	mg/l	TM26
2,3,5-trimethyl phenol	~	~	~	~	~	~	~	~	~	~	<0.01	mg/l	TM26
2-isopropylphenol	~	~	~	~	~	~	~	~	~	~	<0.01	mg/l	TM26
Total Speciated Phenols HPLC	~	~	~	~	~	~	~	~	~	~	<0.15	mg/l	TM26
Total Dissolved Solids	~	~	~	~	~	~	~	~	~	~	<35	mg/l	TM020W
TPH CWG - Aliphatics													
>C5-C6	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM36/PM12
>C6-C8	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM36/PM12
>C8-C10	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM36/PM12
>C10-C12	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM5/PM9
>C12-C16	~	~	~	~	~	~	~	~	~	~	<10	µg/l	TM5/PM9
>C16-C21	~	~	~	~	~	~	~	~	~	~	<10	µg/l	TM5/PM9
>C21-C35	~	~	~	~	~	~	~	~	~	~	<10	µg/l	TM5/PM9
Total aliphatics C5-35	~	~	~	~	~	~	~	~	~	~	<10	µg/l	
TPH CWG - Aromatics													
>C5-EC7	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM36/PM12
>EC7-EC8	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM36/PM12
>EC8-EC10	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM36/PM12
>EC10-EC12	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM5/PM9
>EC12-EC16	~	~	~	~	~	~	~	~	~	~	<10	µg/ l	TM5/PM9
>EC16-EC21	~	~	~	~	~	~	~	~	~	~	<10	µg/ l	TM5/PM9
>EC21-EC35	~	~	~	~	~	~	~	~	~	~	<10	µg/l	TM5/PM9
Total aromatics C5-35	~	~	~	~	~	~	~	~	~	~	<10	µg/ l	
Total aliphatics and aromatics(C5-35)	~	~	~	~	~	~	~	~	~	~	<10	µg/l	

Jones Environmental Laboratory

Client Name:	URS Corporation	**Report :**	**CEN 10:1 Leachate**
Reference:	49341903		
Location:	Lismore Landfill	**Solids:** V=60g VOC jar, J=250g glass jar, T=plastic tub	
Contact:	David Mullan		
JE Job No.:	10/5485		

J E Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30	LOD	Units	Method No.
Sample ID	BH01	BH01	BH01	BH01	BH02	BH02	BH02	BH03	BH03	BH04			
Depth	0.4	1.9	4.1	6.2	0.6	2.1	4.0	0.5	4.1	0.5			
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T			
Sample Date	17/11/10	17/11/10	17/11/10	17/11/10	18/11/10	18/11/10	18/11/10	18/11/10	18/11/10	19/11/10			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Batch Number	1	1	1	1	1	1	1	1	1	1			
Date of Receipt	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10			
BTEX GC-FID											<5	µg/ l	TM031W
MTBE	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM031W
Benzene	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM031W
Toluene	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM031W
Ethyl benzene	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM031W
m/p-Xylene	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM031W
o-Xylene	~	~	~	~	~	~	~	~	~	~	<5	µg/ l	TM031W
Total Xylenes	~	~	~	~	~	~	~	~	~	~	<10	µg/ l	TM031W
Arsenic - dissolved #	~	~	~	~	~	~	~	~	~	~	<2.5	µg/l	TM 030W
Boron - dissolved #	~	~	~	~	~	~	~	~	~	~	<12	µg/l	TM 030W
Cadmium - dissolved #	~	~	~	~	~	~	~	~	~	~	<0.5	µg/l	TM 030W
Chromium - dissolved #	~	~	~	~	~	~	~	~	~	~	<1.5	µg/l	TM 030W
Copper - dissolved #	~	~	~	~	~	~	~	~	~	~	<7	µg/l	TM 030W
Mercury - dissolved #	~	~	~	~	~	~	~	~	~	~	<1	µg/l	TM 030W
Nickel - dissolved #	~	~	~	~	~	~	~	~	~	~	<2	µg/l	TM 030W
Lead - dissolved #	~	~	~	~	~	~	~	~	~	~	<5	µg/l	TM 030W
Selenium - dissolved #	~	~	~	~	~	~	~	~	~	~	<3	µg/l	TM 030W
Zinc - dissolved #	~	~	~	~	~	~	~	~	~	~	<3	µg/l	TM 030W
Aluminium - dissolved #	~	~	~	~	~	~	~	~	~	~	<20	µg/l	TM 030W
Barium - dissolved #	~	~	~	~	~	~	~	~	~	~	<3	µg/l	TM 030W
Antimony - dissolved #	~	~	~	~	~	~	~	~	~	~	<2	µg/l	TM 030W
Molybdenum - dissolved	~	~	~	~	~	~	~	~	~	~	<2	µg/l	TM 030W
Total Alkalinity as CaCO3	~	~	~	~	~	~	~	~	~	~	<1	mg/l	TM075W
Amm N/Tot Ammonia as NH3	~	~	~	~	~	~	~	~	~	~	<0.2	mg/l	TM038W
Bicarbonate Alkalinity as CaCO3	~	~	~	~	~	~	~	~	~	~	<1	mg/l	TM075W
Calcium - dissolved#	~	~	~	~	~	~	~	~	~	~	<0.2	mg/l	TM 030W
Carbonate Alkalinity as CaCO3	~	~	~	~	~	~	~	~	~	~	<1	mg/l	TM075W
Chloride	~	~	~	~	~	~	~	~	~	~	<0.3	mg/l	TM038W
Total Hardness - dissolved	~	~	~	~	~	~	~	~	~	~	<1	mg/l	TM 030W
Iron - dissolved #	~	~	~	~	~	~	~	~	~	~	<20	µg/l	TM 030W
Magnesium - dissolved#	~	~	~	~	~	~	~	~	~	~	<0.1	mg/l	TM 030W
Manganese - dissolved #	~	~	~	~	~	~	~	~	~	~	<2	µg/l	TM 030W
Nitrate as NO_3	~	~	~	~	~	~	~	~	~	~	<0.2	mg/l	TM038W
Nitrite as NO_2	~	~	~	~	~	~	~	~	~	~	<0.02	mg/l	TM038W
Total Oxidised Nitrogen as N	~	~	~	~	~	~	~	~	~	~	<0.05	mg/l	TM038W
Ortho phosphate as PO4	~	~	~	~	~	~	~	~	~	~	<0.06	mg/l	TM038W
Sodium - dissolved#	~	~	~	~	~	~	~	~	~	~	<0.1	mg/l	TM 030W
Potassium - dissolved#	~	~	~	~	~	~	~	~	~	~	<0.1	mg/l	TM 030W
Sulphate	~	~	~	~	~	~	~	~	~	~	<0.05	mg/l	TM038W

Please see attached notes for all abbreviations and acronyms

Jones Environmental Laboratory

Client Name:	URS Corporation
Reference:	49341903
Location:	Lismore Landfill
Contact:	David Mullan
JE Job No.:	10/5485

Report : **Solid**

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

J E Sample No.	31-33	34-36	37-39	40-42	43-45	46-48							
Sample ID	BH04	BH04	BH04	BH05	BH05	BH05							
Depth	2.0	4.2	5.9	0.5	2.0	4.0							
COC No / misc											Please see attached notes for all abbreviations and acronyms		
Containers	V J T	V J T	V J T	V J T	V J T	V J T							
Sample Date	19/11/10	19/11/10	19/11/10	19/11/10	19/11/10	19/11/10							
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil							
Batch Number	1	1	1	1	1	1							
Date of Receipt	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10							
											LOD	Units	Method No.
TPHCWG - Aliphatics													
>C5-C6 #	~	<0.1	<0.1	~	<0.1	<0.1					<0.1	mg/ kg	TM3/PM12
>C6-C8 #	~	<0.1	<0.1	~	0.1	0.3					<0.1	mg/ kg	TM3/PM12
>C8-C10	~	0.1	<0.1	~	10.2	2.1					<0.1	mg/ kg	TM3/PM12
>C10-C12#	~	<0.2	<0.2	~	83.0	24.0					<0.2	mg/ kg	TM5/PM8
>C12-C16#	~	<4	<4	~	<4	30					<4	mg/ kg	TM5/PM8
>C16-C21#	~	<7	<7	~	27	133					<7	mg/ kg	TM5/PM8
>C21-C35#	~	419	235	~	164	1619					<7	mg/ kg	TM5/PM8
Total aliphatics C5-35#	~	419	235	~	284	1808					<19	mg/ kg	
TPHCWG - Aromatics													
>C5-EC7 #	~	<0.1	<0.1	~	<0.1	<0.1					<0.1	mg/ kg	TM3/PM12
>EC7-EC8 #	~	<0.1	<0.1	~	<0.1	<0.1					<0.1	mg/ kg	TM3/PM12
>EC8-EC10 #	~	<0.1	<0.1	~	1.3	0.2					<0.1	mg/ kg	TM3/PM12
>EC10-EC12#	~	<0.2	<0.2	~	15.0	9.0					<0.2	mg/ kg	TM5/PM8
>EC12-EC16#	~	<4	<4	~	20	20					<4	mg/ kg	TM5/PM8
>EC16-EC21#	~	40	<7	~	129	140					<7	mg/ kg	TM5/PM8
>EC21-EC35#	~	330	148	~	812	935					<7	mg/ kg	TM5/PM8
Total aromatics C5-35#	~	370	148	~	977	1104					<19	mg/ kg	TM5/PM8
Total aliphatics and aromatics(C5-35)#	~	789	383	~	1261	2912					<38	mg/kg	
BTEX/MTBE# GC-FID													
MTBE #	~	<5	<5	~	<5	<5					<5	µg/ kg	TM31/PM7
Benzene #	~	<5	<5	~	<5	<5					<5	µg/ kg	TM31/PM7
Toluene #	~	<5	<5	~	48	21					<5	µg/ kg	TM31/PM7
Ethyl benzene #	~	<5	<5	~	294	80					<5	µg/ kg	TM31/PM7
m/p-Xylene #	~	<5	<5	~	669	121					<5	µg/ kg	TM31/PM7
o-Xylene #	~	<5	<5	~	339	66					<5	µg/ kg	TM31/PM7
Total Xylenes	~	<10	<10	~	1008	187					<10	µg/ kg	TM31/PM7
TOC#	~	1.3	1.0	~	3.4	5.6					<0.2	%	TM21

