Appendix 7

Re-Run of SPR Linkages

Landfill SiteName: Clountreem
Landfill Ref. No. : 07/W

Tier 1 Study

Risk Screening/ Prioritisation

Table 1a LEACHATE: SOURC/HAZARD SCORING MATRIX			
	Waste FOOTPRINT (ha)		
WASTE TYPE	≤ 1ha	> 1 ≤ 5 ha	> 5ha
C&D	0.5	1	1.5
Municipal	5	7	10
Industrial	5	7	10
Pre 1977 sites	1	2	3

1a =	7

Table 1b LANDFILL GAS: SOURC/HAZARD SCORING MATRIX			
	Waste FOOTPRINT (ha)		
WASTE TYPE	≤ 1ha	> 1 ≤ 5 ha	> 5ha
C&D	0.5	0.75	1
Municipal	5	7	10
Industrial	3	5	7
Pre 1977 sites	0.5	0.75	1

1b =	7

Table 2a : LEACHATE MIGRATION: PATHWAYS	
GROUNDWATER VULNERABILITY (Vertical Pathway)	Points
Extreme Vulnerability	3
High Vulnerability	2
Moderate Vulnerability	1
Low Vulnerability	0.5
High - Low Vulnerability (use where vulnerability not on GIS)	2
2a =	1

Table 2b : LEACHATE MIGRATION: PATHWAYS	
GROUNDWATER FLOW REGIME (Horizontal Pathway)	Points
Karstified Groundwater Bodies (Rk)	5
Productive Fissured Bedrock Groundwater Bodies (Rf & Lm)	3
Gravel Groundwater Bodies (Rg and Lg)	2
Poorly Productive Bedrock Groundwater Bodies (Ll, Pl, Pu)	1

2b =	1

Risk Screening/ Prioritisation

Table 2c : LEACHATE MIGRATION: PATHWAYS	
SURFACE WATER DRAINAGE (Surface water pathway)	**Points**
Is there a direct connection between drainage ditches associated with the waste body and adjacent surface water body? Yes	2
If no direct connection	0

2c =	**2**

Table 2d : LANDFILL GAS: PATHWAY	
LANDFILL GAS LATERAL MIGRATION POTENTIAL	**Points**
Sand and Gravel, Made ground, urban, karst	3
Bedrock	2
All other Tills (including limestone, sandstone etc - moderate permabi	1.5
All Namurian or Irish Sea Tills (low permability)	1
Clay, Alluvium, Peat	1
2d =	**2**

Table 2e : LANDFILL GAS: PATHWAY (assuming receptor located above source)	
LANDFILL GAS LATERAL MIGRATION POTENTIAL	**Points**
Sand and Gravel, Made ground, urban, karst	5
Bedrock	3
All other Tills (including limestone, standstone etc - moderate permab	2
All Namurian or Irish Sea Tills (low permability)	1
Clay, Alluvium, Peat	1
2e =	**3**

Table 3a : LEACHAGE MIGRATION: *RECEPTORS*	
HUMAN PRESENCE (presence of a house indicaates potential private wells)	**Points**
On or within 50m of the waste body	3
Greater than 50m but less than 250m	2
Greater than 250m but less than 1km from waste body	1
Greater than 1km of the waste body	0

3a =	**2**

Risk Screening/ Prioritisation

Table 3b : LEACHAGE MIGRATION: RECEPTORS PROTECTED AREAS (SWDTE or GWDTE)	Points
Within 50m of waste body	3
Greater than 50m but less than 250m of the waste body	2
Greater than 250m but less than 1km from waste body	1
Greater than 1km of the waste body	0
Undesignated sites within 50m of waste body	1
Undesignated sites greater than 50m but less than 250m	0.5
Undesignated sites greater than 250m of the waste body	0

3b =	1

Table 3c : LEACHAGE MIGRATION: *RECEPTORS*	
AQUIFER CATEGORY (resource potential)	Points
Regionally Important Aquifers (Rk, Rf, Rg)	5
Locally Important Aquifers (Ll, Lm, Lg)	3
Poor Aquifers (Pl, Pu)	1

3c =	3

Table 3d : LEACHAGE MIGRATION: *RECEPTORS*	
PUBLIC WATER SUPPLIES (Other than private wells)	Points
Within 100m of site boundary	7
Greater than 100m but less than 300m or with in Inner SPA for GW supplies	5
Greater than 300m but less than 1km or within Outer SPA (SO) for GW supplies	3
Greater than 1km (karst aquifer)	3
Greater than 1km (no karst aquifer)	0

3d =	0

Table 3e : LEACHAGE MIGRATION: *RECEPTORS*	
SURFACE WATER BODIES	Points
Within 50m of site boundary	3
Greater than 50m but less than 250m	2
Greater than 250m but less than 1km	1
Greater than 1km	0

3e =	3

Risk Screening/ Prioritisation

Table 3f : LEACHAGE MIGRATION: *RECEPTORS*	
HUMAN PRESENCE	Points
On site or within 50m of site boundary	5
Greater than 50m but less than 150m	3
Greater than 150m but less than 250m	1
Greater than 250m	0.5

3f =	1

Note: The table below represents the Tier 1 risk rating for this site. SPR 1 to 9 represent the leachate risk scores. SPR 10 & 11 represent Landfill Gas risks. The migration pathways are colour coded as follows:

Groundwater & Surface Water	Groundwater only	Surface water only	Lateral & Vertical

Calculator	SPR Values	Maximum Score	Linkages	Normalised Score
SPR 1 =	84	300	Leachate => surface water	28%
SPR 2 =	28	300	Leachate => SWDTE	9%
SPR 3 =	28	240	Leachate => human presence	12%
SPR 4 =	14	240	Leachate => GWDTE	6%
SPR 5 =	42	400	Leachate => Aquifer	11%
SPR 6 =	0	560	Leachate => Surface Water	0%
SPR 7 =	42	240	Leachate => SWDTE	18%
SPR 8 =	42	60	Leachate => Surface Water	70%
SPR 9 =	14	60	Leachate => SWDTE	23%
SPR 10 =	14	150	Landfill Gas => Human Presence	9%
SPR 11 =	21	250	Landfill Gas => Human Presence	8%

Risk Classification	Range of Risk Scores
Highest Risk (Class A)	Greater than or equal to 70% for any individual SPR lingage
Moderate Risk (Class B)	Between 40-70% for any individual SPR linkage
Lowest Risk (Class C)	Less than or equal to 40% for any individual SPR linkage

OVERALL RISK RATING	HIGH

Appendix 8

Flow Survey on Stream

water technology limited

Directors:
J.P. Mackey, B.Sc, HDE
B. Creedon, B.Sc., B.Sc. (Econ) Ph.D., Chem., FICI, MRIC, MICorrT. MIWES, MIIEI, MIW

Telephone 021-4965600
Fax 021-4965618

Togher Industrial Estate, Cork Ireland.

Flow Monitoring Project

For

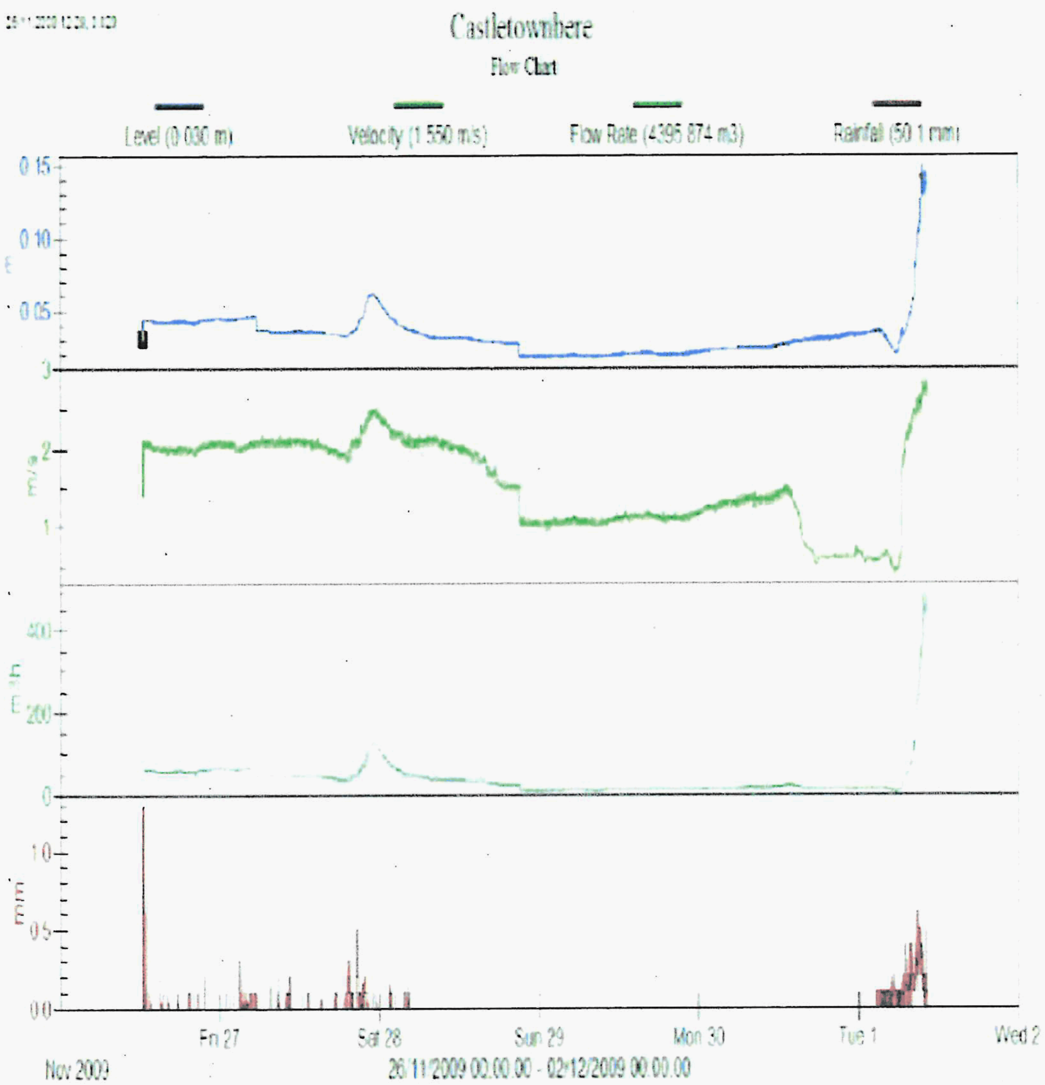
Castletownbere Closed Facility

For and on behalf of;

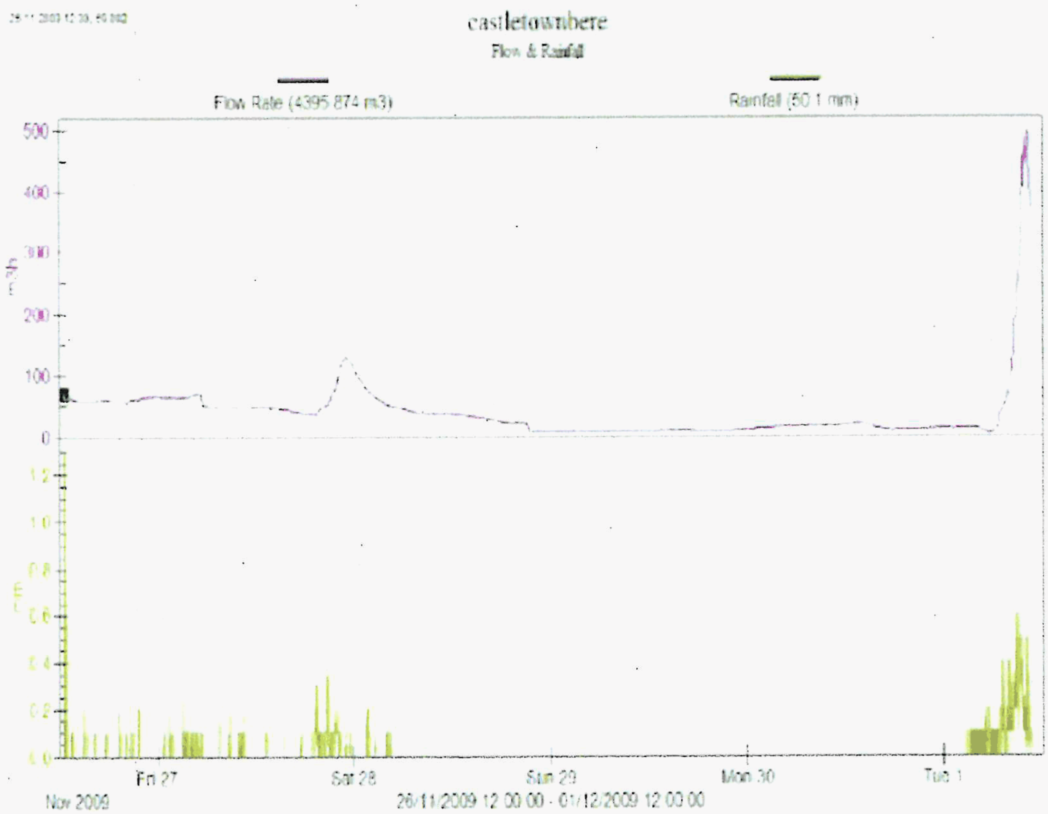
Mr. Kieran Coffey
Environmental Engineer
Cork County Council

December 2nd 2009

Level, velocity and flow for stream.



