ENVIRONMENTAL BALANCE IN DESIGN AND CONSTRUCTION

TIER 2 RISK ASSESSMENT

CARTRON BIG HISTORIC LANDFILL SITE, CO. LONGFORD

NOVEMBER 2018

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TIER 2 RISK ASSESSMENT

CARTRON BIG HISTORIC LANDFILL SITE, CO. LONGFORD

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Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
0	Issue to Client	DH/MG	JON	BG	06.11.2018
1	Final Issue	DH/JON/MG	JON	BG	22.11.2018

Client: Longford County Council

Keywords: Site Investigation, environmental risk assessment, waste, leachate, soil sampling, groundwater sampling.

Abstract: This report represents the findings of a Tier 2 site investigation carried out at Cartron Big Historic Landfill, Cartron Big, Co. Longford, and conducted in accordance with the EPA Code of Practice for unregulated landfill sites. The site investigation was undertaken to determine the extent and impact, if any, of the historic landfilling at the site.

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EXECUTIVE SUMMARY

Fehily Timoney & Company (FT) was appointed by Longford County Council (LCC) to complete a Tier 2 environmental risk assessment (ERA) on Cartron Big Historic Landfill in accordance with the Environmental Protection Agency (EPA) Code of Practice (CoP) (2007): *Environmental Risk Assessment for Unregulated Waste Disposal Sites*.

The site is located within the Cartron Big townland approximately 3km east of Longford Town, at the intersection of the L1071 and L3538 tertiary roads. The site was operated under the ownership of Longford County Council (LCC) for the disposal of municipal and industrial waste. It was previously reported by LCC that the landfill accepted waste throughout the 1970s and 1980s, ceasing in 1989.

A Tier 1 study was conducted by AECOM and determined the site to be a high-risk classification (Class A). The primary risks identified related to the risk of leachate runoff entering a nearby stream and the risk of leachate runoff entering a public water supply. The completed Tier I study is included as Appendix 1.

This Tier 2 study consists of a desktop study, geophysical survey, intrusive site investigation works, environmental monitoring (soil, waste, surface water and groundwater sampling) and laboratory analysis. The results of these works informed the development of the conceptual site model (CSM) and risk screening model.

The site investigation rationale was devised based on findings of the Tier 1 Assessment, a site walkover and historical aerial photography.

The scope of site investigation works included:

- 15 No. Trial pit excavations
- Installation and monitoring of 3 No. groundwater boreholes
- Installation and monitoring of 2 No. leachate boreholes
- 1 No. Geophysical survey (2D resistivity and seismic refraction profiling)

Analysis of waste samples from the trial pits excavated indicate that the waste material encountered within the site is typically non-hazardous waste. However, the waste acceptance criteria (WAC) testing indicated that the waste has a high organic content. The high organic content is contributing to the levels of methane measured in the landfill gas despite landfilling ceasing c. 30 years ago.

The findings of the intrusive works suggest the waste material is deposited in a single infill area tending north-west to south-east and is between 210m in length and 140m in width. Based on this interpretation, the maximum waste footprint is calculated to be 5.80 acres or 2.35 hectares.

A volume calculation was conducted based on the results of the geophysical survey of the existing ground level and the base of waste as interpreted, with estimates indicating an interred waste volume of approximately 206,000 m^3 at the site.

Analysis of groundwater samples reported ammonia concentrations which exceed the IGV and European Groundwater Regulation (2016) guideline threshold values. Ammonia concentrations of 43.5 mg/l recorded at GW03 are 100-times greater than the upgradient levels recorded at GW01 and GW02, therefore the waste body is impacting locally on water quality downgradient of the landfill.

Despite the risk to the County Council's public water supply borehole (ID: 2027SEW013) located 1km east of the site boundary as identified in the Tier 1 assessment, the determined groundwater flow direction is north-north-east of the site which suggests that any leachate plume migrating north from the landfill will not impact on abstracted water quality.

The results of the surface water monitoring from SW01 – SW04 shows 1 No. exceedances of the European Quality Standard (EQS 2009) guideline limit values for ammonia. The detection of ammonia at surface water location SW04 indicates to the presence of a pathway, possibly a man-made drainage channel flowing north / north-west, from the landfill as depicted in historical mapping of the site.

Surface water results recorded at SW1 and SW2 would appear to concur with the Good Status chemical surface water quality at Cartron Bridge as indicated from available EPA water quality data up to 2008. However, water quality monitoring 150m downstream of Cartron Bridge (RS26C200300) at SW4 has detected ammonia concentrations above guideline threshold levels. The detection of ammonia at this location indicates the presence of a pathway, possibly a man-made drainage channel flowing north / north-west, from the landfill, as depicted in historical mapping for the area.

The results of this Tier 2 assessment and risk model indicates that the site is a **High-Risk Classification (Class A)**. The principal risks identified on the site are the migration of leachate from the site to the groundwater aquifer and the risk posed to the Clooncoose Stream from the migration of landfill leachate from the waste material encountered at the site.

The results of this Tier 2 assessment indicate the Cartron Big site is a High-Risk site and is therefore "considered to pose a significant risk to the environment and human health." For a high-risk site, the CoP directs that a Tier 3 Risk assessment be undertaken and further that the site be regularised/authorised in accordance with current waste management legislation. FT recommends:

- Longford County Council proceeds to apply for a Certificate of Registration for this site upon completion of the Tier 3 assessment.
- Additional rounds of groundwater and surface water monitoring and analysis be undertaken at each monitoring location GW01 to GW03 and SW1 to SW4 inclusive.

The results of this analysis should be used to confirm the conclusion of the Tier 3 report and inform works.

1 INTRODUCTION

1.1 Background

Cartron Big Landfill is located in an area of open farmland approximately 3 km east of Longford town at the intersection of the L1071 and L3538 roads. Fehily Timoney (FT) understands the site was formerly operated as a municipal waste landfill by Longford County Council (LCC). The site is currently leased by LCC to a local farmer for grazing.

LCC reported that the landfill accepted waste throughout the 1970s and 1980s, ceasing in 1989. Waste accepted is understood to have included municipal and industrial waste. Anecdotal evidence suggests that the site was a former quarry excavated to 18 m bgl when active. Waste was backfilled into the quarry to 1 m above ground level.

LCC is required to complete a tiered risk assessment of unregulated waste disposal sites in accordance with the Environmental Protection Agency (EPA) Code of Practice for Environmental Risk Assessment for Unregulated Waste Disposal Sites. Once the risk assessment and, if necessary, remediation plans have been prepared to the satisfaction of the EPA, an application can be made for the granting of a Certification of Authorisation to demonstrate compliance with the Regulations.

A data gap analysis & Tier 1 Assessment completed by AECOM in 2017 determined the site had a risk classification of High (Class A) based on a risk of leachate runoff entering the nearby Clooncoose stream, the risk of leachate migration to groundwater and the risk of impacting a nearby public water supply.

1.2 Scope of Works

FT's scope of work was to undertake a Tier 2 assessment of the site in accordance with the EPA Code of Practice (CoP) 2007: *Environmental Risk Assessment for Unregulated Waste Disposal Sites*. This approach required the completion of the following:

- Desk Study;
- Detailed Site Walkover;
- Intrusive Site Investigation;
- Geophysical Surveying to estimate extents and depths of waste;
- Environmental Monitoring, Surface Groundwater and Leachate Testing;
- Environmental Risk Assessment (ERA); and,
- Development of a conceptual site model (CSM)

As part of the initial desk study, a review of available information was undertaken. This was followed-up with a site walkover by FT personnel. The desk study and site walkover were used to determine the locations for the intrusive site investigation.

FT appointed Priority Geotechnical (PGL) to conduct the site investigation which included; excavation of trial pits, a geophysical investigation and the installation of three onsite groundwater monitoring boreholes and two leachate monitoring boreholes.

The purpose of the geophysical study was to attempt to define the vertical and lateral extents of any waste body. Trial pits were excavated to provide a preliminary assessment of the volume, extent and type of waste infilled at the site. The groundwater monitoring boreholes were installed to assess the impact, if any, to local groundwater. The leachate boreholes were installed to assess the type and strength of the leachate encountered in the waste body.

Laboratory analysis of soil/waste samples, groundwater and leachate was conducted to assess and quantify any potential or ongoing environmental impacts.

The information gathered from the desk study, intrusive site investigation and geophysical survey were used to inform the development of both the CSM and the Environmental Risk Assessment (ERA). This report presents the findings of the assessment.

2 DESK STUDY

2.1 Introduction

The desk study included the review of the following literature sources and websites:

- Geological Survey of Ireland, Groundwater Web Mapping: www.gsi.ie
- Environmental Protection Agency Maps: www.epa.ie
- National Parks and Wildlife Service Map Viewer: www.npws.ie
- BS 5930: 1999, Code of Practice for Site Investigations
- BS 10175: 2000, Investigation of Potentially Contaminated Sites – Code of Practice

A desktop review of available documentation for the site was conducted followed by a site walkover. The documentation made available to FT for the desktop review included the data gap analysis and Tier 1 Assessment prepared by AECOM in November 2017.

2.2 Desk Study

This section of the report presents the findings of the desk study.

2.2.1 Site Description & On-Site Conditions

The site is located in Cartron Big townland, approximately 3.5 km east of Longford town centre and 600 m southwest of the Carrickglass housing development on the L1071 road. The Carrickglass Demesne is located north of the site. The site is situated at the junction of the L1071 and L3538 roads, i.e. to the south of the L1071 and on the eastern side of the L3538 roadway.

The site encompasses approximately 4 ha of managed open grassland used for grazing. Eight landfill gas vents are installed across the site.

An aerial photograph of the site is shown in Figure 2.1, overleaf.

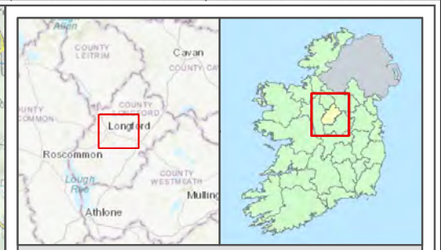
2.2.2 Previous Studies

A data gap analysis and Tier 1 Assessment completed by AECOM comprised the following:

- Development of a conceptual site model (CSM);
- Identification of contaminant sources, pathways of contaminant migration and potential receptors which may be vulnerable if exposed to those contaminants; i.e. the identification of Source- Pathway-Receptor (SPR) linkages; and
- The prioritisation of sites and SPR linkages based on their perceived risk.

Based on available information, the Tier 1 Assessment determined that the overall risk score for Cartron Big Landfill was 70%, resulting in a risk classification of High (Class A).

A copy of this assessment is included in Appendix 1.



Legend

Site Boundary

Figure Title	Site Location Plan and Aerial View
Figure No.	2.1
Project	Historical Landfills: Cartron Big
Client	Longford County Council
Scale	1:50,000
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2.2.3 Topography

The countryside surrounding the site is gently undulating. There is a gentle gradient across the site from southeast to the north/northwest toward the channel of the Clooncoose stream. The site is at an elevation of between 60 m and 70 m above Ordnance Datum (OD).

2.2.4 Geology

Drift/Quaternary Geology

The Quaternary Map provided by GSI Online identifies the quaternary sediments at the site as till derived from cherts, with the subsoils in the north-western corner mapped as till derived from Lower Palaeozoic sandstones and shales. Localised deposits of alluvium are noted along the channel of the Clooncoose stream to the north of the site, within Carrickglass Demesne, and also to the southeast, upstream of the site (see Figure 2.2).

Solid or Bedrock Geology

The GSI online 1:100,000 scale bedrock geology map, shows the bedrock beneath the site as argillaceous limestone and shale (Visean stage of the Carboniferous) consisting of dark, fine gained, bedded fossiliferous limestones and shales with chert. Within the bedrock are thin but distinct bands of volcanic ash. This bedrock is usually seen overlying Waulsortian limestones, but it may directly succeed the Ballysteen Formation in the absence of these.

Bedrock outcrop has been mapped along the western site boundary with the L3538 roadway and also along the northern boundary, close to Clooncoose stream in the north eastern corner of the site. The bedrock geology is presented in Figure 2.3.

Bedrock was encountered during borehole installations as referenced in the PGL borehole logs, Appendix 2.