Jones Environmental Laboratory

Client Name:	URS Corporation
Reference:	49341903
Location:	Lismore Landfill
Contact:	David Mullan
JE Job No.:	10/5485

Report : **Solid**

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

J E Sample No.	31-33	34-36	37-39	40-42	43-45	46-48					LOD	Units	Method No.
Sample ID	BH04	BH04	BH04	BH05	BH05	BH05							
Depth	2.0	4.2	5.9	0.5	2.0	4.0							
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T							
Sample Date	19/11/10	19/11/10	19/11/10	19/11/10	19/11/10	19/11/10							
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil							
Batch Number	1	1	1	1	1	1							
Date of Receipt	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10							
PAH 17_MS													
Naphthalene	~	<0.04	<0.04	~	<0.04	0.20					<0.04	mg/kg	TM4/PM8
Acenaphthylene	~	<0.03	<0.03	~	<0.03	0.04					<0.03	mg/kg	TM4/PM8
Acenaphthene	~	0.06	0.06	~	0.08	0.10					<0.05	mg/kg	TM4/PM8
Fluorene	~	0.07	0.06	~	0.07	0.11					<0.04	mg/kg	TM4/PM8
Phenanthrene	~	0.53	0.40	~	0.25	0.59					<0.03	mg/kg	TM4/PM8
Anthracene	~	0.17	0.12	~	0.08	0.14					<0.04	mg/kg	TM4/PM8
Fluoranthene	~	1.34	0.78	~	0.42	0.75					<0.03	mg/kg	TM4/PM8
Pyrene	~	1.21	0.66	~	0.41	0.59					<0.03	mg/kg	TM4/PM8
Benz(a)anthracene	~	0.79	0.45	~	0.17	0.27					<0.06	mg/kg	TM4/PM8
Chrysene	~	0.69	0.38	~	0.22	0.33					<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene	~	1.08	0.49	~	0.39	0.47					<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene	~	0.69	0.33	~	0.24	0.28					<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene	~	0.45	0.23	~	0.16	0.20					<0.04	mg/kg	TM4/PM8
Dibenzo(ah)anthracene	~	0.16	0.07	~	<0.04	0.05					<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene	~	0.42	0.20	~	0.14	0.21					<0.04	mg/kg	TM4/PM8
Coronene	~	<0.04	<0.04	~	<0.04	<0.04					<0.04	mg/kg	TM4/PM8
PAH 17 Total	~	7.66	4.23	~	2.63	4.33					<0.64	mg/kg	TM4/PM8
PCB (7 congeners)											<5	µg/ kg	TM076 S
PCB 28	~	<5	<5	~	<5	<5					<5	µg/ kg	TM076 S
PCB 52	~	<5	<5	~	<5	<5					<5	µg/ kg	TM076 S
PCB 101	~	<5	<5	~	<5	<5					<5	µg/ kg	TM076 S
PCB 118	~	<5	<5	~	<5	<5					<5	µg/ kg	TM076 S
PCB 138	~	<5	<5	~	<5	<5					<5	µg/ kg	TM076 S
PCB 153	~	<5	<5	~	<5	<5					<5	µg/ kg	TM076 S
PCB 180	~	<5	<5	~	<5	<5					<5	µg/ kg	TM076 S
Total 7 PCBs	~	<35	<35	~	<35	<35					<35	µg/ kg	TM076 S
Arsenic #	~	9.0	14.3	~	9.0	8.1					<0.5	mg/kg	TM030
Cadmium #	~	0.7	0.6	~	0.6	2.8					<0.1	mg/kg	TM030
Chromium #	~	13.5	12.9	~	16.3	15.7					<0.5	mg/kg	TM030
Copper #	~	17	14	~	36	58					<1	mg/kg	TM030
Mercury #	~	0.1	0.1	~	<0.1	0.9					<0.1	mg/kg	TM030
Nickel #	~	22.9	22.0	~	20.0	18.1					<0.7	mg/kg	TM030
Lead #	~	47	192	~	52	113					<5	mg/kg	TM030
Selenium #	~	<1	<1	~	<1	1					<1	mg/kg	TM030
Zinc #	~	168	163	~	160	6066					<5	mg/kg	TM030
Water Soluble Boron #	~	1.6	1.2	~	5.8	7.8					<0.1	mg/kg	TM074
Barium #	~	84	112	~	81	144					<1	mg/kg	TM030
Aluminium	~	8463	7875	~	7927	5853					<50	mg/kg	TM030
Antimony	~	1	2	~	1	3					<1	mg/kg	TM030
Molybdenum #	~	0.6	0.5	~	1.5	0.9					<0.1	mg/kg	TM030

Please see attached notes for all abbreviations and acronyms

Jones Environmental Laboratory

Client Name: URS Corporation

Reference: 49341903

Location: Lismore Landfill

Contact: David Mullan

JE Job No.: 10/5485

Report : **CEN 10:1 Leachate**

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

J E Sample No.	31-33	34-36	37-39	40-42	43-45	46-48							
Sample ID	BH04	BH04	BH04	BH05	BH05	BH05							
Depth	2.0	4.2	5.9	0.5	2.0	4.0							
COC No / misc											Please see attached notes for all abbreviations and acronyms		
Containers	V J T	V J T	V J T	V J T	V J T	V J T							
Sample Date	19/11/10	19/11/10	19/11/10	19/11/10	19/11/10	19/11/10							
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil							
Batch Number	1	1	1	1	1	1							
Date of Receipt	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10					LOD	Units	Method No.
Fluoride	~	<0.3	<0.3	~	<0.3	<0.3					<0.3	mg/l	TM027W
Sulphate	~	31.05	41.55	~	44.00	23.38					<0.05	mg/l	TM038W
DOC	~	19	14	~	32	77					<2	mg/l	TM060W
Total Phenols HPLC	~	<0.15	<0.15	~	<0.15	0.39					<0.15	mg/l	TM26
Total Dissolved Solids	~	223	178	~	283	343					<35	mg/l	TM020W
TPH CWG - Aliphatics													
>C5-C6	~	<5	<5	~	<5	<5					<5	µg/ l	TM36/PM12
>C6-C8	~	<5	<5	~	<5	<5					<5	µg/ l	TM36/PM12
>C8-C10	~	<5	<5	~	272	112					<5	µg/ l	TM36/PM12
>C10-C12	~	<5	<5	~	1154	<5					<5	µg/ l	TM5/PM9
>C12-C16	~	<10	<10	~	151	<10					<10	µg/l	TM5/PM9
>C16-C21	~	<10	<10	~	298	<10					<10	µg/l	TM5/PM9
>C21-C35	~	1222	<10	~	7827	<10					<10	µg/l	TM5/PM9
Total aliphatics C5-35	~	1222	<10	~	9702	112					<10	µg/l	
TPH CWG - Aromatics													
>C5-EC7	~	<5	<5	~	<5	<5					<5	µg/ l	TM36/PM12
>EC7-EC8	~	<5	<5	~	<5	<5					<5	µg/ l	TM36/PM12
>EC8-EC10	~	<5	<5	~	95	31					<5	µg/ l	TM36/PM12
>EC10-EC12	~	<5	<5	~	120	<5					<5	µg/ l	TM5/PM9
>EC12-EC16	~	<10	<10	~	<10	<10					<10	µg/ l	TM5/PM9
>EC16-EC21	~	<10	<10	~	78	<10					<10	µg/ l	TM5/PM9
>EC21-EC35	~	605	<10	~	1269	<10					<10	µg/l	TM5/PM9
Total aromatics C5-35	~	605	<10	~	1562	31					<10	µg/ l	
Total aliphatics and aromatics(C5-35)	~	1827	<10	~	11264	143					<10	µg/l	

Jones Environmental Laboratory

Client Name:	URS Corporation	**Report :**	**CEN 10:1 Leachate**
Reference:	49341903		
Location:	Lismore Landfill	**Solids:** V=60g VOC jar, J=250g glass jar, T=plastic tub	
Contact:	David Mullan		
JE Job No.:	10/5485		

