3. TIER 2 SITE INVESTIGATION

3.1 Site Investigation Works

A site investigation rationale was devised based on findings of the Tier 1 assessment, site walkover, historical aerial photography and the preliminary risk assessment which formed part of that report.

The scope of site investigation works included:

- Topographical Survey
- 1 No. Geophysical survey (2D resistivity, EM31 Ground Conductivity and seismic refraction profiling)
- 11 No. trial pits excavations
- Installation of 2 no. groundwater monitoring wells
- Installation of 1 no. leachate monitoring well
- Sampling of an existing groundwater monitoring well and leachate collection system
- Factual reporting

The locations of the intrusive works conducted at the site are presented in Figure 3-1.

The site investigation methodology considered the following literature sources:

- EPA 2003, Landfill Manuals: Landfill Monitoring (2nd Edition)
- EPA 1999, Landfill Manuals: Site Investigations
- BS 5930: 1999, Code of Practice for Site Investigations
- BS 6068 Water Quality: Sampling (parts 6.1-6.6 and 6.11-6.12, 6.14)
- BS 8855 Soil analysis (all parts)
- CLM: Ready Reference 2002, Section 3.1 Soil sampling strategies
- CLM: Ready Reference 2002, Section 3.2 Groundwater sampling/monitoring strategies
- CLM: Ready Reference 2002, Section 3.3 Gas sampling/monitoring strategies.

Site Boundary

Groundwater Well

Trial Pit

Leachate Borehole

Existing Leachate Collection Manhole

N
W E
S

0 50 100 200 Meters

TITLE: Site Investigation Location Plan			
PROJECT: Gort Historic Landfill ERA			
FIGURE NO:	3.1		
CLIENT:	Galway County Council		
SCALE:	1:2,000	**REVISION:**	0
DATE:	15/10/2020	**PAGE SIZE:**	A3

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3.1.1 Geophysical Investigation

Minerex Geophysics Ltd (MGX) were instructed by FT to undertake a geophysical investigation of the historic landfill site. The survey was carried out between the 21st and 29th of May 2020. The complete MGX geophysical survey report is included in Appendix 3.

The geophysical survey consisted of reconnaissance EM Ground Conductivity Mapping with follow-up 2D Resistivity Profiling (RT) and Seismic Refraction Profiling. A total of 348m for Resistivity Profiling (RT) and 348m for Seismic Refraction Profiling of geophysical profiles were collected. The geophysical survey was used to estimate a general profile of the buried waste above the bedrock.

The survey identified a waste body in the centre of the site, with high surface conductivities indicating as mainly mixed municipal solid waste (MSW) material, and another waste body towards the periphery of the site, where the conductivities decrease which indicates construction and demolition type waste material. The extent of the historic landfill is estimated to be 16,500 m^2. Based on geophysical survey profile, applying an estimated average depth of 3.5 m below ground level, this provides an estimated waste volume of 57,750 m^3 including fill material placed on top of the landfill.

MGX recorded RT profiles data along 2 designated profiles named R1 and R2, and two seismic refraction profiles (S1 and S2) were recorded across the site. See Figure 3-2.

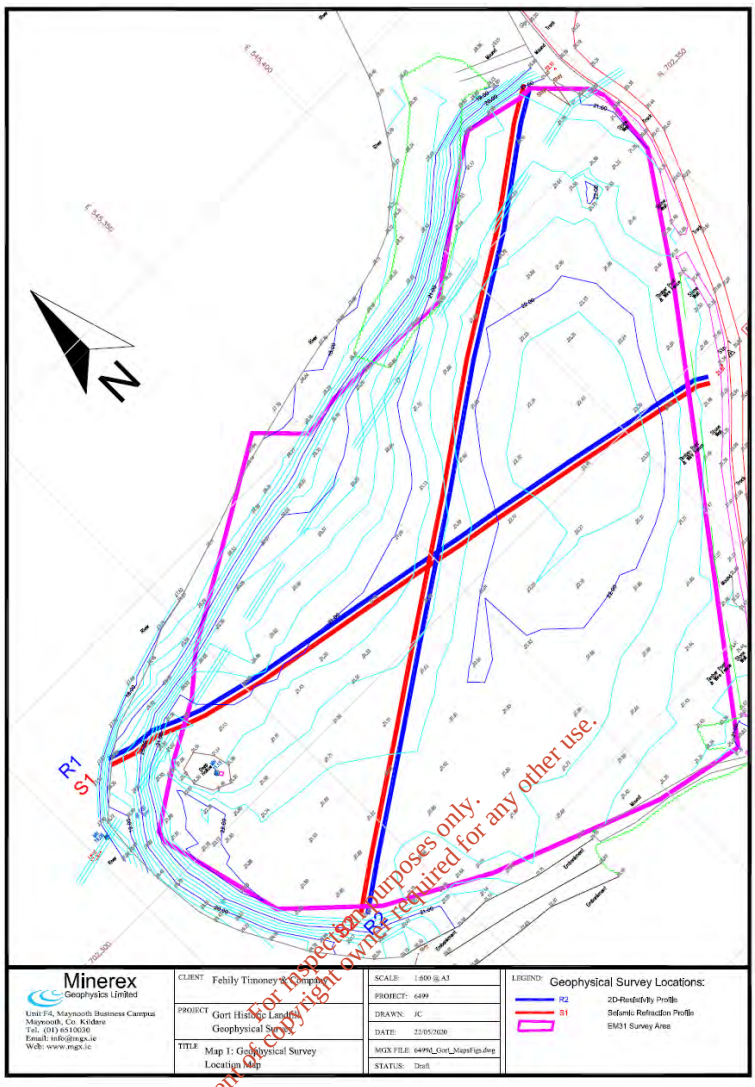

Figure 3-2: Geophysical Survey Location Map

Results

The geophysical survey succeeded in validating the general location of the waste material. Both the elevated EM conductivity readings in combination with the trial pit logs show the waste to be present within most of the survey area.

The scale used on this site represents the very high conductivity results surveyed throughout the site. The highest conductivities are found in the centre of the site where conductivities are typically above 30 mS/m. Very high conductivities indicate deep MSW waste material. Around the edge of the site the conductivities begin to decrease. Conductivities between 20 – 30 mS/m would indicate some waste material, while conductivities of less than 20 mS/m would usually indicate mainly Construction and Demolition (C&D) waste, soil and rock fill or natural material.

Both profiles show a rapid change with depth from low resistivities to high resistivities at approx. 12.5 – 15 mOD. Low resistivities (<62.5 Ohm) indicate mainly MSW material or leachate but may also indicate clay-rich or peat overburden. High resistivities (>500 Ohm) at depth indicate fresh limestone. Higher resistivities near the surface, particularly at the end of the profiles indicate mainly C&D waste or soil and rock fill.

At the start of profile R1 towards the river, low resistivities penetrate to about 7.5 mOD. These deeper low resistivities may be due to leachate migration into the rock in this area.

A layered ground model was created from the modelled seismic data (See Figure 3-3):

Layers 1a and 1b have a seismic velocity range of 200 m/s and found in most of the survey area. This velocity would represent domestic and industrial waste and C&D or soil and rock fill, materials that have a lower velocity than the surrounding natural ground.

Layer 2 has a seismic velocity range of 1600 and 2000 m/s. This layer is interpreted as overburden material with leachate, and it is found in most of the survey area below layers 1a and 1b.

Layer 3a is interpreted as fresh Limestone and is found in most of the survey area, under layers 2 and 3b. This layer has N/A seismic velocity.

Layer 3b is interpreted as Limestone with Leachate and is found to the West of the survey area, under layer 2. This layer has N/A seismic velocity.