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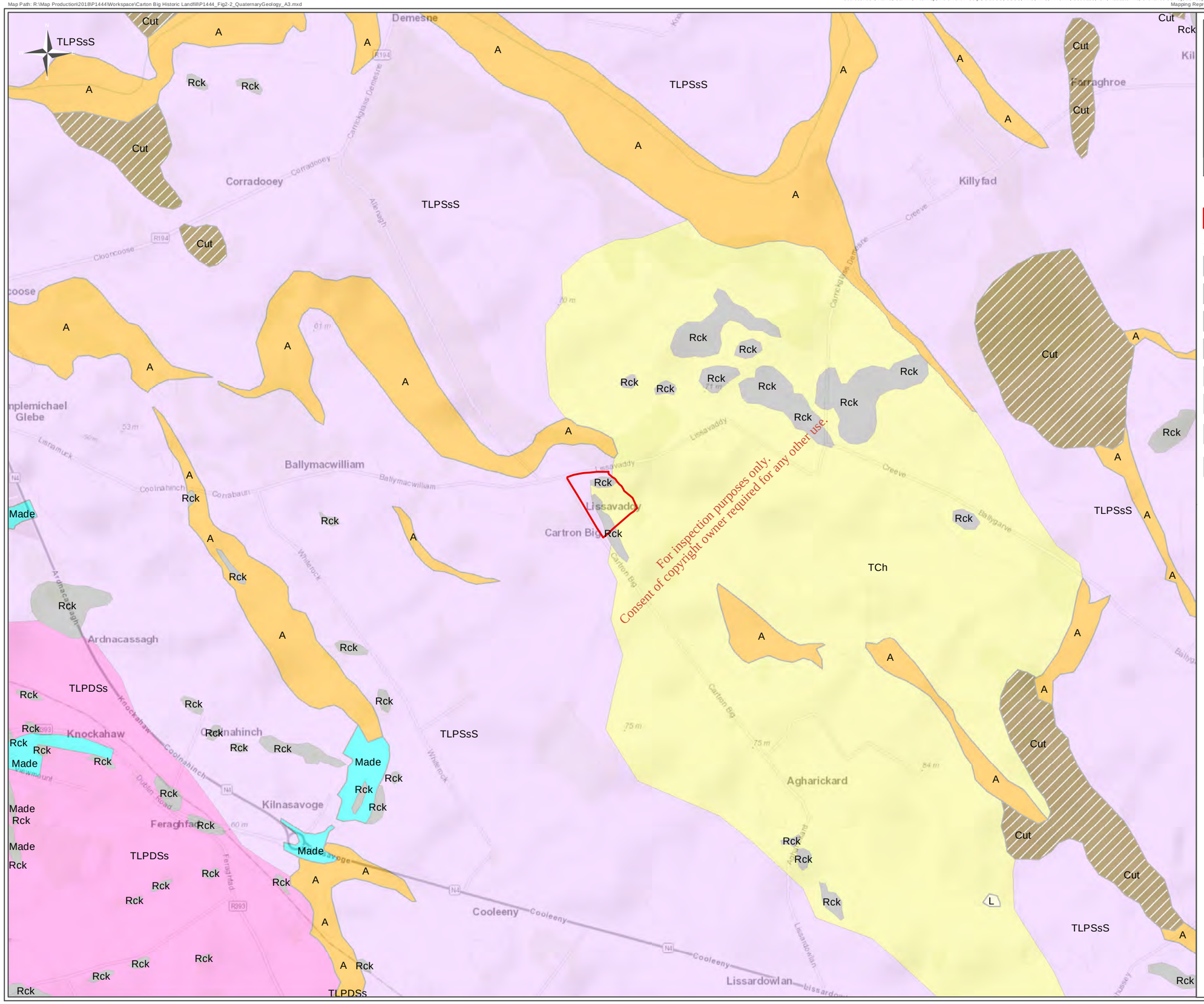

Legend

- Site Boundary

Subsoils Data

- A, alluvium
- Cut, cutover peat
- L, lake sediment
- Made, made ground
- Rck, bedrock at surface
- TCh,
- TLPDSs, sandstone till - Lower Palaeozoic / Devonian
- TLPSsS, sanstone and shales till - Lower Paleozoic

Figure Title
Quaternary Geology

Figure No. 2.2

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Historical Landfills: Cartron Big

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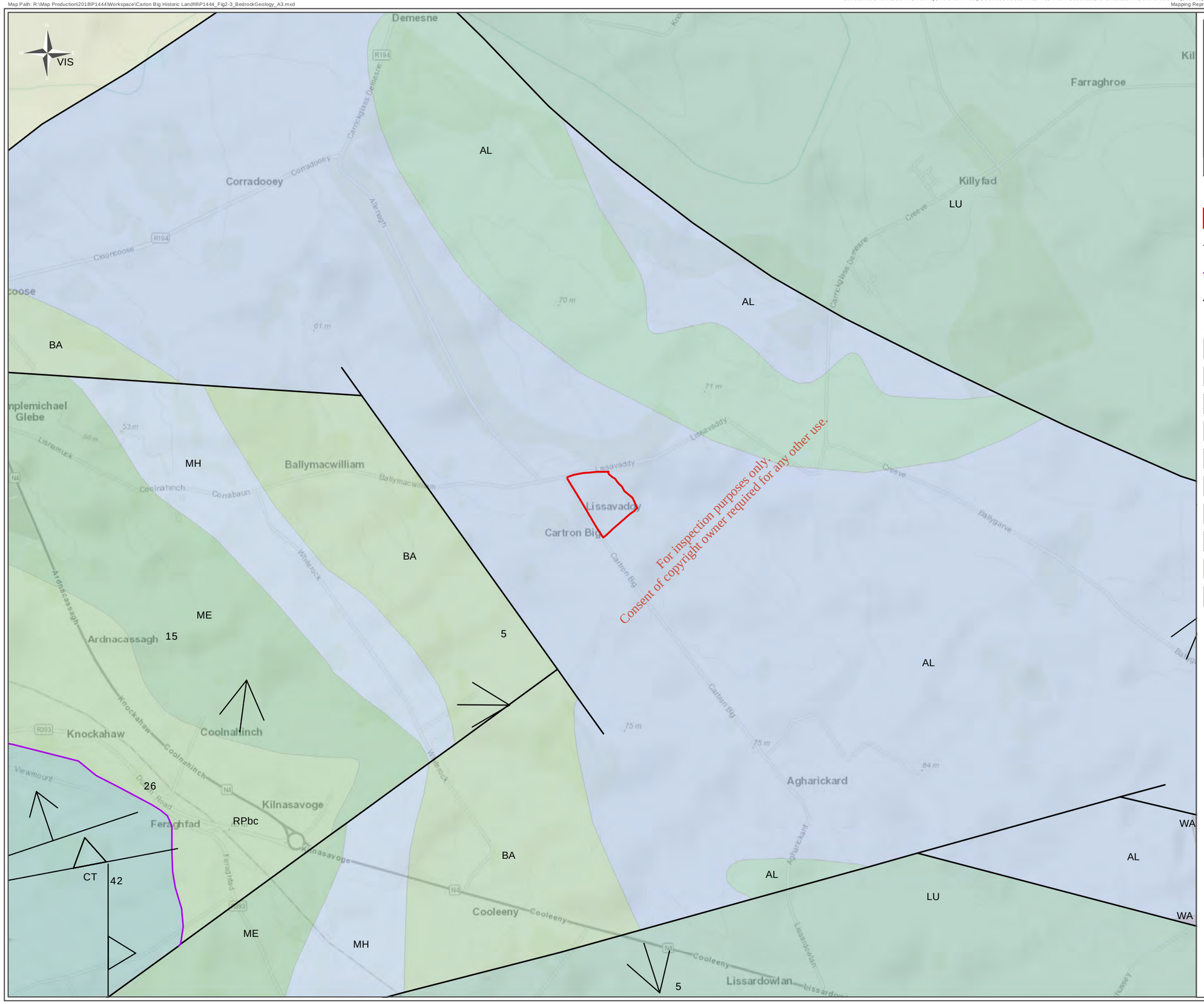
0 0.5 1 2 Kilometers

Map Path: R:\Map Production\2018\P1444\Workspace\Carton Big Historic Landfill\P1444_Fig2-3_BedrockGeology_A3.mxd



Legend

- Site Boundary
- Dip of Bedding in Degrees
- Stratigraphical Linework
- Structural Linework

Bedrock Geology

- AL: Argillaceous Limestones
- AL: in Argillaceous Limest
- BA: Ballysteen Formation
- CT: Carrickateane Formation
- LU: Lucan Formation
- ME: Meath Formation
- MH: Moathill Formation
- RPbc: Basal clastics
- VIS: Visean Limestones (undifferentiated)
- WA: Waulsortian Limestones

Figure Title
Bedrock Geology

Figure No. 2.3

Project
Historical Landfills: Cartron Big

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2.2.5 Hydrogeology

An examination of the national bedrock aquifer map on the GSI online mapping identified that the aquifer underlying the site is classified as a locally important aquifer which is moderately productive in local zones. The bedrock aquifer mapping is presented in
Figure 2.4.

There are no wells or springs within the site boundary. According to the GSI website, a County Council public water supply borehole is located approximately 1 km to the east of the site. The well record indicates that the well was installed in 1963 and was drilled to a depth of 36.6 m below ground level with a 0.9 m depth to bedrock. The yield is specified as being moderate, 98.1 m^3/d. It is not known whether the well remains in use or not; however, no inner or outer source protection zones have been defined for it, indicating that it is unlikely to be in active use. This is the well referenced in the Tier 1 report.

There are two other wells mapped within a 2.0 km radius of the site. One is recorded south of the site in the townland of Cooleeney. The well record indicates it was installed for agricultural and domestic use. Reported yield of the well is poor, and bedrock was encountered at 0.9 m below ground level (bgl). The second well is located to the east, with a depth to bedrock of 3.1 m bgl. Yield of this well is recorded as moderate (53.4 m3/d), it is not reported whether this well is to supply domestic, agricultural or industrial needs. Both well records date from 1899, and it is not known if these wells remain in use.

Table 2.2 presents the details of the boreholes and springs within 2km of the site.

There are no Groundwater Drinking Water Protection Areas within the site boundary according to GSI. The closest groundwater protection area to the site is approximately 2.5 km to the west of the site in the townland of Ballymachugh. The inner and outer protection area of the water body is 0.35 km^2 and 0.76 km^2 respectively.

The potentiometric mapping completed as part of this Tier 2 site investigation works has determined the direction of groundwater flow is to the north/northeast, towards the Clooncoose stream (see Section 4.3, Figure 4.1).

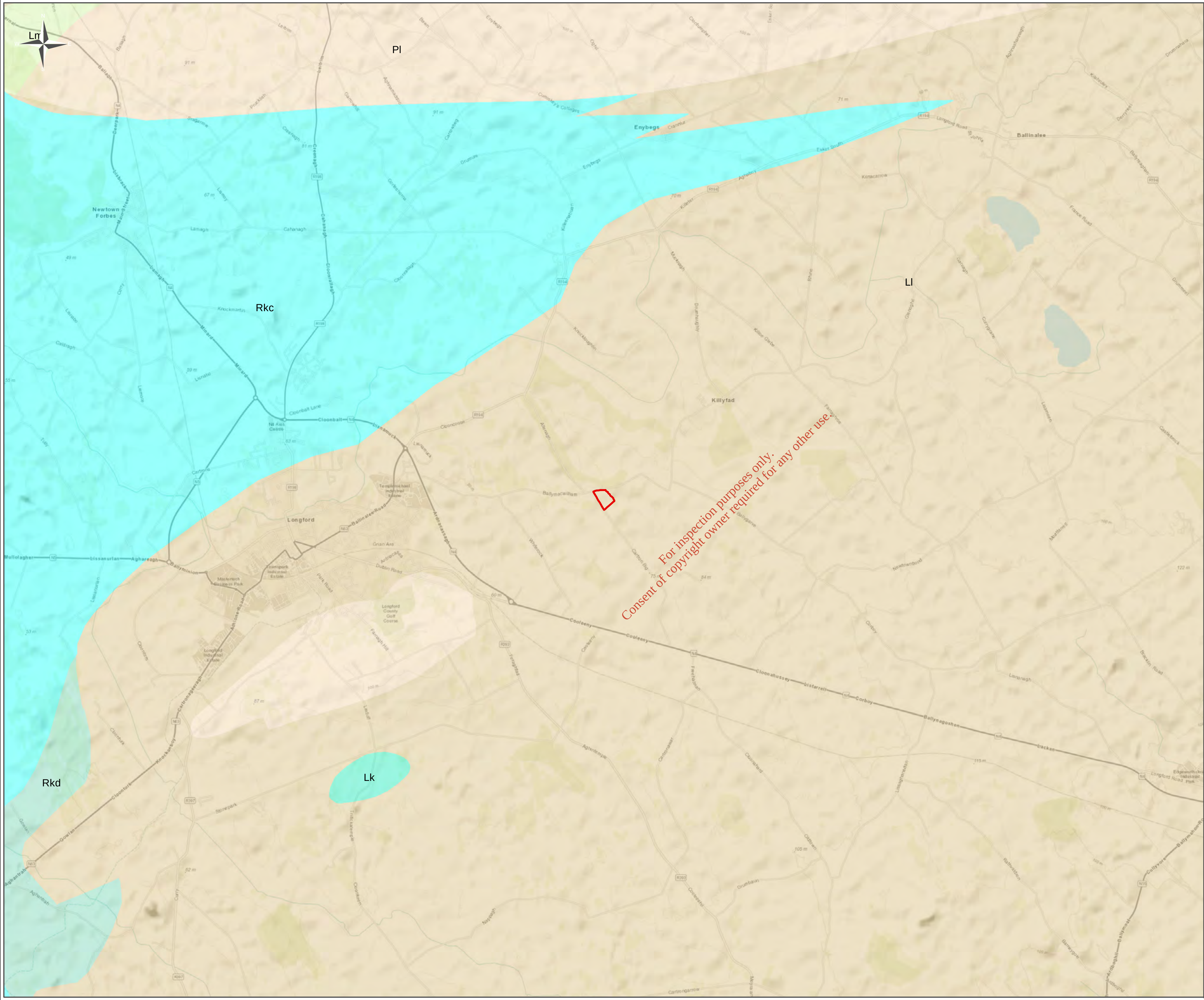
The Water Framework Directive Groundwater Bodies dataset from GSI shows that the groundwater body (GWB) is named Longford and has a poorly productive bedrock flow regime. The low permeability rocks which make up this GWB most groundwater flow is expected to occur within 15 m of the top of the rock, comprising a weathered zone of a few metres and a zone of interconnected fissures below this of about 10 m thick. The site is within the Shannon River Basin District.

Table 2.2: Borehole and Spring Descriptions near the Project Site

BH ID / Spring	Yield class	Yield (m^3/d)	Use	Depth (m)	Depth to Rock Confidence	Distance from site (km)	Date
2027SEW013	Moderate	91.1	Public Supply	36.6	0.9	0.9	1963
2027SEW008	Poor	20	Agri & Domestic	19.2	0.9	1.67	1899
2027SEW011	Moderate	53.4	Unknown	48.2	3.1	2.0	1899

The GSI mapping showing approximate locations of known wells and springs is included in
Figure 2.5.