Flow and rainfall.



Flow table showing daily flow rates.

Castletownbere
Flow Table

Date/Time	Average Flow Rate (m3h)	Maximum Flow Rate (m3h)	Minimum Flow Rate (m3h)	Average Flow Rate (m3)
26/11/2009 12:00:00	57.99	71.00	45.03	1392
27/11/2009 12:00:00	55.31	129.9	35.14	1327
28/11/2009 12:00:00	15.53	36.16	7.18	372.7
29/11/2009 12:00:00	12.02	18.39	8.32	288.6
30/11/2009 12:00:00	46.67	496.2	3.82	1050

	Average Flow Rate	Maximum Flow Rate	Minimum Flow Rate	Average Flow Rate
	37.50 (m3h)	496.2 (m3h)	3.82 (m3h)	886.1 (m3)
	Total 4430.415 m3			Total 4430 m3

Report compiled by:

Liam O Riain
Water Technology
Cork.

Appendix 9

CCTV Survey of Concrete Pipe

DYNO-ROD

CROWLEY SERVICES T/A DYNO-ROD
Centre Park Road
Cork
Tel: 021 4322 444 Fax: 021 4322 433

Project-information

Project name	Contract number	Contact:	Date
			15.12.2009

Client	**Cork County Council**
Contact:	**Kieran Coffey**
Position:	
Road	**Enviromental Department**
Town	**Inniscarra**
County	**Co.Cork**
Telephone:	
Fax:	
Mobile:	
E-Mail:	

Site	**Clountreem.**
Contact:	
Position:	
Road	
Town	**Castletownbere**
County	**Co.Cork.**
Telephone:	
Fax:	
Mobile:	
E-Mail:	

Contractor	**CROWLEY SERVICES T/A DYNO-ROD**
Contact:	
Position:	
Road	**Unit P1Marina Commercial Park**
Town	**Centre Park Road**
County	**Cork**
Telephone:	**021 4322 444**
Fax:	**021 4322 433**
Mobile:	
E-Mail:	

DYNO-ROD

CROWLEY SERVICES T/A DYNO-ROD
Centre Park Road
Cork
Tel: 021 4322 444 Fax: 021 4322 433

Defect Grade Description

Project name:	Contract number	Contact:	Date
			15.12.2009

1:

Occurances without damage, for example: laterals, joints etc

NO DEFECTS WERE DETECTED.

2:

Constructional deficiencies or occurances with insignificant influence to tightness, hydraulic or static pressure of pipe. i.e. wide joints, badly finished intakes, minor deformation of plastic pipes, minor erosions etc.

REHABILITATION CAN BE SCHEDULED LONG-TERM

3:

[illegible]

REHABILITATION IS NECESSARY MEDIUM-TERM WITHIN 3 TO 5 YEARS

4:

Constructional damages with nonsufficient static safety, hydraulic or tightness. i.e. axial/radial pipebursts, pipe deformations visually noticeable, infiltration/exfiltration, cavities in pipe-wall, severe protruding laterals, severe root penetrations, severe corrosion of pipe wall etc.

REHABILITATION PROCEDURE IS URGENT AND HAS TO BE COMPLETED WITHIN 1 TO 2 YEARS. NECESSITY FOR EMERGENCY OPERATIONS HAS TO BE EXAMINED

5:

Pipe is already or will shortly be impermeable. i.e. collapsed pipe, deeply rooted pipe, other drainage obstructions. Pipe loses water or danger of backwater in basements etc.

REHABILITATION IS URGENT AND SHORT-TERM, IN ORDER TO PREVENT FURTHER DAMAGE. NECESSARY TEMPORARY SPOT REPAIR HAS TO BE CONDUCTED ON EMERGENCY LEVEL

DYNO-ROD

CROWLEY SERVICES T/A DYNO-ROD
Centre Park Road
Cork
Tel: 021 4322 444 Fax: 021 4322 433

Inspection report

Date	Job nr.	Weather	Operator	section number	PLR
15.12.2009			BA	1	MH 1 X
Present:	Vehicle:	Camera:	Preset:	Cleaned:	Grade

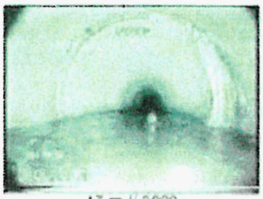
Road:	Castletownbere	Division:		start MH	MH 1
Place:	Clountreem	District:		end MH	Upstream
Location:		Tape No.:	1	Total length:	46.7 m

Purpose:	Asset condition	Size/Shape:	Circular 600
Use:	Watercourse	Material:	Concrete Pipe length:
Catchment:		Lining:	
		Category:	

Comment:

Location details:

1:400	position	code	observation	grade
MH 1	0.00	ST	Start of survey	0
	0.00	WL	Water level, 20 % height/diameter	0
	[illegible]		[illegible]	
	27.00	WL	Water level, 10 % height/diameter	0
	[illegible]	[illegible]	[illegible] cross sectional area lost	[illegible]
	[illegible]	[illegible]	[illegible] cross sectional area lost	4
Upstream	[illegible]	[illegible]	[illegible] % height/diameter [illegible]	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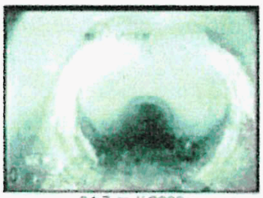
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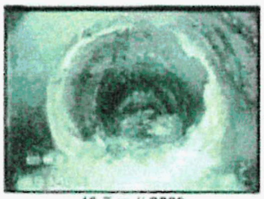
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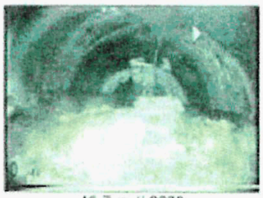
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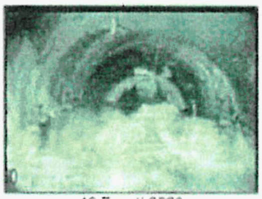

46.7 m // 0000

DYNO-ROD

CROWLEY SERVICES T/A DYNO-ROD
Centre Park Road
Cork
Tel: 021 4322 444 Fax: 021 4322 433

Inspection photos

Place	Road:	Date	section number	PLR
Clountreem	**Castletownbere**	**15.12.2009**	**1**	**MH 1 X**

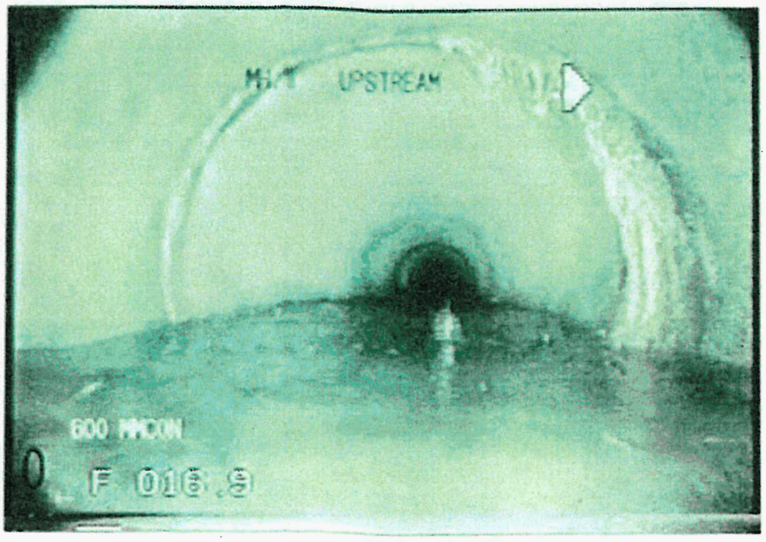


Photo: 5a, Tape No.: 1, 00O0
17m. Infiltration Dripping from 10 to 03 o´clock

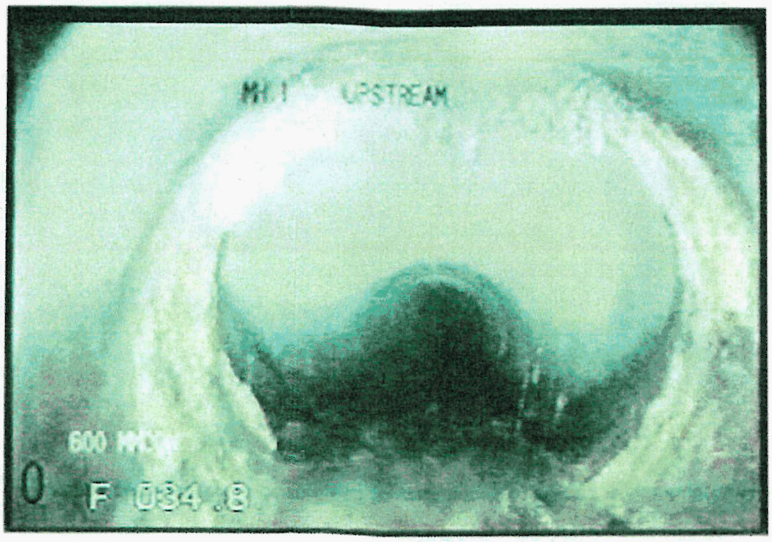


Photo: 7a, Tape No.: 1, 000 0
34.7m. Encrustation medium, from 09 to 08 o´clock, cross-sectional area loss

DYNO-ROD

CROWLEY SERVICES T/A DYNO-ROD
Centre Park Road
Cork
Tel 021 4322 444 Fax 021 4322 433

Inspection photos

Place	Road	Date	section number	PLR
Clountreem	Castletownbere	15.12.2009	1	MH 1 X

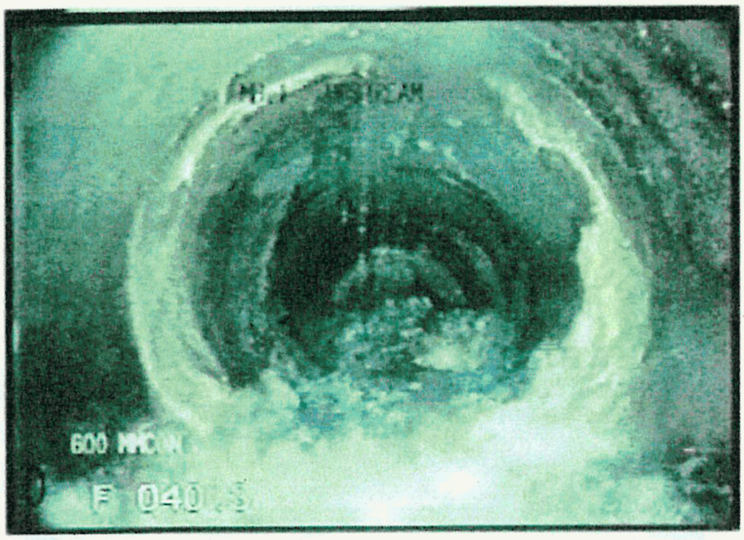


Photo: 9a, Tape No.: 1, 0000
40.7m, Encrustation medium, from 12 to 11 o'clock, cross-sectional area loss

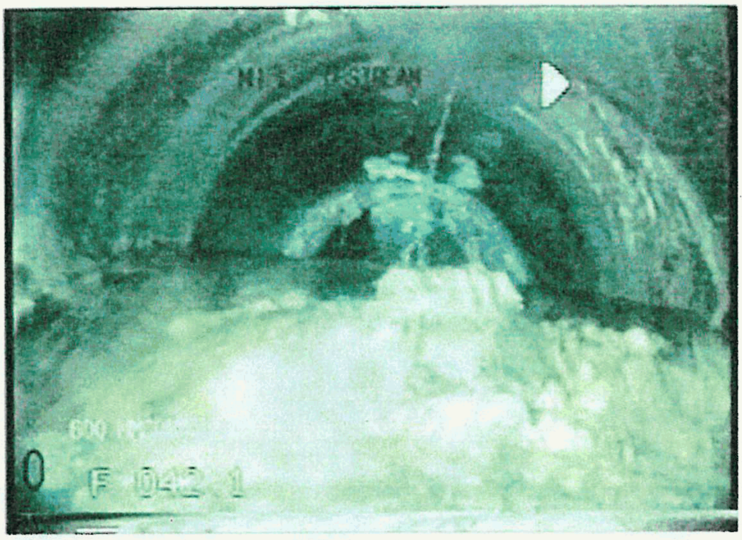


Photo: 11a, Tape No.: 1, 0000
46.7m, Obstruction, 60 % height/diameter loss

DYNO-ROD

CROWLEY SERVICES T/A DYNO-ROD
Centre Park Road
Cork
Tel: 021 4322 444. Fax: 021 4322 433