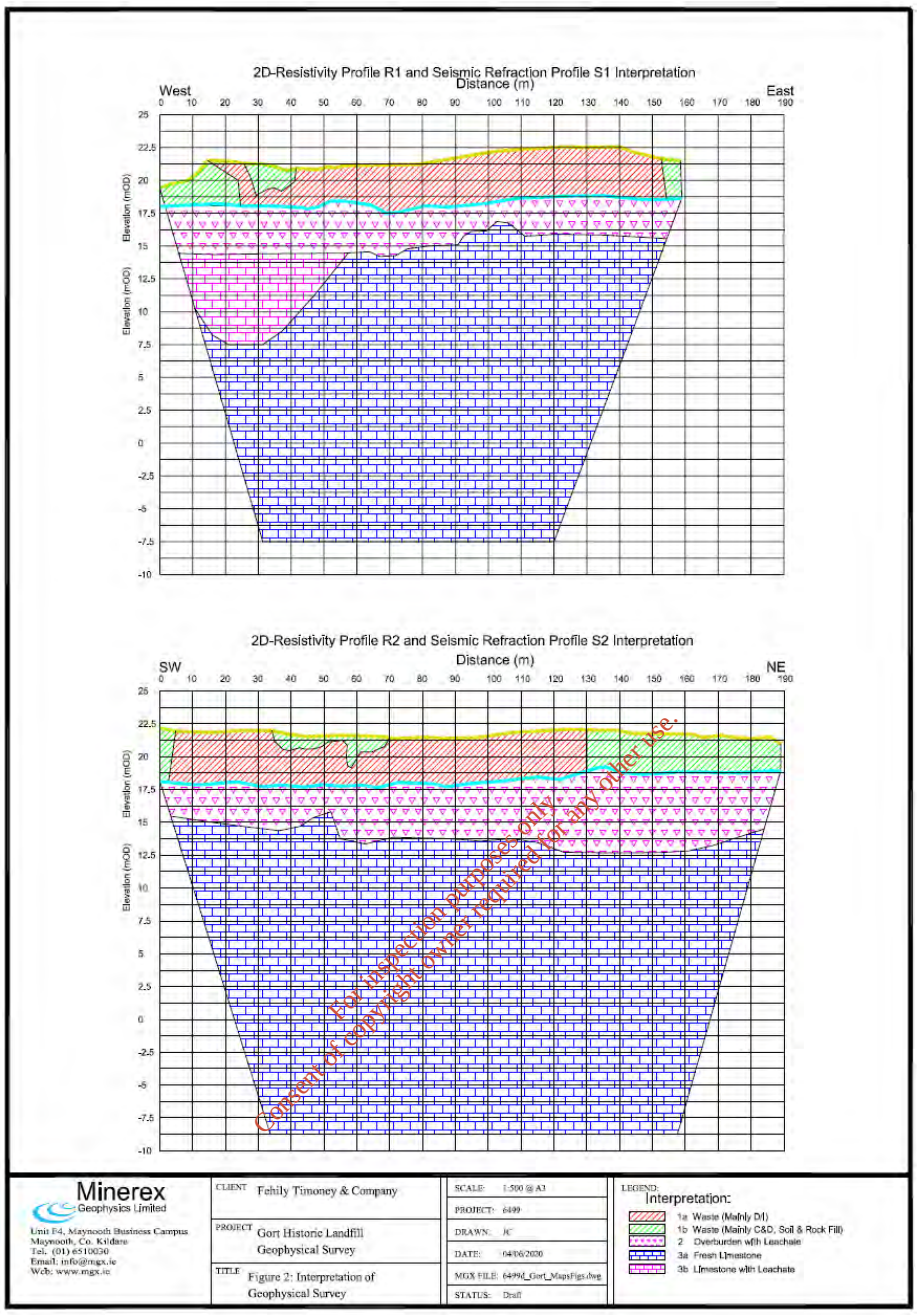

Figure 3-3: Integration of Geophysical Survey

3.1.2 Trial Pitting

A Causeway Geotech (CGL) Engineering Geologist supervised the advancement of 11 No. trial pit, shown in Figure 3-1, on the 26th June 2020.

The trial pits (TP01 to TP11) were excavated to depths of 1.0m to 4.50m below existing ground level (BGL) using a 13t tracked excavator fitted with a 600mm wide bucket. Trial pits TP01 to TP08 were excavated within the known historical landfill area, while trial pits TP09 to TP11 within the adjacent borrow pit, east of the historical landfill.

The geophysical survey used in conjunction with the profiles identified during trial pitting provided a picture of the underlying geology of the site and a general profile of the buried waste.

A summary of the ground conditions is presented in Table 3.1 below with photographs and exploratory hole logs provided in the CGL site investigation report, Appendix 4.

Table 3.1: Summary of Ground Condition

Trial Pit ID	Depth of cover material (m BGL)	Depth to base of made ground/waste (m BGL)	Profile Description
TP01	0.0 – 0.20 (Reworked Topsoil) 0.20 – 0.80 (Made Ground) 0.80 – 3.0 (Made Ground) 3.0 – 4.50 (Clay)	4.50 (base of excavation - terminated at scheduled depth)	Reworked Topsoil; Brownish yellow sandy silty GRAVEL of limestone with low cobble content. Lenses of soft black clay with sheets of plastic, plastic bottles, glass bottles, and pieces of wood. Soft grey CLAY
TP02	0.0 – 0.70 (Made Ground) 0.70 – 3.6 (Made Ground) 3.6 – 4.5 (Peat)	4.50 (base of excavation - terminated at scheduled depth)	Sandy gravelly CLAY with plastic; Plastic, glass, wood and Styrofoam; Brown pseudo-fibrous PEAT.
TP03	0.0 – 0.25 (Reworked Topsoil) 0.25 – 0.75 (Made Ground) 0.75 – 3.50 (Made Ground) 3.50 – 4.0 (CLAY)	4.0 (base of excavation – terminated at possible boulder)	Reword Topsoil; Sandy gravelly SILT with limestone cobbles; Plastic, wood and Styrofoam; Sandy gravelly CLAY with gravel of mixed lithologies.
TP04	0.0 – 0.30 (Reworked Topsoil) 0.30 – 0.80 (Made Ground) 0.80 – 1.60 (Made Ground) 1.60 – 4.0 (Made Ground)	4.0 (base of excavation – terminated on virtual refusal)	Reworked Topsoil; Slightly sandy gravelly SILT with red brick; Slightly sandy gravelly SILT with limestone gravel; Slightly sandy gravelly CLAY with plastic and glass.
TP05	0.0 – 0.60 (Made Ground) 0.60 – 3.90 (Made Ground)	4.5 (base of excavation –	Slightly sandy gravelly CLAY with plastic; CLAY lenses with plastic, pipes, wood and Styrofoam;

Trial Pit ID	Depth of cover material (m BGL)	Depth to base of made ground/waste (m BGL)	Profile Description
	3.90 – 4.50 (Clay)	terminated at scheduled depth)	Soft CLAY.
TP06	0.0 – 1.10 (Made Ground) 1.10 – 3.90 (Made Ground) 3.90 – 4.50 (Sand)	4.5 (base of excavation – terminated at scheduled depth)	Slightly sandy gravelly CLAY with limestone cobbles; CLAY lenses with plastic, pipes, wood and Styrofoam; Gravelly silty SAND.
TP07	0.0 – 0.20 (Made Ground) 0.20 – 2.10 (Made Ground)	2.10 (base of excavation – terminated on collapse)	Sandy gravelly CLAY; Slightly sandy gravelly CLAY with plastic, tree trunks, glass, carpet, pipe, nylon straps and Styrofoam.
TP08	0.0 – 0.60 (Made Ground) 0.60 – 2.40 (Made Ground) 2.40 – 3.10 (Clay)	3.10 (base of excavation – terminated on possible boulder)	Slightly sandy gravelly CLAY with plastic; CLAY lenses with plastic, wood, glass, carpet and Styrofoam; Soft CLAY.
TP09	0.0 – 0.60 (Made Ground) 0.60 – 1.30 (Sand)	1.30 (base of excavation – terminated on possible boulder)	Slightly sandy gravelly SILT with plastic and concrete; Gravelly silty SAND with limestone cobbles.
TP10	0.0 – 0.40 (Made Ground) 0.40 – 1.0 (Made Ground)	1.0 (base of excavation – terminated on possible boulder)	Slightly sandy gravelly CLAY; Gravelly silty SAND.
TP11	0.0 – 0.10 (Made Ground) 0.10 – 0.90 (Made Ground) 0.90 – 3.20 (Sand)	3.20 (base of excavation – terminated on virtual refusal)	Sandy silty limestone GRAVEL; Sandy gravelly SILT with clay lenses; Gravelly silty SAND.

Made ground comprising landfill waste was encountered in 8 No. trial pits (TP01 to TP08). No bedrock was encountered at any trial pit.