Map Path: R:\Map Production\2018\P1444\Workspace\Carton Big Historic Landfill\P1444_Fig2-4_AquiferClassification_A3.mxd



0 0.5 1 2 Kilometers

Co. Longford

Legend

- Site Boundary
- Lk: Locally Important Aquifer -
- Ll: Locally Important Aquifer - Bedrock Mod Productive Locally
- Lm: Locally Important Aquifer - Bedrock Generally Mod Productive
- Pl: Poor Aquifer Bedrock Generally Unproductive Except Locally
- Rkc: Regionally Important Aquifer - Karstified (conduit)
- Rkd: Regionally Important Aquifer - Karstified (diffuse)

Figure Title	Aquifer Classification
Figure No.	2.4
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Map Path: R:\Map Production\2018\P1444\Workspace\Carton Big Historic Landfill\P1444_Fig2-5_WellsAndSprings_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
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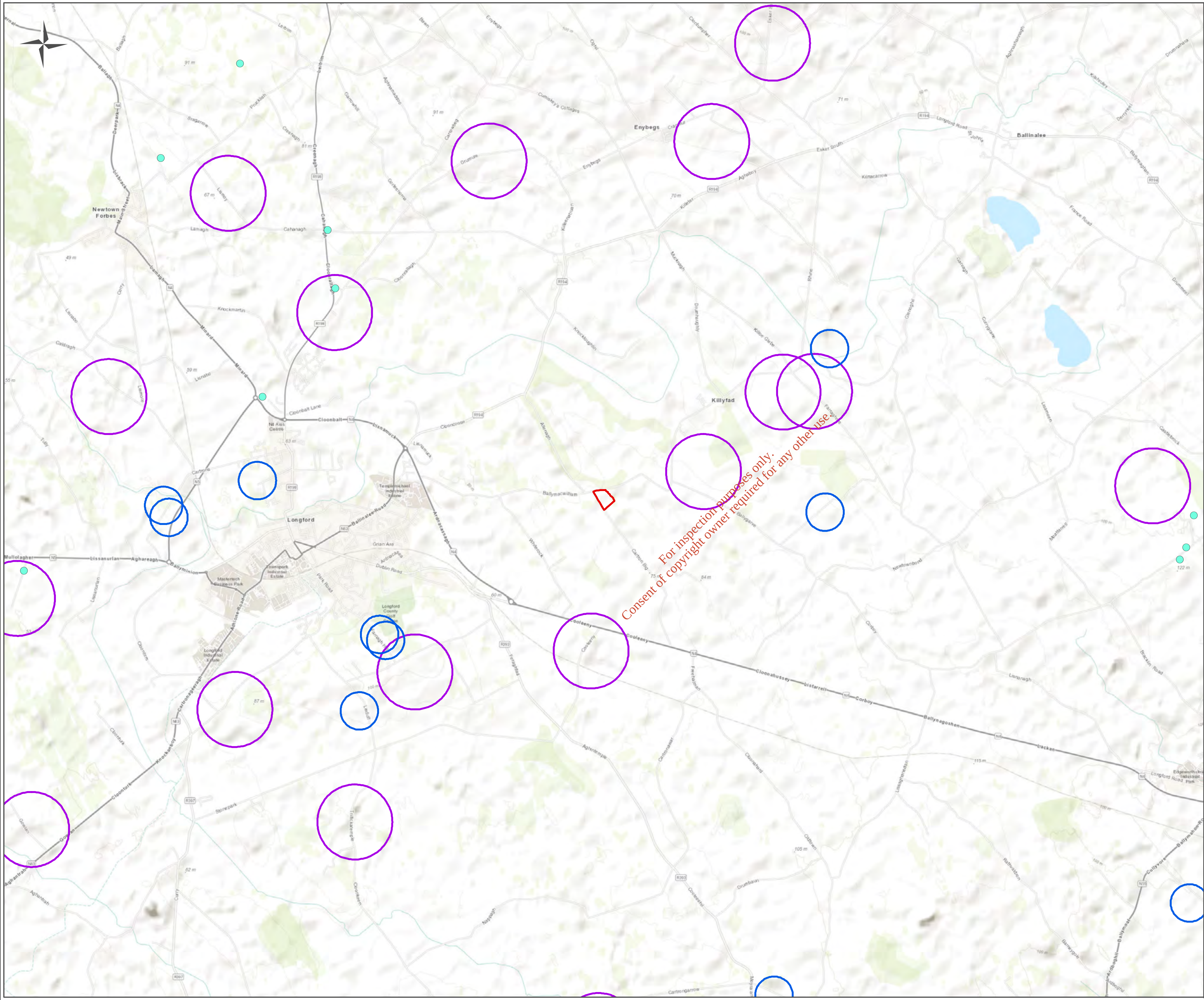

Co. Longford

Legend

- Site Boundary
- Groundwater Well (10-50m Accuracy)
- Groundwater Well (100-200m Accuracy)
- Groundwater Well (200-500m Accuracy)
- Groundwater Well (50-100m Accuracy)
- Groundwater Well (500m-1km Accuracy)

Figure Title
Wells and Springs

Figure No. 2.5

Project
Historical Landfills: Cartron Big

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0 0.5 1 2 Kilometers

2.2.6 Groundwater Vulnerability

Groundwater vulnerability, as defined by the GSI, is the term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.

The factors used in assessing groundwater vulnerability include subsoil type and thickness and recharge type as indicated in Table 2.1. The GSI procedure whereby groundwater protection is assessed is outlined in the EPA-GSI publication *Groundwater Protection Schemes* (DELG/EPA/GSI, 1999).

The GSI Online mapping data set identifies the vulnerability of groundwater to contamination is classified as extreme to high, given the presence of bedrock outcrop at the site and thin overburden cover. The Groundwater Vulnerability mapping is presented in
Figure 2.6.

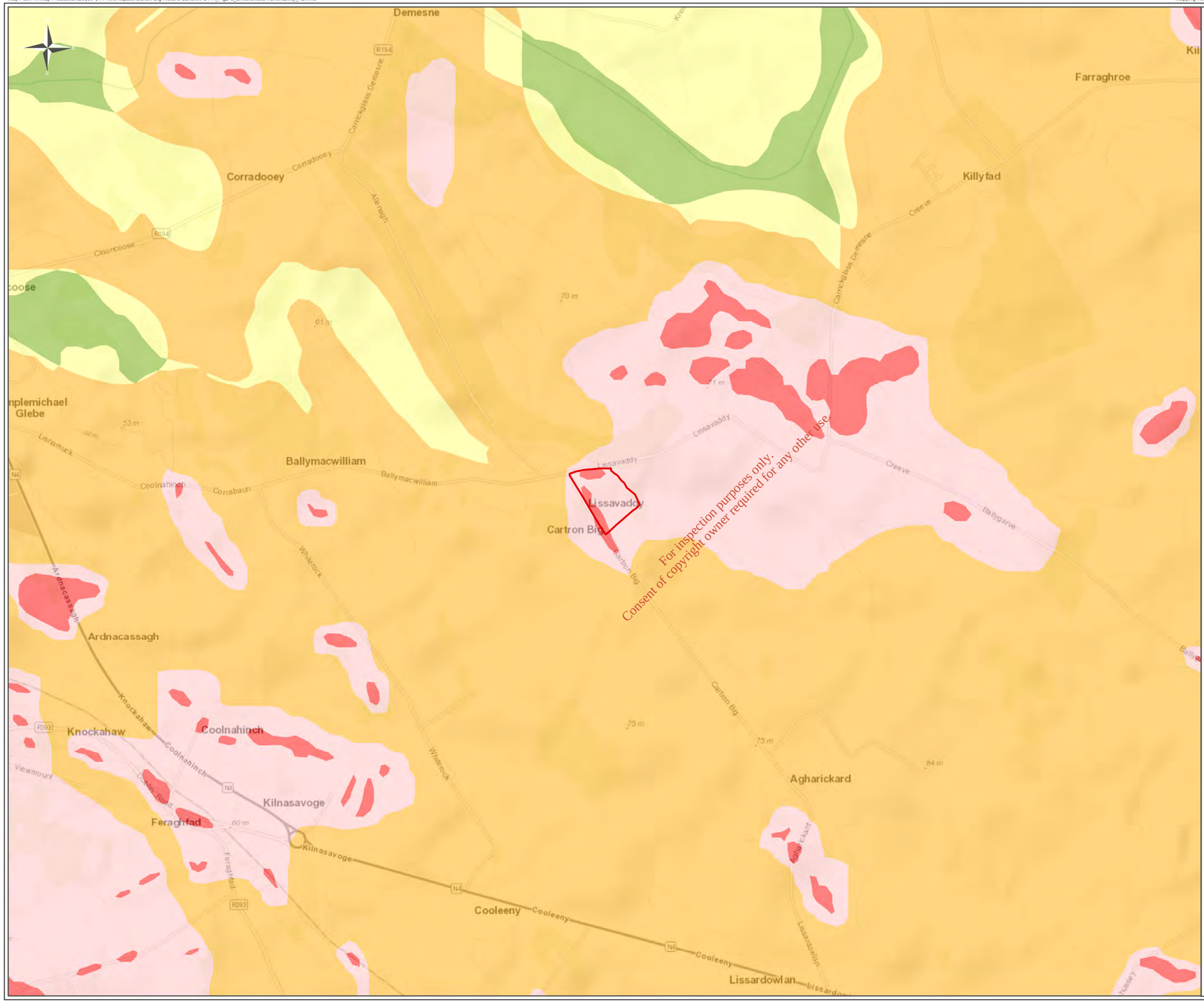
The recharge coefficient associated with the western section of the site is 85% and the recharge rate is 200mm/year.

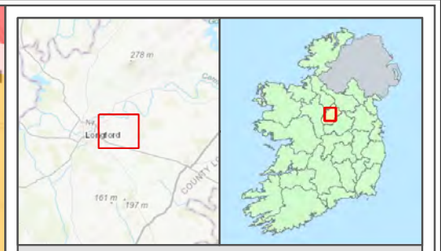
Table 2.1: GSI Guidelines – Aquifer Vulnerability Mapping

Vulnerability Rating	Hydrogeological Conditions		
	Subsoil Permeability (Type) and Thickness		
	High Permeability (Shallow Bedrock)	Moderate Permeability (e.g. Sandy soil)	Low Permeability (e.g. Clayey subsoil, clay, peat)
Extreme (E)	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m
High (H)	>3.0 m	3.0 -10.0 m	3.0 - 5.0 m
Moderate (M)	N/A	>10.0 m	5.0 - 10.0 m
Low (L)	N/A	N/A	>10 m

Notes:
N/A = Not Applicable
Precise permeability values cannot be given at present

Map Path: R:\Map Production\2018\P1444\Workspace\Carton Big Historic Landfill\P1444_Fig2-6_GroundwaterVulnerability_A3.mxd





Legend

- Site Boundary

Groundwater Vulnerability

- E - Extreme
- H - High
- M - Moderate
- L - Low
- X (Rock Near Surface or Karst)

Figure Title	Groundwater Vulnerability
Figure No.	2.6
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Kilometers
0 0.5 1 2

2.2.7 Hydrology

The nearest surface water body to the site is the Clooncoose stream, which flows along the eastern site boundary from southeast to northwest. The EPA has water quality stations on this stream and data from these stations are as follows:

- Cartron Bridge (RS26C200300) adjacent to the north eastern corner of the site. Status at this point is listed as Good (Q4) by the EPA, based on data collated between 2004 and 2016.
- R194 Road Bridge (RS26C200500) located approximately 2.5 km downstream of the site to the northwest at the point where the Clooncoose Stream flows under the R194 near its junction with the N4 and N5 routes. This location is approximately 900 m southeast (upstream) of the Clooncoose stream confluence with the Camlin River. Water quality status at this point is also Good (Q4), according to the EPA's river quality data from 2004 to 2016.
- The Mall Bridge Longford (RS26C010800) this location is situated on the River Camlin on the northern outskirts of Longford town and is downstream and to the south of its confluence with the Cooncloose Stream. Water quality status is Good (Q4) according to the EPA's river quality data from 2004 to 2016.

The Camlin River is not used for public water supply purposes downstream of the site.

There are records of recurring, small scale, flood events at Cartron Bridge.

Results for chemical surface water monitoring carried out by the EPA out up to 2008 indicate that the quality of surface water in the north-eastern site corner at Cartron Bridge is not adversely affected by the presence of the landfill. The findings of this Tier 2 assessment generally concur with these findings, however water quality monitoring 150m downstream of Cartron Bridge at SW-4 has detected ammonia concentrations above the surface water guideline threshold levels (EQS 2009). The detection of ammonia at this location indicates the presence of a pathway, possibly a man-made drainage channel flowing north / north-west, from the landfill, as identified in the historical mapping below in Section 2.2.9.

Continued biological monitoring by the EPA classifies the Clooncoose stream as being of Good status at Cartron Bridge, based on data collated between 2004 and 2016.

2.2.8 Ecology

There are no Special Areas of Conservation or Special Protection Areas within a 5 km radius of the site. Carrickglass Demesne is a proposed NHA. There are a number of national monuments in the vicinity of the site, such as a number of ringforts and the entrance gates to Carrickglass Demesne, but none are within the site boundary. The ecology protected areas mapping is presented in
Figure 2.7.

2.2.9 Site History

The earliest historical map available on the OSI website dates from 1837-1842. Most of the site appears to have been in agricultural use with a small wood stretching south from the north-western corner of the site along the western boundary with the L3538. On the eastern edge of this forested zone is marked the location of a quarry. Dwellings are visible to the south and east, at the same locations where dwellings are present today.

In addition, there appears to be a small dwelling on the western side of the cross roads at the north-western corner of the site and on the opposite side of the L1071 to the north of the site. There is no evidence of the presence of either dwelling in the present day. The gate lodges to Carrickglass Demesne are present to the east of the site.