J E Sample No.	31-33	34-36	37-39	40-42	43-45	46-48					LOD	Units	Method No.
Sample ID	BH04	BH04	BH04	BH05	BH05	BH05							
Depth	2.0	4.2	5.9	0.5	2.0	4.0							
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T							
Sample Date	19/11/10	19/11/10	19/11/10	19/11/10	19/11/10	19/11/10							
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil							
Batch Number	1	1	1	1	1	1							
Date of Receipt	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10	24/11/10							
BTEX GC-FID											<5	µg/ l	TM031W
MTBE	~	<5	<5	~	<5	<5					<5	µg/ l	TM031W
Benzene	~	<5	<5	~	<5	<5					<5	µg/ l	TM031W
Toluene	~	<5	<5	~	<5	<5					<5	µg/ l	TM031W
Ethyl benzene	~	<5	<5	~	17	7					<5	µg/ l	TM031W
m/p-Xylene	~	<5	<5	~	56	17					<5	µg/ l	TM031W
o-Xylene	~	<5	<5	~	22	7					<5	µg/ l	TM031W
Total Xylenes	~	<10	<10	~	78	24					<10	µg/ l	TM031W
Arsenic - dissolved #	~	10.8	5.3	~	8.2	8.0					<2.5	µg/l	TM 030W
Boron - dissolved #	~	64	47	~	177	323					<12	µg/l	TM 030W
Cadmium - dissolved #	~	<0.5	<0.5	~	<0.5	<0.5					<0.5	µg/l	TM 030W
Chromium - dissolved #	~	4.2	2.7	~	2.2	2.3					<1.5	µg/l	TM 030W
Copper - dissolved #	~	7	7	~	<7	<7					<7	µg/l	TM 030W
Mercury - dissolved #	~	<1	<1	~	<1	<1					<1	µg/l	TM 030W
Nickel - dissolved #	~	4	3	~	7	11					<2	µg/l	TM 030W
Lead - dissolved #	~	6	18	~	<5	<5					<5	µg/l	TM 030W
Selenium - dissolved #	~	<3	<3	~	<3	<3					<3	µg/l	TM 030W
Zinc - dissolved #	~	18	18	~	11	15					<3	µg/l	TM 030W
Aluminium - dissolved #	~	1928	980	~	883	507					<20	µg/l	TM 030W
Barium - dissolved #	~	17	26	~	26	25					<3	µg/l	TM 030W
Antimony - dissolved #	~	3	2	~	2	5					<2	µg/l	TM 030W
Molybdenum - dissolved	~	15	25	~	25	39					<2	µg/l	TM 030W
Total Alkalinity as CaCO3	~	125	~	~	204	~					<1	mg/l	TM075W
Amm N/Tot Ammonia as N#	~	6.47	~	~	17.00	~					<0.03	mg/l	TM038W
Bicarbonate Alkalinity as CaCO3	~	125	~	~	175						<1	mg/l	TM075W
Calcium - dissolved#	~	31.9	~	~	36.4						<0.2	mg/l	TM 030W
Carbonate Alkalinity as CaCO3	~	<1	~	~	29	~					<1	mg/l	TM075W
Chloride	~	8.7	7.4	~	19.1	34.7					<0.3	mg/l	TM038W
Total Hardness - dissolved	~	97	~	~	120	~					<1	mg/l	TM 030W
Iron - dissolved #	~	1229	~	~	539	~					<20	µg/l	TM 030W
Magnesium - dissolved#	~	4.3	~	~	7.0	~					<0.1	mg/l	TM 030W
Manganese - dissolved #	~	83	~	~	381	~					<2	µg/l	TM 030W
Nitrate as NO_3	~	0.7	~	~	0.3	~					<0.2	mg/l	TM038W
Nitrite as NO_2	~	0.03	~	~	<0.02	~					<0.02	mg/l	TM038W
Total Oxidised Nitrogen as N	~	<0.05	~	~	<0.05	~					<0.05	mg/l	TM038W
Ortho phosphate as PO4	~	0.88	~	~	0.06	~					<0.06	mg/l	TM038W
Sodium - dissolved#	~	5.5	~	~	14.9	~					<0.1	mg/l	TM 030W
Potassium - dissolved#	~	17.9	~	~	21.7	~					<0.1	mg/l	TM 030W
Sulphate	~	31.05	~	~	44.00	~					<0.05	mg/l	TM038W

Please see attached notes for all abbreviations and acronyms

Jones Environmental Laboratory

Client Name:	URS Corporation	**Report :**	**Liquids**
Reference:	49341903		
Location:	Lismore Landfill		
Contact:	David Mullan	**Liquids/products:**	V=40ml vial, G=glass bottle, P=plastic bottle
JE Job No.:	10/5485		$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

J E Sample No.	49-53	54-58	59-63	64-68							LOD	Units	Method No.
Sample ID	BH01	BH02	BH03	BH05									
Depth	-	-	-	-									
COC No / misc													
Containers	V H HN G	V H HN G	V H HN G	V H HN G									
Sample Date	22/11/10	22/11/10	22/11/10	22/11/10									
Sample Type	Water	Water	Water	Water									
Batch Number	1	1	1	1									
Date of Receipt	24/11/10	24/11/10	24/11/10	24/11/10									
BTEX GC-FID											<5	µg/ l	TM031W
MTBE	<5	<5	<5	<5							<5	µg/ l	TM031W
Benzene	<5	<5	<5	<5							<5	µg/ l	TM031W
Toluene	<5	<5	<5	<5							<5	µg/ l	TM031W
Ethyl benzene	<5	<5	<5	<5							<5	µg/ l	TM031W
m/p-Xylene	<5	<5	<5	<5							<5	µg/ l	TM031W
o-Xylene	<5	<5	<5	<5							<5	µg/ l	TM031W
Total Xylenes	<10	<10	<10	<10							<10	µg/ l	TM031W
TPH CWG - Aliphatics													
>C5-C6	<5	<5	<5	<5							<5	µg/ l	TM36/PM12
>C6-C8	<5	<5	<5	<5							<5	µg/ l	TM36/PM12
>C8-C10	<5	<5	<5	<5							<5	µg/ l	TM36/PM12
>C10-C12	<5	<5	<5	<5							<5	µg/ l	TM5/PM9
>C12-C16	<10	<10	<10	<10							<10	µg/l	TM5/PM9
>C16-C21	<10	<10	<10	<10							<10	µg/l	TM5/PM9
>C21-C35	<10	<10	<10	<10							<10	µg/l	TM5/PM9
Total aliphatics C5-35	<10	<10	<10	<10							<10	µg/l	
TPH CWG - Aromatics													
>C5-EC7	<5	<5	<5	<5							<5	µg/ l	TM36/PM12
>EC7-EC8	<5	<5	<5	<5							<5	µg/ l	TM36/PM12
>EC8-EC10	<5	<5	<5	<5							<5	µg/ l	TM36/PM12
>EC10-EC12	<5	<5	<5	5							<5	µg/ l	TM5/PM9
>EC12-EC16	<10	<10	<10	1167							<10	µg/ l	TM5/PM9
>EC16-EC21	<10	<10	<10	14							<10	µg/ l	TM5/PM9
>EC21-EC35	<10	<10	<10	<10							<10	µg/l	TM5/PM9
Total aromatics C5-35	<10	<10	<10	1186							<10	µg/ l	
Total aliphatics and aromatics(C5-35)	<10	<10	<10	1186							<10	µg/l	
TOC	4	6	5	35							<2	mg/l	TM060W
Arsenic - dissolved #	<2.5	<2.5	<2.5	6.5							<2.5	µg/l	TM 030W
Boron - dissolved	93	77	53	1691							<12	µg/l	TM 030W
Cadmium - dissolved #	<0.5	<0.5	0.8	<0.5							<0.5	µg/l	TM 030W
Chromium - dissolved #	3.2	14.8	<1.5	16.6							<1.5	µg/l	TM 030W
Copper - dissolved #	<7	<7	<7	<7							<7	µg/l	TM 030W
Mercury - dissolved #	<1	<1	<1	<1							<1	µg/l	TM 030W
Nickel - dissolved #	<2	<2	<2	18							<2	µg/l	TM 030W
Lead - dissolved #	<5	<5	<5	<5							<5	µg/l	TM 030W
Selenium - dissolved #	<3	<3	<3	<3							<3	µg/l	TM 030W
Zinc - dissolved #	21	46	99	21							<3	µg/l	TM 030W
Aluminium - dissolved #	<20	<20	<20	25							<20	µg/l	TM 030W
Barium - dissolved #	24	11	11	84							<3	µg/l	TM 030W
Antimony - dissolved #	<2	<2	<2	7							<2	µg/l	TM 030W

Please see attached notes for all abbreviations and acronyms

Please include all sections of this report if it is reproduced
All solid results are expressed on a dry weight basis unless stated otherwise.

Jones Environmental Laboratory

Client Name: URS Corporation

Reference: 49341903

Location: Lismore Landfill

Contact: David Mullan

JE Job No.: 10/5485

Report : **Liquids**

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
$H=H_2SO_4$, Z=ZnAc, N=NaOH, $HN=HN0_3$

J E Sample No.	49-53	54-58	59-63	64-68							LOD	Units	Method No.
Sample ID	BH01	BH02	BH03	BH05									
Depth	-	-	-	-									
COC No / misc													
Containers	V H HN G	V H HN G	V H HN G	V H HN G									
Sample Date	22/11/10	22/11/10	22/11/10	22/11/10									
Sample Type	Water	Water	Water	Water									
Batch Number	1	1	1	1									
Date of Receipt	24/11/10	24/11/10	24/11/10	24/11/10									
Molybdenum - dissolved #	<2	<2	<2	53							<2	µg/l	TM 030W
Total Alkalinity as CaCO3#	495	1845	339	3238							<1	mg/l	TM075W
Amm N/Tot Ammonia as N#	0.04	0.08	0.73	0.22							<0.03	mg/l	TM038W
Bicarbonate Alkalinity as CaCO3	495	1845	339	3238							<1	mg/l	TM075W
Calcium - dissolved#	160.6	122.7	134.3	79.5							<0.2	mg/l	TM 030W
Carbonate Alkalinity as CaCO3	<1	<1	<1	<1							<1	mg/l	TM075W
Chloride#	21.4	38.6	19.0	77.3							<0.3	mg/l	TM038W
Total Hardness - dissolved	437	358	358	544							<1	mg/l	TM 030W
Iron - dissolved #	<20	67	<20	838							<20	µg/l	TM 030W
Magnesium - dissolved#	8.5	12.4	5.4	82.3							<0.1	mg/l	TM 030W
Manganese - dissolved #	9	16	2	493							<2	µg/l	TM 030W
Nitrate as NO_3#	2.6	35.2	29.2	0.5							<0.2	mg/l	TM038W
Nitrite as NO_2#	0.39	1.75	<0.02	<0.02							<0.02	mg/l	TM038W
Total Oxidised Nitrogen as N#	0.71	8.48	6.60	0.10							<0.05	mg/l	TM038W
Ortho phosphate as PO4#	<0.06	<0.06	<0.06	2.27							<0.06	mg/l	TM038W
Potassium - dissolved#	3.8	6.9	2.9	321.8							<0.1	mg/l	TM 030W
Sodium - dissolved#	10.2	21.0	8.8	190.5							<0.1	mg/l	TM 030W
Sulphate#	16.40	32.39	13.19	93.31							<0.05	mg/l	TM038W
pH#	7.13	7.08	7.11	7.97							<0.01	pH units	TM073
Electrical Conductivity# @25°C	959	770	700	7517							<100	µS/cm	TM28/PM11
BOD settled*	6	34	2	65100							<1	mg/l	Subcontracted
COD*	1800	5995	120	35300							<7	mg/l	Subcontracted
Faecal Coliforms*	<3	7	4	NDP	NDP - No determination possible						<3	mpn/g	subcontracted

Please see attached notes for all abbreviations and acronyms

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

SOILS

Please note we are only MCERTS accredited for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. Your final report will reflect this, with non-MCERTS results on separate pages.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary. If we are instructed to keep samples, a storage charge of £1 (1.5 Euros) per sample per month will be applied until we are asked to dispose of them.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Asbestos screens where requested will be undertaken by a UKAS accredited laboratory.