Waste material was encountered up to a maximum depth of 4.0m bgl in trial pits TP01 to TP08, with the greatest depth of 4.0m bgl recorded at TP04. It is noted that trace quantities of C&D type material were identified within the upper 0.6m in TP09, located within the borrow pit area. However, review of trial pit photographs show that the quantity of waste material is very low and it is not likely that landfilling activity and deposition of municipal waste extended to this area. Slow seepage was encountered in TP01 and TP03 to TP06 between 3.40m – 4.0m. Slow water strike in TP02, at 3.0m.

Natural ground comprising of quaternary glacial till was also confirmed in 8 No. trial pits (TP01, TP02, TP03, TP05, TP06, TP08, TP09 and TP11).

3.1.3 Waste Sampling

2 No. samples of the made ground/waste at the site was collected from trial pits TP03 (to the north west of the site) and TP06 (advanced in the southwestern portion of the site).

Samples were submitted for Waste Acceptance Criteria (WAC) testing to Chemtest Ltd., a UKAS/MCERTS approved laboratory. Samples were collected from site under Chain of Custody procedures.

The results are provided in Appendix G of the CGL Ground Investigation report, Appendix 4 of this report.

The results are discussed in Section 4.2.

3.1.4 Evidence of Contamination

The trial pits excavation works identified waste material tending to the western portion of the site up to a maximum depth of 4.0m BGL. Evidence of waste material was identified in 8 No. trial pits locations (TP01 to TP08). The waste encountered was described as plastic, glass, wood, styrofoam, red brick, pipes, tree trunks, carpet, nylon straps and concrete.

Landfill waste was not encountered in trial pits TP10 and TP11 advanced within the former borrow pit area. Only trace quantities of inert materials were recorded at TP09 within the borrow bit area, however examination of trial pits photographs shows that this doesn't indicate deposition of waste as evident in the known historical landfill area.

The base of the waste material was reached in 7 No. trial pits (TP01, TP02 TP03, TP05, TP06 and TP08) at the termination depths between 0.60m – 3.90m BGL. The base of the waste material was not confirmed at trial pits TP04 and TP07 with waste material found up to 4.0m and 2.10m bgl respectively, where the excavations were terminated. TP04 was terminated at a depth of 4.0m bgl was terminated on 'possible bedrock/boulder', additionally slow seepage of water was recorded at 3.4m bg and is visible in trial pits photographs. (see Appendix 4). TP07 was terminated at a depth of 2.1m bgl due to collapsing sides. No groundwater was encountered at this trial pit.

Borehole LH01 was excavated within the waste body to a depth of 10m bgl. Drillers recorded landfill waste at LH01 up to a depth of 3.5m bgl (18.61 mAOD), underlain by clays, sands and gravel from 3.5m bgl to 10m bgl (12.11 mAOD). Waste material encountered included various plastics, glass, wood, Styrofoam, carpet and pipe

As noted, most of the Made Ground waste material encountered comprised sandy gravelly Clay and sandy gravelly Silt mixed with waste material.

3.1.5 Waste Delineation

The combined findings of the geophysical survey and intrusive site investigation were used to interpret the aerial extent of the waste mass.

The findings of the ground conductivity and 2D-Resistivity show the area where landfill material is present. The interpreted landfill extent covers an area of approx. 16,500 m^2.

The depth of waste has been estimated from 2D-Resistivity. An average thickness of 3.5m is calculated for the landfill material. The estimate includes capping or natural fill material on top of the main waste body.

An initial volume calculation estimates an interred waste volume of approximately 57,750m^3 at the site.

The maximum anticipated waste footprint is presented in

Figure 3-4.

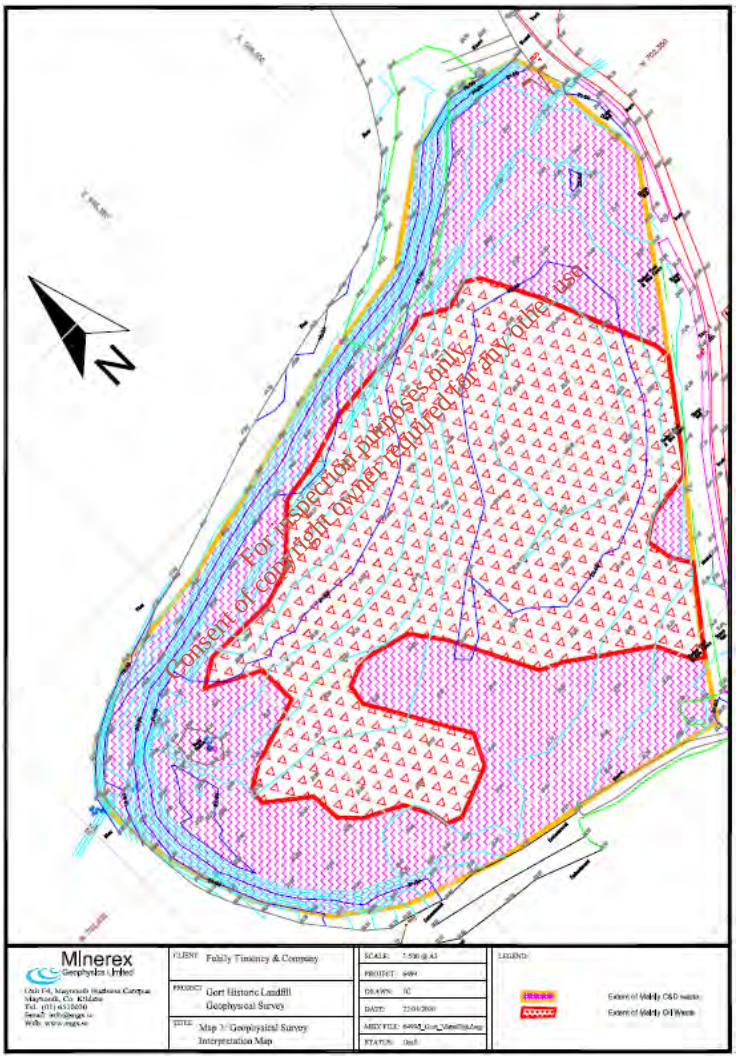

Figure 3-4: Geophysical Survey Estimated Waste Footprint

MGX note that leachate is identified in a layer beneath the landfill within the overburden, while deeper leachate may be present near the river at the start of Profile R1/S1. Leachate is indicated on Profile R1 and is also likely to occur all along the edge of the landfill facing the river.

3.1.6 Borehole Installation, Groundwater and Leachate Sampling

Three boreholes (GW01, GW02 and LH01) were drilled to depths of, 9.5m BGL, 10.0m BGL and 10.0m BGL respectively. GW01 and GW02 were drilled for the installation of groundwater monitoring wells and LH01 for the purpose of monitoring leachate within the waste body.

The purpose of the boreholes was to intercept and define the groundwater flow direction upstream and downstream of the identified waste body.

Groundwater and leachate monitoring was undertaken in boreholes GW01, GW02 and LH01 on 30th July 2020 and 25th August 2020. Prior to sampling, the standpipe wells were purged and developed with Waterra groundwater sampling pipework/foot valves and gas caps installed by CGL between 26th June and 13th July 2020 in preparation for groundwater monitoring to be undertaken by FT.

All samples were appropriately bottled (using prepared laboratory bottle ware) and packaged for submission to the laboratory. The samples were submitted for laboratory testing to ALS Environmental Ltd. The analysis results are contained in Appendix 5 and are further discussed in the proceeding sections.

3.2 Geotechnical Analysis

3.2.1 In-situ Capping Testing

Two bulk disturbed soil samples from TP05 and TP08 were submitted for geotechnical analysis by Causeway Geotech Ltd for analysis of moisture content, Atterberg limits and particle size distribution (PSD). The soil description for both samples were classified as being 'Brown sandy gravelly SILT'.

The results of the geotechnical analysis are included in the Intrusive Site Investigation Report prepared by CGL in Appendix 4 of this report.

3.2.2 In-situ Variable Head Tests

Groundwater hydraulic conductivity/permeability by variable head permeability methods was also completed on boreholes GW01, GW02 and LH01.

The result of the permeability testing is shown below in Table 3.2.