The next historic map dates from 1888-1913, the small dwellings to the north and north-west no longer appear to be present. The quarry doesn't appear to be active, but a steep depression appears to be present close to the western site boundary, indicating that the quarry has not been infilled. The site appears to be in agricultural use with no forested area along the western site boundary.

The land to the north of the site, within Carrickglass Demesne, is mapped as bog or marsh. Evidence of cutaway drainage channels are indicated in the field just north of the L1071 roadway with channels excavated in a south-east to north-west direction.

The OSI Historical Mapping is presented in
Figure 2.8.

LCC have reported that the landfill accepted waste throughout the 1970s and 1980s, ceasing in 1989. Waste accepted is understood to have included municipal and industrial waste. Anecdotal evidence suggests that the quarry was excavated to 18 m bgl when it was active. Waste was backfilled into the quarry to 1 m above ground level. Following closure, gas vents were installed, and the landfill was subsequently capped. It was reported by LCC during the site walkover that the landfill was capped with a layer of pine bark from a local wood mill, overlaid by shale gravel with a final covering of topsoil.

2.2.10 Existing Geological Heritage

There are no Geological Heritage sites within the site boundary according to the GSI Geological Heritage map layer. The nearest recorded area of Geological Heritage held by the GSI is Creeve Quarry located approximately 0.9 km north-east of the project site. It comprises good examples of geological features '*representative of the Lower Carboniferous rocks in Longford'*. The geological heritage mapping is presented in
Figure 2.9.

2.2.11 Existing Geotechnical Stability

GSI landslides database has no record of geotechnical instability within the site boundaries. The nearest recorded geo-hazard was at the Bog of Rine, adjacent to the Camlin River approximately 2.8 km north-east of the site in the townland of Killyfad. The incident is reported to have occurred on the 31st December 1808. The landslide mechanism is undefined.

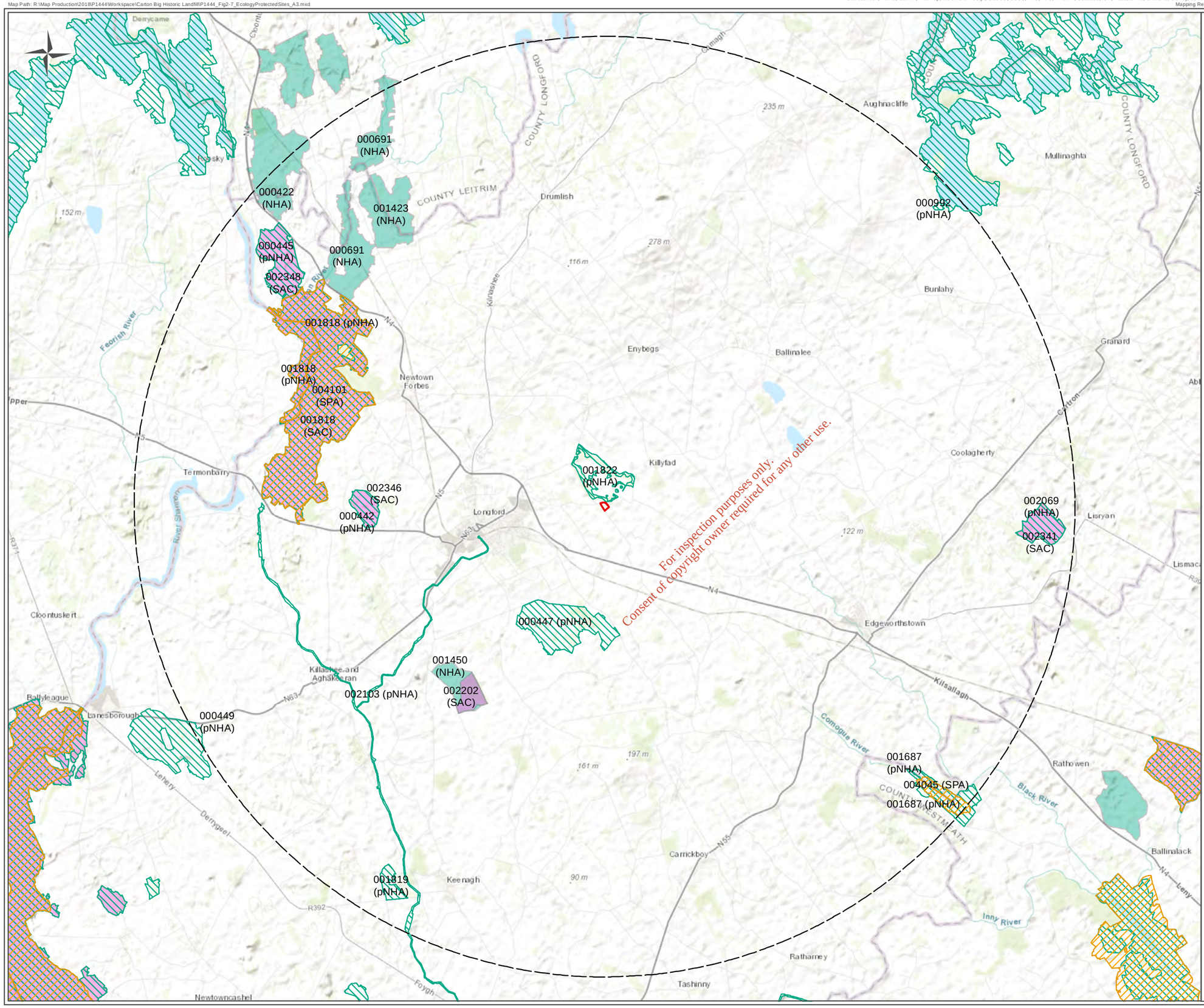
GSI online mapping indicates there is no peat within the site boundary.

Based on the existing database and topography it is considered that the landfill will have a negligible risk of geotechnical instability and there will be no perceived impact on any existing known geohazards.

2.2.12 Archaeological Heritage

There are no Archaeological Heritage sites with the site boundary according to the Heritage Ireland GSI Geological Heritage map layer.

Map Path: R:\Map Production\2018\P1444\Workspace\Carton Big Historic Landfill\P1444_Fig2-7_EcologyProtectedSites_A3.mxd



Legend

- Site Boundary
- 15km Distance from Site Boundary

Special Protection Area (SPA)

- Closest Site: 7.9km

Proposed Natural Heritage Area (pNHA)

- Closest Site: 0.01km

Special Area of Conservation (SAC)

- Closest Site: 6.7km

Natural Heritage Area (NHA)

- Closest Site: 6.7km

Figure Title
Ecology: Protected Sites

Figure No. 2.7

Project
Historical Landfills: Cartron Big

Client
Longford County Council

Scale 1:120,000 **Page Size** A3

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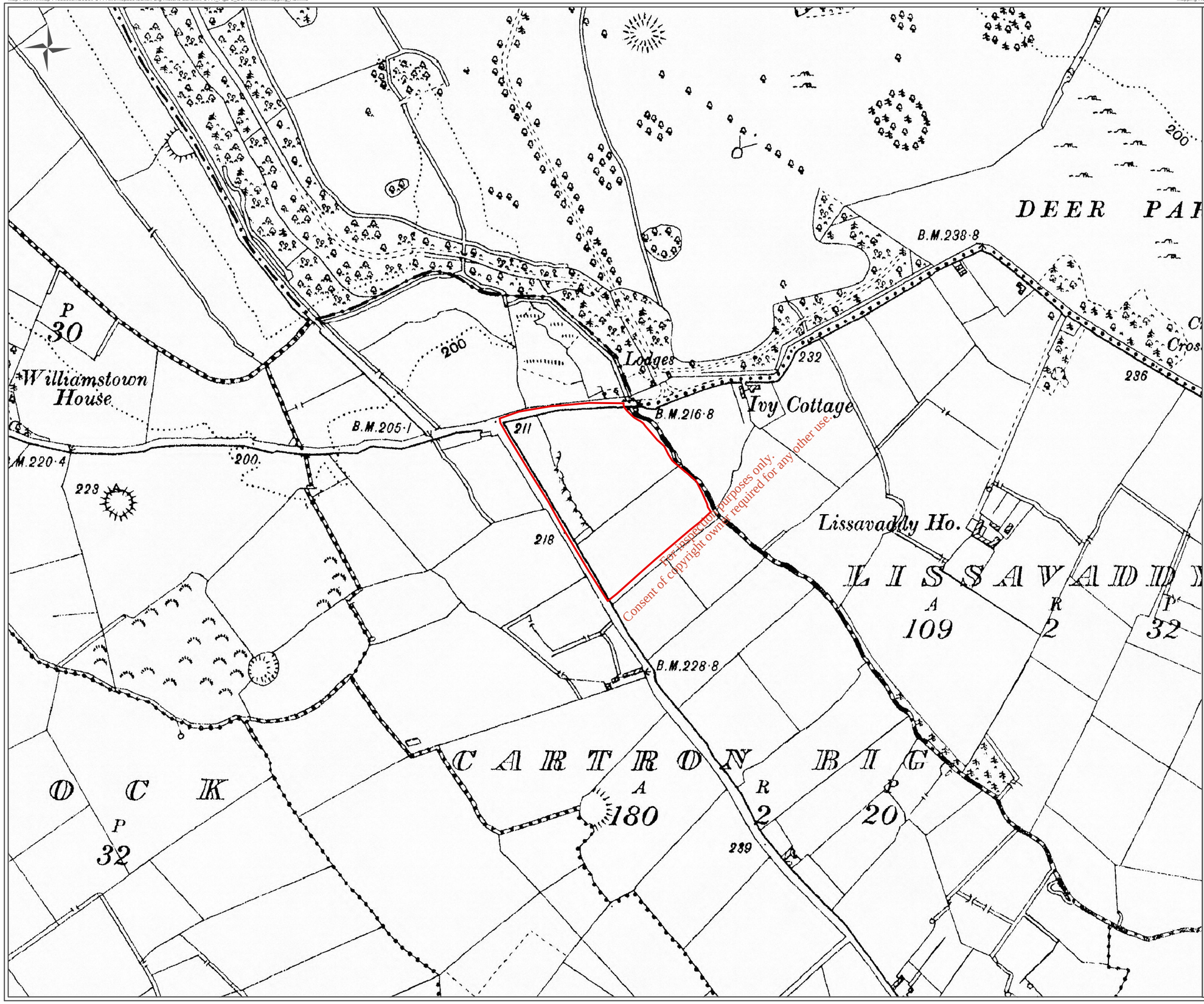
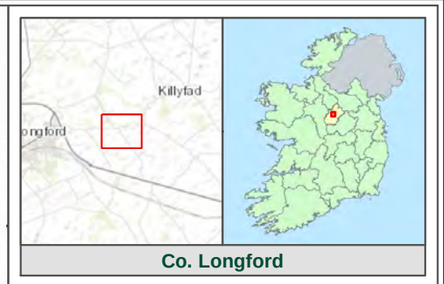
Map Path: R:\Map Production\2018\P1444\Workspace\Carton Big Historic Landfill\P1444_Fig2-8_OSiHistoricalMapping_A3.mxd





Legend

Site Boundary

0 100 200 400 Meters

Figure Title
OSi Historical Mapping

Figure No. 2.8

Project
Historical Landfills: Cartron Big

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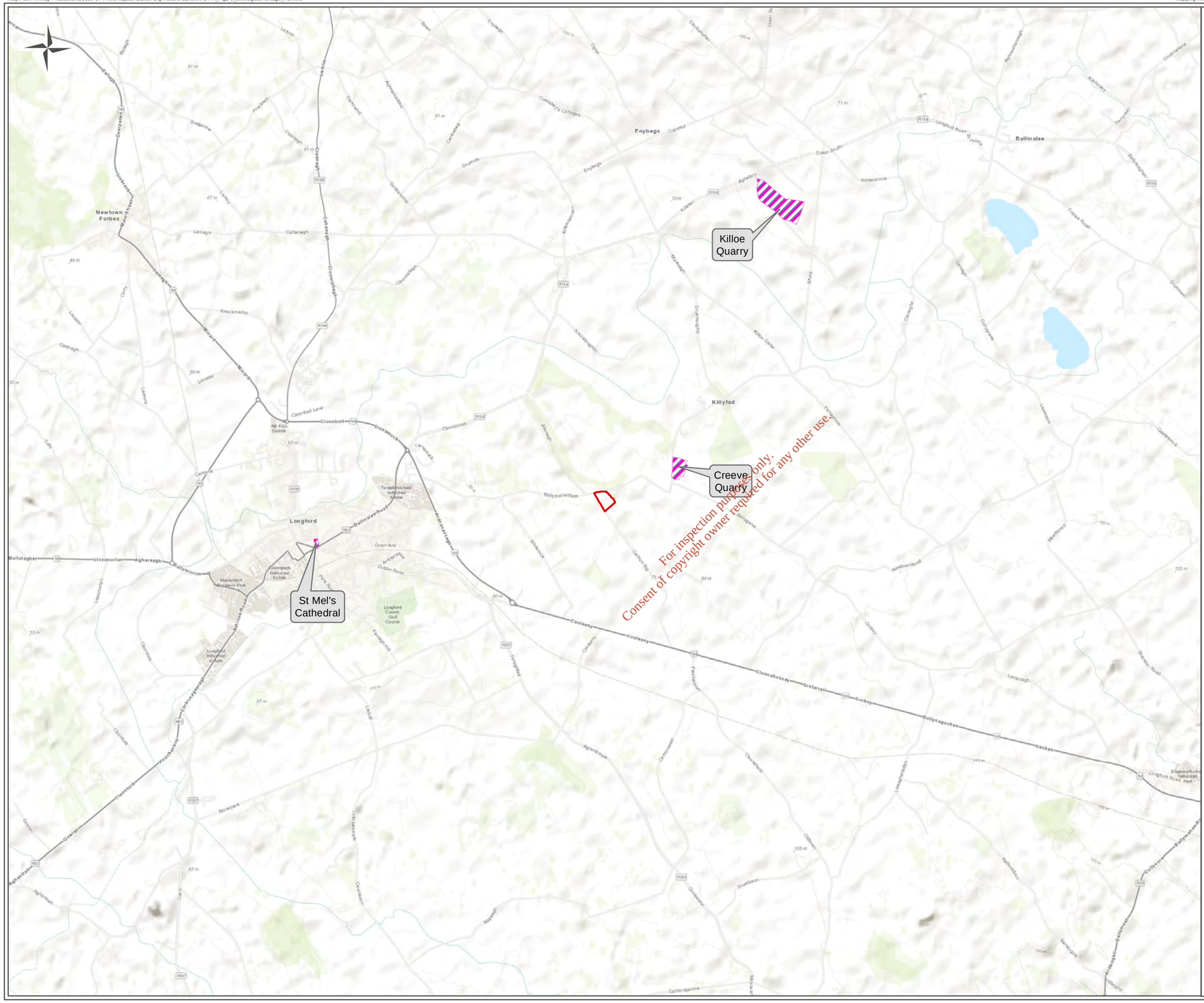
Map Path: R:\Map Production\2018\P1444\Workspace\Carton Big Historic Landfill\P1444_Fig2-9_GeologicalHeritage_A3.mxd



Legend

- Site Boundary
- Geological Heritage Sites

Kilometers
0 0.5 1 2

Figure Title	Geological Heritage
Figure No.	2.9
Project	Historical Landfills: Cartron Big
Client	Longford County Council
Scale	1:50,000
Page Size	A3
Revision	A
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3 TIER 2 SITE INVESTIGATION

3.1 Site Investigation Works

The site investigation rationale was devised based on findings of the Tier 1 Site, a site walkover and historical aerial photography.