WATERS

Please note we are not a Drinking Water Inspectorate (DWI) Approved Laboratory . It is important that detection limits are carefully considered when requesting water analysis.

UKAS accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples. All samples are treated as groundwaters and analysis performed on settled samples unless we are instructed otherwise.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any analysis that may be compromised highlighted on your schedule/ report by the use of a symbol.

The use of any of the following symbols indicates that the sample was deviating and the test result may be unreliable:

$ sample temperature on receipt considered inappropriate for analysis requested
^ samples exceeding recomended holding times
& samples received in inappropriate containers (e.g. volatile samples not submitted in VOC jars/vials)
~ no sampling date given, unable to confirm if samples are with acceptable holding times

ABBREVIATIONS and ACRONYMS USED

- UKAS accredited
M - MCERTS accredited
NAD - No Asbestos Detected
ND - None Detected (usually refers to VOC and/SVOC TICs)
SS - Calibrated against a single substance
* - analysis subcontracted to a Jones Environmental approved laboratory.
W - Results expressed on as received basis
+ Failed AQC results should be considered as indicative only and are not accredited.
++ Result outside calibration range, may be possible to re-run with higher detection limits

ENVIRONMENTAL
LABORATORY SERVICES
Acorn Business Campus,
Mahon Industrial Park,
Blackrock,
CorkTel: 021-4536141
Fax: 021-4536149

Analysis Report

Attention:		**Report No:**	19905
Paul Carroll			
Waterford County Council		**Date of receipt:**	26/11/2010
Water Laboratory		**Date Started:**	01/12/2010
Kilmeaden			
County Waterford			
Fax No:		**Issue Date:**	17/12/2010
Tel No:	051-384393	**Page**	1 **of** 4
	086-8210414		
PO Number:	400117608	**Delivery Mode**	Courier
Sample Type	Drinking Water	**No. of Samples**	3
Condition on receipt	Satisfactory	**Client Ref:**	Below

QN2314 Drinking Water-Metals,VOC,PAH

SIGNED **(17/12/2010)**

Technical Manager (or Deputy)
Brendan Murray

Method		ICPMS								GCMS		Purge and Trap			
Method Number		EM130								EO129		EO025			
Parameter		As	Cd	Cr	Hg	Ni	Pb	Sb	Cu	Benzo(a) Pyrene	PAH	1,2-diCl ethane	Benzene	Tetra+ TriCl ethene	THM Sum
Units		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Limit of Detection		0.2	0.1	1.0	0.20	0.5	0.3	0.1	0.003	0.003	0.01	0.1	0.1	0.2	5.0
Parametric Value		10.0	5.0	50.0	1.00	20.0	25	5.0	2.000	0.01	0.10	3.0	1.0	0.2	100
Date Testing Initiated		03/12								29/11		01/12			
ELS Ref	Client Ref														
19905-1	Samshire Upstream (Bottles reference: 1)	0.80	0.2	<1.0	<0.2	0.9	0.4	<0.1	<0.003	<0.003	<0.01	<0.1	<0.1	<0.2	<5.0
19905-2	Samshire Downstream(Bottles reference: 2)	0.90	0.2	<1.0	<0.2	1.4	0.5	<0.1	<0.003	<0.003	<0.01	<0.1	<0.1	<0.2	<5.0
19905-3	Samshire Groundwater(Bottles reference: 3)	0.9	<0.1	<1.0	<0.2	0.6	0.3	<0.1	<0.003	<0.003	<0.01	<0.1	<0.1	<0.2	<5.0

NOTES

1 Sub-contract analysis denoted by *

2 ND = Concentration was below the limit of detection

Pesticides and PAH

PAH	Parametric Value	LOD	19905-1	19905-2	19905-3
Naphthalene	-	0.01	<0.01	<0.01	<0.01
Acenaphthylene	-	0.01	<0.01	<0.01	<0.01
Acenaphthene (Note 3)	-	0.01	<0.01	<0.01	<0.01
Fluorene	-	0.01	<0.01	<0.01	<0.01
Phenanthrene	-	0.01	<0.01	<0.01	<0.01
Anthracene	-	0.01	<0.01	<0.01	<0.01
Fluoranthene	-	0.01	<0.01	<0.01	<0.01
Pyrene	-	0.01	<0.01	<0.01	<0.01
Chrysene	-	0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	-	0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	-	0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	-	0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	-	0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene (Note 3)	-	0.01	<0.01	<0.01	<0.01
PAH (Sum of 4 above)	0.1	-	<0.01	<0.01	<0.01

NOTES
1. ND = Concentration was below the limit of detection
2. Limit of detection for some parameters updated arising from recent INAB audit
3. Result is non accredited due to QC Breach, retest not possible due to lack of sample

Volatile Organic Compounds and THM's

No.	Analyte	Parametric Value (ug/l)	LOD (ug/l)	19763-1	19905-1	19905-2	19905-3
61	Bromoform	-	1.0	<1.0	<1.0	<1.0	<1.0
43	Bromodichloromethane	-	2.0	<2.0	<2.0	<2.0	<2.0
31	Trichloromethane/ Chloroform	-	1.0	<1.0	<1.0	<1.0	<1.0
53	Dibromochloromethane	-	1.0	<1.0	<1.0	<1.0	<1.0
	Total THM's	100	5.0	<5.0	<5.0	<5.0	<5.0
50	Tetrachloroethylene/ Tetrachloroethene	-	0.1	<0.1	<0.1	<0.1	<0.1
39	Trichloroethylene/ Trichloroethene	-	0.1	<0.1	<0.1	<0.1	<0.1

NOTES

1. ND = Concentration below limit of detectioon

ELS LTD INAB ACCREDITATION SCHEDULE SUMMARY SHEET

Miscellaneous (P,G,W,S)
Ammonia/Ammonium 0.007-1mg/l N EW003
Chloride 2.6-250 mg/l EW015
Flouride 0.1 - 2 mg/l EW137
COD 8-1500 mg/l EW094
Nitrate 0.12-50 mg/l N EW034
Nitrite 0.013-1 mg/l N EW035
pH 4 – 10 pH Units EW138
Phosphate 0.009-1 mg/l P EW007
Alkalinity 10-1000mg/l EW062
TOC 0.25-100mg/l EW123
BOD 1-1300mg/l EW001
Total Nitrogen 1-100mg/l N EW140
Total Phosphorous 0.01-40 mg/l P EW143

Miscellaneous (P,G,S)
Bromate 1 to 50ug/l BRO3 (EW137)
Colour 2.5-50mg/l PtCCo (EW021)
Conductivity 25-6000 us/cm EW139
Dissolved Oxygen 1 to 10 mg/l (EW043)
Sulphate 1-250mg/l SO4(EW016)
Suspended Solids 5-1000mg/l (EW013)
Total Dissolved Solids 1-1000mg/l (EW046)
Total Hardness 3-330mg/l CaCO3 (EM099)
Total Oxidised Nitrogen 0.138-51mg/l N (EW051)

Metals EM130 (P,G,S)
Aluminium 5.0 – 500 µg/l
Antimony 0.1 – 10µg/l
Arsenic 0.2 - 20µg/l
Barium 1.0 - 100µg/l
Boron 0.02 – 2mg/l
Cadmium 0.1 – 10µg/l
Calcium 1.0 – 100mg/l
Chromium 1.0 - 100µg/l
Cobalt 1.0 - 100µg/l
Copper 3 - 4000µg/l
Iron 5.0 - 500µg/l
Lead 0.3 - 30µg/l
Magnesium 0.3 – 20mg/l
Manganese 1.0 - 100µg/l
Mercury 0.02 - 2µg/l
Molybdenum 1.0 - 100µg/l
Nickel 0.5 - 50µg/l
Potassium 0.2 – 20mg/l
Selenium 0.2 - 20µg/l
Sodium 0.5 – 50mg/l
Strontium 1.0 - 100µg/l
Tin 1.0 - 100µg/l
Vanadium 1.0 - 100µg/l
Zinc 1.0 - 100µg/l

SI439 Potable Water VOCs & THM
EO025 (P,G,S)
Benzene 0.1-35 µg/l
1.2-Dichloroethane 0.1-35 µg/l
Tetrachloroethene 0.1-35 µg/l
Trichloroethene 0.1-35 µg/l
Chloroform 1.0-150 µg/l
Bromoform 1.0-35 µg/l
Dibromochloromethane 1.0-35 µg/l
Bromodichloromethane 2.0-35 µg/l