Inspection photos

Place	Road	Date	section number:	PLR
Clountreem	**Castletownbere**	**15.12.2009**	**1**	**MH 1 X**

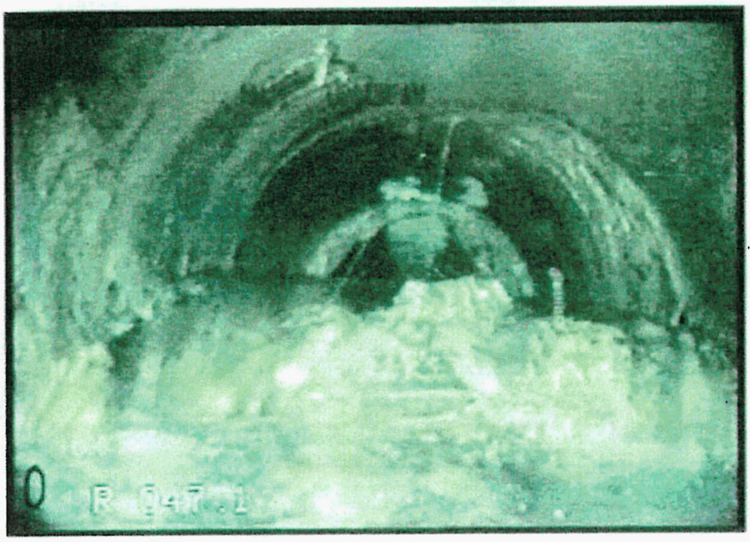


Photo: 11b, Tape No.: 1, 0000
46.7m, Obstruction, 60 % height/diameter loss

Photo: 12a, Tape No.: 1, 0000
46.7m, Multiple Cracks, from 11 to 01 o'clock

DYNO-ROD

CROWLEY SERVICES T/A DYNO-ROD
Centre Park Road
Cork
Tel 021 4322 444 Fax 021 4322 433

Inspection report

Date	Job nr.	Weather:	Operator	section number	PLR
15.12.2009			BA	2	MH 1 X
Present:	Vehicle:	Camera:	Preset:	Cleaned:	Grade:

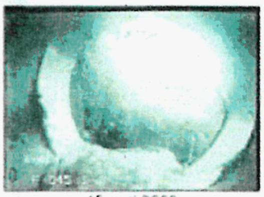
Road	Castletownbere	Division		start MH:	MH 1
Place	Clountreem	District:		end MH:	Downstream
Location		Tape No.:	1	Total length:	45 m

Purpose	Asset condition	Size/Shape:	Circular 600
Use	Watercourse	Material:	Concrete Pipe length
Catchment		Lining:	
		Category:	

Comment:

Location details

1:375	position	code	observation	grade
MH 1	0.00	ST	Start of survey	0
	0.00	WL	Water level, 15 % height/diameter	0
Downstream	45.00	FH	Finish survey Outfall	0



45 m // 0000

DYNO-ROD

CROWLEY SERVICES T/A DYNO-ROD
Centre Park Road
Cork
Tel: 021 4322 444 Fax: 021 4322 433

Inspection photos

Place	Road:	Date:	section number	PLR
Clountreem	**Castletownbere**	**15.12.2009**	2	**MH 1 X**

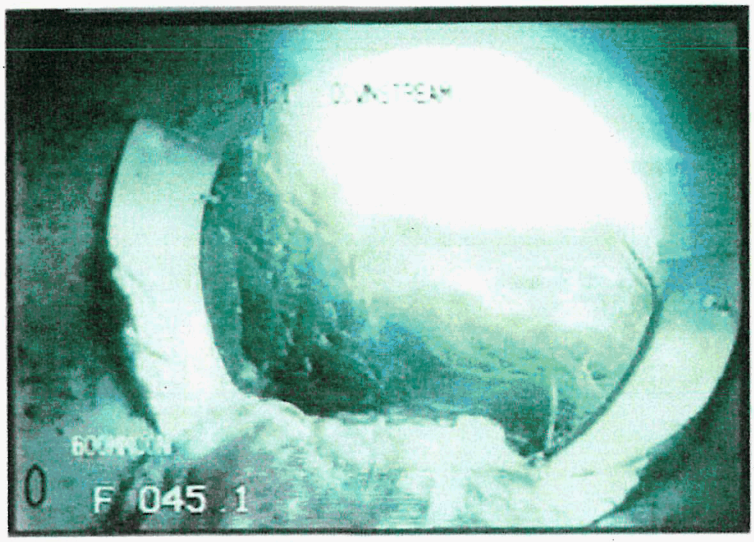


Photo: 16a, Tape No.: 1, 0000
45m, Finish survey Outfall

Cork County Council

Clountreem Landfill,
Castletownbere,
Co Cork.

Tier 3 Environmental Risk Assessment

WYG Environmental and Planning (Ireland) Ltd

06/10/10

REPORT CONTROL

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Project:	CCC – TIER 3 Risk Assessment/ DQRA
Client:	Cork County Council
Job Number:	CE08234
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Primary Author	Brian Duggan	Signed:	

Contributor	Donal Marron	Signed	

Review By	Darragh Musgrave	Signed:	

Issue	Date	Status	Checked for Issue
1	17/09/10	Issue 1 for Client Review	BD/DJM
2	06/10/10	Issue 2	BD/DJM
3			
4			

Contents

Figures

Tables

Appendices

1 INTRODUCTION

WYG Environmental (Ireland) Ltd. (WYG) was retained by Cork County Council (CCC) to carry out a Tier 3 Risk Assessment and Outline Remediation Plan for Clountreem Landfill, Castletown Bearhaven, Co Cork. The objective of the Tier 3 Risk Assessment was to determine the impact, if any, of the waste on the local environment.

A Tier 1 site assessment and Tier 2 site investigation had previously been completed at the site by CCC in accordance with the Environmental Protection Agency Code of Practice "Environmental Risk Assessment for Unregulated Waste Disposal Sites" (EPA, 2007)

1.1 SCOPE OF WORK

The scope of the project is to complete a Tier 3 Detailed Quantitative Risk Assessment (DQRA) to assess the impact of leachate from the landfill on nearby surface water (SPR 8) as identified by the Tier 1 and tier 2 assessment works. The DQRA provides a scientifically based understanding of the risks associated with potential contamination at the site. The risk assessment took account of the "suitable for use" principle and considered the proposed site end use in relation to any potential contamination issues that may have arisen.

1.2 REPORT TERMS AND CONDITIONS

Attention is drawn to the report conditions included in Appendix A, and the terms of engagement. This report is produced solely for the benefit of Cork County Council. No liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing. The recommendations and opinions expressed in this report are based on the information provided by Cork County Council and other sources of readily available information. Where relevant reference has been made to reports or information provided by the client, such data has been reviewed in good faith and it has been assumed that their contents are correct, as it is impractical to fully validate this data.

1.3 CONCEPTUAL MODEL

An important thread throughout the overall process of risk assessment is the need to formulate and develop a **conceptual model** for the site, which supports the identification and assessment of pollutant linkages. A conceptual model "represents the characteristics of the site in diagrammatic or written form that shows the possible relationships between contaminant sources, pathways and receptors" (CLR 11).

Conceptual models have been developed for Clountreem Landfill by Cork County Council and are discussed in detail further in the report.

1.4 POLLUTANT LINKAGE CONCEPT

The possible relationships between contaminants, pathways and receptors are the essential elements to any risk:

- A contaminant **source** – a substance that is in, on or under the land and has the potential to cause harm or to cause pollution of controlled waters.
- A **receptor** – in general terms, something that could be adversely affected by a contaminant, such as people, an ecological system, property, or a water body.
- A **pathway** – a route or means by which a receptor can be exposed to, or affected by, a contaminant.

Each of these elements can exist independently, but they create a risk only where they are linked together, so that a particular contaminant affects a particular receptor through a particular pathway. This kind of linked combination of contaminant–pathway–receptor is described as a pollutant linkage.

2 SITE DETAILS

The site covers and area of approximately 1.16 hectares and is located approximately 1km northeast of Castletownbere at coordinates E68,880 - N47,310, the site location is presented in Figure 1. It is located off a minor road in a rural mountainous area used for sheep grazing. The closest house is approximately 180m northwest of the site.

The site itself is undulating with the edges built up approximately 2.0m above the centre of the site. The site is surfaced in scrub consisting of heather and reeds with small amounts of surface waste visible.

2.1 GEOLOGY, HYDROGEOLOGY & HYDROLOGY

Details of the geology and hydrogeology underlying the site have been obtained from the following sources of information:

- Geological Survey of Ireland (GSI) National Draft Generalised Bedrock Map and Teagasc Subsoil Map;
- GSI groundwater information service;
- Completed site Investigations.

2.1.1 Geology

According to the Teagasc Subsoil Data, obtained from the GSI public files, soil in the area of the site consists of peat and till derived from Devonian sandstone and bedrock outcrops. Based on the information available from the GSI the site is underlain by Devonian Old Red Sandstone.

2.1.2 Hydrogeology

According to the GSI maps the site straddles an aquifer boundary. The aquifer to the north is classified as 'Pi' which is a poor aquifer i.e. bedrock which generally unproductive accept for local zones; to the south the aquifer is classified as 'Li' which is a Locally Important Aquifer i.e. bedrock which is Moderately Productive only in Local Zones. The vulnerability rating for the underlying aquifer is classified as extreme as there is rock at or close to the surface. There are no karstic features of bedrock faults in the immediate vicinity of the site.

A review of the GSI groundwater well data does not identify any groundwater wells within 1km radius of the site. The closest known well is approximately 2.0km east of the site and is 17.7m in depth but classified as a poor aquifer. A review of the regional topography and site information indicates that groundwater flow direction is likely from northeast to southwest in line with the topography of the area.

2.1.3 Hydrology

Details of the hydrology of the area have been obtained from the EPA website and from 1:50,000, Ordnance Survey Discovery Series Map 86. The closest surface water body is an unnamed mountain stream that flows beneath the site within a 600mm diameter concrete pipe. The stream flows from northeast to the southwest beneath the site and is likely to be a tributary of the Aghakista River which flows into the sea at Castletownbere. This stream does not have a Q rating but according to the EPA Status Report 2009 the Aghakista River has a good status (approximately Q4).

2.1.4 Rainfall and Meteorological Conditions

The Irish National Meteorological Service (Mét Éireann) reports that the mean annual rainfall at the weather station at Valentia, located approximately 40km north west of the site, was 1,433mm in 2008, while mean annual temperature was 10.4°C.

2.2 SITE HISTORY

The site was acquired by Cork County Council in 1975 and used as the main municipal landfill for the area for 25 years until its closure in 1999. Initially waste was dumped directly onto the peaty soil, which surfaced the site, but in later years peat was dug out prior to infilling with waste and covering with peat. It is reported by CCC that approximately 1330 tonnes of waste were deposited here on an annual basis. The majority of waste deposited is thought to be municipal with some end of life vehicles and waste sludge's, including oil sludge's, have been placed in it. Fish waste was deposited at the site in large amounts until it was banned in the early eighties.

3 PREVIOUS INVESTIGATION WORK

3.1 REVIEW OF CORK COUNTY COUNCIL TIER 1 STUDY

Cork County Council carried out a Tier 1 Conceptual Site Model, Risk Screening & Prioritisation in February 2008. This consisted of a desktop study, site walkover and risk calculation based on the EPA code of practice. The risk calculation is presented in Table 3.1 below.

This report concluded that the site had a high risk rating and recommended that Tier 2 site investigation and testing be completed to examine if there is a leachate risk from the site and to check water quality data that may be available for the stream to see if there is any evidence of pollution.

Table 3.1 Tier 1 Risk Assessment Scores

Calculator	SPR Values	Maximum Score	Linkages	Normalised Score
SPR 1 =	126	300	Leachate => surface water	42%
SPR 2 =	42	300	Leachate => SWDTE	14%
SPR 3 =	56	240	Leachate => human presence	23%
SPR 4 =	28	240	Leachate => GWDTE	12%
SPR 5 =	84	400	Leachate => Aquifer	21%
SPR 6 =	0	560	Leachate => Surface Water	0%
SPR 7 =	84	240	Leachate => SWDTE	35%
SPR 8 =	42	60	Leachate => Surface Water	70%
SPR 9 =	14	60	Leachate => SWDTE	23%
SPR 10 =	14	150	Landfill Gas => Human Presence	9%
SPR 11 =	21	250	Landfill Gas => Human Presence	8%

Risk Classification	Range of Risk Scores
Highest Risk (Class A)	Greater than or equal to 70% for any individual SPR lingage
Moderate Risk (Class B)	Between 40-70% for any individual SPR linkage
Lowest Risk (Class C)	Less than or equal to 40% for any individual SPR linkage

OVERALL RISK RATING	HIGH

3.2 REVIEW OF CORK COUNTY COUNCIL TIER 2 STUDY

In December 2009 Cork County Council completed a Tier 2 Site Investigation at the site. The purpose of this was to characterise the waste on site; delineate the vertical and lateral extent of waste; determine depth and composition of capping layer; determine subsoil type thickness and permeability, appraise the Tier 1 conceptual site model and determine if there is evidence of the landfill causing environmental damage. Analytical results from of this assessment are discussed in Section 4 with results presented in Tables 1 to 5.