The scope of site investigation works included:

- 15 No. Trial pit excavations
- Installation and monitoring of 3 No. groundwater boreholes
- Installation and monitoring of 2 No. leachate boreholes
- 1 No. Geophysical survey (2D resistivity and seismic refraction profiling)
- Factual reporting

The site investigation included the review of the following literature sources and websites:

- 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)
- BRE (1991) Soakaway design, Digest 365, Buildings Research Establishment, London.
- 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

3.1.1 Site Walkover

A site walkover was conducted prior to site investigation works by LCC and an FT representative. During the site walkover the scope of the investigative works were evaluated based on the findings in the Tier I assessment.

The locations of the intrusive works at the site are presented in Figure 3.1.

A site walkover checklist and photographic log are provided in Appendix 5.

Legend

- Groundwater Well
- Leachate Well
- Trial Pit
- Site Boundary

Meters
0 50 100 200

Figure Title
Site Investigation Location Plan

Figure No. 3.1

Project
Historical Landfills: Cartron Big

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3.1.2 Trial Pitting

An intrusive investigation involving trial pitting was undertaken by PGL on 31st July and 1st August 2018 under the supervision of PGLs Engineering Geologist.

A total of 15 No. trial pits (TP01 to TP15) were excavated to a maximum depth of 4.5m below existing ground level (bgl) using a 13-tonne tracked excavator. An additional 4 No. shallow trial pits (SA01 to SA04) were advanced across the site to assess the permeability of the existing capping material. The 4 No. shallow trial pits were advanced to a maximum depth of 0.5m bgl.

A summary of the ground conditions is presented in Tables 3.1 below with photographs and exploratory hole logs provided in the PGL site investigation report, Appendix 2.

Table 3.1: Summary of Ground Condition

Strata	Trial Pits	Depth to Top of Strata	Strata Thickness	Description
Made Ground	TP01 – TP15	0 - 0.5mBGL	0.65m	Made Ground comprising Brown sandy slightly gravelly SILT.
Made Ground and Waste Materials	**TP01 – TP05 TP07 TP09 – TP11 TP13 – TP15**	**0.5 – 4.25mBGL**	**3.75m**	**MADE GROUND comprising dark brown/ black, organic FILL with mixed refuse, plastic, brick, metal, steel pipes, timber, glass, fabric and mulch.**
Glacial Till	TP06, TP10, TP11, TP12, TP15	1.6 – 3.0mBGL	1.5m	Grey sandy gravelly CLAY with frequent cobbles and boulders.

Natural ground comprising of sandy gravelly CLAY was encountered in trial pits TP06, TP10, TP11, TP12, TP15.

Within areas where pockets of deposited waste were encountered the ground conditions generally comprised of *MADE GROUND dark brown/ black FILL with refuse, plastic, metal, timber, glass, fabric and mulch.* Waste material was encountered to depths in excess of 4.25m at 12 No. trial pits (TP01 – TP05; TP07; TP09 – TP11 and TP13 – TP15). Leachate was encountered in all these trial pits during the intrusive site investigation.

Evidence of animal waste (bones, hair, hides), most likely from local abattoirs, was encountered during the excavation of trial pit TP01 and TP02. This waste type would contribute to the high organic content of the waste and elevated methane levels.

It is noted that trial pitting was unable to determine the full depth of waste material in most of locations due to the presence of a high-water table.

The waste material as described by PGLs Engineering Geologist is very typical of municipal solid waste (MSW) material and shows evidence of industrial waste (steel pipes, metal) being encountered, as referenced in the PGL borehole logs (Appendix 2).

As noted most of the waste encountered was organic in nature with fragments of waste typical of MSW and industrial waste material. Visual and olfactory evidence of putrescible / biodegradable waste and hydrocarbon odours were noted by PGLs supervising Geologist during the site investigation.

3.1.3 Capping Infiltration Tests

Four soakaway test pits (SA01 to SA04) were excavated to depths ranging between 0.35m bgl to 0.5m bgl using a 13t tracked excavator. The exploratory logs are presented in the PGL site investigation report, Appendix 2. The locations of the soakaway tests at the site are presented in Figure 3.2.

Four infiltration tests were carried out in general accordance with the BRE Digest 365, 2007 Soakaway Design Standards. Single and double cycles of infiltration / drainage were undertaken. The soakaway pits failed to drain in full over the test durations of 60 minutes to 120 minutes. The calculated infiltration rates (f) for each test are presented in Table 3.2.

Table 3.2: Soakaway Infiltration Rate Results

Test No.	Test Depth (m BGL)	Test Time (min)	Infiltration Rate (f)
SA01	0.08 - 0.27	120	1.10 x 10^{-5} m/s
SA02 (1 of 2)	0.08 - 0.35	60	6.53 x 10^{-5} m/s
SA02 (2 of 2)	0.10 - 0.35	90	3.89 x 10^{-5} m/s
SA03	0.06 - 0.40	90	1.84 x 10^{-5} m/s
SA04 (1 of 2)	0.11 - 0.40	120	5.23 x 10^{-5} m/s
SA04 (2 of 2)	0.08 - 0.40	120	2.98 x 10^{-5} m/s

Figure 3.2: Capping Infiltration Testing Locations

3.1.4 Soil Sampling

5 No. samples of the made ground/waste material were collected from trial pits (TP01, TP03, TP04, TP05 & TP11) across the landfill site.

Samples were submitted for Waste Acceptance Criteria (WAC) to ALS Environmental Ltd, a UKAS/MCERTS approved laboratory.

The results are provided in Appendix 3.

3.1.5 Geophysical Investigation

Priority Geotechnical Ltd. were instructed by FT to undertake a geophysical investigation of the site. The survey was carried out on the 15th and 16th August 2018.

The geophysical survey comprised of 2D electrical resistivity and seismic refraction profiling along 5 no. designated profiles in the survey area. A total of 1,215m of electrical resistivity and 46m of seismic refraction profiles were collected.

The geophysical survey, calibrated against the findings of the trial pitting and borehole installations was used to estimate a general profile of the buried waste above the in-situ bedrock.

Seismic Refraction Profiling & Electrical Resistivity Tomography (ERT)

PGL recorded 2 no. seismic refraction profiles (SRP) and these are named S1 and S2. PGL recorded 5 no. ERT profiles data along three designated profiles. ERT profiles are named R1 through R5. The location of these profiles is given in Drawing No's P18159_GP_D01 and an interpretation of the results are included in Appendix 2.

Results

The geophysical survey succeeded in validating the general location of the waste material. The ERT profiles mapped the lateral extent of the landfill material with an increase in resistivity close to the surface outside areas of landfill material. ERT profiles R3, R4 (to the south) and R5 did not image the lateral extent of the landfill material as it extended across the entire length of the profiles.

The modelled profiles and geophysical interpretations are presented in Figure 3.3 to Figure 3.7.

The geophysical results confirm the finding of the desk study and anecdotal information gathered, indicating that the quarried site was backfilled with municipal solid waste to depths exceeding 10m directly atop the underlying limestone bedrock.