Other VOC's EO025 (P,G,S)
Bromomethane 0.5 - 35 µg/l
Ethyl Ether/Diethyl Ether0.5 - 35 µg/l
11 Dichloroethene0.5 - 35 µg/l
Iodomethane/Mehyl Iodide 0.5 - 35 µg/l
Carbon Disulphide 0.5 - 35 µg/l
Allyl Chloride0.5 - 35 µg/l
Methylene Chloride/DCM 5.0 - 35 µg/l
2-Propenenitrile/Acrylonitrile 2.0 - 35 µg/l
Chlormethyl Cyanide 0.5 - 35 µg/l
Hexachlorobutadiene0.5 - 35 µg/l
Trans-1,2 Dichloroethene0.5 - 35 µg/l
MtBE0.5 - 35 µg/l
11 Dichloroethane0.5 - 35 µg/l
22 Dichloropropane0.5 - 35 µg/l
Cis-12 Dichloroethene0.5 - 35 µg/l
Methyl Acrylate5.0 - 35 µg/l
Bromochloromethane0.5 - 35 µg/l
Tetrahydrofuran5.0 - 35 µg/l
111 Trichloroethane0.5 - 35 µg/l
1-Chlorobutane0.5 - 35 µg/l
Carbon Tetrachloride0.5 - 35 µg/l
11 Dichloropropene0.5 - 35 µg/l
12 Dichloropropane0.5 - 35 µg/l
Dibromomethane0.5 - 35 µg/l
Methyl Methacrylate0.5 - 35 µg/l
13 Dichloropropene, cis2.0 - 35 µg/l
MIBK/4 Methyl 2 Pentanone 2.0 - 35 µg/l
Toluene0.5 - 35 µg/l
13 Dichloropropene,trans2.0 - 35 µg/l
Ethyl Methacrylate2.0 - 35 µg/l
112 Trichloroethane0.5 - 35 µg/l
13 Dichloropropane0.5 - 35 µg/l
2 Hexanone1.0 - 35 µg/l
12 Dibromoethane0.5 - 35 µg/l
Chlorobenzene0.5 - 35 µg/l
1112 Tetrachloroethane2.0 - 35 µg/l
Ethyl Benzene0.5 - 35 µg/l
m & p Xylene0.5 - 35 µg/l
O Xylene0.5 - 35 µg/l
Stryene2.0 - 35 µg/l
Isopropyl Benzene0.5 - 35 µg/l
Bromobenzene0.5 - 35 µg/l
1122 Tetrachloroethane0.5 - 35 µg/l
123 Trichloropropane2.0 - 35 µg/l
Propyl Benzene0.5 - 35 µg/l
2-Chlorotoluene0.5 - 35 µg/l
4 Chlorotoluene0.5 - 35 µg/l
135 Trimenthylbenzene0.5 - 35 µg/l
Tert Butyl Benzene0.5 - 35 µg/l
124 Trimethlbenzene0.5 - 35 µg/l
Sec Butyl Benzene0.5 - 35 µg/l
13 Dichlorobenzene0.5 - 35 µg/l
P Isopropyltoluene0.5 - 35 µg/l
14 Dichlorobenzene0.5 - 35 µg/l
12 Dichlorobenzene0.5 - 35 µg/l
N Butyl Benzene0.5 - 35 µg/l
Hexachloroethane5.0 - 35 µg/l
12 Dibromo 3Chloropropane 2.0 - 35 µg/l
124 Trichlorobenzene0.5 - 35 µg/l
123 Trichlorobenzene0.5 - 35 µg/l

PAH EO129 (P,G,S)
Range 0.01 - 0.2 µg/l
Acenaphthene
Benzo (a) Anthracene
Benzo (a) Pyrene
Benzo (b) Fluoranthene
Benzo (ghi) Perylene
Benzo (k) Fluoranthene
Chrysene
Dibenzo (ah) Anthracene
Fluoranthene
Fluorene
Indeno (123-cd) Pyrene
Phenanthrene
Pyrene

Acid Herbicides (P,G,S)
Range 0.01 - 0.2 µg/l
2,4,5-T H
2,4-D H
2,4-DB H

Organophosphorus Pesticides(P,G,S)
Range 0.01 - 0.2 µg/l
Famphur OP
Methyl Parathion OP
Parathion OP

Organochlorine Pesticides (P,G,S)
Range 0.01 - 0.2 µg/l
Aldrin
BHC Alpha isomer OC
BHC Beta isomer OC
BHC Delta isomer OC
Dieldrin OC
Endosulphan Alpha isomer OC
Endosulphan Beta isomer OC
Endosulphan Sulphate OC
Endrin OC
Heptachlor Epoxide OC
Heptachlor OC
Lindane OC
P,P' DDE OC
P,P'-DDD OC
P,P'-DDT OC

Notes
1.Sample Matrix:P=Potable Water (Drinking) , G=Ground Water , S=Surface Water, W=Waste Water

Appendix C - Logs

URS Ireland Ltd
Iveagh Court, 4th Floor
6-8 Harcourt Road
Dublin 2, Ireland
Telephone: 01 4155100
Fax: 01 4155101

BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Lismore Landfill Assessment	Waterford County Council	**BH01**

Job No	Date	Ground Level (m)	Co-Ordinates ()
49341903	Start Date 17-11-10 End Date 17-11-10		

Contractor	Method / Plant Used	Sheet
JS Drilling	Shell and auger	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thick-ness)	DESCRIPTION	COMMENTS	Instalation /Backfill
0.5	BH01_0.4m	0.0			(1.50)	Light brown slightly gravelly sandy CLAY with occasional roots and fibrous material.	NEC	
1.0		0.0			1.50			
1.5								
2.0	BH01_1.9m	0.3			(3.30)	Gravelly CLAY. Gravel is sub angular to sub rounded.	Very dry, NEC	
2.5								
3.0								
3.5								
4.0	BH01_4.1m	0.2			4.80			
4.5								
5.0					(2.20)	Light grey sandy GRAVEL.	Dry	
5.5								
6.0		0.0			7.00			
6.5								
7.0					(3.50)	Soft light grey/brown LIMESTONE.	Very dry, NEC	
7.5								
8.0								
8.5								
9.0								
9.5								
10.0					10.50			
10.5						Hard Light brown/grey LIMESTONE.	Dry	
11.0								
11.5								
12.0								
12.5								
13.0								
13.5								
14.0								
14.5								
15.0					(9.30)			
15.5								
16.0								
16.5								
17.0								
17.5								
18.0								
18.5								
19.0								
19.5			▼1		19.80			
20.0						Light brown CLAY lense.	Water at 20m	
20.5					(1.70)			
21.0								
21.5					21.50			
22.0					22.00	Very hard light brown/grey LIMESTONE.		
						EOH @ 22m		

WELL INSTALLATION DETAILS

- Cement seal riser
- Bentonite seal riser
- Filter pack riser
- Filter pack screen

SAMPLE TYPE DETAILS

LEGEND

- Gravelly Sandy Clay
- Gravelly CLAY
- Sandy Gravel
- LIMESTONE
- CLAY
- Groundwater Table
- Water Strike

bgl = Below Ground Level

GENERAL REMARKS

Logged By	Approved By
AMR	DM

EXPLORATORY HOLE LOG 21/09/07 LISMORE LANDFILL BH LOGS.GPJ AGS3 ALL.GDT 9/12/10

URS Ireland Ltd
Iveagh Court, 4th Floor
6-8 Harcourt Road
Dublin 2, Ireland
Telephone: 01 4155100
Fax: 01 4155101

BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Lismore Landfill Assessment	Waterford County Council	**BH02**

Job No	Date	Ground Level (m)	Co-Ordinates ()
49341903	Start Date 18-11-10 End Date 18-11-10		

Contractor	Method / Plant Used	Sheet
JS Drilling	Shell and auger	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thick-ness)	DESCRIPTION	COMMENTS	Instalation /Backfill
0.5	BH02_0.6m	0.0			(1.30)	Brown slightly gravelly sandy CLAY.	Dry, NEC	
1.0					1.30			
1.5		0.3				Light grey clayey GRAVEL. Gravel is sub rounded to rounded.	Dry, NEC	
2.0	BH02_2.1m	0.2			(2.60)			
2.5								
3.0								
3.5					3.90			
4.0	BH02_4.0m	0.0			(0.80)	Brown gravelly CLAY.	Dry, NEC	
4.5					4.70			
5.0					(1.30)	Hard LIMESTONE.		
5.5								
6.0		0.0			6.00	Soft clayey MUDSTONE.		
6.5								
7.0								
7.5								
8.0					(4.00)			
8.5								
9.0								
9.5								
10.0					10.00	Hard light grey LIMESTONE.		
10.5					(1.00)			
11.0					11.00	Soft brown MUDSTONE.		
11.5								
12.0								
12.5					(3.50)			
13.0								
13.5								
14.0								
14.5					14.50			
15.0					15.00	Hard light grey LIMESTONE.	Hole collapsed at base.	
						EOH @15m		

WELL INSTALLATION DETAILS

- Cement seal riser
- Filter pack riser
- Bentonite seal riser
- Filter pack screen
- Hole Collapse

SAMPLE TYPE DETAILS

LEGEND

- Gravelly Sandy Clay
- Clayey GRAVEL
- Gravelly CLAY
- LIMESTONE
- Mudstone
- Groundwater Table
- Water Strike

bgl = Below Ground Level

GENERAL REMARKS

Logged By	Approved By
AMR	DM

EXPLORATORY HOLE LOG 21/09/07 LISMORE LANDFILL BH LOGS.GPJ AGS3_ALL.GDT 9/12/10

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Telephone: 01 4155100
Fax: 01 4155101

BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Lismore Landfill Assessment	Waterford County Council	**BH03**

Job No	Date	Ground Level (m)	Co-Ordinates ()
49341903	Start Date 18-11-10 End Date 18-11-10		

Contractor	Method / Plant Used	Sheet
JS Drilling	Shell and auger	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thick-ness)	DESCRIPTION	COMMENTS	Instalation /Backfill
0.5	BH03_0.5m				(0.80) 0.80	Brown slightly gravelly sandy CLAY.	Dry, NEC	
1.0						Light grey sandy GRAVEL.	Very dry, NEC, no sample recovery at 2m.	
1.5								
2.0					(2.50)			
2.5								
3.0					3.30			
3.5						Brown clayey GRAVEL with cobbles. Gravel is rounded.	Dry, NEC	
4.0	BH03_4.1m							
4.5					(2.90)			
5.0								
5.5								
6.0					6.20			
6.5						LIMESTONE (fractured).	Water at 8m, hole collapsed at base.	
7.0								
7.5								
8.0			▽1					
8.5								
9.0								
9.5								
10.0								
10.5					(8.80)			
11.0								
11.5								
12.0								
12.5								
13.0								
13.5								
14.0								
14.5								
15.0					15.00			
						EOH @ 15m		