Table 3.2: Permeability Results

Sample ID	K (m/s)
GW01	6.15×10^{-5} m/s
GW02	7.70×10^{-5} m/s
LH01	1.08×10^{-5} m/s

4. ENVIRONMENTAL ASSESSMENT

The results of the environmental assessment at the Gort Historic Landfill site are presented in the following sections.

Waste samples obtained during trial pitting were analysed and compared to waste acceptance criteria to aid defining the characteristics of the waste material present. The surface water and groundwater results were compared to relevant environmental quality standards in order to identify the potential and magnitude of any impacts on receiving surface water and groundwater.

4.1 Chemical Assessment Criteria

- Council Decision 2003/33/EC – Waste Acceptance Criteria.
- European Communities, Environmental Objectives (Groundwater)(Amendment) Regulations, 2016 (S.I. No. 366 of 2016).
- Interim Guideline Values (IGV) set out in the EPAs Groundwater *Towards Setting the Guideline Values for the Protection of Groundwater in Ireland*.
- European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009), as amended 2012 (S.I. No. 327 of 2012), 2015 (S.I. No. 386 of 2015), 2019 (S.I. No. 77 of 2019)
- European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989 (S.I. No. 294/1989).

4.2 Waste / Made Ground Assessment

The waste/made ground samples analysed during this assessment have been compared against Waste Acceptance Criteria (WAC) to determine the appropriate waste classification rating associated with the interred waste. WAC screening is chosen for this assessment to suitably categorise the interred waste as being either inert, non-hazardous or hazardous material.

4.2.1 Chemical Results for Waste Samples

The waste/ made ground samples analysed from the site investigations were assessed against the Waste Classification Assessment Criteria. A summary of the results for Gort Historic Landfill is outlined in Table 4.1 below, while the laboratory reports are presented in Appendix G of the CGL Ground Investigation report, Appendix 4 of this report.

Table 4.1: Waste Sampling Results – Solid Waste Analysis

Parameter	Units	Inert Waste Acceptance Criteria	Non-Hazardous Waste Acceptance Criteria	Hazardous Waste Acceptance Criteria	Sampling Results - Sample ID	
					TP03 (2.0m)	TP06 (2.50m)
Arsenic	mg/kg	**0.5**	**2**	**25**	< 0.050	< 0.050
Barium	mg/kg	**20**	**100**	**300**	0.72	0.60
Cadmium	mg/kg	**0.04**	**1**	**5**	< 0.010	< 0.010
Chromium	mg/kg	**0.5**	**10**	**70**	< 0.050	< 0.050
Copper	mg/kg	**2**	**50**	**100**	< 0.050	< 0.050
Mercury Dissolved	mg/kg	**0.01**	**0.2**	**2**	< 0.0050	< 0.0050
Molybdenum	mg/kg	**0.5**	**10**	**30**	0.49	**0.82**
Nickel	mg/kg	**0.4**	**10**	**40**	< 0.050	0.16
Lead	mg/kg	**0.5**	**10**	**50**	< 0.010	< 0.010
Antimony	mg/kg	**0.06**	**0.7**	**5**	0.012	0.036
Selenium	mg/kg	**0.1**	**0.5**	**7**	< 0.010	0.084
Zinc	mg/kg	**4**	**50**	**200**	< 0.50	< 0.50
Chloride	mg/kg	**800**	**15000**	**25000**	19	**810**
Fluoride	mg/kg	**10**	**150**	**500**	1.6	1.9
Sulphate	mg/kg	**1000**	**20000**	**50000**	**3400**	**6500**
Total Dissolved Solids	mg/kg	**4000**	**60000**	**100000**	**6100**	**12000**
Phenol Index	mg/kg	**1**	--	--	< 0.30	0.30
Dissolved Organic Carbon	mg/kg	**500**	**800**	**1000**	99	**700**
Total Organic Carbon	%	**3**	**5**	**6**	**4.4**	**7.8**
Loss on Ignition	%	--	--	**10**	**11**	**33**
Total BTEX	mg/kg	**6**	--	--	< 0.010	[B] 0.030
Total PCBs (7 Congeners)	mg/kg	**1**	--	--	< 0.10	< 0.10
TPH Total WAC (Mineral Oil)	mg/kg	**500**	--	--	< 10	[B] 260
Total (Of 17) PAH's	mg/kg	**100**	--	--	< 2.0	< 2.0
pH		--	**>6**	--	8.0	8.2
Acid Neutralisation Capacity	mol/kg	--	**To evaluate**	**To evaluate**	0.011	0.0090

* Hazardous Waste Landfill Criteria: >6% TOC
* Items in **bold** are in exceedance of the Inert WAC limit value
* Items shaded in **orange** are in exceedance of the Hazardous WAC limit value

4.2.2 Waste Classification

As can be seen in Table 4.1, based on the 2 No. samples submitted for laboratory analysis, waste material encountered within the site are typically inert in terms of their leachate production, with the exception of Total Organic Carbon (TOC) and Loss on Ignition. These results indicate a high organic content within the waste/made ground material.

4.3 Groundwater and Leachate Analysis

Two rounds of groundwater quality monitoring were undertaken on the 30th July 2020 and 25th August 2020. The findings from the monitoring and an interpretation of the results are presented in the following sections.

4.3.1 Groundwater and Leachate Depth Analysis

Groundwater depth analysis was undertaken on two occasions at GW01, GW02 and existing groundwater monitoring well BH01. Static groundwater levels from the 30th July 2020 and 25th August 2020 are calculated below.

Table 4.2: Groundwater Depth Analysis

Well ID	Location Gradient	Ground Level (mAOD)	Depth to Water/leachate (m bgl)	Groundwater/leachate Level (mAOD)
BH01	Within eastern borrow pit area. Upgradient	23.56	0.94	22.62
GW01	South/south-west of landfill Upgradient	22.18	1.655	20.53
GW02	Within eastern borrow pit area. Upgradient	23.55	1.53	22.02
LH01*	In waste	22.11	3.67	18.44

***Note:** standpipe was screened within waste material therefore levels are reflective of leachate not underlying aquifer groundwater

Based on the above field survey measurements, the groundwater flow direction is estimated to be south to north towards the River Gort and following the local topography. A potentiometric map illustrating the hydraulic gradient and the direction of groundwater flow is presented in Figure 4-1.

Path: R:\Map Production\2020\P2282\Workspace\P2282_Tier2_ERA_Gort_A3.aprx

Site Boundary

Borehole Locations

1m Ground Elevation Contours

Indicative Groundwater Flow Direction

N
W E
S

0 50 100 200 Meters

TITLE:	Groundwater Flow Direction		
PROJECT:	Gort Historic Landfill ERA		
FIGURE NO:	4.1		
CLIENT:	Galway County Council		
SCALE:	1:2,500	**REVISION:**	0
DATE:	15/10/2020	**PAGE SIZE:**	A3

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4.3.2 Groundwater Quality Monitoring

The results of groundwater samples analysed from the 3 No. groundwater monitoring wells (BH01, GW01 and GW02) at the site have been assessed against the EPAs Interim Guideline Values (IGVs) and S.I No. 9 of the European Communities Environmental Objectives (Groundwater) Regulations 2010 (amended) threshold values. A summary of the results reported for each parameter for the monitoring rounds is outlined in Table 4.3, while the laboratory reports are presented in Appendix 5.