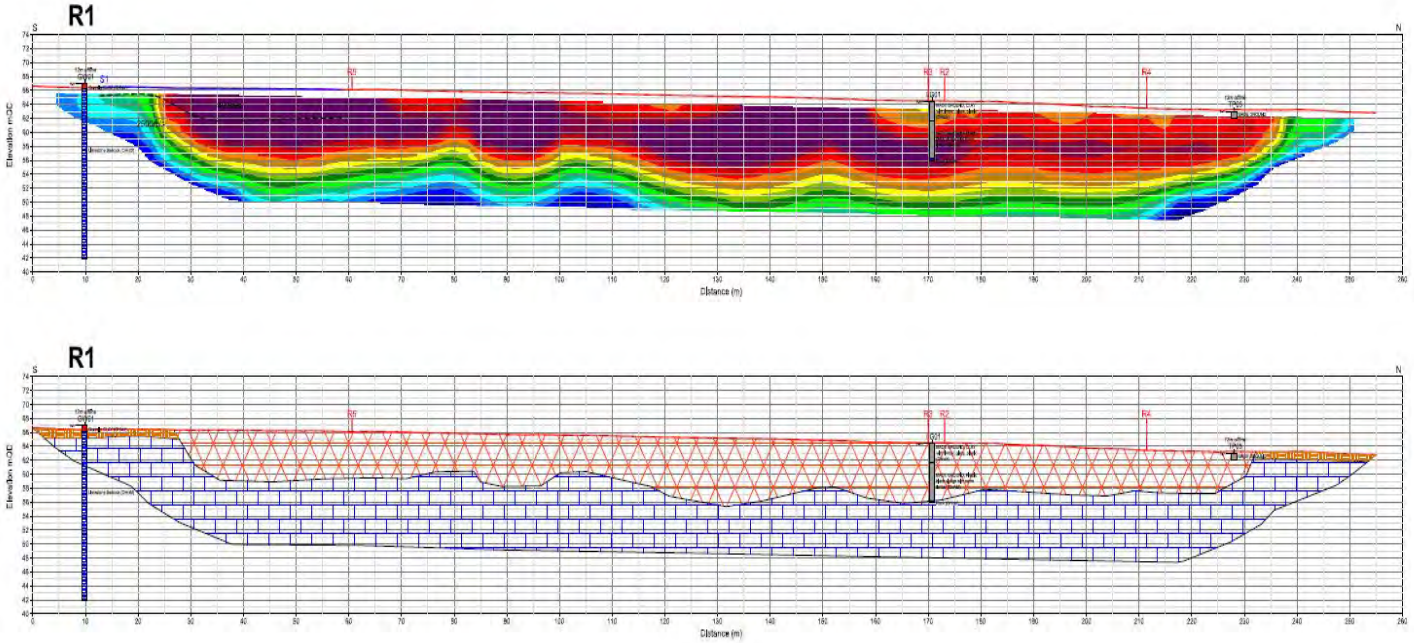

Figure 3.3: ERT Profile R1 Interpreted Cross Section

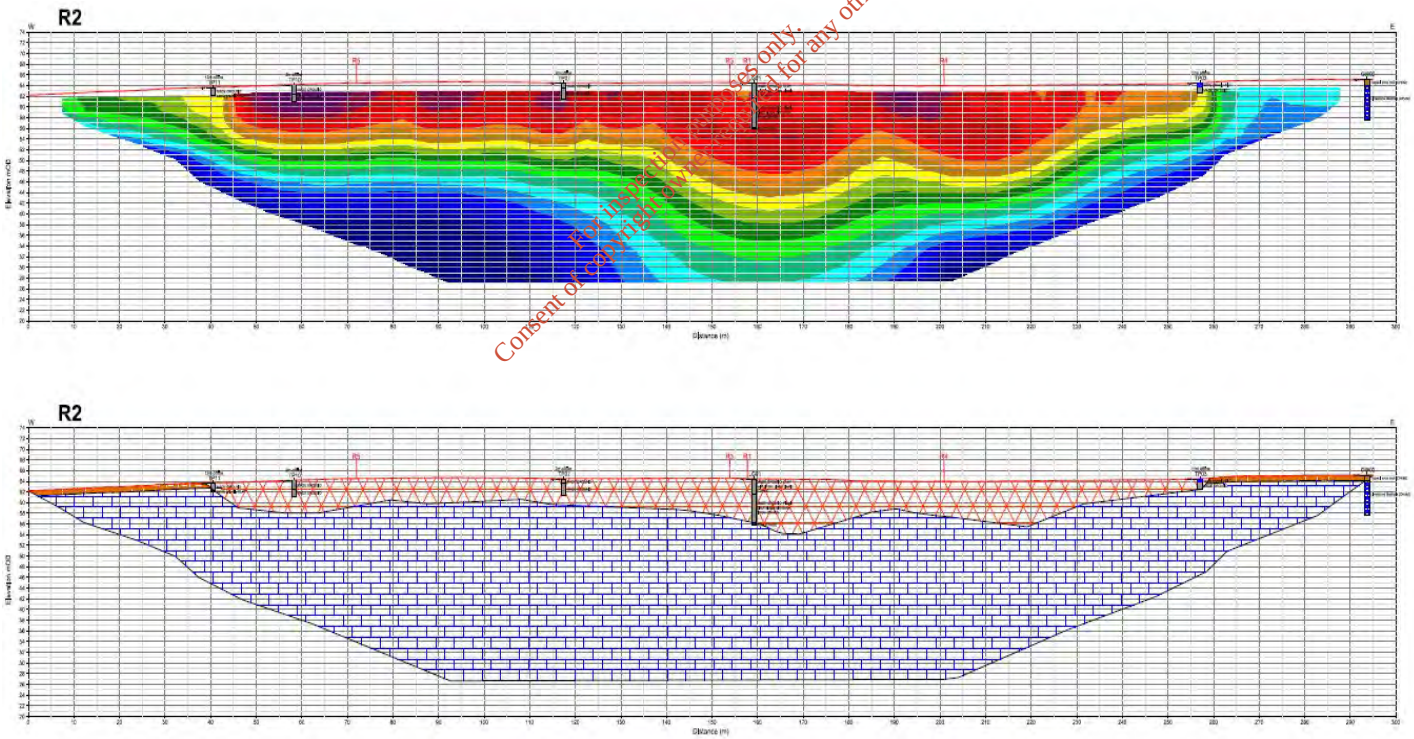

Figure 3.4: ERT Profile R2 Interpreted Cross Section

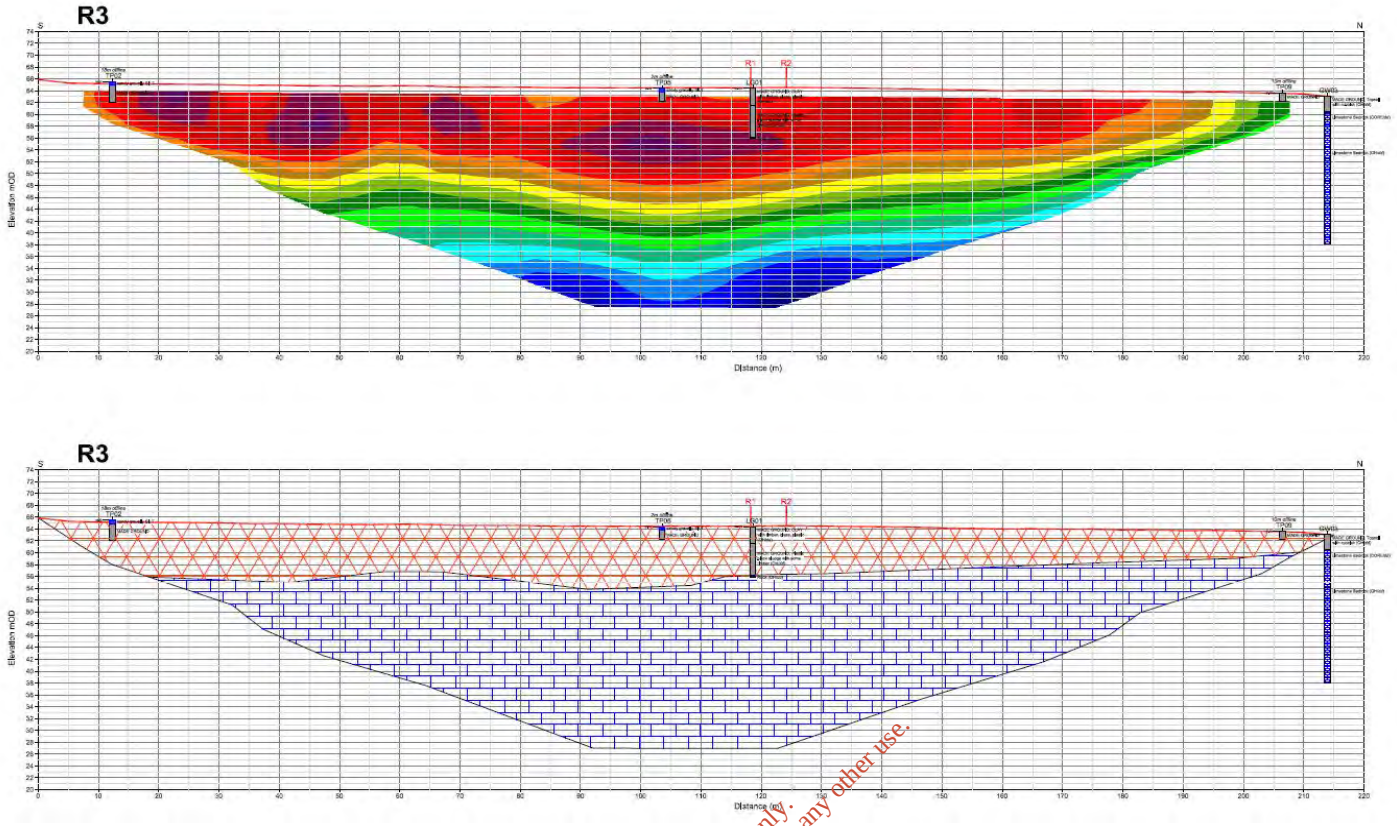

Figure 3.5: ERT Profile R3 Interpreted Cross Section

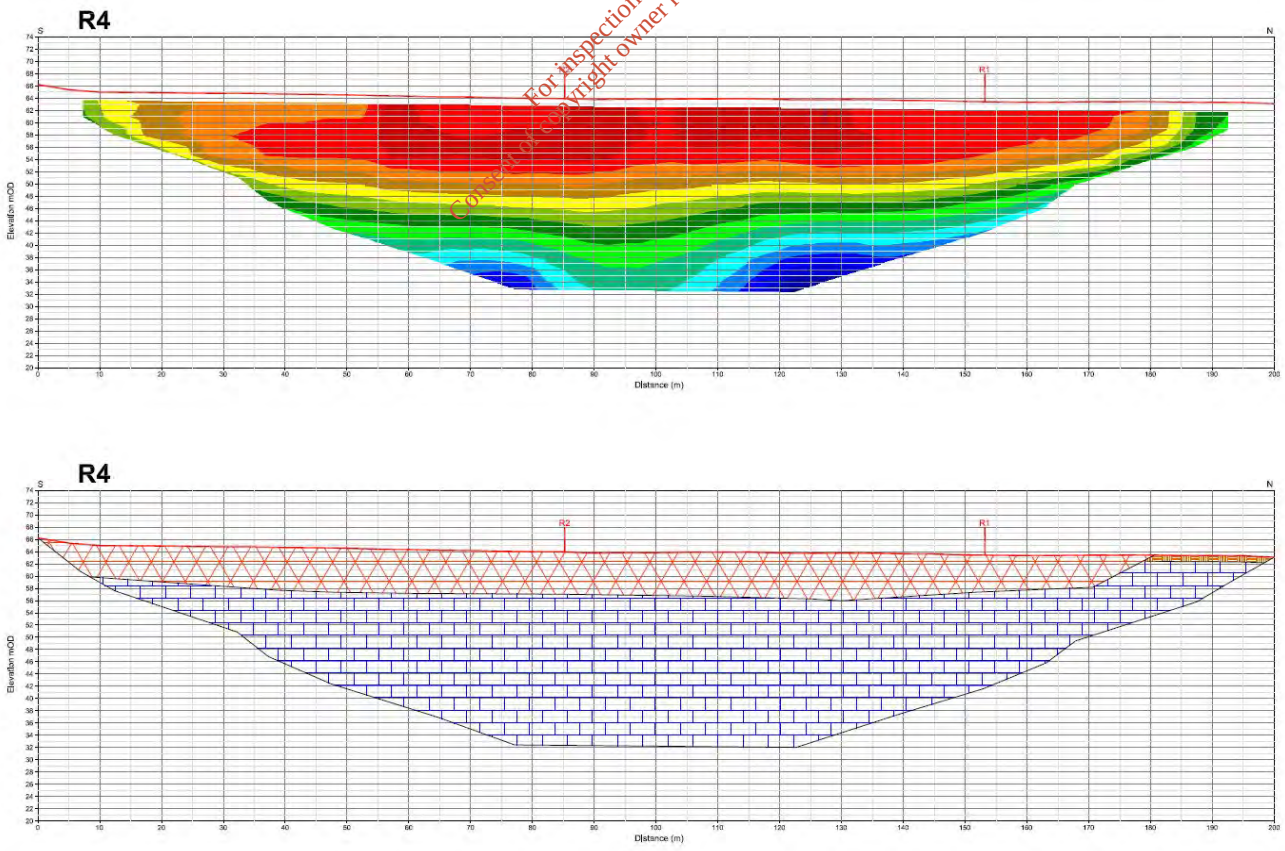

Figure 3.6: ERT Profile R4 Interpreted Cross Section

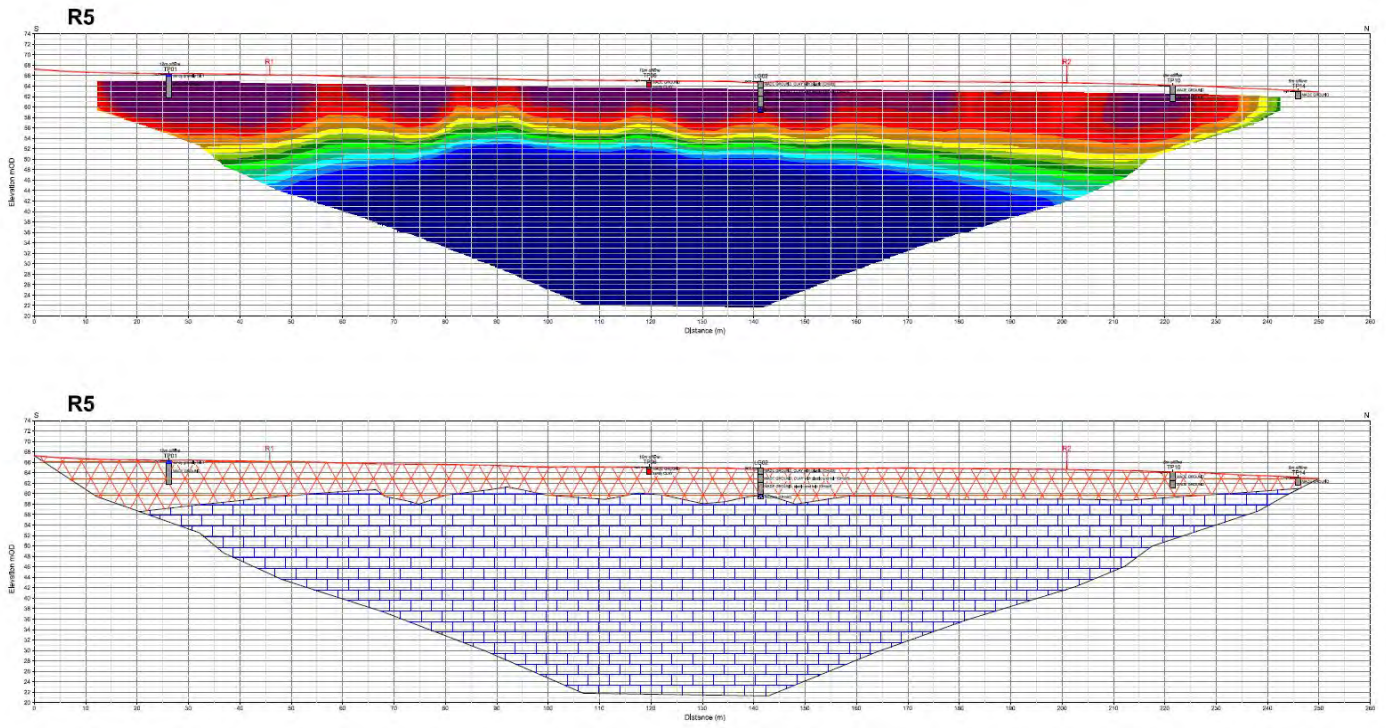

Figure 3.7: ERT Profile R5 Interpreted Cross Section

3.1.6 Borehole Installation & Groundwater / Leachate Sampling

Three groundwater boreholes (GW01 to GW03) were drilled to depths ranging between 7.50m bgl to 25.0m bgl at the site. Two leachate boreholes (LG01 and LG02) were drilled to depths ranging between 6.0m bgl to 8.50m bgl in the centre of the site i.e. waste body. The boreholes were drilled and installed as groundwater and leachate monitoring locations.

Groundwater boreholes were advanced near the boundary of the deposited waste as identified during the desk study and geophysical survey. The purpose of these wells was to intercept and define the groundwater flow direction upstream and downstream of the identified waste body.

The leachate monitoring boreholes were advanced near the centre of the site following interpretation of the geophysical survey and trial pit logs. The primary purpose of these wells was to assess the type and strength of leachate within the waste body at these locations.

The boreholes were also used to confirm the depth to bedrock at these locations for the calibration of the geophysical survey ERT profiles as discussed in Section 3.1.5.

Groundwater and leachate monitoring was undertaken in boreholes GW01 – GW03, LG01 and LG02 on 25th September and 8th October 2018. Prior to sampling the groundwater locations, the standpipe wells were purged and developed with Waterra groundwater sampling pipework / foot valves and gas caps installed by PGL on the 13th September 2018 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.

The analysis results are presented in Appendix 4 and are further discussed in the proceeding sections.

3.1.6.1 In-situ Permeability Testing

The permeability of the limestone bedrock aquifer was assessed by undertaking 60-minute falling head permeability tests at the installed groundwater wells GW01 – GW03. The falling head tests were carried out within each borehole at depths of approximately 2.00m below existing ground level. The permeability tests undertaken at the site were undertaken in accordance with B.S. 5930:1999.