WELL INSTALLATION DETAILS

- Cement seal riser
- Bentonite seal riser
- Filter pack riser
- Filter pack screen
- Hole Collapse

SAMPLE TYPE DETAILS

LEGEND

- Gravelly Sandy Clay
- Sandy GRAVEL
- Clayey GRAVEL
- LIMESTONE
- Groundwater Table
- Water Strike

bgl = Below Ground Level

GENERAL REMARKS

Logged By	Approved By
AMR	DM

EXPLORATORY HOLE LOG 21/09/07 LISMORE LANDFILL BH LOGS.GPJ AGS3_ALL.GDT 9/12/10

URS Ireland Ltd
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Telephone: 01 4155100
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BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Lismore Landfill Assessment	Waterford County Council	**BH04**

Job No	Date	Ground Level (m)	Co-Ordinates ()
49341903	Start Date 19-11-10 End Date 19-11-10		

Contractor	Method / Plant Used	Sheet
JS Drilling	Shell and auger	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thick-ness)	DESCRIPTION	COMMENTS	Instalation /Backfill
0.5	BH04_0.5m				(1.00)	MADE GROUND Dark brown sandy clay with plastic bags and wood fragments.		
1.0					1.00			
1.5						MADE GROUND Light gravelly clay with plastic bags, metal and wood fragments. Rubbish becoming more abundant with depth.	Sweet smell	
2.0	BH04_2.0m							
2.5								
3.0								
3.5					(5.40)			
4.0								
4.5								
5.0								
5.5								
6.0	BH04_5.9m							
6.5					6.40 6.50	Weathered LIMESTONE. EOH @ 6.5m	Sweet smell, rotting	

WELL INSTALLATION DETAILS

Cement seal riser
Bentonite seal riser
Filter pack riser
Filter pack screen

SAMPLE TYPE DETAILS

LEGEND

Made Ground (Fill)
LIMESTONE
Groundwater Table
Water Strike
bgl = Below Ground Level

GENERAL REMARKS

Logged By	Approved By
AMR	DM

EXPLORATORY HOLE LOG 21/09/07 LISMORE LANDFILL BH LOGS.GPJ AGS3_ALL.GDT 9/12/10

URS Ireland Ltd
Iveagh Court, 4th Floor
6-8 Harcourt Road
Dublin 2, Ireland
Telephone: 01 4155100
Fax: 01 4155101

BOREHOLE LOG

Project Name and Site Location	Client	BOREHOLE No
Lismore Landfill Assessment	Waterford County Council	**BH05**

Job No	Date	Ground Level (m)	Co-Ordinates ()
49341903	Start Date 19-11-10 End Date 19-11-10		

Contractor	Method / Plant Used	Sheet
JS Drilling	Shell and auger	1 of 1

Depth BGL	Sample / Test Details	PID (ppm)	Water	STRATA: Legend	Depth (Thick-ness)	DESCRIPTION	COMMENTS	Instalation /Backfill
0.5	BH05_0.5m	2.0			(1.00)	MADE GROUND Brown gravelly clay with plastic.	Dry, slight rotted waste odour	
1.0					1.00			
1.5						MADE GROUND Black rotted waste with plastic, wood and metal.	Strong odour, sweet rotting waste	
2.0	BH05_2.0m	0.7						
2.5								
3.0								
3.5								
4.0	BH05_4.0m	1.9						
4.5								
5.0								
5.5								
6.0					(9.50)			
6.5								
7.0								
7.5								
8.0								
8.5								
9.0								
9.5								
10.0								
10.5					10.50	EOH @ 10.5m (LIMESTONE bedrock)		

WELL INSTALLATION DETAILS

Cement seal riser
Filter pack riser
Bentonite seal riser
Filter pack screen

SAMPLE TYPE DETAILS

LEGEND

Made Ground (Fill)

Groundwater Table
Water Strike
bgl = Below Ground Level

GENERAL REMARKS

Logged By	Approved By
AMR	DM

EXPLORATORY HOLE LOG 21/09/07 LISMORE LANDFILL BH LOGS.GPJ AGS3_ALL.GDT 9/12/10

Appendix D - Groundwater Elevation Measurements

Groundwater Elevations
Townspark East, Lismore, Co. Waterford

		22-Nov-10				04-Jan-11*		17-Jan-11*		18-Oct-11*	
Monitoring Well	**Reduced Level of Top of Well (mOD)**	**Depth to Water (mbgl)**	**Relative Water Level (mA0D)**	**Depth of Base of Well**	**NAPL Present**	**Depth to Water (mbgl)**	**Relative Water Level (mA0D)**	**Depth to Water (mbgl)**	**Relative Water Level (mA0D)**	**Depth to Water (mbgl)**	**Relative Water Level (mA0D)**
BH01	30.38	15.33	15.05	22.45	No	14.52	15.86	15.70	14.68	13.30	17.08
BH02	29.33	12.65	16.68	13.20	No	11.66	17.67	12.70	16.63	6.50	22.83
BH03	25.36	8.46	16.90	9.90	No	8.90	16.46	8.80	16.56	6.20	19.16
BH04	28.98	Dry	-	6.50	No	nm	-	6.90	22.08	Blocked	n/a
BH05	30.84	7.60	23.24	10.50	No	nm	-	5.70	25.14	9.40	21.44

Notes: mOD - metres above Ordnance Datum
mbgl - metres below ground level
NAPL - non aqueous phase liquid
* Measurements taken by Waterford Co. Co.

Waterford County Council

Environmental Risk Assessment for Unregulated Waste Disposal Site

Tier 3

Finalised Quantitative Risk Assessment & Recommendations

Townspark East, Lismore Landfill

	Name	Position	Date
Prepared By	L Ahearn	Assistant Engineer	September 2012
Checked By	A O' Flaherty	Executive Engineer	September 2012
Approved by	G Hynes	Senior Engineer	September 2012

Table of Contents

1.0 Introduction

As per the "Code of Practice Environmental Risk Assessment for Unregulated Waste Disposal Sites (COP) document issued by the EPA in April 2007, a quantitative risk assessment (QRA) is required where the site is deemed following the risk screening process to intrinsically pose a high or moderate risk to the environment or human health. The two basic types of quantitative risk assessment identified in this document are (i) Generic Quantitative Risk Assessment and (ii) Detailed Quantitative Risk Assessment.

In relation to this particular Tier 3 risk assessment; Waterford County Council proposes to compile a Generic Quantitative Risk Assessment for the historic landfill at Townspark East, Lismore, Co. Waterford. The decision for a Generic QRA as opposed to a Detailed QRA was based on the sites' classification in the moderate/low risk category and quantity and quality of the data available. It was considered that sufficient data was available from the desk study, exploratory study and intrusive investigations in order to adequately assess any impacts of the landfill on nearby receptors by comparing the sampling results found in our investigations with generic assessment criteria.

This assessment shall also include proposals for a remediation and monitoring plan.

1.1 Tier 1 & 2 Risk Assessments:

The conceptual site model (CSM) compiled in the Tier 1 Risk Assessment identified leachate and landfill gas as the primary sources; surface waters, groundwater and humans as the potential receptors. However, the overall site classification was Class C – 'low risk'.

The Exploratory Investigation was performed in September 2010 by Waterford County Council technical staff. The exploratory investigation gave an overview of the type and extent of material which had been disposed off on site and provided information on the best locations for the installation of borewells as part of the further Tier 2 investigation.

Waterford County Council then commissioned URS Ireland Ltd to carry out the main Tier 2 intrusive ground investigation on the historic landfill in November 2010 including the installation of groundwater, gas and leachate wells and the undertaking of a geophysical survey. On foot of the findings of the Tier 2 Investigation, URS completed an initial Quantitative Risk Assessment to assess the leachate migration risk to groundwater and the gas migration risk to human presence within close proximity of the site. Following on from the Tier 2 Exploratory and Intrusive Investigation the site was classified as a Moderate Risk Class 'B'. This reclassification was primarily due to the

underlying aquifer being categorised as karstified and not a poorly productive aquifer as originally envisaged in the Tier 1 Assessment.

This report is now a finalised Quantitative Risk Assessment (Tier 3) which takes on board the Tier 2 and Quantitative Risk Assessment undertaken by URS combining it with details and results found by Waterford County Council in their Exploratory and sampling investigations.

2.0 Potential Sources

2.1 Waste Body:

The Tier 1 Risk Assessment concluded that the site was used to deposit domestic and commercial and possibly some limited quantity of industrial wastes. The site was reported (from local knowledge) to be 5 – 10m deep. At closure, the landfill was capped with approximately 0.3m of topsoil and the majority of the historic landfill was planted with trees.

The geophysical survey showed that there is a large landfill/waste body under the central part of the survey area. The geophysical data indicated a waste body beneath the site with a thicknesses varying from 1m to 18m. The estimated volume of the waste body was estimated at 100,000m^3. The Tier 2 Risk Assessment intrusive investigation indicated that the site was characterised by Municipal Solid Waste (MSW) with a maximum depth of waste of 10.5m bgl encountered in borehole 5. Overall, the waste body was identified as comprising of plastics and general waste materials mixed with gravelly clay. The waste materials appeared to be quite decomposed being black in colour and strong sweet odours. Hazardous waste, as defined in the EPA European Waste Catalogue, was not identified on the site.

The material covering the waste body comprised sandy/gravelly clay and was approximately 0.3m thick across the waste body. The drilling returns indicated that the waste materials were deposited directly onto bedrock.

2.2 Leachate:

Leachate was encountered in 4 out of 8 trial holes dug on site. Samples were taken from the trial holes and from the borewells installed within the waste body. Groundwater and leachate analytical results were compared to the EPA Interim Guideline Values (IGVs)

and threshold values from the Groundwater Regulations 2010 that indicate the chemical status of a groundwater body.

A number of elevated metals were detected in BH05 including boron and nickel. Concentrations of iron, manganese, orthophosphates, potassium and sodium were also elevated. In addition BOD and COD levels were elevated. These results are typical concentrations associated with that off landfill leachate.