There were a number of distinct elements to the site investigation which are outlined below:

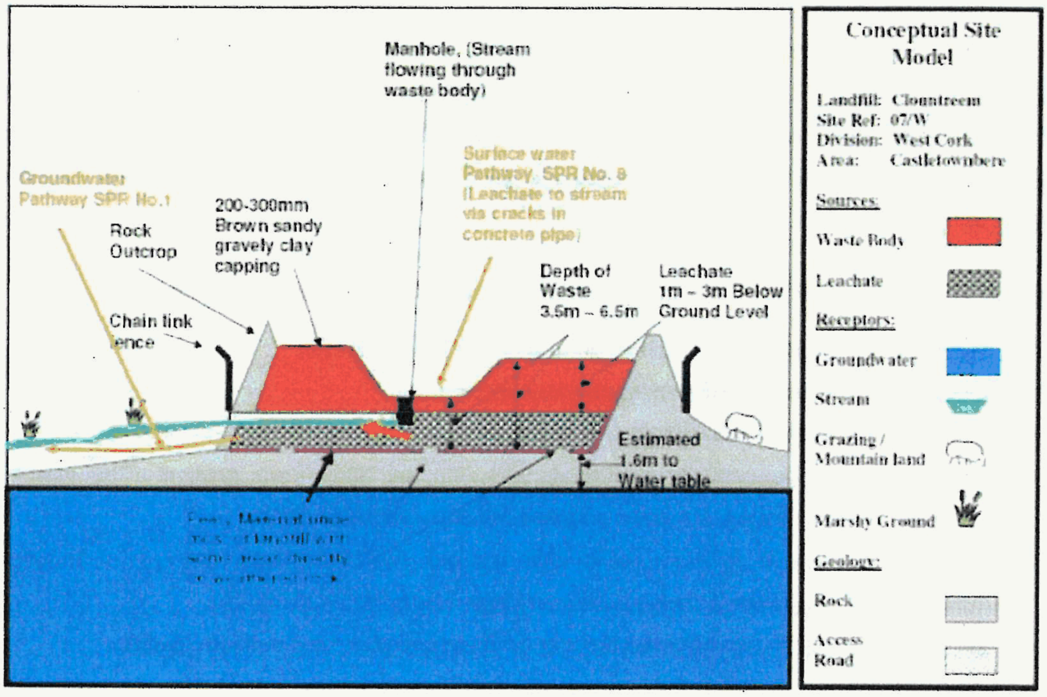
- Excavation of 15 trial pits across the site using a tracked excavator;
- Collection and characterisation of waste encountered;
- Collection of three leachate samples;
- Installation of two groundwater monitoring wells 50m and 300m down gradient of the waster body and collection and analysis of water samples from each of these wells;
- Collection and analysis of three groundwater samples, one immediately upstream of the site, one immediately downstream of the site and one 200m downstream of the site;
- Completion of a CCTV survey of the 600mm concrete pipe that runs beneath landfill;
- Completion of an ecological study of the site and immediate area surrounding the site including a biological assessment of the stream upstream and downstream of the site;
- Completion of flow monitoring in the stream over a five day period.

Waste was found in all areas of the site and was predominantly domestic waste including plastics, textiles, glass paper but also included steel roofing, concrete, fishing nets, rope, radiators, tyres, car and truck batteries and timber.

The biological assessment at the site showed that the stream upstream of the landfill had a Q rating of 4-5 (high status) while just below the landfill it had a Q rating of 2-3 (poor status) which improved again with distance from the landfill.

The conceptual site model was revised following the Tier 2 investigation and is presented in Table 3.1 below. The conceptual site model shows that the waste is cradled between two areas of rock indicating that leachate is likely to be channelled to the southwest and towards the stream. Leachate was found in nearly all areas and is approximately 3m deep. Based on the findings of the groundwater well drilling, it is estimated that the water table is approximately 1.6m below rock surface.

Table 3.1 Revised Site Conceptual Model



The Tier 2 site investigation showed that there is an impermeable organic layer under most of the landfill. This reduced the risk from pollutant linkage SPR No. 1 (Vertical and Horizontal Groundwater to Surface Water Drainage Runoff) to low risk; however, SPR No. 8 (Surface Water Drainage/Runoff) remains high. The report concluded that the adjacent surface water is being impacted by the landfill and that cracks and leakage in the pipe joins are responsible for the majority of the leachate migration to the stream.

The report concluded that there was no or very limited risk from landfill gas at the site and the risk to groundwater is low. There were no protected areas identified near to this site.

The main recommendation of the Tier 2 assessment was to stop/prevent leachate migration from the landfill to the local stream. It was also recommended that a Quantitative Risk Assessment be completed to quantify the risk to the local stream and once this has been done a remediation plan should be prepared outlining how best the main pollution linkage can be broken.

4 ANALYTICAL RESULTS

Analytical results for surface water, leachate and groundwater were received from Cork County Council are presented in Tables 1 to 3 along with analytical results for SVOCs and VOCs which are presented in Tables 4 and 5 respectively. Figures showing surface water, leachate and groundwater sampling locations are presented in Figures 2 to 4 respectively. WYG was not involved with sample collection or analysis.

4.1 SURFACE WATER ANALYSIS

Surface water analysis was completed for Cork County Council on two occasions in October 2009 and in July 2010. Samples were taken from three locations; SW-1 which is up gradient of the waste body, SW-2 which is immediately down gradient of the waste body and SW-3 which is 200m down gradient of the waste body.

Surface water results are presented in Table 1 with SVOCs and VOCs in Tables 4 and 5 and are compared with the screening criteria in S.I. 272 of 2009 European Communities (Surface Water) Regulations. Where there are no relevant limit values outlined in the regulations the results are compared with the EPA Environmental Quality Standards (EQS) guideline limits of 1997.

Exceedences were detected in ammonical nitrogen, manganese and iron where in all cases noticeably higher levels were detected in SW-2 and SW-3 down gradient of the waste body. Noticeable increases were also detected in boron, calcium, magnesium, potassium, sodium and chloride in SW-2 and SW-3 down gradient of the waste body even though exceedances to the standards were not detected.

4.2 LEACHATE ANALYSIS

Leachate analysis was completed for Cork County Council on two occasions in October 2009 and in July 2010. Samples were taken from three locations throughout the waste body, leachate 1, Leachate 2 and Leachate 3.

Leachate results are presented in Table 2 with SVOCs and VOCs in Tables 4 and 5 and are compared with the screening criteria in S.I. 272 of 2009 European Communities (Surface Water) Regulations. Where there are no relevant limit values outlined in the regulations the results are compared with the EPA EQS guideline limits of 1997.

Exceedences were detected in ammonical nitrogen, iron, manganese, zinc, conductivity and BOD where there were significant exceedances to both the environmental quality standards for surface water and the EPA EQS.

4.3 GROUNDWATER ANALYSIS

Groundwater analysis was completed for Cork County Council on two occasions in October 2009 and in July 2010. Samples were taken from two wells GW-1 and GW-2 which are 50m and 300m down gradient of the waste body respectively.

Groundwater results are presented in Table 3 with SVOCs and VOCs in Tables 4 and 5 and compared to the limits set out in S.I. No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulation 2010. Where there was no suitable target value, the limits set out in S.I. No. 278 of 2007 European Communities (Drinking Water) Regulations 2007 were utilised, if there was no limit value specified for a parameter in either of the above regulations the EPA interim Guideline Values (IGVs) 2003 were referenced.

Exceedences were detected in four parameters iron, manganese, conductivity and ammonical nitrogen. Cork County Council concluded that three of these, iron, manganese and chloride are naturally occurring in the Castletownbere area. Ammonical nitrogen above the EPA IGV was detected in GW-2 and Cork County Council concluded that this could be due to the landfill or impact from agricultural activity in the area.

Summary

These analytical results indicate that there is significant contamination within leachate in the landfill that is leading to surface water contamination. Concentrations of a number of key surface water parameters including ammonical nitrogen, iron and manganese are significantly higher downstream than upstream of the landfill and also higher in surface water than in groundwater. This shows that contamination is due to leachate entering from the landfill and not due to naturally elevated groundwater concentrations in the local area.

5 DETAILED QUANTITATIVE RISK ASSESSMENT

The Detailed Quantitative Risk Assessment (DQRA) comprised an environmental risk assessment to provide a more site specific assessment of risks to nearby surface water receptors. The pollutant linkage between the contamination resulting from the presence of waste on the site and contamination of groundwater have been quantified and modelled to provide recommendations for the key contaminants of concern.

5.1 METHODOLOGY

To assess the potential risks posed by leachate to nearby environmental receptors, the Environment Agency Guidance Document 'Remedial Targets Methodology – Hydrogeological Risk Assessment for Land Contamination, 2006' has been used. Leachate beneath the site is entering the surface water stream causing exceedances to a number of surface water screening values. The implications of this are further assessed by considering dilution at the stream. The guidance document considers dilution a special circumstance when the receptor is a stream or surface water and is only considered acceptable when:

- Any impact on the resource does not jeopordise future use of the resource
- The cost of remediation is disproportionate in relation to the improvement of groundwater or surface water.

The compliance point at the Clountreem Landfill is considered to be the stream which flows beneath the site as this has been shown to receive at least some of the leachate flow from the site. This approach allows for the actual impacts on the receptor to be examined but does not take account of the acceptability of the impact on the surface water. The dilution factor is calculated using the following equation:

$$\frac{[\text{Leachate Flow (Qc) + Surface water flow (Qu)}] \times \text{Leachate concentration (Cc)}}{[\text{Leachate flow (Qc)} \times \text{Leachate concentration (Cc)} + [\text{surface water flow (Qu)} \times \text{Upstream concentration (Cu)}]}$$

The model was run for three key parameters, iron, manganese and ammonical nitrogen, as these parameters were found to be the most elevated within the leachate and exceedances to these parameters were also detected during the surface water sampling rounds downstream of the waste body

The model was run for three situations based on flow within the stream, flow calculations were based on the data obtained during the flow monitoring project completed for Cork County Council in December 2009. This flow monitoring project was completed in what is presumed to be a wet period and there was significant rainfall on three of the five days of the survey. Flow was measured at between 3.82m^3/hr and 496m^3/hr and the flow monitoring showed the stream to be extremely flashy with significant be variations within hours of rainfall. Dry weather flow was estimated as 1.0m^3/hr, low flow was based on the lowest flow during the monitoring period of 3.82m^3/hr and high flow was based on the average flow during the monitoring period which was 36.8m^3/hr but this is considered to be high in relation to an annual average flow. Leachate infiltration into the pipe was calculated based on the groundwater regime and physical attributes of the pipe, the CCTV survey of the pipe found many of the pipe joints to be leaking leachate. Input criteria for the model are presented in Table 5.1 below with model inputs for contaminants of concern presented in Table 5.2.

Table 5.1 Model inputs for dilution factor calculation

Parameter		Unit	Value	Justification
Target Concentration	C_t	mg/l	Table 5.2	Surface water regulations
Leachate concentration	C_c	mg/l	Table 5.2	Maximum Leachate value - Table 5.2
Background Concentration	C_u	mg/l	Table 5.2	Maximum upstream concentration – Table 5.2
Hydraulic Conductivity	K	m/day	6.35	Value for sand (SC050021-SR3)
Hydraulic Gradient	i	-	0.0354	Estimate based on site gradient
Length of pipe	w	m	110	Length of pipe measured on maps
Fraction of cracks in pipe	f	m^2/m	0.112	Based on 5% cracks
Leachate Infiltration	Q_c	m^3/day	1.18	Infiltration to stream calculated by Qc=K.i.w.f
Surface water flow	Q_u	m^3/day	885	Average flow rate (measured for flow monitoring report)
			92	Minimum flow rate (measured for flow monitoring report)
			24	Dry weather flow (estimate based on flow monitoring report)
Dilution Factor	DF		Table 5.3	Calculated from equation above

Table 5.2: Model inputs for contaminants of concern

Determinant	Units	Surface Water Standard (EPA EQS)	Maximum Leachate Concentration	Maximum Upstream Concentration
Iron	mg/l	1.0	19.42	0.231
Manganese	mg/l	0.3	3.715	0.022
Ammonical Nitrogen	mg/l	0.02	84.79	0.03

5.2 DQRA OUTPUTS

The model outputs for dilution at compliance point are presented in Table 6 to 8 and are summarised below. in Table 5.3, results are shaded where they exceed they exceed the EPA EQS. It can be seen that both iron and manganese will exceed the EPA EQS in dry weather and in flows up to 2.16 m^{3}/hr and 1.41m^{3}/hr respectively. Ammonical nitrogen shows far higher exceedances to the EAP EQS and exceeds the EPA EQS in dry weather, low flow and high flow. These results show that there is insufficient dilution capacity on the stream that flows beneath the waste body to assimilate contamination and receive contaminated leachate from the site without causing exceedances to the surface water standards.