The results of the permeability testing including the horizontal permeability factor at each borehole location is presented in Table 3.3. The test data and associated infiltration graphs are presented in the PGL site investigation report, Appendix 2.

Table 3.3: In-Situ Permeability Test Results

Test No.	Test Depth (m BGL)	Test Time (min)	Permeability Factor (k)
GW01	0.1 – 1.72	60	6.98 x 10^{-8} m/s
GW02	0.00 – 1.51	60	3.29 x 10^{-7} m/s
GW03	0.00 – 2.09	60	9.33 x 10^{-8} m/s
		Mean	**1.64 x 10^{-7} m/s**

Results of the permeability tests demonstrate the low infiltration rates observed at each monitoring well location. The mean k-value from the three tests completed estimates an overall bedrock permeability of 1.64 x 10^{-7} m/s can be taken to reflect the limestone bedrock underlying the site.

3.1.6.2 Bedrock Core Description

FT requested the recovery of a limestone bedrock core sample during the installation of borehole GW03 to better understand the nature of the bedrock below the waste body. A 1.5m core was recovered and sent for core logging by one of PGLs sub-contracted geologists. The following extract taken from the GW02 borehole log describes the rock mass in detail:

- Lithology: Strong, dark grey LIMESTONE.
- Weathering: Slightly weathered with slight clay smearing on fracture planes and clay infill.
- Fractures: One main fracture set dipping sub-horizontal 0 to 15 degrees, planar to undulated smooth fracture surfaces, closely spaced.
- Detail: Not intact from 3.90m to 4.00m. Large clay in fill section from 2.93m to 3.03m. Slightly fossiliferous.

3.1.7 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 geophysical survey comprised of 2D electrical resistivity tomography (ERT) to measure the ground resistivity distribution across the landfill area.

The extent of the waste deposit has been interpreted by the presence of undisturbed ground encountered in 12 No. trial pits TP01 to TP05; TP07; TP09 to TP11 and TP13 to TP15.

PGL described the 5 No. areas of anomalous resistivity picked up on ERT profiles R1 to R5 are the areas of waste material. Landfill material was seen to extend to a maximum depth of 10m bgl and was imaged on all ERT profiles. The ERT profiles mapped the lateral extent of the landfill material with an increase in resistivity close to the surface outside areas of landfill material.

The findings of the site investigation work suggest the waste material is deposited in a single infill area tending north-west to south-east and between 210m in length and 140m in width. Based on this interpretation, the maximum waste footprint is calculated to be 5.80 acres or 2.35 hectares.

The maximum anticipated waste footprint is presented in Figure 3.8.

Al volume calculation was conducted based on the surveyed surface profiles for the existing ground level and the base of waste as interpreted, preliminary estimates indicate an interred waste volume of approximately 206,000 m^3 at the site.

Figure 3.8: Maximum Anticipated Waste Footprint

4 ENVIRONMENTAL ASSESSMENT

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) (Amendment) Regulations, 2012 (S.I. No. 327 of 2012)
- European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I No. 272 of 2009)
- European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989 (S.I. No. 294/1989).

The results of the environmental assessment at Cartron Big Landfill site is presented in the following sections.

4.2 Waste Classification Assessment

Waste samples collected 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 inert, non-hazardous or hazardous material.

4.2.1 Chemical Results for Soil Samples

The waste samples analysed from the site investigations were assessed against the Waste Classification Assessment Criteria to determine the broad classification of waste landfilled. A summary of the results for Cartron Big Landfill is outlined in Table 4.1 below, while the laboratory reports are presented in Appendix 3.

Table 4.1: Waste Sampling Results – WAC Analysis

Parameter	Units	Inert Waste Acceptance Criteria	Non-Hazardous Waste Acceptance Criteria	Hazardous Waste Acceptance Criteria	Sampling Results - Sample ID				
					TP01 (1.8m)	TP03 (2.5m)	TP04 (1.2m)	TP05 (1.8m)	TP11 (0.9m)
Asbestos in soil	--	**Detected**	**Detected**	**Detected**	ND	ND	ND	ND	ND
Arsenic	$mg.kg^{-1}$	**0.5**	**2**	**25**	0.371	0.067	0.071	0.038	0.021
Barium	$mg.kg^{-1}$	**20**	**100**	**300**	0.244	0.657	0.935	0.249	0.655
Cadmium	$mg.kg^{-1}$	**0.04**	**1**	**5**	0.0043	<0.0008	<0.0008	<0.0008	<0.0008
Chromium	$mg.kg^{-1}$	**0.5**	**10**	**70**	5.41	<0.01	<0.01	<0.01	<0.01
Copper	$mg.kg^{-1}$	**2**	**50**	**100**	0.213	<0.003	<0.003	<0.003	0.034
Mercury Dissolved	$mg.kg^{-1}$	**0.01**	**0.2**	**2**	0.0003	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	$mg.kg^{-1}$	**0.5**	**10**	**30**	0.284	0.546	0.117	0.627	0.106
Nickel	$mg.kg^{-1}$	**0.4**	**10**	**40**	0.617	0.0134	0.0207	0.0287	0.0177
Lead	$mg.kg^{-1}$	**0.5**	**10**	**50**	0.16	<0.002	<0.002	<0.002	<0.002
Antimony	$mg.kg^{-1}$	**0.06**	**0.7**	**5**	0.039	0.0192	<0.01	0.0244	0.0258
Selenium	$mg.kg^{-1}$	**0.1**	**0.5**	**7**	0.018	<0.01	<0.01	0.0192	<0.01
Zinc	$mg.kg^{-1}$	**4**	**50**	**200**	0.48	<0.01	0.0205	0.0264	<0.01
Chloride	$mg.kg^{-1}$	**800**	**15000**	**25000**	8120	47	213	51	<20
Fluoride	$mg.kg^{-1}$	**10**	**150**	**500**	6.04	<5	<5	<5	<5
Sulphate	$mg.kg^{-1}$	**1000**	**20000**	**50000**	<100	441	153	3140	76
Total Dissolved Solids	$mg.kg^{-1}$	**4000**	**60000**	**100000**	31000	2980	3190	6700	1720
Total Monohydric Phenols	$mg.kg^{-1}$	**1**	**--**	**--**	75.8	<0.16	<0.16	<0.16	<0.16
Dissolved Organic Carbon	$mg.kg^{-1}$	**500**	**800**	**1000**	1880	206	147	142	58.7
Sum of BTEX	$mg.kg^{-1}$	**6**	**--**	**--**	0.007	<0.001	<0.001	<0.001	<0.001
Total Organic Carbon *	%	**3**	**5**	**6**	4.13	7.08	10.7	7.17	0.95
Moisture Content ratio	%	**--**	**--**	**--**	35	44	56	50	18
Mineral Oil	$mg.kg^{-1}$	**500**	**--**	**--**	898	1080	1160	2390	50.3

Parameter	Units	Inert Waste Acceptance Criteria	Non-Hazardous Waste Acceptance Criteria	Hazardous Waste Acceptance Criteria	Sampling Results - Sample ID				
					TP01 (1.8m)	TP03 (2.5m)	TP04 (1.2m)	TP05 (1.8m)	TP11 (0.9m)
PCBs (Sum of 7)	$mg.kg^{-1}$	**1**	**--**	**--**	<0.105	<0.021	<0.021	<0.105	<0.021
PAH (Sum of 17)	$mg.kg^{-1}$	**100**	**--**	**--**	<10	<10	<10	<10	<10
pH	pH units	**>6 or <9**	**>6**	**--**	8.68	7.02	7.77	7.67	7.86
Loss on ignition	%	**--**	**--**	**10**	15.7	18.9	36.7	22.4	3.58

* ND – non-detected
* Hazardous Waste Landfill Criteria: >6% TOC

4.2.2 Waste Classification

Based on the 5 No. soil samples submitted for laboratory waste acceptance criteria (WAC) testing and the representative spread across the site, analysis of waste samples from the trial pits excavated indicate that the waste material encountered within the site is typical of non-hazardous waste.

4.3 Groundwater & Leachate Analysis

Two rounds of groundwater and leachate quality monitoring were undertaken at the site on the 26th September and 8th October 2018. The findings from the monitoring and an interpretation of the results are presented in the following sections.

4.3.1 Groundwater Depth Analysis

Groundwater depth analysis was undertaken on two occasions following the installation of the rotary core standpipes. Static groundwater levels from the 8th October 2018 are calculated in Table 4.2.

Table 4.2: Groundwater Depth Analysis

Borehole ID	Top of Casing (mAOD)	Dip (m) 8/10/18	Groundwater Level (mAOD)	Location Gradient
GW01	67.27	2.71	64.56	Upgradient
GW02	65.38	1.15	64.23	Upgradient
GW03	63.26	2.45	60.81	Down-gradient
LG01	64.55	1.68	62.87	Centre of waste body
LG02	64.98	1.92	63.06	Western portion of waste body

*Note: Location gradient is in reference to the identified waste deposition area

Based on the above field survey measurements, the groundwater flow direction is assumed to be due north-north-east. The measured leachate levels within LG01 and LG02 appear to be higher than the anticipated potentiometric groundwater level at this location of the site. The raised levels in this portion of the site suggest perched leachate

A potentiometric map illustrating the hydraulic gradient and the direction of groundwater flow is presented in Figure 4.1.

4.3.2 Groundwater Borehole Position

The location of the groundwater boreholes (GW01 to GW03) installed at the site were based on the anticipated groundwater flow direction. A desktop analysis of the site in tandem with a site walkover estimated that the likely groundwater flow direction is north to north east.

GW03 was therefore located to the North of the waste mass to act as a downgradient monitoring location.

GW01 and GW02 were positioned south of the waste body along the south-eastern site boundary to act as up-gradient or cross-gradient monitoring boreholes.

4.3.3 Leachate Borehole Position

The leachate monitoring boreholes (LG01 and LG02) were advanced near the centre of the site following interpretation of the geophysical survey and trial pit logs. The purpose of these wells was to assess the type and strength of leachate within the waste body at these locations.

Map Path: R:\Map Production\2018\P1444\Workspace\Carton Big Historic Landfill\P1444_Fig4-1_GroundwaterFlow_A3.mxd

Legend

- Dipped Water Level (mAOD)
- Dipped Leachate Level (mAOD)
- Groundwater Flow Direction
- Site Boundary

Interpolated Dipped Water Level (mAOD)

- 61.5 - 62
- 62.1 - 62.5
- 62.6 - 63
- 63.1 - 63.5
- 63.6 - 64
- 64.1 - 64.5

Meters
0 50 100 200

Figure Title
Groundwater Flow

Figure No. 4.1

Project
Historical Landfills: Cartron Big

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Scale 1:2,000 **Page Size** A3

Revision A **Date** 17/10/2018

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4.3.4 Groundwater Quality Monitoring

The results of groundwater samples analysed from the 3 No. boreholes (GW01 – GW03) at the site have been assessed against the EPAs Interim Guideline Values (IGVs) and the European Groundwater Regulations (2016) assessment criteria. A summary of the maximum results reported for each parameter over two monitoring rounds is outlined in Table 4.3, while the laboratory reports are presented in Appendix 4.

Table 4.3: Groundwater Sampling Results

Parameter	Units	EPA IGV Standards [1]	S.I. No. 9 of 2016 Standards [2]	GW01	GW02	GW03
pH	pH units	**6.5 - 9.5**	--	7.6	7.27	7.03
Conductivity	mS/cm	**1**	**1.875**	0.78	0.711	1.69
Alkalinity as CaCO3	mg/l	**200**	--	**415**	**630**	**942**
Ammoniacal Nitrogen as N	mg/l	**0.15**	**0.175**	**0.401**	**0.423**	**43.5**
Sodium	mg/l	**150**	**150**	18.8	11.2	**166**
Sulphate as SO4	mg/l	**200**	**250**	32	26.9	124
Total Oxidised Nitrogen	mg/l	--	--	0.556	0.144	0.114
Total Organic Carbon	mg/l	--	--	<3	4.46	22.2
Arsenic	mg/l	**0.01**	**0.0075**	0.0046	0.0020	**0.0079**
Boron	mg/l	**1.0**	**0.75**	0.0837	0.0168	0.214
Cadmium	mg/l	**0.005**	**0.005**	<0.0008	<0.0008	0.00008
Calcium	mg/l	**200**	--	179	165	**246**
Chloride	mg/l	**30**	**187.5**	15.1	24	**66.3**
Chromium	mg/l	**0.03**	**0.05**	<0.001	<0.001	0.0017
Copper	mg/l	**0.2**	**2**	0.00086	<0.0003	0.00767
Cyanide	mg/l	**0.01**	**0.0375**	<0.05	<0.05	<0.05
Fluoride	mg/l	**1.0**	**0.8**	<0.5	<0.5	<0.5
Iron	mg/l	**0.2**	--	**0.277**	0.054	**2.31**
Lead	mg/l	**0.01**	**0.025**	0.0042	<0.0002	0.0014
Magnesium	mg/l	**50**	--	32.5	9.59	**52.3**
Manganese	mg/l	**0.05**	--	**0.12**	**0.404**	**0.989**
Mercury	mg/l	**0.001**	**0.001**	<0.0001	<0.0001	<0.0001
Nickel	mg/l	**0.02**	**0.02**	0.0168	0.00331	**0.0365**
Phosphorus	mg/l	**0.03**	**0.035**	0.00103	0.0103	**0.0316**
Potassium	mg/l	**5**	--	3.56	0.936	**35.4**
Zinc	mg/l	**0.1**	--	0.00465	0.00318	0.0304
Dissolved Oxygen	mg/l	**no abnormal change**	--	9.02	8.69	6.02
Total Coliforms	cfu/100ml	**0**	--	**19700**	**7680**	**1990**

[1] EPA - Towards Setting Guideline Values for the Protection of Groundwater in Ireland (2003) – Interim Guideline Values
[2] European Communities Environmental Objectives (Groundwater)(Amendment) Regulations (2016) – SI No. 366 of 2016
* Items shaded in **bold** are in exceedance of both EPA IGV Standards
* Items shaded in **orange** are in exceedance of the Drinking Water Regulations

4.3.5 Groundwater Analysis Discussion

The results of the groundwater monitoring from GW01 – GW03 have reported several exceedances of the IGVs and European Groundwater limit values.