2.3 Landfill Gas:

Landfill gas monitoring was compiled during the exploratory investigation. During the excavations of each of the trial pits, landfill gas monitoring was carried out using a gas meter. Each trial pit recorded 0% for methane gas presence.

Concentrations of landfill gas were also recorded during the intrusive works and are presented in Table 16 of the URS, Tier 2 Landfill Assessment report. Low concentrations of methane and carbon dioxide were recorded at only one monitoring well (BH04) within the waste body, with concentrations of 1.2% and 0.8 recorded

No landfill gas levels (methane) were detected in all 3 wells outside the site.

3.0 Potential Pathways

A pathway is a mechanism or route by which a contaminant comes into contact with, or otherwise, affects a receptor. A pathway must exist if a hazard is to pose a risk to a receptor. The pathway defines the likelihood of contact with, or transport to, a receptor. The pathways may allow the passage of a hazard in any if it's three basic phases or in a combination, i.e. as a liquid as a solid or as a gas.

There are 3 potential pathways identified for this site which are identified below in Table 3.1.below.

Potential Pathway	Route
1. Groundwater	Contamination to the water table via Waulsortian Mudbank Limestone overlain by till derived predominantly from Devonian Sandstone.
2. Surface Water	Leachate migration from the landfill discharging into the River Owbeg via groundwater
3. Air/Soil	Landfill gas migration to residential dwellings along the

	subsurface or surface pathway.

Table 3.1 Potential Pathways

4.0 Potential Receptors

There are 3 potential receptors identified for the site which is identified in Table 4.1 below:

Potential Receptor	Type
1. Groundwater	Regionally important & Karstified aquifer beneath the site – Extreme Vulnerability rating used.
2. Surface Water	River Owbeg located 130m south of site.
3. Human Beings/Animals	Agricultural Activity and Residential Dwellings adjacent to the site.

Table 4.1 Potential Receptors

5.0 Pollution Linkage

Potential hazards, pathways and receptors have been identified in and around the site. It is important to note that in order for a risk to pose a significant threat or impact to a receptor, a linkage via a pathway must exist or be established.

5.1 Soil/Waste Results:

The survey showed that there is a large landfill/waste body under the central part of the survey area. The estimated volume of the waste body was 100,000m^3. The waste materials appeared to be quite decomposed being black in colour with strong sweet odours. These waste materials were municipal and commercial in nature. The approximate waste footprint was found to be 0.95 hectares.

Hazardous materials were not observed within the waste body and the GACs protective of human health were not exceeded in any of the samples analysed.

The soil/waste analysis indicated that there is a potential risk to controlled waters from hydrocarbon compounds, PAHs and some metals. PAH and metal concentrations were low, with most metal concentrations (with the exception of aluminium in all samples and

zinc in sample BH05_4.0) either below or in line with EPA background soil concentrations.

The waste leachate analysis indicated that elevated levels of TPH, some metals and ammonia were likely to leach from the waste body. Overall, the findings of the assessment indicate that a leachate source is present.

Conclusion: All groundwater and surface water sampling taken outside the site boundary demonstrated that there was no leachate leakage from the site into adjacent borewells and watercourses. Therefore the leachate generated on site appears to be contained within the site perimeter.

5.2 Surface Water:

Following the exploratory and Tier 2 report and findings, the surface water results indicate that there may be no direct connection of leachate migration to the River Owbeg. The Owbeg River lies approximately 130m to the south of the site and flows eastwards along an east-west trending fault.

VOCs, THMs and PAHs were not detected in the surface water samples analysed. Ammonia concentrations of 0.02mg/l and 0.01mg/l were recorded in samples SW01 and SW02 respectively. These concentrations were below the assessment criteria of 0.14mg/l. Concentrations of other inorganic parameters phosphate, chloride and nitrate were also below the assessment criteria. BOD was below the limit of detection in both surface water samples, while COD ranged from 9mg/l in SW01 to 12mg/l in SW02.

Laboratory analysis of samples collected from the Owbeg River upstream and downstream of the site indicated that leachate from the site was not impacting on surface water quality. The assessment criteria were not exceeded in either of the samples analysed.

Conclusion: The potential risk to surface water is low considering inferred groundwater flow direction proximity of the site to the Owbeg River and the nature of the geology beneath the site. In addition, the surface water analytical results indicate that the site is not impacting on water quality in the river.

5.3 Groundwater:

Water strikes were encountered in bedrock at depths of 8m bgl and 20m bgl in boreholes BH03 and BH01 respectively. The water level measurements from across the site show

the highest groundwater elevations in well BH02 (located to the east of the site) and the lowest elevations in well BH01 (located to the south of the site). Consequently, shallow groundwater flow direction beneath the site is inferred to be northwest towards the River Blackwater, with an average hydraulic gradient of 0.031.

The bedrock aquifer is characterized by the GSI (MapInfo) and is classified as a Regionally Important Karstified Aquifer. GSI data identified a number of wells in the area. Furthermore, information from the GSI indicates that a significant aquifer in the form of the Kiltorcan Sandstones underlies the limestone beneath the site, with the two formations likely to be in hydraulic conductivity.

Hydrocarbons compounds (including BTEX and MTBE) were not detected in any of the three groundwater samples analysed. Concentrations of arsenic, boron, cadmium, chromium, lead, zinc and barium detected were below their assessment criteria. No other metals were detected in groundwater.

The sample collected from Tobar na Glóire spring was analysed for PAHs, with all fifteen PAH compounds below the laboratory detection limit.

There is a dwelling with a groundwater abstraction well approximately 250m to the south (upgradient) of the site, however it was confirmed during the exploratory stage that this dwelling is connected to the mains water and the well is no longer in use. The GSI database notes two wells used for agricultural and domestic use within 1km of the site (both cross gradient). There are a number of wells located approximately 1km northwest (downgradient) of the site, the use of which is unknown.

With the exception of nitrite which is likely to be attributed to sewage or agricultural sources adjacent to the site, no other parameters were detected at concentrations above the available guideline criteria in the downgradient monitoring well BH01. This indicates that leachate breakout is not occurring and that the site is not impacting on groundwater quality downgradient of the site.

Conclusion: The groundwater samples taken outside the site indicates that leachate breakout is not occurring from the site into adjacent groundwater sources. As a result, Waterford County Council considers that the groundwater pathway is not a significant pollution linkage.

5.4 Landfill Gas:

Methane gas concentrations recorded during the assessment were below the lower explosive limit of 5% in all wells and was only detected in well BH05 (within the site) at

a concentration of 1.2%. Carbon Dioxide levels were low between 0.1% in all wells with the exception of BH05 which registered a reading of 0.8%. There was no evidence of landfill gas egress on the surface of the site. This indicates that the waste body is generating relatively low levels of landfill gas. The waste body was found to be quite decomposed and displayed a strong sweet odour.

Landfill gas was not detected in the 3 borewells immediately outside the landfill site.

The Department of Environment publication on the '*Protection of new Buildings and Occupants from Landfill Gas' (1994)* recommends methane levels below 1% and Carbon Dioxide levels below 0.5%. All Borewells immediately outside the site and nearest to existing dwellings comply with these levels. As there are no dwellings or useable buildings located within the site, the low methane and carbon dioxide levels registered in BH05 are not considered significant.

Conclusion: Overall, the findings of the assessment indicate that, while there is a potential source of landfill gas present, it is not impacting on receptors outside the site. As a result, Waterford County Council considers that the landfill gas pathway (vertical) is not significant as a pollution linkage. Furthermore, as the office on the site is no longer in use, Waterford County Council considers that the landfill gas pathway (horizontal) is no longer a pollution linkage.

6.0 Conclusions and Recommendations:

6.1 Conclusions:

Risk Category – The Tier 2 Intrusive Investigations demonstrated a breakage in the original pollution linkages identified in Tier 1. All sampling results indicated that there was no evidence of pollution seepage from the site to neighbouring receptors.

The Tier 1 risk screening exercise indicated that the overall risk classification for the site was 'low risk'. Following the Tier 2 Exploratory and Intrusive Investigations which provided further information about the site, the overall risk classification for the site was deemed to be a 'moderate risk'. The main changed was owing to the underlying aquifer being classified as 'karstified' and not 'poorly productive' as originally envisaged.

The two main SPR linkages identified below were highlighted as posing the greatest risk to identified receptors:

- *SPR 5 – Leachate migration to bedrock via groundwater*
- *SPR 10 – Gas migration to human receptors via subsoil – lateral*

The intrusive investigations focused on these areas to assess whether the landfill was having a negative impact on groundwater sources and human receptors in terms of landfill gas migration.

The conclusions were as follows:

Waste body: Hazardous materials were not observed within the waste body and the GACs protective of human health were not exceeded in any of the samples analysed.

Groundwater - The historic landfill is located within an area which consists of a Regionally important and karstified aquifer. The groundwater analysis indicates that the waste body is not impacting on groundwater quality downgradient of the site and there is no pollutant linkage between the leachate source and the groundwater aquifer beneath the site.

Landfill Gas- No landfill gas measurement was detected in the ambient sampling points outside the site. From these results there appears to be no impact from the landfill gas on neighbouring residents. In addition concentrations within the site were recorded at <5%. However, there are no buildings in use on the site.

Surfacewater - The potential risk to surface water is low considering inferred groundwater flow direction proximity of the site to the Owbeg River and the nature of the geology beneath the site. In addition, the surface water analytical results indicate that the site is not impacting on water quality in the river.

Special Area of Conservation - The surface water monitoring data and findings indicate that the historic landfill is not having a significant impact on the River Owbeg or River Blackwater which is a designated SAC, SPA & pNHA.

Quantitative Risk Assessment Findings

The QRA indicates that the Source-Pathway-Receptor linkages originally calculated in Tier 1 Assessment have been severed. While the site was classed as a Class *B* – Moderate Risk following the Tier 2 Assessment, the QRA results indicate that there is no link existing between the leachate or gas from the site to neighbouring receptors.