Table 5.3: Model outputs for contaminants of concern

Parameter	Standard EPA EQS	Stream concentration dry weather	Stream concentration low flow	Stream concentration high flow	Exceeds EPA EQS until flow of
Iron	1.0mg/l	**2.19mg/l**	0.64mg/l	0.096mg/l	2.16 m^{3}/hr
Manganese	0.3mg/l	**0.43mg/l**	0.13mg/l	0.139mg/l	1.41m^{3}/hr
Ammonical Nitrogen	0.02mg/l	**2.42mg/l**	**0.69mg/l**	**0.08mg/l**	Background Exceeds EQS

***Shaded results exceed EPA EQS**

These results support the physical findings and analytical results of surface water sampling completed in the surface water stream downstream of the waste body which displayed odours and rust coloured staining. The Q rating of the stream downstream of the waste body which was 2-3 (poor status) also indicates that the landfill is having a detrimental impact upon the stream and that there is insufficient assimilative capacity available to alleviate the impact of leachate upon the stream.

6 DQRA ASSESSMENT FINDINGS AND CONCLUSIONS

The Tier 1 and Tier 2 risk assessment and site investigation was completed by Cork County Council for the Clountreem Landfill, Castletownbere, Co Cork. These showed potentially unacceptable risks to a surface water stream that flows beneath the site due to leachate generation within the landfill. The landfill itself was used as the main municipal landfill for the area for 25 years until its closure in 1999. Initially waste was dumped directly onto the peaty soil which surfaced the site, but in later years peat was dug out prior to infilling with waste and covering with peat. It is reported by CCC that approximately 1,330 tonnes of waste were deposited here on an annual basis. The principal pathway for contaminant migration is by leachate entering the adjacent surface water through cracks and leakage in the pipe and joints.

WYG were commissioned to complete a Tier 3 risk assessment to examine the leachate to surface water risks (SPR 8) identified in the Tier 1 and 2 reports. The risk assessment was completed using the Environment Agency Guidance Document 'Remedial Targets Methodology – Hydrogeological Risk Assessment for Land Contamination, 2006' using date from the tier 2 assessment and additional sampling completed in July 2010 for Cork County Council.

The risk assessment model was run for three key parameters, iron, manganese and ammonical nitrogen, as these parameters were found to be the most elevated within the leachate and exceedances to these parameters were also detected downstream of the waste body during the surface water sampling rounds. The model was run for three situations, dry weather, low flow and high flow, based data obtained during the flow monitoring project completed in December 2009.

The model outputs show that both iron and manganese will exceed the EPA EQS in dry weather and in flows up to 2.16 $m^{3/}$hr and 1.41$m^{3/}$hr respectively. Ammonical nitrogen shows far higher exceedances to the EAP EQS and exceeds the EPA EQS in dry weather, low flow and high flow. These results show that there is insufficient dilution capacity on the stream that flows beneath the waste body to assimilate contamination and receive leachate from the site without causing exceedances to the surface water standards.

7 OUTLINE SITE REMEDIATION PLAN

The completed Quantitative Risk Assessment has shown that there is ongoing risk of environmental impact to the local water course. Therefore remediation is required and an outline remediation plan is presented below. Further feasibility works will be required to fully scope, design and cost any preliminary options.

The focus of the remediation plan for the Clountreem Landfill site should be to prevent, as far as possible, leachate entering the surface water in the water course that flows through the waste mass and to prevent/reduce, as far as possible, the potential for leachate generation at the site. These actions will help break the identified source-pathway-receptor linkages at the site.

7.1 WATER COURSE MANAGEMENT

Surface water needs to be segregated from the landfill leachate as comprehensively as possible as there will always be a high risk of surface water contamination while the stream is flowing through the landfill.

Repairing or relining the existing drainage pipe that goes through the landfill is not considered the best option as there are access restrictions and the existing pipe makes a 90 degree turn which would make in-situ re-lining of the pipe very difficult. it is probable that settlement and cracking of the repairs or new liner could occur allowing leachate to seep into the surface water pipe again at some stage in the future.

Diverting the water course up stream of the landfill and redirecting it around the waste body is considered the most preferable option in terms of preventing leachate from entering the stream. Based on the existing contour map available for the site it should be possible to do this along the side of the rock outcrop on north eastern side of the landfill site. Refer to the schematic layout as presented in Figure 5. Site specific assessment of this section of the site will be required for a detailed re-alignment design to be developed.

We would expect that the stream diversion work would be completed as part of the landfill capping works proposed below.

The closure of the pipe and diversion of the stream would break the link between leachate and surface water flowing through the site.

7.2 CAPPING

The proper capping of the waste mass is an important element of the site remediation plan. Currently rainwater is able to percolate through the waste mass which generates leachate runoff. The completion of a properly engineered cap, will reduce/eliminate the percolation of rainfall through the waste and significantly reduce the volume of leachate generated in the waste mass.

WYG recommend that options to reduce percolation through the waste mass are assessed once the stream is diverted and the volume of leachate emanating form the waste mass is assessed. Methodologies such as the emplacement of a impermeable geo-membrane liner, possibly used in conjunction with subsoil and topsoil layers would form an impermeable or low permeability barrier which will prevent/reduce leachate generation. This will limit potential leachate generation and greatly reduce or even eliminate the need to manage the containment and collection of leachate that may come from the waste mass in the long term.

Given the topography of the site there is likely to be need to re-grade and contour the landfill cap and to include surface drainage to eliminate water ponding and ensure that rain water will runoff the landfill. Passive gas venting systems may also need to be designed into the cap.

7.3 LEACHATE COLLECTION & TREATMENT

The need for any leachate treatment would only become evident after the stream diversion and capping works are completed. With the installation of an impermeable or low permeability capping layer the potential for leachate generation within the waste mass would be greatly reduced or eliminated and it is anticipated that no long term leachate treatment or collection will be required.

Provision can be made in the design for the existing drainage pipe to be blocked at the downstream end of the landfill in such a way that any leachate that collects in the pipe could be periodically drained off into a containment area/lagoon. Depending on the volume and nature of any leachate emanating from the waste there may be a requirement for some leachate removal or treatment, especially in the early period after the restoration works are done when remaining leachate would be expected to drain out of the landfill.

While the need for long term treatment is not expected options such as periodic removal of the leachate off site, or the use of a small package system for biological treatment of the leachate and or the construction of a wet land area are options that could be considered if required. An assessment of the leachate generated by the landfill is required after capping is completed. The necessity of leachate remediation can be quantified and suitable and cost effective solutions to be considered at that stage as required.

8 REFERENCES

- "Code of Practice: Environmental Risk Assessment for Unregulated Waste Disposal Sites" EPA, 2007
- Contaminated Land Report (CLR) 11 Environment Agency [UK], 2003
- 1:50,000, Ordnance Survey Discovery Series Map 85
- "Towards Setting Guidelines Values for the Protection of Groundwater in Ireland" EPA, 2003
- Discussion Document "Environmental Quality Objectives & Environmental Quality Standards" EPA, 1997
- S.I. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations 2009
- S.I. 9 of 2010 Communities Environmental Objectives (Groundwaters) Regulation 2010
- EPA Landfill Site Design (EPA 2000)
- EPA Landfill Restoration and Aftercare (EPA 1999)