Table 4.3: Groundwater Sampling Results

Parameter	Units	S.I. No. 9 of 2010 Standards[1]	EPA IGV Standards[2]	Round 1 (30/07/2020)			Round 2 (25/08/2020)		
				BH01	GW01	GW02	BH01	GW01	GW02
Inorganics									
Conductivity @ 20 deg.C	mS/cm	0.8 - 1.875		0.62	0.623	0.593	0.664	0.699	0.609
Fluoride	mg/l	1	**1**	<0.5	<0.5	<0.5	0.972	<0.5	<0.5
Oxygen, dissolved	mg/l		**NAC**	9.4	9.5	9.12	9.71	-	-
Sulphate	mg/l	187.5	**200**	12.9	39.8	49.8	8.1	31.2	13.5
Chloride	mg/l	24	**30**	20.2	**45.7**	20.7	21.4	**58.6**	19.4
COD, unfiltered	mg/l			94.5	116	412	150	25.6	135
Ammoniacal Nitrogen as N (low level)	mg/l	0.065	**0.15**	0.0297	0.0331	0.0627	0.0572	0.0516	0.0745
Cyanide, Total	mg/l	0.0375	**0.01**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Oxidised Nitrogen as N	mg/l		**NAC**	1.86	1.76	1.35	1.78	1.76	1.92
Alkalinity, Total as HCO3	mg/l		**NAC**	952	744	1710	1050	382	1180
Filtered (Dissolved) Metals									
Mercury (diss.filt)	µg/l	0.75	**1**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic (diss.filt)	µg/l	7.5	**10**	0.532	0.642	0.754	0.982	1.6	0.939
Barium (diss.filt)	µg/l		**100**	20.3	22.7	38.4	23.2	20	28.9
Boron (diss.filt)	µg/l	750	**1000**	12.5	21.9	25.1	33.4	22.9	17.4
Cadmium (diss.filt)	µg/l	3.75	**5**	<0.08	<0.08	<0.08	<0.08	0.0863	<0.08
Chromium (diss.filt)	µg/l	37.5	**30**	<1	<1	<1	<1	<1	<1
Copper (diss.filt)	µg/l	1500	**30**	1.46	0.926	3.77	<0.3	0.895	0.932

Parameter	Units	S.I. No. 9 of 2010 Standards[1]	EPA IGV Standards[2]	Round 1 (30/07/2020)			Round 1 (30/07/2020)		
				BH01	GW01	GW02	BH01	GW01	GW02
Lead (diss.filt)	µg/l	7.5	10	<0.2	<0.2	<0.2	<0.2	1.01	<0.2
Manganese (diss.filt)	µg/l		50	<3	<3	5.72	15.2	30.3	13.8
Nickel (diss.filt)	µg/l	15	20	1.78	3.64	7.68	1.39	15	4.78
Zinc (diss.filt)	µg/l	75	100	1.52	1.49	2.6	1.03	10.8	2.69
Sodium (Dis.Filt)	mg/l	150	150	9.71	33.9	17.2	9.23	39.5	9.51
Magnesium (Dis.Filt)	mg/l		50	7.69	12.8	9.62	7.72	15.4	8.09
Potassium (Dis.Filt)	mg/l		5	1.83	4.19	2.43	1.77	4.38	1.94
Calcium (Dis.Filt)	mg/l		200	130	91	112	129	102	128
Iron (Dis.Filt)	mg/l		200	<0.019	<0.019	<0.019	<0.019	0.0433	<0.019
PCBs									
All results were found to be below the LOD (refer to Appendix 5)									
Semi-volatile Organic Compounds									
All results were found to be below the LOD (refer to Appendix 5)									
Volatile Organic Compounds									
Chloroform	µg/l			<1	8.44	7.39	<1	<1	<1
Bromodichloromethane	µg/l			<1	4.04	3.94	<1	<1	<1
Dibromochloromethane	µg/l			<1	1.31	1.04	<1	<1	<1
Pesticides and Herbicides									
Altrazine	µg/l	0.075	1	0.0305	0.0605	<0.01	<0.02	0.0233	0.0125
Simazine	µg/l	0.075	1	<0.01	0.0362	<0.01	<0.02	<0.01	<0.01

Parameter	Units	S.I. No. 9 of 2010 Standards[1]	EPA IGV Standards[2]	Round 1 (30/07/2020)			Round 1 (30/07/2020)		
				BH01	GW01	BH01	GW01	BH01	GW01
Microbiological									
Coliforms, Total*	MPN/100ml		**0**	-	-	-	**345**	**425**	**146**
Coliforms, Faecal*	CFU/100 ml		**0**	-	-	-	**47**	**2**	**21**
Miscellaneous Organics									
MCPA	µg/l	0.075		<0.05	<0.25	<0.25	<0.05	<0.1	<0.05
Mecoprop	µg/l	0.075	**10**	<0.04	<0.2	<0.2	<0.08	<0.08	<0.04
Dichlorprop	µg/l		**100**	<0.1	<0.5	<0.5	<0.1	<0.2	<0.1
2,4-Dichlorophenoxyacetic acid	µg/l	0.075		<0.05	<0.25	<0.25	<0.05	<0.1	<0.05
Bromoxynil	µg/l		**5**	<0.04	<0.2	<0.2	<0.04	<0.08	<0.04
Pentachlorophenol	µg/l		**2**	<0.04	<0.2	<0.2	<0.08	<0.08	<0.04

[1] OTV-Overall threshold value, European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010) as amended in 2011, 2012, 2016.

[2] IGV-Interim Guideline Values, from EPA, Towards Setting Guideline Values for the Protection of Groundwater in Ireland, 2003.

* Items shaded in **orange** are in exceedance of the Drinking Water Regulations

* Items shaded in **bold** are in exceedance of the EPA IGV Standards

4.3.3 Groundwater Analysis Discussion

The results of the groundwater monitoring from BH01, GW01 and GW02 have reported some exceedances of the IGVs and European Groundwater limit values.

Samples recovered from monitoring well GW02 reported an ammoniacal nitrogen concentration of 0.0745 mg/l, which exceed groundwater regulations limit value. Based on the estimated groundwater flow direction GW02 is considered to be upgradient of the historic landfill. Ammoniacal nitrogen concentration at upgradient boreholes could be considered representative of background levels possibly due to agricultural activities. The ammonia concentration differences between upgradient and downgradient monitoring locations are not that significant to consider that the historic landfill could be impacting water quality.

Elevated concentrations of chloride, above the OTV and EPA IGV are observed in borehole GW01. Landfill leachate has the potential to contain high concentrations of chloride ions however the location of GW01 upgradient of the site , and its distance from the landfill means that it is unlikely that the elevated chloride concentration recorded are attributed to the migration of leachate from the historic landfill to this location.

Faecal and total coliforms were detected in all three boreholes on the second monitoring round. However, the presence of this pollutant in groundwater is not likely attributed to the historical landfill, but more likely present due to agricultural or domestic sources i.e. human/animal waste, slurry, septic tanks etc.

The results of groundwater monitoring are below groundwater threshold values for List 1 and List 2 substances (SVOCs, pesticides, herbicides, organics).

As stated in Section 4.3.1 groundwater monitoring wells BH01, GW01 and GW02 all appear to be upgradient of the site landfill site with respect to groundwater flow direction, therefore it is not expected that leachate migration from the site would impact groundwater quality at these locations or influence the characteristics of the groundwater.

4.3.4 Leachate Monitoring

Two rounds of leachate monitoring were undertaken at the site on the 30th July 2020 and 25th August 2020 for borehole LH01. A leachate collection and drainage system was previously installed at site, whereby leachate is collected and drains to the foul sewer network at Gort to be treated at the Gort WWTP. An access manhole was identified during) the site walkover (see Appendix 2 and Figure 3.1 and samples were taken from this manhole (MH-1) for the purpose of analysing leachate at the site. A summary of the findings from the monitoring can be found in Table 4.4 below and the laboratory reports can be found in Appendix 5.

Table 4.4: Leachate Sampling Results

Parameter	Units	LH01	LH01	MH-1	MH-1
		30/07/2020	25/08/2020	01/07/2020	30/07/2020
Carbon					
Organic Carbon, Total	mg/l	26.6	28.4	5.71	6.67
Inorganics					
Conductivity @ 20 deg.C	mS/cm	1.87	1.77	0.624	0.603
Fluoride	mg/l	<0.5	<0.5	<0.5	<0.5
Oxygen, dissolved	mg/l	7.64	6.13	9.64	9.33
pH	pH Units	7.06	7.1	7.75	7.41
Phosphate (Ortho as PO4)	mg/l	<0.05	<0.05	0.095	0.2
Sulphate	mg/l	223	128	22.5	18.3
Chloride	mg/l	95.1	49	24.5	22.3
COD, unfiltered	mg/l	640	143	16.8	25.8
Ammoniacal Nitrogen as N (low level)	mg/l	59.2	42	0.573	0.63
BOD, unfiltered	mg/l	61.9	7.95	<1	2.18
Total Oxidised Nitrogen as N	mg/l	0.558	<0.1	4.37	4.69
Filtered (Dissolved) Metals					
Mercury (diss.filt)	µg/l	<0.01	<0.01	<0.01	<0.01
Arsenic (diss.filt)	µg/l	3.16	2.14	<0.5	<0.5
Cadmium (diss.filt)	µg/l	<0.08	<0.08	<0.08	<0.08
Chromium (diss.filt)	µg/l	<1	<1	<1	<1
Copper (diss.filt)	µg/l	1.19	3.02	1.09	1.3
Lead (diss.filt)	µg/l	0.308	<0.2	<0.2	<0.2
Manganese (diss.filt)	µg/l	1920	4310	32.7	19.2
Nickel (diss.filt)	µg/l	16.3	13.7	1.35	1.73
Phosphorus (diss.filt)	µg/l	30.9	23.6	67.9	82.3
Selenium (diss.filt)	µg/l	1.12	<1	<1	<1
Zinc (diss.filt)	µg/l	11.3	19	22.9	26.3
Sodium (Dis.Filt)	mg/l	69.5	37.3	18.7	16.8
Magnesium (Dis.Filt)	mg/l	44.7	27.1	10.9	9.92
Potassium (Dis.Filt)	mg/l	53.1	36.4	7.65	6.97
Iron (Dis.Filt)	mg/l	0.0299	0.0492	0.0943	0.0494