The only exceedances noted in that the groundwater samples were ammonia, nitrate, nitrite, potassium and coliforms all collected from upgradient monitoring wells. Given that these wells are located hydraulically upgradient of the waste body, it is considered that sewage effluent and agricultural practices (such as fertilizer application and spreading organic waste) are the likely sources of these contaminants. In conclusion, the findings indicate that leachate from the historic landfill is not impacting on the groundwater bearing bodies beneath the site.

6.2 Recommendations:

As outlined in Chapter 7 of the Code of Practice, the selection of suitable remediation options is dependent on the results of the quantitative risk assessment process. The findings of the QRA indicate that the Source-Pathway-Receptor linkage identified in Tier 1 and Tier 2 Assessments have been broken and Waterford County Council considers the site to be of Low Risk. The groundwater, surface water and gas monitoring results demonstrate that the receptors outside the site are not being impacted by the waste body within the site.

Having regard to the above report and information obtained, Waterford County Council (WCC) recommends that the following be implemented;

- Routine monitoring on a quarterly basis of surface water and groundwater sources for year 1 & 2. Ongoing monitoring of both groundwater and surface water is recommended to assess for seasonal variations in water quality in the vicinity of the site. All parameters tested during the Tier 2 & Exploratory Investigation will be re-tested as part of the monitoring regime and in accordance with the EPA 'Landfill Monitoring Manual (2003).

- No landfill gas was detected in monitoring undertaken outside the site. Notwithstanding this, it is proposed to perform routine monitoring on a quarterly basis for presence of gas both within and outside the site.

- If negative changes or impacts are noted during the monitoring regime, Waterford County Council will proceed to notify the EPA and undertake a Detailed Quantitative Risk Assessment for the site.

- If no changes or impacts are noted in year 1 & 2, it is proposed to reduce monitoring requirement to bi-annually in years 3 and thereafter.

- Annual monitoring results will be presented to the EPA and a validation report submitted after 1 full year of monitoring.

- It is also proposed to create a GIS layer marking the site and monitoring wells. This can be incorporated into the Planning system to assist in planning assessments in the future and in order for applications to comply with the requirements of *Protection of new Buildings and Occupants from Landfill Gas' (1994).*

Appendix 1:

Re-run of SPR linkages

The risk assessment methodology outlined in the Code of Practice Manual is based on the principle of linkages between the Source, Pathway, and Receptor. Refer to Chapter 4 of the Manual for the Risk Score Tables. The Environment Section also incorporated the Environmental Protection Agency historic landfills website for inputting the data.

Table 2

Ref	**Source**	*Score*	*Max*	*Rational*
1a	Leachate	5	10	▪ <1 hectare ▪ Waste included both municipal & commercial wastes
1b	Gas	5	10	▪ <1 hectare ▪ Highest rating given as large proportion of municipal waste present

Table 3

Ref	**Pathways**	*Score*	*Max*	*Rational*
2a	Groundwater vulnerability	3	3	▪ GSI data states that part of the site is rated as having extreme vulnerability.
2b	Groundwater flow regime	5	5	▪ Aquifer is Karstified. (Originally thought that aquifer was poorly productive).
2c	Surface water drainage	0	2	▪ Sample analysis does not provide direct connection of surface water from landfill.
2d	Landfill gas lateral migration	3	3	▪ Sand & Clay soil properties identified. Property located 30m south of the site. Possible lateral migration of landfill gas.
2e	Landfill gas vertical migration	N/A	5	▪ No structure located directly over landfill ▪ Civic amenity closed in November 2010.

Table 4

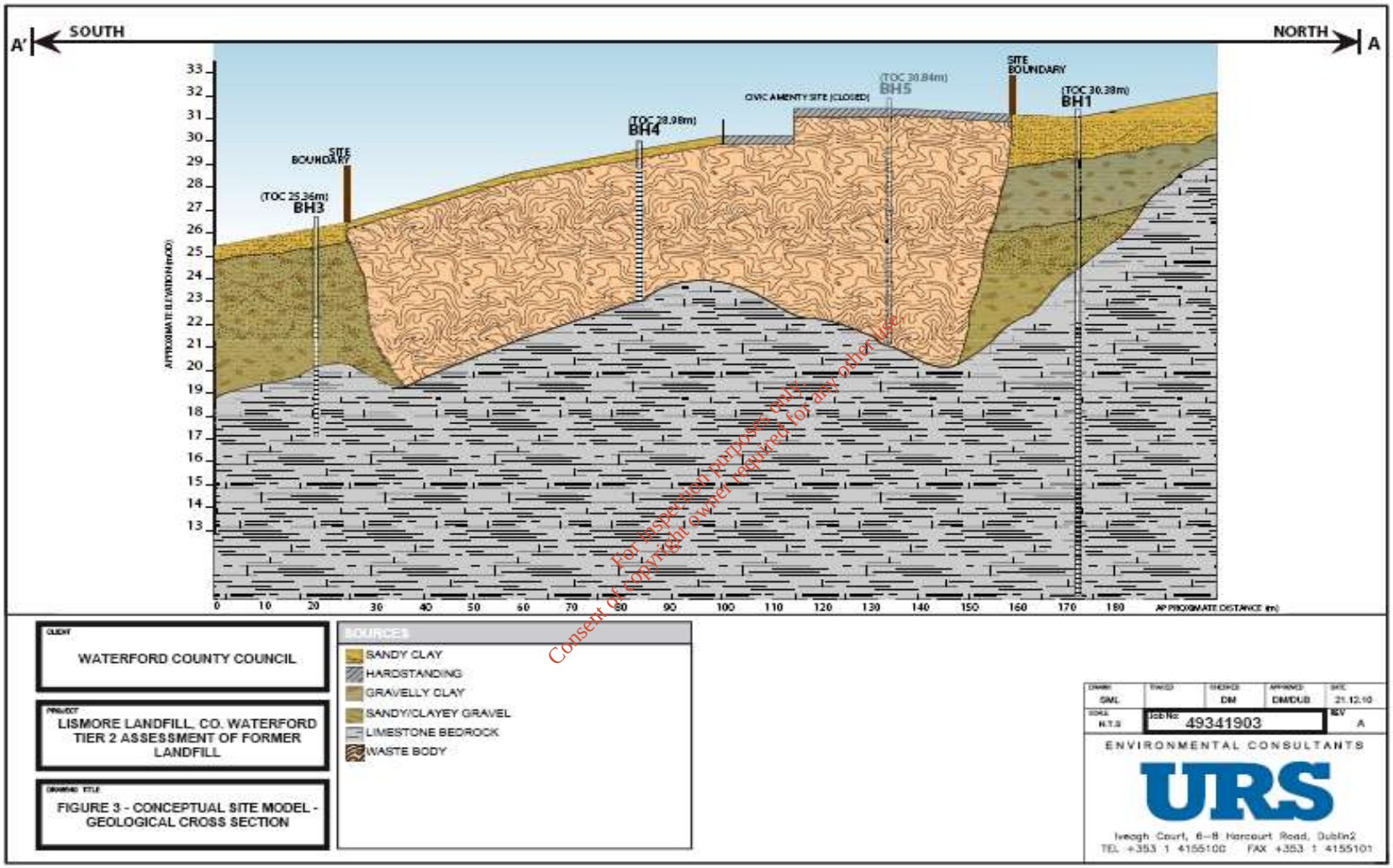
Ref	**Receptors**	*Score*	*Max*	*Rational*
3a	Human presence (leachate)	2	3	▪ House with private well <250m from landfill
3b	Protected areas	0	3	▪ No designated sites in the vicinity of the landfill.
3c	Aquifer category	5	5	▪ Regional Important Karstified Aquifer (Rk)
3d	Public water supply	3	7	▪ >1 km from the source ▪ Karst Aquifer
3e	Surface water bodies	2	3	▪ River Owbeg is >50m but <250m from the site boundary
3f	Human presence (gas)	5	5	▪ House within 50m of gas monitoring levels recorded on site

S-P-R Linkage Score		**Max Score**	**Actual Score**	**Normalised Score**	**Risk Classification**
SPR 1	Leachate migration to surface waters through combined groundwater and surface water pathways	300	1a x (2a + 2b + 2c) x 3e = 80	26%	Class C – Lowest risk
SPR 2	Leachate migration to protected areas through combined groundwater and surface water pathways	300	1a x (2a + 2b + 2c) x 3b = 0	0%	Class C – Lowest risk
SPR 3	Leachate migration to human receptors via groundwater	240	1a x (2a + 2b) x 3a = 80	33%	Class C – Lowest risk
SPR 4	Leachate migration to protected areas via groundwater	240	1a x (2a + 2b) x 3b = 0	0%	Class C – Lowest risk
*SPR 5	Leachate migration to bedrock via groundwater	400	1a x (2a + 2b) x 3c = 200	50%	Class B – Moderate risk
SPR 6	Leachate migration to public water sources via groundwater	560	1a x (2a + 2b) x 3d = 120	21%	Class C – Lowest risk
SPR 7	Leachate migration to surface water via groundwater	240	1a x (2a + 2b) x 3e = 80	33%	Class C – Lowest risk
SPR 8	Leachate migration to surface water via surface water	60	1a x 2c x 3e = 0	0%	Class C – Lowest risk
SPR 9	Leachate migration to protected area via surface water	60	1a x 2c x 3b = 0	0%	Class C – Lowest risk
**SPR 10	Gas migration to human receptors via subsoil – lateral	150	1b x 2d x 3f = 75	50%	Class B – Moderate risk
SPR 11	Gas migration to human receptors via subsoil – vertical	250	1b x 2e x 3f = 0	0%	Class C – Lowest risk

***SPR 5: Groundwater results have shown no leachate migration from the site into groundwater sources outside the site, therefore the original link can be considered broken**

**** SPR 10: Gas monitoring results have shown that landfill gas is not impacting on sources outside the site, therefore the original link can be considered broken**

SPR 5 and SPR 10 links have been broken- Waterford County Council consider the site to be of Low Risk



Historic Landfill Site – Townspark East, Lismore – Refined Conceptual Site Model
Tier 3 Risk Assessmen