Figures

Figure 1 Site location map

Figure 2 Site Layout showing stream and surface water sampling locations

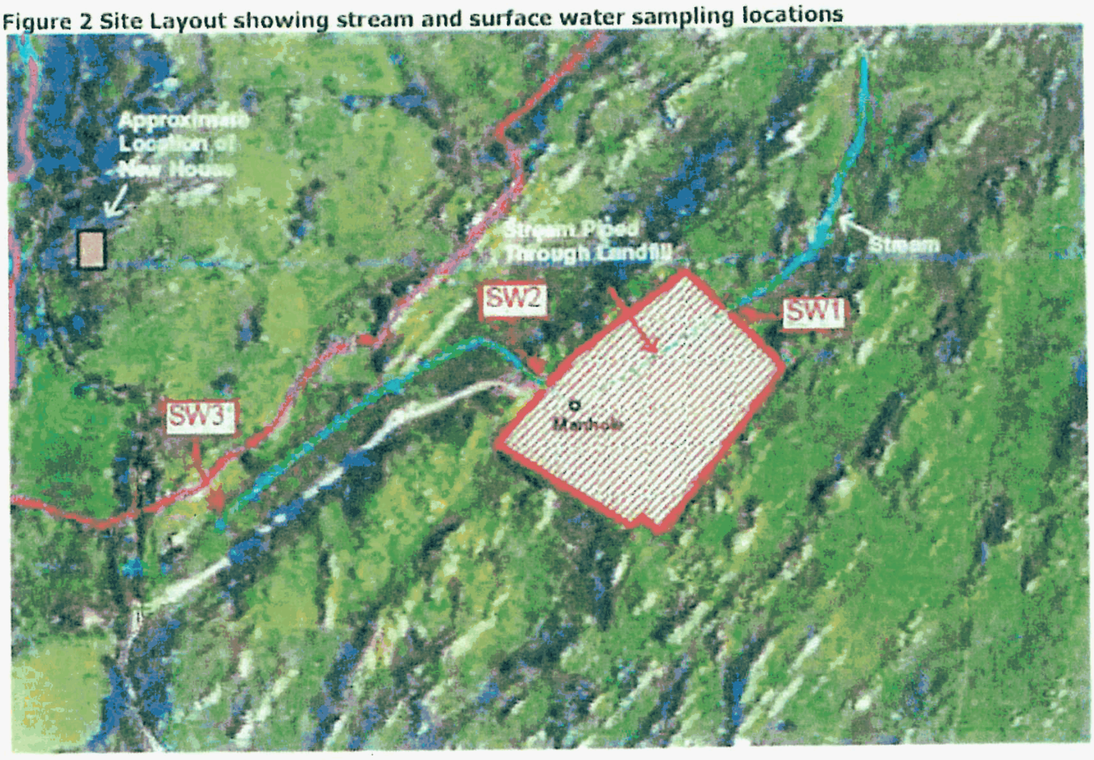


Figure 3 Site Layout showing leachate sampling locations

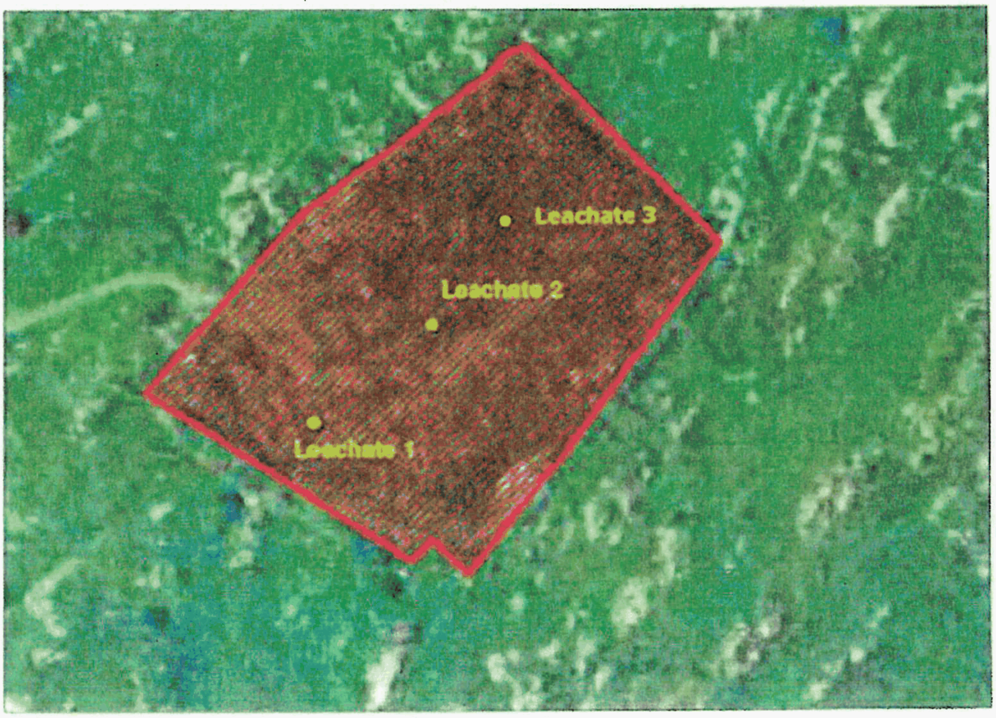
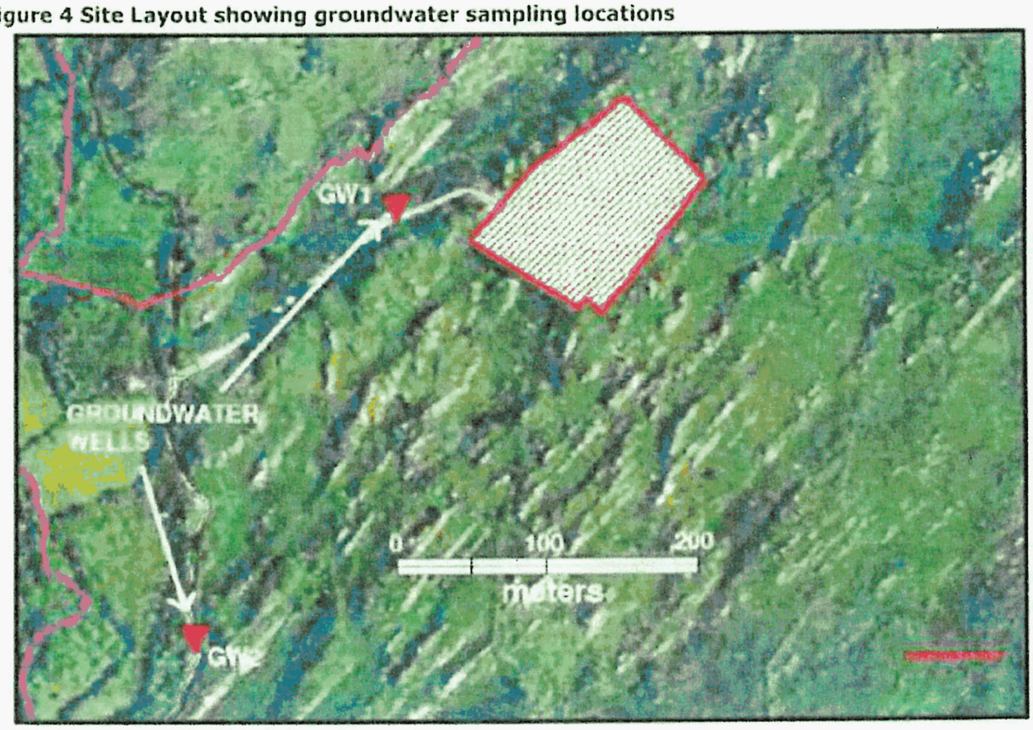
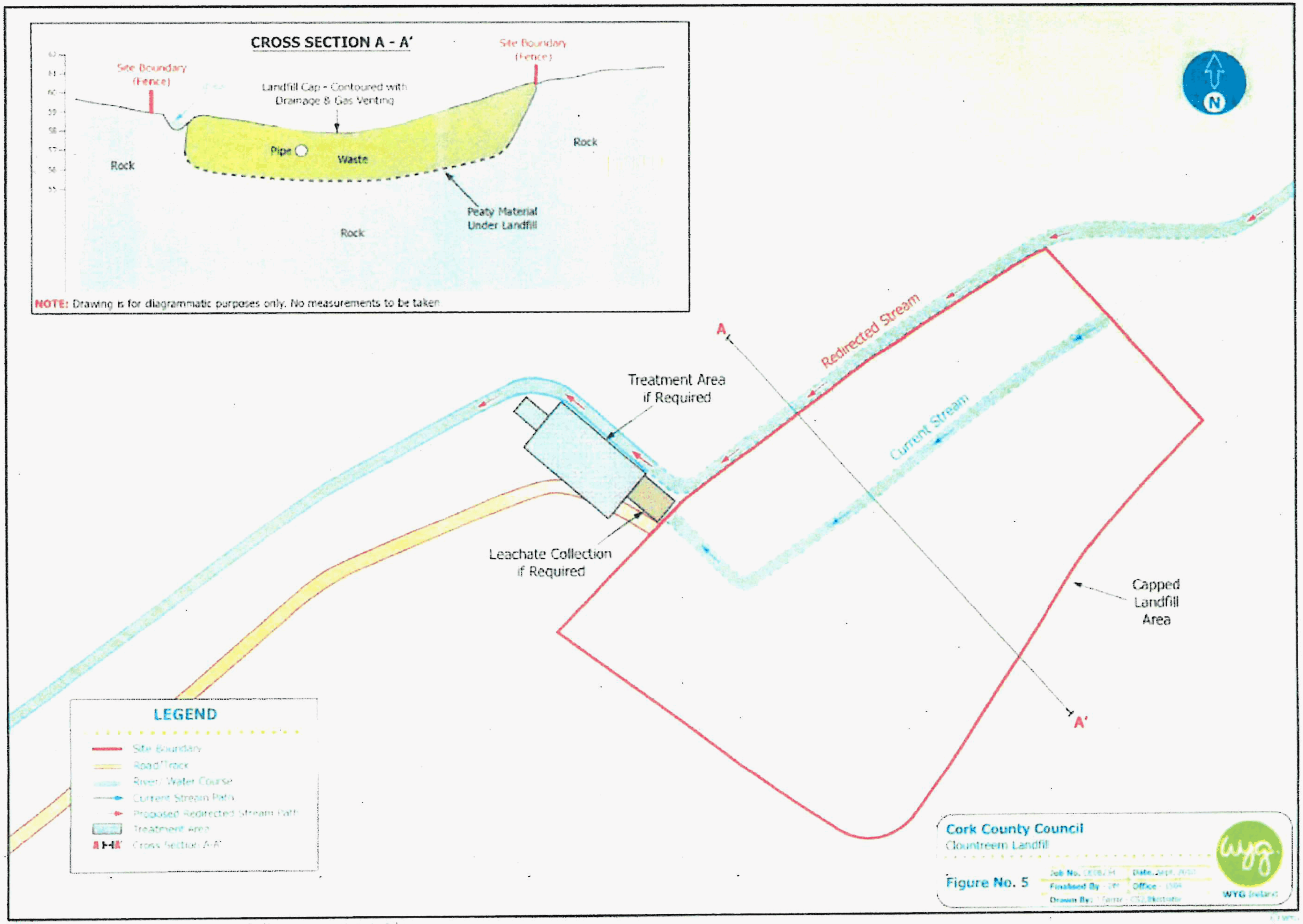


Figure 4 Site Layout showing groundwater sampling locations





NOTE: Drawing is for diagrammatic purposes only. No measurements to be taken.

Tables

Table 1 - Surface Water Analysis (Metals and Non-Metals)

Sample	Units	SW-1	SW-2	SW-3	SW-1	SW-2	SW-3	SI 272 of 2009	EPA EQS
Date		30/10/09	30/10/09	30/10/09	05/07/10	05/07/10	05/07/10		
Arsenic, Filtered as As	mg/l	<0.0002	<0.0002	<0.0002	<0.0025	<0.0025	<0.0025	0.025(1)	0.025
Boron, Filtered as B	mg/l	0.07	0.18	0.06	<0.012	0.038	0.045	-	2
Cadmium, Filtered as Cd	mg/l	<0.0001	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	≤0.00045, 0.00045, 0.0006, 0.0009 or 0.0015(2)(5)	0.005
Calcium, Filtered as Ca	mg/l	6.8	27.5	22.3	2.9	32.5	31.6	-	-
Copper, Filtered as Cu	mg/l	0	0	0	<0.007	<0.007	<0.007	0.005 or 0.03(1)(3)	0.03
Chromium	mg/l	<0.001	<0.001	<0.001	<0.0015	<0.0015	<0.0015	0.032(2)	0.03
Iron, Filtered as Fe	mg/l	0.231	9.13	2.84	0.03	0.02	0.069	-	1
Mercury, Filtered as Hg	mg/l	<0.00002	<0.00002	<0.00002	<0.001	<0.001	<0.001	0.00007(2)*	0.001
Magnesium, Filtered as Mg	mg/l	2.4	4.7	4.1	1.8	4.3	4.9	-	-
Manganese, Filtered as Mn	mg/l	0.022	0.337	0.256	<0.002	0.267	0.023	-	0.3
Nickel, Filtered as Ni	mg/l	0.002	0.003	0.003	<0.002	<0.002	<0.002	0.02(1)	0.05
Lead, Filtered as Pb	mg/l	0.002	0.002	0.001	<0.005	<0.005	<0.005	0.0072(1)	0.01
Zinc, Filtered as Zn	mg/l	0.005	0.007	0.004	<0.003	<0.003	<0.016	0.008 or 0.05 or 0.1(1)(4)	0.1
Potassium	mg/l	0.3	2.4	1.9	0.2	2.5	2.9		-
Sodium	mg/l	8.9	10.9	11.1	10.2	14.2	15.8	-	-
Nitrogen, Total as N	mg/l			0.7				-	NAC
Total Oxidised Nitrogen as N	mg/l				<0.05	<0.05	1.35	-	-
Chloride	mg/l	18.44	22.28	21.75	13.6	18.5	22.8	-	250
Fluoride	mg/l			0.15	<0.3	<0.3	<0.3	0.5(1)	5
Sulphate	mg/l	<1.39	<1.39	<1.39	12.77	40.45	5.3	-	200
Phosphate	mg/l			0.008				-	-
Molybate Reactive Phosphate	mg/l				<0.005	<0.005	<0.005	0.025	-
Total Cyanide	mg/l			<0.005	<0.004	<0.004	<0.004	0.01(1)*	0.01*
pH	pH units	7	6.9	7.5	6.68	7.4	7.95	4.5<pH<9.0	>6.5 and <9.5
Electrical Conductivity	μs/cm	84	258	217	<100	223	228	-	1000
Total Suspended Solids	mg/l			5	16	370	10	-	50
Total Dissolved Solids	mg/l			109				-	-
Total Alkalinity	mg/l			62	18	114	99	-	-
Ammoniacal Nitrogen as N	mg/l	0.03	2.74	1.3	0.02	3.21	1.15	-	0.02
BOD	mg/l	<2		<2	**11**	<1	4	1.3(1)*	5
TOC	mg/l			5.6				-	N.A.C
COD	mg/l			14	27	14	15	-	-

Legend:

SI 272 of 2009 European Communities Environmental Objectives (surface waters) Regulations 2009

EPA EQS = Environmental Quality Standard for Surface Waters

Shading = Value has exceeded EPA EQS

Bold = Value has exceeded SI 272 of 2009

- = No Standard

NAC - No Abnormal Changes - Refers to no significant change compared to background

Notes:

(1) Mean value for A-A EQS Inland Surface Waters outlined in SI 272 of 2009

(2) MAC-EQS Inland Surface Water Waters outlined in SI 272 of 2009

(3) 5μg/l applies where water hardness is mg/l CaCo3 is <100mg/l, 30μg/l applies where water hardness is mg/l CaCo3 is greater >100mg/l

(4) 8μg/l applies where water hardness is mg/l CaCo3 is <10mg/l, 50μg/l applies where water hardness is mg/l CaCo3 is greater >10mg/l and <100mg/l, 100μg/l applies where water hardness is mg/l CaCo3 is greater >100mg/l

(5) Class 1 applies where water hardness is mg/l CaCo3 is ≤0.45μg/l <40mg/l, class 2applies where water hardness is mg/l CaCo3 is 0.45μg/l 40mg/l to <50mg/l, class 3 0.6μg/l applies where water hardness is mg/l CaCo3 is 50mg/l to <100mg/l, class 4 0.9μg

* The laboratory Detection Limit is Greater Than the limit value

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Table 2 - Leachate Analysis (Metals and Non-Metals)