4.3.5 Leachate Analysis Discussion

The leachate monitoring results show elevated concentrations of pollutants commonly encountered within MSW landfill leachate i.e. ammoniacal nitrogen, chloride and COD. The results shown are typical of MSW landfill leachate

4.4 Landfill Gas Monitoring

FT carried out monitoring of landfill gas (LFG) parameters at each monitoring borehole location (BH01, GW01, GW02 and LH01) as indicated on Figure 3-1. Methane, carbon dioxide, oxygen and atmospheric pressure were analysed at the 3 No. groundwater monitoring wells located outside the waste body and 1 No. leachate monitoring well located within the waste body using a Landfill Gas analyser.

4.4.1 Monitoring Results

The EPA Landfill Manuals - Landfill Monitoring 2nd Edition specifies trigger values for landfill gas monitoring at offsite monitoring locations. The trigger level for methane outside the waste body is 1% v/v and for carbon dioxide is 1.5% v/v. The monitoring results for methane, carbon dioxide and oxygen levels for the perimeter borehole are summarised in Table 4.5.

Table 4.5: Perimeter Well Monitoring Results

Date: 29/07/2020						
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member	Weather
BH01	0	0.4	20.7	1008	Daniel Hayden	Overcast, Light Rain, Warm, 18-20°C
GW01	0	0.3	20.8			
GW02	0	0.2	21.1			
LH01	**19.8**	**7.1**	12.1			
Date: 24/08/2020						
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member	Weather
BH01	0	0.7	19.9	1009	Daniel Hayden	Overcast, Light Rain, Warm, 16-18°C
GW01	0	0.4	20.3			
GW02	0	0.1	21			
LH01	**51**	**16**	0.5			

As can be seen in Table 4.4, concentrations of both CO_2 and CH_4 at most monitoring boreholes were below the threshold values during both monitoring rounds. However, the leachate borehole LH01 exceeds CH_4 and CO_2 concentrations on both rounds. This indicates that the site is still biologically active and landfill gas is still being produced. Monitoring results for BH01, GW01 and GW02 also indicate that lateral migration of landfill gas to these locations is not occurring.

4.5 Surface Water Monitoring

4.5.1 Monitoring Locations

The surface water monitoring locations were selected upstream and downstream of the landfill footprint, as shown on **Error! Reference source not found.**. Monitoring location SW1 was selected as the upstream location on Gort river to the south of the landfill. Monitoring location SW2 samples the Gort River downstream of the landfill.

The surface water sampling locations at the site are presented in Figure 4.2.

Two rounds of surface water monitoring were carried out on the 1st and 30th of July 2020.

4.5.2 Monitoring Parameters

The results of surface water sampling analysed from the 2 No. sampling locations (SW1 and SW2) have been assessed against the Maximum Admissible Concentration (MAC) and the Environmental Quality Standard (EQS) as per S.I. No. 77/2019 - European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 where applicable.

A summary of results for each parameter from the monitoring round is outlined in Table 4.6, while the laboratory reports are presented in Appendix 5.

Path: R:\Map Production\2020\P2282\Workspace\P2282_Tier2_ERA_Gort_A3.aprx

Site Boundary

Surface Water Monitoring Locations

N
W E
S

0 50 100 200 Meters

TITLE:	Surface Water Sampling Locations		
PROJECT:	Gort Historic Landfill ERA		
FIGURE NO:	4.2		
CLIENT:	Galway County Council		
SCALE:	1:2,500	**REVISION:**	0
DATE:	15/10/2020	**PAGE SIZE:**	A3

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Table 4.6: Surface Water Sampling Results

Parameter	Units	EQS[1]	MAC[2]	Upstream	Downstream	Upstream	Downstream
				SW01	SW02	SW01	SW02
				01/07/2020	01/07/2020	30/07/2020	30/07/2020
Inorganics							
Fluoride	mg/l	0.5		<0.5	<0.5	<0.5	<0.5
pH	-	6.0<pH<9.0		7.52	7.52	7.37	7.54
Ortho-phosphate (as PO_4)	mg/l	≤0.075 (95%ile)		<0.05	<0.05	<0.05	<0.05
Ammoniacal Nitrogen as N (low level)	mg/l	≤0.140 (95%ile)		0.03	0.0653	0.0229	0.0246
Cyanide, Total	mg/l	0.01		<0.05	<0.05	<0.05	<0.05
Filtered (Dissolved) Metals							
Mercury (diss.filt)	µg/l		**0.07**	<0.01	<0.01	<0.01	<0.01
Arsenic (diss.filt)	µg/l	25		<0.5	<0.5	<0.5	<0.5
Cadmium (diss.filt)	µg/l	0.15	**0.9**	<0.08	<0.08	<0.08	<0.08
Chromium (diss.filt)	µg/l	4.7	**32**	<1	<1	<1	<1
Copper (diss.filt)	µg/l	30		1.11	0.699	0.92	1.14
Lead (diss.filt)	µg/l	1.2	**14**	0.483	0.268	<0.2	0.442
Nickel (diss.filt)	µg/l	4	**34**	1.24	0.795	1.09	1.03
Zinc (diss.filt)	µg/l	100		6.61	8.97	1.7	2.81
Semi-Volatile Organic Compounds (SVOCs)							
1,2,4-Trichlorobenzene (aq)	µg/l	0.4	**not applicable**	<1	<1	<8	<10
Anthracene (aq)	µg/l	0.1	**0.1**	<1	<1	<8	<10
bis(2-Ethylhexyl) phthalate (aq)	µg/l	1.3	**not applicable**	<2	<2	<16	<20
Benzo(b)fluoranthene (aq)	µg/l		**0.017**	<1	<1	<8	<10

Parameter	Units	EQS[1]	MAC[2]	Upstream	Downstream	Upstream	Downstream
				SW01	SW02	SW01	SW02
				01/07/2020	01/07/2020	30/07/2020	30/07/2020
Benzo(k)fluoranthene (aq)	µg/l		**0.017**	<1	<1	<8	<10
Benzo(a)pyrene (aq)	µg/l	0.00017	**0.27**	<1	<1	<8	<10
Benzo(g,h,i)perylene (aq)	µg/l		**0.0082**	<1	<1	<8	<10
Diethyl phthalate (aq)	µg/l	1.3	**not applicable**	<1	<1	<8	<10
Fluoranthene (aq)	µg/l	0.0063	**0.12**	<1	<1	<8	<10
Hexachlorobenzene (aq)	µg/l		**0.05**	<1	<1	<8	<10
Hexachlorobutadiene (aq)	µg/l		**0.6**	<1	<1	<8	<10
Pentachlorophenol (aq)	µg/l	0.4	**1**	<1	<1	<8	<10
Phenol (aq)	µg/l	8	**46**	<1	<1	<8	<10
Naphthalene (aq)	µg/l	2	**130**	<1	<1	<8	<10
Indeno(1,2,3-cd)pyrene (aq)	µg/l		**not applicable**	<1	<1	<8	<10

Notes:

1. Environmental Quality Standard (EQS) as per European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I No. 272 of 2009). Refers to Annual-Average (AA) EQS for relevant parameters.
2. Maximum Admissible Concentration (MAC), as classified by European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I No. 272 of 2009).