Sample	Units	Leachate 1	Leachate 2	Leachate 3	Leachate 1	Leachate 2	SI 272 of 2009	EPA EQS
Date		30/10/09	30/10/09	30/03/10	05/07/10	05/07/10		
Arsenic, Filtered as As	mg/l	0.0062	0.0046	0.0061	<0.0025	<0.025	0.025[1]	0.025
Boron, Filtered as B	mg/l	0.54	0.26	0.36	0.021	0.155	-	2
Cadmium, Filtered as Cd	mg/l	0.002	<0.001	0.002	<0.0005	<0.0005	≤0.00045, 0.00045, 0.0006, 0.0009 or 0.0015[2][5]	0.005
Calcium, Filtered as Ca	mg/l	82	42.6	61.1	52.7	101.3	-	-
Copper, Filtered as Cu	mg/l	<0.0002	<0.0002	<0.002	<0.007	<0.007	0.005 or 0.03[1][3]	0.03
Chromium	mg/l	0.0011	0.0082	0.0085	<0.0015	<0.0015	0.032[2]	0.03
Iron, Filtered as Fe	mg/l	13.9	17.69	19.42	<0.02	<0.02	-	1
Mercury, Filtered as Hg	mg/l	0.0002	0.0001	0.0001	<0.001	<0.001	0.00007[2]*	0.001
Magnesium, Filtered as Mg	mg/l	18.6	6.5	9.1	5.7	21.3	-	-
Manganese, Filtered as Mn	mg/l	1.865	0.96	1.838	1.375	3.815	-	0.3
Nickel, Filtered as Ni	mg/l	0.0139	0.0095	0.00163	<0.002	0.005	0.02[1]	0.05
Lead, Filtered as Pb	mg/l	**0.148**	**0.106**	**0.293**	<0.005	<0.005	0.0072[1]	0.01
Zinc, Filtered as Zn	mg/l	**0.509**	**0.533**	**0.895**	<0.003	**0.011**	0.008 or 0.05 or 0.1[1][4]	0.1
Potassium	mg/l	24.6	4.2	8	3.1	9.4	-	-
Sodium	mg/l	40.4	12.2	16.5	21.2	25.7	-	-
Total Oxidised Nitrogen as N	mg/l			<0.03	<0.05	<0.05	-	-
Chloride	mg/l	55.35	29.06	51.42	34.3	33.9	-	250
Fluoride	mg/l			0.35	<0.3	<0.3	0.5[1]	5
Sulphate	mg/l	7.31	<1.39	5.3	6.84	8.57	-	200
Phosphate	mg/l			0.76			-	-
Total Cyanide	mg/l			0.02	<0.04	<0.04	0.01[1]*	0.01*
pH	pH units	6.9	6.6	**12.2**	7.36	7.71	4.5<pH<9.0	>6.5 and < 9.5
Electrical Conductivity	us/cm	1030	350	567	447	665	-	1000
Ammoniacal Nitrogen as N	mg/l	84.79	5.17	11.3	0.71	6.31	-	0.02
BOD	mg/l	**15**	**7**	**20**	**135**	**46**	1.3[1]*	5
COD	mg/l			1510	<7	20	-	-

Legend:

SI 272 of 2009 European Communities Environmental Objectives (surface waters) Regulations 2009

EPA EQS = Environmental Quality Standard for Surface Waters

Shading = Value has exceeded EPA EQS

Bold = Value has exceeded SI 272 of 2009

- = No Standard

NAC - No Abnormal Changes - Refers to no significant change compared to background

Notes:

(1) Mean value for A-A EQS Inland Surface Waters outlined in SI 272 of 2009

(2) MAC-EQS Inland Surface Water Waters outlined in SI 272 of 2009

(3) 5μg/l applies where water hardness is mg/l CaCo3 is <100mg/l, 30μg/l applies where water hardness is mg/l CaCo3 is greater >100mg/l

(4) 8μg/l applies where water hardness is mg/l CaCo3 is <10mg/l, 50μg/l applies where water hardness is mg/l CaCo3 is greater >10mg/l and <100mg/l, 100μg/l applies where water hardness is mg/l CaCo3 is greater >100mg/l.

(5) Class 1 applies where water hardness is mg/l CaCo3 is ≤0.45μg/l <40mg/l , class 2applies where water hardness is mg/l CaCo3 is 0.45μg/l 40mg/l to <50mg/l, class 3 0.6μg/l applies where water hardness is mg/l CaCo3 is 50mg/l to <100mg/l, class 4 0.9μg

* The laboratory Detection Limit is Greater Than the limit value

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Table 3 - Ground Water Analytical Results

Monitoring Well No.	Units	GW-1	GW-2	GW-1	GW-2	Irish Drinking Water Standard	EPA IGVs
Date		30/10/09	30/10/09	05/07/10	05/07/10		
Arsenic	mg/l	0.0009	0.001	<0.0025	<0.0025	0.01	0.01
Boron	mg/l	0.101	0.173	<0.0012	0.0027	1	1
Cadmium	mg/l	0.0002	<0.0009	<0.0006	<0.0005	0.005	0.005
Total Chromium	mg/l	0.023	0.021	<0.0015	<0.0015	0.05	0.03
Copper	mg/l	0.096	0.0104	<0.007	0.02	0.2	0.03
Iron	mg/l	**0.77**	**0.29**	0.037	<0.02	0.2	0.02
Lead	mg/l	0.0015	0.0009	<0.005	<0.005	0.025	0.01
Magnesium	mg/l	1.74	4.08	2.7	4.1	50	50
Manganese	mg/l	**0.26**	**6.13**	**0.178**	**3.717**	0.05	0.05
Mercury	mg/l	<0.000003	<0.000003	<0.0001	<0.0001	0.001	0.001
Nickel	mg/l	0.0044	0.0017	<0.0002	<0.0002	0.02	0.02
Zinc	mg/l	0.0209	0.0157	0.008	0.016	5	0.1
Phosphates (As P)	mg/l	0.008	<0.005	<0.005	<0.005	0.7	-
pH	pH Units	6.2	6.6	6.52	6.73	≥6.5-9.5≤	≥6.5-9.5≤
Conductivity	mS/cm	0.151	0.286	0.149	0.177	2.5	1
Chloride	mg/l	31.96	32.11	27	28.1	250	30
Fluoride	mg/l	0.21	0.14	<0.3	<0.3	1.5	1.5
Sulphate	mg/l	11.8	8.12	50.04	12.7	250	200
Ammoniacal Nitrogen	mg/l	<0.01	0.244	0.06	0.19	0.3	0.15
Total Oxidised Nitrogen	mg/l	0.35	<0.28	0.48	0.28	N.A.C	N.A.C
Total Dissolved Solids	mg/l	~	~	98	115	1000	1000
Calcium	mg/l	7.75	14.02	10.3	10.8	200	200
Sodium	mg/l	14.12	18.6	18.5	19	150	150
Potassium	mg/l	0.97	4.18	0.7	2.1	12	5
Total Alkalinity	mg/l	~	~	29	45	-	N.A.C
Total Cyanide	mg/l	~	~	<0.040	<0.040	0.05	0.01
Total Coliforms	mpn/100ml	~	~	<3	<3	0 counts/100ml	0 counts/100ml
Faecal Coliforms	cfu/100ml	~	~	<3	<3	0 counts/100ml	0 counts/100ml
BOD	mg/l	<2	<2	~	~		
COD	mg/l	25	<5	~	~		
Total Organic Carbon	mg/l	~	~	5	3	N.A.C	N.A.C

Legend:

- = No Standard

NAC - No Abnormal Changes - Refers to no significant change compared to background

Bold font indicates exceedances of the Irish drinking water Standards (Jan 2004)

Shaded cells indicate exceedances above the EPA IGV values

< Indicates less than the laboratory detection limit

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Table 4 - Groundwater, Surface Water & Leachate Analysis (SVOCs)

Client Sample No.	Units	GW-1	GW-2	SW-1	SW-2	SW-3	Leachate 1	Leachate 2	SI 272 of 2009
Sample Date		05/07/10	05/07/10	05/07/10	05/07/10	05/07/10	05/07/10	05/07/10	
Phenol	ug/l	<10	<10	<10	<10	<10	<10	<10	46(2)
Bis(2-chloroethyl)ether	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2-Chlorophenol	ug/l	<10	<10	<10	<10	<10	<10	<10	-
1,3-Dichlorobenzene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
1,4-Dichlorobenzene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2-Methylphenol	ug/l	<10	<10	<10	<10	<10	<10	<10	-
3&4-Methylphenol	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Dibenzofuran	ug/l	<10	<10	<10	<10	<10	<10	<10	
1,2-Dichlorobenzene	ug/l	<10	<10	<10	<10	<10	<10	<10	10**
Bis(2-chloroisopropyl)ether	ug/l	<10	<10	<10	<10	<10	<10	<10	-
n-Nitrosodi-n-propylamine	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Hexachloroethane	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Nitrobenzene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Isophorone	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2,4-Dimethylphenol	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2-Nitrophenol	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Bis(2-chloroethoxy)methane	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2,4-Dichlorophenol	ug/l	<10	<10	<10	<10	<10	<10	<10	-
1,2,4-Trichlorobenzene	ug/l	<10	<10	<10	<10	<10	<10	<10	0.4(1)*
Naphthalene	ug/l	<10	<10	<10	<10	<10	<10	<10	2.4(1)
Hexachlorobutadiene	ug/l	<10	<10	<10	<10	<10	<10	<10	0.6(2)*
4-Chloro-3-methylphenol	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2-Methylnaphthalene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2,4,6-Trichlorophenol	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2,4,5-Trichlorophenol	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2-Chloronaphthalene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Dimethylphthalate	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2,6-Dinitrotoluene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Acenaphthylene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Acenaphthene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
2,4-Dinitrotoluene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Diethylphthalate	ug/l	<10	<10	<10	<10	<10	<10	<10	-
4-Nitrophenol	ug/l	<10	<10	<10	<10	<10	<10	<10	-
4-Chlorophenyl Phenyl Ether	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Fluorene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Diphenylamine	ug/l	<10	<10	<10	<10	<10	<10	<10	-
4-Bromophenyl Phenyl Ether	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Hexachlorobenzene	ug/l	<10	<10	<10	<10	<10	<10	<10	0.05(2)*
Phenanthrene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Anthracene	ug/l	<10	<10	<10	<10	<10	<10	<10	0.4(2)*
di-n-Butylphthalate	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Fluoranthene	ug/l	<10	<10	<10	<10	<10	<10	<10	1(2)*
Pyrene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Benzyl Butyl Phthalate	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Benzo(a)anthracene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Chrysene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Bis(2-ethylhexyl)phthalate	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Di-n-octylphthalate	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Benzo(b)fluoranthene	ug/l	<10	<10	<10	<10	<10	<10	<10	0.3(1)*
Benzo(k)fluoranthene	ug/l	<10	<10	<10	<10	<10	<10	<10	0.3(1)*
Benzo(a)pyrene	ug/l	<10	<10	<10	<10	<10	<10	<10	0.1(2)*
Indeno(1,2,3-c,d)pyrene	ug/l	<10	<10	<10	<10	<10	<10	<10	0.2(1)*
Dibenz(a,h)anthracene	ug/l	<10	<10	<10	<10	<10	<10	<10	-
Benzo(g,h,i)perylene	ug/l	<10	<10	<10	<10	<10	<10	<10	0.2(1)*

Legend:

SI 272 of 2009 European Communities Environmental Objectives (surface waters) Regulations 2009

**EPA EQS = Environmental Quality Standard for Surface Waters 1997

The results are in bold where they exceed the Surface Water Regulations

Notes:

(1) Mean value for A-A EQS Inland Surface Waters outlined in SI 272 of 2009

(2) MAC-EQS Inland Surface Water Waters outlined in SI 272 of 2009

- No Standard

* The laboratory Detection Limit is Greater Than the limit value

Table 5 - Groundwater, Surface Water & Leachate Analysis (VOCs)

Client Sample No.	Units	GW-1	GW-2	SW-1	SW-2	SW-3	Leachate 1	Leachate 2	SI 272 of 2009
Sample Date		05/07/10	05/07/10	05/07/10	05/07/10	05/07/10	05/07/10	05/07/10	
Dichlorodifluoromethane	µg/l	<2	<2	<2	<2	<2	<2	<2	-
Chloromethane	µg/l	<3	<3	<3	<3	<3	<3	<3	-
Chloroethane	µg/l	<3	<3	<3	<3	<3	<3	<3	-
Bromomethane	µg/l	<1	<1	<1	<1	<1	<1	<1	-
Trichlorofluoromethane	µg/l	<3	<3	<3	<3	<3	<3	<3	
1,1-Dichloroethene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
Dichloromethane	µg/l	<3	<3	<3	<3	<3	<3	<3	20(1)
1,1-Dichloroethane	µg/l	<6	<6	<6	<6	<6	<6	<6	
cis-1-2-Dichloroethene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
2,2-Dichloropropane	µg/l	<1	<1	<1	<1	<1	<1	<1	-
Chloroform	µg/l	<3	<3	<3	<3	<3	<3	<3	12**
Bromochloromethane	µg/l	<2	<2	<2	<2	<2	<2	<2	
1,1,1-Trichloroethane	µg/l	<3	<3	<3	<3	<3	<3	<3	500**
1,1-Dichloropropene	µg/l	<3	<3	<3	<3	<3	<3	<3	
1,2-Dichloroethane	µg/l	<2	<2	<2	<2	<2	<2	<2	10(1)
Benzene	µg/l	<3	<3	<3	<3	<3	<3	<3	50(2)
1,2-Dichloropropane	µg/l	<2	<2	<2	<2	<2	<2	<2	
Trichloroethene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
Bromodichloromethane	µg/l	<3	<3	<3	<3	<3	<3	<3	-
Dibromomethane	µg/l	<3	<3	<3	<3	<3	<3	<3	-
cis-1-3-Dichloropropene	µg/l	<2	<2	<2	<2	<2	<2	<2	
Toluene	µg/l	<3	<3	<3	<3	<3	<3	<3	10(1)
trans-1-3-Dichloropropene	µg/l	<2	<2	<2	<2	<2	<2	<2	
1,1,2-Trichloroethane	µg/l	<2	<2	<2	<2	<2	<2	<2	-
Carbon tetrachloride	µg/l	<2	<2	<2	<2	<2	<2	<2	
Vinyl Chloride	µg/l	<2	<2	<2	<2	<2	<2	<2	
1,3-Dichloropropane	µg/l	<2	<2	<2	<2	<2	<2	<2	-
Tetrachloroethene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
Dibromochloromethane	µg/l	<2	<2	<2	<2	<2	<2	<2	
1,2-Dibromoethane	µg/l	<2	<2	<2	<2	<2	<2	<2	-
Chlorobenzene	µg/l	<2	<2	<2	<2	<2	<2	<2	1**
1,1,1,2-Tetrachloroethane	µg/l	<2	<2	<2	<2	<2	<2	<2	-
Ethylbenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	10(1)
p/m-Xylene	µg/l	<5	<5	<5	<5	<5	<5	<5	10(1)
o-Xylene	µg/l	<3	<3	<3	<3	<3	<3	<3	10(1)
Styrene	µg/l	<2	<2	<2	<2	<2	<2	<2	-
Bromoform	µg/l	<2	<2	<2	<2	<2	<2	<2	
Isopropylbenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
trans-1-2-Dichloroethene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
1,1,2,2-Tetrachloroethane	µg/l	<4	<4	<4	<4	<4	<4	<4	
1,2,3-Trichloropropane	µg/l	<3	<3	<3	<3	<3	<3	<3	-
n-Propylbenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	
Bromobenzene	µg/l	<2	<2	<2	<2	<2	<2	<2	-
2-Chlorotoluene	µg/l	<3	<3	<3	<3	<3	<3	<3	
1,3,5-Trimethylbenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
4-Chlorotoluene	µg/l	<3	<3	<3	<3	<3	<3	<3	
tert-Butylbenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
1,2,4-Trimethylbenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	
sec-Butylbenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
p-Isopropyltoluene	µg/l	<3	<3	<3	<3	<3	<3	<3	
1,3-Dichlorobenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
1,4-Dichlorobenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
n-Butylbenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
1,2-Dichlorobenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	10**
1,2-Dibromo-3-chloropropane	µg/l	<3	<3	<3	<3	<3	<3	<3	-
1,2,4-Trichlorobenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	0.4(1)*
Hexachlorobutadiene	µg/l	<3	<3	<3	<3	<3	<3	<3	-
Naphthalene	µg/l	<2	<2	<2	<2	<2	<2	<2	2.4(1)
1,2,3-Trichlorobenzene	µg/l	<3	<3	<3	<3	<3	<3	<3	0.4(1)*
Methyl Tertiary Butyl Ether	µg/l	<2	<2	<2	<2	<2	<2	<2	-

Legend:

SI 272 of 2009 European Communities Environmental Objectives (surface waters) Regulations 2009

**EPA EQS = Environmental Quality Standard for Surface Waters 1997

The results are in bold where they exceed the Surface Water Regulations

Notes:

(1) Mean value for A-A EQS Inland Surface Waters outlined in SI 272 of 2009

(2) MAC-EQS Inland Surface Water Waters outlined in SI 272 of 2009

- No Standard

* The laboratory Detection Limit is Greater Than the limit value

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Table 6 - Tier 3 Risk Assessmemnt Outputs - Iron

Iron Dry Weather

Parameter		Unit	Value	Justification
Target Concentration	C_t	mg/l	1	Surface water regulations
Leachate Concentration	C_c	mg/l	19.42	Maximum Leachate value - Table 5.2
Background Concentration	C_u	mg/l	0.03	Maximum upgradient concentration – Table 5.2
Hydraulic Conductivity	K	m/day	6.35	Value for sand (SC050021-SR3)
Hydraulic Gradient	i	-	0.0354	Estimate based on site gradient
Length of pipe	w	m	110	Width of site measured on maps
Fraction of cracks in pipe	f	m^2/m	0.122	Based on 5% cracks
Leachate Infiltration	Q_c	m^3/day	3.0166818	Infiltration to river calculated by Qc=K.i.w.f
Surface water flow	Q_u	m^3/day	24	Dry weather flow (estimate based on flow monitoring report)
Dilution Factor	DF		8.8470307	Calculated from equation above
Remedial Target - Leachate	RT	mg/l	8.8470307	Calculate from Ct*DF

Dilution Factor 8.847
Concentration in Stream 2.1951

Iron Low Flow

Parameter		Unit	Value	Justification
Target Concentration	C_t	mg/l	1	Surface water regulations
Leachate Concentration	C_c	mg/l	19.42	Maximum Leachate value - Table 5.2
Background Concentration	C_u	mg/l	0.03	Maximum upgradient concentration – Table 5.2
Hydraulic Conductivity	K	m/day	6.35	Value for sand (SC050021-SR3)
Hydraulic Gradient	i	-	0.0354	Estimate based on site gradient
Length of pipe	w	m	110	Width of site measured on maps
Fraction of cracks in pipe	f	m^2/m	0.122	Based on 5% cracks
Leachate Infiltration	Q_c	m^3/day	3.0166818	Infiltration to river calculated by Qc=K.i.w.f
Surface water flow	Q_u	m^3/day	92	Minimum flow rate (measured for flow monitoring report)
Dilution Factor	DF		30.079961	Calculated from equation above
Remedial Target - Leachate	RT	mg/l	30.079961	Calculate from Ct*DF

Dilution Factor 30.08
Concentration in Stream 0.6456

Iron High Flow

Parameter		Unit	Value	Justification
Target Concentration	C_t	mg/l	1	Surface water regulations
Leachate Concentration	C_c	mg/l	19.42	Maximum Leachate value - Table 5.2
Background Concentration	C_u	mg/l	0.03	Maximum upgradient concentration – Table 5.2
Hydraulic Conductivity	K	m/day	6.35	Value for sand (SC050021-SR3)
Hydraulic Gradient	i	-	0.0354	Estimate based on site gradient
Length of pipe	w	m	110	Width of site measured on maps
Fraction of cracks in pipe	f	m^2/m	0.122	Based on 5% cracks
Leachate Infiltration	Q_c	m^3/day	3.0166818	Infiltration to river calculated by Qc=K.i.w.f
Surface water flow	Q_u	m^3/day	885	Average flow rate (measured for flow monitoring report)
Dilution Factor	DF		202.56645	Calculated from equation above
Remedial Target - Leachate	RT	mg/l	202.56645	Calculate from Ct*DF

Dilution Factor 202.57
Concentration in Stream 0.0959

Table 7 - Tier 3 Risk Assessment Outputs - Manganese

Manganese Dry Weather

Parameter		Unit	Value	Justification
Target Concentration	C_t	mg/l	0.3	Surface water regulations
Leachate Concentration	C_c	mg/l	3.715	Maximum Leachate value - Table 5.2
Background Concentration	C_u	mg/l	0.022	Maximum upgradient concentration – Table 5.2
Hydraulic Conductivity	K	m/day	6.35	Value for sand (SC050021-SR3)
Hydraulic Gradient	i	-	0.0354	Estimate based on site gradient
Length of pipe	w	m	110	Width of site measured on maps
Fraction of cracks in pipe	f	m^2/m	0.122	Based on 5% cracks
Leachate Infiltration	Q_c	m^3/day	3.0166818	Infiltration to river calculated by Qc=K.i.w.f
Surface water flow	Q_u	m^3/day	24	Dry weather flow (estimate based on flow monitoring report)
Dilution Factor	DF		8.5528082	Calculated from equation above
Remedial Target - Leachate	RT	mg/l	2.5658425	Calculate from Ct*DF

Dilution Factor 8.5528
Concentration in Stream 0.4344

Manganese Low Flow

Parameter		Unit	Value	Justification
Target Concentration	C_t	mg/l	0.3	Surface water regulations
Leachate Concentration	C_c	mg/l	3.715	Maximum Leachate value - Table 5.2
Background Concentration	C_u	mg/l	0.022	Maximum upgradient concentration – Table 5.2
Hydraulic Conductivity	K	m/day	6.35	Value for sand (SC050021-SR3)
Hydraulic Gradient	i	-	0.0354	Estimate based on site gradient
Length of pipe	w	m	110	Width of site measured on maps
Fraction of cracks in pipe	f	m^2/m	0.122	Based on 5% cracks
Leachate Infiltration	Q_c	m^3/day	3.0166818	Infiltration to river calculated by Qc=K.i.w.f
Surface water flow	Q_u	m^3/day	92	Minimum flow rate (measured for flow monitoring report)
Dilution Factor	DF		26.678837	Calculated from equation above
Remedial Target - Leachate	RT	mg/l	8.0036512	Calculate from Ct*DF

Dilution Factor 26.679
Concentration in Stream 0.1392

Manganese High Flow

Parameter		Unit	Value	Justification
Target Concentration	C_t	mg/l	0.3	Surface water regulations
Leachate Concentration	C_c	mg/l	3.715	Maximum Leachate value - Table 5.2
Background Concentration	C_u	mg/l	0.022	Maximum upgradient concentration ~ Table 5.2
Hydraulic Conductivity	K	m/day	6.35	Value for sand (SC050021-SR3)
Hydraulic Gradient	i	-	0.0354	Estimate based on site gradient
Length of pipe	w	m	110	Width of site measured on maps
Fraction of cracks in pipe	f	m^2/m	0.122	Based on 5% cracks
Leachate Infiltration	Q_c	m^3/day	3.0166818	Infiltration to river calculated by Qc=K.i.w.f
Surface water flow	Q_u	m^3/day	885	Average flow rate (measured for flow monitoring report)
Dilution Factor	DF		107.53936	Calculated from equation above
Remedial Target - Leachate	RT	mg/l	32.261807	Calculate from Ct*DF

Dilution Factor 107.54
Concentration in Stream 0.0345

Table 8 - Tier 3 Risk Assesment Outpurs - Ammonical Nitrogen

Ammonical Nitrogen Dry Weather

Parameter		Unit	Value	Justification
Target Concentration	C_t	mg/l	0.02	Surface water regulations
Leachate Concentration	C_c	mg/l	84.79	Maximum Leachate value - Table 5.2
Background Concentration	C_u	mg/l	0.03	Maximum upgradient concentration – Table 5.2
Hydraulic Conductivity	K	m/day	6.35	Value for sand (SC050021-SR3)
Hydraulic Gradient	i	-	0:0354	Estimate based on site gradient
Length of pipe	w	m	110	Width of site measured on maps
Fraction of cracks in pipe	f	m^2/m	0.122	Based on 5% cracks
Leachate Infiltration	Q_c	m^3/day	3.0166818	Infiltration to river calculated by Qc=K.i.w.f
Surface water flow	Q_u	m^3/day	24	Dry weather flow (estimate based on flow monitoring report)
Dilution Factor	DF		8.9306227	Calculated from equation above
Remedial Target - Leachate	RT	mg/l	0.1786125	Calculate from Ct*DF

Dilution Factor 8.9306
Concentration in Stream 2.42

Ammonical Nitrogen Low Flow

Parameter		Unit	Value	Justification
Target Concentration	C_t	mg/l	0.02	Surface water regulations
Leachate Concentration	C_c	mg/l	84.79	Maximum Leachate value - Table 5.2
Background Concentration	C_u	mg/l	0.03	Maximum upgradient concentration – Table 5.2
Hydraulic Conductivity	K	m/day	6.35	Value for sand (SC050021-SR3)
Hydraulic Gradient	i	-	0.0354	Estimate based on site gradient
Length of pipe	w	m	110	Width of site measured on maps
Fraction of cracks in pipe	f	m^2/m	0.122	Based on 5% cracks
Leachate Infiltration	Q_c	m^3/day	3.0166818	Infiltration to river calculated by Qc=K.i.w.f
Surface water flow	Q_u	m^3/day	92	Minimum flow rate (measured for flow monitoring report)
Dilution Factor	DF		31.160849	Calculated from equation above
Remedial Target - Leachate	RT	mg/l	0.623217	Calculate from Ct*DF

Dilution Factor 31.161
Concentration in Stream 0.69

Ammonical Nitrogen High Flow

Parameter		Unit	Value	Justification
Target Concentration	C_t	mg/l	0.02	Surface water regulations
Leachate Concentration	C_c	mg/l	84.79	Maximum Leachate value - Table 5.2
Background Concentration	C_u	mg/l	0.03	Maximum upgradient concentration – Table 5.2
Hydraulic Conductivity	K	m/day	6.35	Value for sand (SC050021-SR3)
Hydraulic Gradient	i	-	0.0354	Estimate based on site gradient
Length of pipe	w	m	110	Width of site measured on maps
Fraction of cracks in pipe	f	m^2/m	0.122	Based on 5% cracks
Leachate Infiltration	Q_c	m^3/day	3.0166818	Infiltration to river calculated by Qc=K.i.w.f
Surface water flow	Q_u	m^3/day	885	Average flow rate (measured for flow monitoring report)
Dilution Factor	DF		266.68702	Calculated from equation above
Remedial Target - Leachate	RT	mg/l	5.3337405	Calculate from Ct*DF

Dilution Factor 266.69
Concentration in Stream 0.08