*** NAC – no abnormal change

4.5.3 Surface Water Analysis Discussion

The results of the surface water laboratory analysis as presented in Table 4.6, when assessed against the MAC and EQS quality standards show no exceedances of the EQS and MAC quality threshold values.

Results show little variation in parameter concentrations between upstream and downstream sampling locations which also indicates that the landfill is not having a deleterious effect on water quality in the Gort River.

5. RISK ASSESSMENT

5.1 Introduction

Risk assessment considers the likelihood of occurrence and the consequence of occurrence of an event (Royal Society, 1992[1]). ERA (Environmental Risk Assessment) is based on the development of a Conceptual Site Model (CSM) which is used to determine the potential exposure of a vulnerable receptor to a contaminant. The CSM is used as the basis for the risk assessment. It is used to identify all possible sources (S), pathways (P) and receptors (R) as well as the processes that are likely to occur along each of the source-pathway-receptor (S-P-R) linkages and uncertainties.

Based on the desktop investigation and completed site investigation, this CSM assumes the source to be the made ground containing waste deposit, the pathway to involve the migration of landfill gas, surface water and groundwater and the ultimate receptors to be the surface water features, groundwater, groundwater abstraction well and all human presence near the waste material.

5.2 Potential Pathways and Receptors

A pathway is a mechanism or route by which a contaminant encounters, or otherwise affects, a receptor. Contaminants associated with deposited waste may include leachate generated from groundwater/rainwater infiltration into the waste material and/or the lateral or vertical migration of landfill gas to human receptors.

The potential pathway associated with the Gort site is:

- Groundwater; and
- Surface Water

5.2.1 Groundwater/Leachate Migration

According to the EPA CoP, there are three main pathways for leachate migration. These are:

- Vertically to the water table or top of an aquifer, where groundwater is the receptor
- Vertically to an aquifer and then horizontally in the aquifer to a receptor such as a well, spring, stream or in this case, the adjacent coastline
- Horizontally at the ground surface or at shallow depth to a surface receptor

The migration and attenuation of leachate from the site depends on the permeability and thickness of subsoil and on both the bedrock permeability value and type. These elements are encompassed in groundwater vulnerability, groundwater flow regime and surface water drainage.

[1] Royal Society 1992, Risk: Analysis, Perception and Management. The Royal Society, London (ISBN 0-85403-467-6).

The main receptors to leachate migration from this site are:

- Aquifer;
- Surface water features; and
- Human presence nearby the site.

5.2.2 Landfill Gas Migration

According to the EPA CoP, there are two main pathways for landfill gas migration. These are:

- Lateral migration via subsoil,
- Vertical migration via subsoil.

The migration of landfill gas from the site depends on the nature of the material deposited and the nature, permeability and thickness of the surrounding subsoil or bedrock.

The main receptors to potential landfill gas migration from this site are:

- Human Presence/Buildings nearby the waste body

5.3 Conceptual Site Model

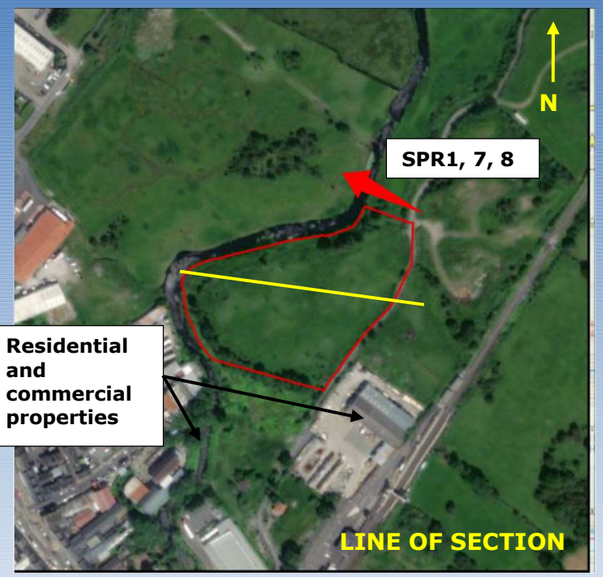
Based on the review of the Tier 1 assessment and site investigation works undertaken for Gort Historic Landfill, an assessment of the risk is made to confirm the source – pathway – receptor (S-P-R) linkages identified in the preliminary investigation. The results and analysis of the investigation has enabled a revised conceptual model to be produced for the site, which is presented in Figure 5-1, overleaf.

GROUNDWATER LEVEL

WASTE BODY

LANDFILL GAS

LEACHATE MIGRATION



Residential and commercial properties

River Gort

Soil and Rock Fill

TP01

Soil Cap

WASTE BODY
Average thickness 3.5m

LH01
22.11mOD

TP07

~17.8 mAOD

~17.50 mAOD

Alluvium soil

Limestone tiils

Estimated groundwater flow direction (E to W)

Bedrock: Dark, muddy limestone - Waulsortian Limestones and Ballysteen Formation

LOCALLY IMPORTANT AQUIFER - MODERATELY PRODUCTIVE
GW VULNERABILITY - EXTREME, ROCK AT OR NEAR SURFACE

FIGURE 5.1 GORT HISTORIC LANDFILL CONCEPTUAL SITE MODEL

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5.4 Risk Prioritisation

Risk prioritisation enables resources to be prioritised on the highest risk facilities and on the highest source – pathway – receptor linkage potential.

The risk prioritisation process assigns a score to each linkage and the overall score is the maximum of the individual linkages for the site. The higher the score a site/linkage receives the higher the risk.

To classify the risk, scores will be applied to the information obtained during the site investigation of Gort Historic Landfill. Where there is insufficient information available (i.e. where there is a high degree of uncertainty) the highest score is assumed.

In accordance with the EPA CoP (2007) the scoring matrices are as follows:

- Leachate: Source/hazard scoring matrix, based on waste footprint
- Landfill gas: Source/hazard scoring matrix based on waste footprint
- Leachate migration: Pathway (Vertical)
- Leachate migration: Pathway (Horizontal)
- Leachate migration: Pathway (Surface water drainage)
- Landfill gas: Pathway (Lateral migration potential)
- Landfill gas: Pathway (Upwards migration potential)
- Leachate migration: Receptor (Surface water drainage)
- Leachate migration: Receptor (Human presence)
- Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/groundwater dependent terrestrial ecosystems)
- Leachate migration: Receptor (Aquifer category – Resource potential)
- Leachate migration: Receptor (Public water supplies – other than private wells)
- Leachate migration: Receptor (Surface water bodies)
- Landfill gas: Receptor (Human presence)

Table 5.1 calculates the points awarded to each of the headings listed above.

Table 5.1: Risk Classification Calculation – Gort Landfill

EPA Ref	Risk	Points	Rationale
1a	Leachate; source/hazard scoring matrix, based on waste footprint.	7	Based on a waste footprint of 1.6 ha and the presence of municipal waste the score of 7 is being maintained.
1b	Landfill gas; source/hazard scoring matrix, based on waste footprint.	7	Based on a waste footprint of 1.6 ha and the presence of municipal waste the score of 7 is being maintained.
2a	Leachate migration: Pathway (Vertical)	3	GSI describes the groundwater vulnerability as X (Rock near surface) and extreme (E).
2b	Leachate migration: Pathway (Horizontal)	2	The bedrock groundwater comprises 'Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones'.
2c	Leachate migration: Pathway (Surface water drainage)	2	Gort River is located immediately adjacent to and bounds the site along its western and northern boundary
2d	Landfill gas: Pathway (Lateral migration potential)	1.5	GSI shows a combination of tills derived from limestones
2e	Landfill gas: Pathway (Upwards migration potential)	0	No buildings or structure are located directly above estimated waste footprint area.
3a	Leachate migration: Receptor (Human presence)	2	No buildings or structures are located directly above estimated waste footprint area. Nearest residential dwellings are located between 50m and 250m from the site, although it's expected due to the urban setting of these residences that drinking water supply is via public mains supply.
3b	Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/ groundwater dependent terrestrial ecosystems)	0	The Coole-Garryland Complex SAC and pNHA (Site Code: 000252) is located c.1.1 km north-west of the site at its closest point.
3c	Leachate migration: Receptor (Aquifer category – Resource potential)	3	'Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones'.
3d	Leachate migration: Receptor (Public water supplies – other than private wells)	3	The River Gort is part of the Coole ZOC Group Scheme Preliminary Source Protection Areas however water is abstracted from the Gort River upstream of the site.

EPA Ref	Risk	Points	Rationale
			The site is c.1.1km from edge of groundwater source area for Coole Group Scheme. Defined scheme area is also underlain by a karst aquifer.
3e	Leachate migration: Receptor (Surface water bodies)	3	Gort river is located immediately adjacent to the site.
3f	Landfill Gas: Receptor (Human presence)	5	No buildings or structures are located directly above estimated waste footprint area. Nearest human receptors are located 50m south-west of the waste body.

Table 5.2: Normalised Score of S-P-R Linkage

Calculator		S-P-R Values	Maximum Score	Linkage	Normalised Score
Leachate migration through combined groundwater and surface water pathways					
SPR1	1a x (2a + 2b + 2c) x 3e	**147**	300	Leachate => surface water	**49%**
SPR2	1a x (2a + 2b + 2c) x 3b	**0**	300	Leachate => SWDTE	0%
Leachate migration through groundwater pathway					
SPR3	1a x (2a + 2b) x 3a	**70**	240	Leachate => human presence (private well)	29%
SPR4	1a x (2a + 2b) x 3b	**0**	240	Leachate => GWDTE	0%
SPR5	1a x (2a + 2b) x 3c	**105**	400	Leachate => Aquifer	26%
SPR6	1a x (2a + 2b) x 3d	**105**	560	Leachate => Public Supply (Well)	19%
SPR7	1a x (2a + 2b) x 3e	**105**	240	Leachate => Surface Water	**44%**
Leachate migration through surface water pathway					
SPR8	1a x 2c x 3e	**42**	60	Leachate => Surface Water	**70%**
SPR9	1a x 2c x 3b	**0**	60	Leachate => SWDTE	0%
Landfill gas migration pathway (lateral & vertical)					
SPR10	1b x 2d x 3f	**53.5**	150	Landfill Gas => Human Presence	35%
SPR11	1b x 2e x 3f	**0**	250	Landfill Gas => Human Presence	0%
Site maximum S-P-R Score					**44%**
Risk Classification					**Class A**

Table 5.2 shows the maximum S-P-R scoring for the site is **70%.**

The following are the risk classifications applied:

- Highest Risk (Class A) Greater than 70 for any individual SPR linkage
- Moderate Risk (Class B) 41-69 for any individual SPR linkage
- Lowest Risk (Class C) Less than 40 for any individual SPR linkage.

Based on this, the site can be classified as a **High-Risk Classification (Class A)**. The main risks identified on the site are the risk posed to the surface water from the migration of leachate.

6. CONCLUSION

A Tier 2 site investigation and risk assessment was conducted by Fehily Timoney and Company (FT) in accordance with the EPA Code of Practice - Environmental Risk Assessment for Unregulated Waste Disposal Sites for Gort Historic Landfill. The study consisted of a desktop study, site walkover, topographical survey, geophysical survey, intrusive site investigation works and environmental monitoring and analysis of groundwater, surface water, landfill and waste/soil. These works informed the development of the Conceptual Site Model (CSM) and the completion of an environmental risk screening model.

The findings of the site investigation work and geophysical surveying suggest the waste material is deposited in a single infill area within the extent of the landfill and is estimated to be 16,500 m^2 in area. A volume calculation based on the surveyed surface profiles for the existing ground level and the base of waste as interpreted and preliminary estimates indicate an interred waste volume of 57,750 m^3 including fill material placed on top of the landfill.

Analysis of waste samples from the trial pits advanced at the site, when assessed against the waste acceptance criteria indicated that much of the waste material within the site can be classified as inert. This waste classification is considered to reflect the level of biological degradation that has taken place since waste placement commenced. Trial pits confirmed the waste material is near the surface with a minimal soil cover across the site.

Landfill gas monitoring carried out at groundwater monitoring wells BH01, GW01, GW02 and leachate monitoring well LH01 at the site indicates gas concentrations detected are below threshold levels for offsite boreholes and monitoring locations as set by the EPA Landfill Manuals - Landfill Monitoring (2nd Edition) , except for the leachate borehole LH01 (located centrally within the waste mass). The results at LH01 indicate that the site remains biologically active with landfill gas remaining, however results at offsite wells indicate that there is no lateral landfill gas migration to these locations.

Analysis of groundwater samples recovered from the monitoring wells BH01, GW01 and GW02 have reported one sample with ammoniacal nitrogen concentrations exceeding guideline threshold values on the second round. Site investigation showed that wells BH01, GW01 and GW02 are upgradient of the site are not likely to be impacted by leachate migration from the site. Ammoniacal nitrogen concentrations at upgradient boreholes could be considered representative of background levels possibly due to agricultural activities. Elevated chloride concentrations were also measured at well GW01 however, due to its location with respect to the landfill these concentrations are not expected to be attributed to leachate migration.

Analysis of surface water samples from the River Gort found all results to be below the MAC and EQS guideline limit values in all assessments. The results indicate the landfill is not having an impact on surface water quality.

Based on the results of the Tier 2 site assessment, the site can be classified as a **High-Risk Classification (Class A)**. The main risk identified on the site is the risk posed to the surface water from migration of leachate.

6.1 Recommendations

Based on the results of the initial Tier 2 assessment the site is classified as High Risk. For a high risk site, the CoP indicates that a Tier 3 Environmental risk analysis be undertaken including a Quantitative Risk Assessment (QRA) The purpose of the QRA will be to quantitatively assess the primary S-P-R linkage identified i.e. leachate migration to the Karst aquifer.

It is therefore recommended by FT that a Tier 3 QRA be undertaken for the site in conjunction with an application for a Certificate of Authorisation for this site.

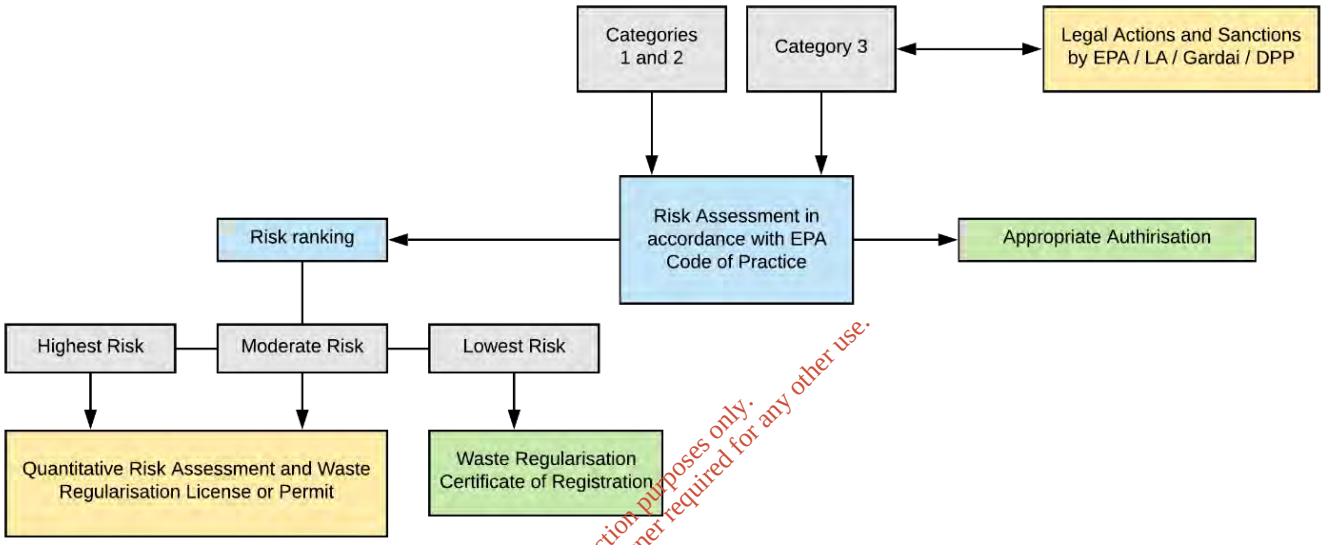

Figure 6-1: Extract from Section 1.3 of the EPA Code of Practice