Samples recovered monitoring wells GW01, GW02 and GW03 reported ammonia concentrations of 0.401 mg/l, 0.423 mg/l and 43.5 mg/l respectively, which exceed guideline threshold values. Ammonia concentrations at both upgradient boreholes GW01 and GW02 are representative of background levels possibly due to agricultural land spreading. Given the ammonia concentration of 43.5 mg/l recorded at GW03 is 100-times greater than upgradient levels, the landfill is impacting downgradient water quality due to the significant ammonia concentration differences between upgradient and downgradient monitoring locations.

All groundwater monitoring rounds have detected high levels of coliforms within samples collected from each monitoring well GW01 – GW03. Concentrations of total coliforms are reported within a range between 1,990 cfu/ml to 19,700 cfu/ml with the highest concentrations recorded at upgradient borehole GW01.

The combined presence of elevated ammonia and coliform concentrations in all monitoring wells may also be evidence of localised contamination due to agricultural land spreading or poorly functioning septic tanks.

Elevated alkalinity (CaCO3) is consistent across all three sampling locations. The alkaline groundwater quality in upgradient boreholes GW01 (415 mg/l) and GW02 (630 mg/l) is a factor of local bedrock conditions, however the alkalinity concentration of 942 mg/l recorded in downgradient borehole GW03, being over twice the levels in the upgradient boreholes, is considered to be influenced by leachate migrating from the waste body.

The elevated sodium concentration of 166 mg/l detected in GW03 is a result of leachate migration from the waste body. Sodium concentrations are reported well below threshold values at boreholes GW01 and GW02.

The slightly elevated iron concentration of 0.277 mg/l at borehole GW01 and elevated manganese concentrations ranging from 0.12 mg/l to 0.989 mg/l across all monitoring wells are considered to be typical of the local bedrock hydrochemistry. However, the iron concentration of 2.31 mg/l detected in downgradient borehole GW03 is 10-times the groundwater threshold value and is therefore considered to be a result of leachate migration from the waste body.

The elevated nickel concentration of 0.0365 mg/l detected in downgradient borehole GW03 exceeds both guideline threshold values of 0.02 mg/l. The significant concentration difference between the upgradient and downgradient monitoring locations suggests that the waste body is contributing to the increased nickel concentration in the downstream groundwater quality.

Samples collected from downgradient borehole GW03 show the phosphorus concentration at 0.0316 mg/l exceeds the IGV standard limit value but lies within the European Groundwater threshold value of 0.035 mg/l.

The hydraulic conductivity concentration of 1.69 mS/cm detected in downgradient borehole GW03 provides an indicator of leachate migrating north towards the Clooncoose Stream.

Given the groundwater flow from the landfill is due north-north-east, any leachate plume migrating from the landfill is not considered to pose a threat to water quality abstracted from the County Council public water supply borehole (ID: 2027SEW013) which is located approximately 1 km to the east of the site.

4.3.6 Leachate Quality Monitoring

The results of leachate samples analysed from the 2 No. boreholes (LG01 and LG02) at the site have been assessed against both the methanogenic and acetogenic constituents contained within Table 7.2 of the EPA Landfill Manual (2003). A summary of the results is outlined in Table 4.4 and Table 4.5, while the laboratory reports are presented in Appendix 4.

Table 4.4: Summary of Methanogenic Leachate Composition at LG01 and LG02

	Overall Range		Overall Values		Cartron Big Leachate Quality	
	Minimum	Maximum	Median	Mean	LG01	LG02
pH-value	6.8	8.2	7.35	7.52	7.14	7.52
Conductivity (µS/cm)	5,990	19,300	10,000	11,502	4.38	47.6
Alkalinity (as CaCO3)	3,000	9,130	5,000	5,376	1680	9500
COD	622	8,000	1,770	2,307	178	19800
BOD5	97	1,770	253	374	3.5	1310
TOC	184	2,270	555	733	55.9	6400
Fatty Acids (as C)	<5	146	5	18	1.31	0.721
Ammoniacal-N	283	2,040	902	889	223	3080
Nitrate-N	0.2	2.1	0.7	0.86	<0.1	0.125
Nitrite-N	<0.01	1.3	0.09	0.17	<0.0152	<0.0152
Sulphate (as SO4)	<5	322	35	67	25.5	130
Phosphate (as P)	0.3	18.4	2.7	4.3	<0.05	30.7
Chloride	570	4,710	1,950	2,074	613	14500
Sodium	474	3,650	1,400	1,480	329	6690
Magnesium	40	1,580	166	250	58.9	95.5
Potassium	100	1,580	791	854	82.4	197
Calcium	23	501	117	151	188	303
Chromium	<0.03	0.56	0.07	0.09	2.1	150
Manganese	0.04	3.59	0.3	0.46	958	2300
Iron	1.6	160	15.3	27.4	34.7	23.4
Nickel	<0.03	0.6	0.14	0.17	29.8	132
Copper	<0.02	0.62	0.07	0.13	1.16	<1.8

* Results in reported in mg/l except pH-value and conductivity (µS/cm).
* Source: UK Department of the Environment (1995)

Table 4.5: Summary of Acetogenic Leachate Composition at LG01 and LG02

	Overall Range		Overall Values		Leachate Quality	
	Minimum	Maximum	Median	Mean	LG01	LG02
pH-value	5.12	7.8	6.0	6.73	7.14	7.52
Conductivity (µS/cm)	5,800	52,000	13,195	16,921	4.38	47.6
Alkalinity (as CaCO3)	2,720	15,870	5,155	7,251	1680	9500
COD	2,740	152,000	23,600	36,817	178	19800
BOD5	2,000	68,000	14,600	18,632	3.5	1310
TOC	1,010	29,000	7,800	12,217	55.9	6400
Fatty Acids (as C)	963	22,414	5,144	8,197	1.31	0.721
Ammoniacal-N	194	3,610	582	922	223	3080
Nitrate-N	0.2	2.1	0.7	0.86	<0.1	0.125

	Overall Range		Overall Values		Leachate Quality	
	Minimum	Maximum	Median	Mean	LG01	LG02
Sulphate (as SO4)	<5	1,560	608	676	25.5	130
Phosphate (as P)	0.6	22.6	3.3	5.0	<0.05	30.7
Chloride	659	4,670	1,490	1,850	613	14500
Sodium	474	2,400	1,270	1,371	329	6690
Magnesium	25	820	400	384	58.9	95.5
Potassium	350	3,100	900	1,143	82.4	197
Calcium	270	6,240	1,600	2,241	188	303
Chromium	0.03	0.3	0.12	0.13	2.1	150
Manganese	1.4	164.0	22.95	32.94	958	2300
Iron	48.3	2,300	475	653.8	34.7	23.4
Nickel	<0.03	1.87	0.23	0.42	29.8	132
Copper	0.02	1.1	0.075	0.13	1.16	<1.8

* Results in reported in mg/l except pH-value and conductivity (µS/cm).
* Source: UK Department of the Environment (1995)

4.3.7 Leachate Analysis Discussion

As can be seen from Table 4.4 the leachate strength in monitoring well LG02 is greater than LG01. When assessed against typical landfill leachate parameters reported in the EPA Landfill Manual (2003), the leachate composition at the Cartron Big landfill appears to be representative of the mean to maximum concentrations of the acetogenic phase.

According to the Landfill Manual, conditions within the landfill during the acetogenic phase are such that the leachate can be chemically aggressive so that the resulting leachate may contain high concentrations of iron, manganese, calcium and magnesium.

Leachate concentrations for nickel, manganese, chromium, sodium, chloride, phosphate, nitrate, ammonia, TOC, and alkalinity at Cartron Big are found to be above the typical maximum reported ranges for these parameters.

4.4 Landfill Gas Monitoring

FT carried out monitoring of landfill gas (LFG) parameters at each monitoring borehole location (GW01 – GW03; LG01 and LG02) as indicated on Figure 3.1. In accordance with the EPA COP, methane, carbon dioxide, oxygen and atmospheric pressure were analysed at the 3 No. groundwater monitoring wells located outside the waste body and the 2 No. leachate wells located within the waste body using a geotechnical instrument GEM5000 Landfill Gas analyser.

4.4.1 Monitoring Results

In accordance with the COP, 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 and with onsite leachate boreholes summarised in Table 4.6.

Table 4.6: Perimeter Well Monitoring Results September & October 2018

Date: 25-9-2018						
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member	Weather
GW01	**1.8**	**4.2**	15.5	1032	Daniel Hayden	Sunny with light wind S-SE, 14°C - 16°C
GW02	0.1	0.1	22.3	1032		
GW03	**8.8**	**11.6**	8.7	1032		

Date: 8-10-2018						
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member	Weather
GW01	**1.0**	1.1	20.7	1012	Daniel Hayden	Cloudy with light rain and wind NW-W, 13°C - 15°C
GW02	0.1	**1.9**	21.5	1012		
GW03	**2.1**	**3.3**	20.1	1012		

As can be seen in Table 4.5, carbon dioxide (CO_2) and methane (CH_4) levels were detected at 2 No. groundwater monitoring wells GW01 and GW03 during the monitoring rounds. Concentrations of both CO_2 and CH_4 at upgradient borehole GW01 and downgradient GW03 exceed the threshold values set by the CoP during both monitoring rounds. Gas concentrations from borehole GW03 are significantly higher than the upgradient boreholes and may be due to the proximity of this borehole to the waste body and the prevailing direction of gas migration. It is considered that the proximity of the waste body to borehole GW01 may also be leading to the elevated traces of ground gases at this location.

Concentrations of both CO_2 and CH_4 at upgradient borehole GW02 were generally below the threshold values set by the CoP during both monitoring rounds with the exception of a slight CO_2 exceedance on the 8th October.

Table 4.7: Onsite Leachate Well Monitoring Results September & October 2018

Date: 25-09-2018						
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member	Weather
LG01	30.4	12.5	11.8	1032	Daniel Hayden	Sunny with light wind S-SE, 14°C - 16°C
LG02	49.5	21.3	1.7	1032		
Date: 8-10-2018						
Sample Station	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	Atmospheric Pressure (mbar)	Staff Member	Weather
LG01	40.7	15.3	11.2	1012	Daniel Hayden	Cloudy with light rain and wind NW-W, 13°C - 15°C
LG02	49.0	17.0	5.5	1012		

As can be seen in Table 4.6, carbon dioxide (CO_2) and methane (CH_4) were detected at both leachate monitoring wells LG01 and LG02 during the monitoring rounds. Concentrations of both CO_2 and CH_4 within the waste body remain substantially high indicating that biodegradation of the interred waste remains active and the landfill gas risk remains high.

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 Figure 4.2. Monitoring locations SW1 and SW2 are located adjacent to the landfill boundary, with SW2 positioned at the location of EPA monitoring station Cartron Bridge (RS26C200300). Monitoring locations SW3 and SW4 are located downstream of the landfill with SW4 being the furthest point from the site.

Two surface water monitoring rounds were carried out on the 6th September and 26th September 2018.

4.5.2 Monitoring Parameters

The results of surface water sampling analysed from the 4 No. sampling locations (SW01 – SW04) at the site have been assessed against the Maximum Admissible Concentration (MAC) Regulations (1989) and the Environmental Quality Standard (EQS) for Surface Waters Regulations (2009) assessment criteria.

A summary of the maximum values reported for each parameter from the two monitoring rounds is outlined in Table 4.7, while the laboratory reports are presented in Appendix 4.

Table 4.8: Surface Water Sampling Results

Parameter	Units	MAC [1] / EQS [2]	26/09/2018			
			SW1	SW2	SW3	SW4
pH (Laboratory)	pH Units	6.0<pH<9.0[2]	8.08	8.17	8.24	8.05
Dissolved Oxygen	mg/l	<9 – 6 [1]	12.6	12.1	11.9	9.69
Conductivity	µS/cm	1 [1]	0.60	0.613	0.605	0.615
BOD, unfiltered	mg/l	≤2.6 (95%ile)[2]	<1	<1	<1	<1
COD, unfiltered	mg/l	40 [1]	12.8	24.4	<7	16.3
Sulphate	mg/l	200 [1]	32.3	31.9	32	32.1
Chloride	mg/l	250 [1]	27.3	24.7	27.4	29.7
Ammoniacal Nitrogen as N	mg/l	≤0.140(95%ile) [2]	<0.2	<0.2	<0.2	**0.842**
Arsenic	mg/l	0.1 [1]	0.0011	0.00104	0.00115	0.00124
Boron	mg/l	2.0 [1]	0.017	0.021	0.018	0.026
Cadmium	mg/l	0.005 [1]	<0.0008	<0.0008	<0.0008	<0.0008
Calcium	mg/l	--	113	111	109	109
Cyanide, Total	mg/l	0.05 [1]	<0.05	<0.05	<0.05	<0.05
Potassium	mg/l	--	3.17	3.14	3.16	3.43
Sodium	mg/l	200 [1]	15.3	16	20	19.4

Notes:

[1] Maximum Admissible Concentration (MAC), as classified by European Communities (Quality of Surface Water intended for abstraction of drinking water) Regulations 1989 (S.I No. 294 of 1989)

[2] Environmental Quality Standard (EQS), European Communities Environmental Objectives (Surface Waters) Regulations 2009 (S.I No. 272 of 2009)

* Items shaded in **orange** are in exceedance of the 2009 EQS Regulations

4.5.3 Surface Water Analysis Discussion

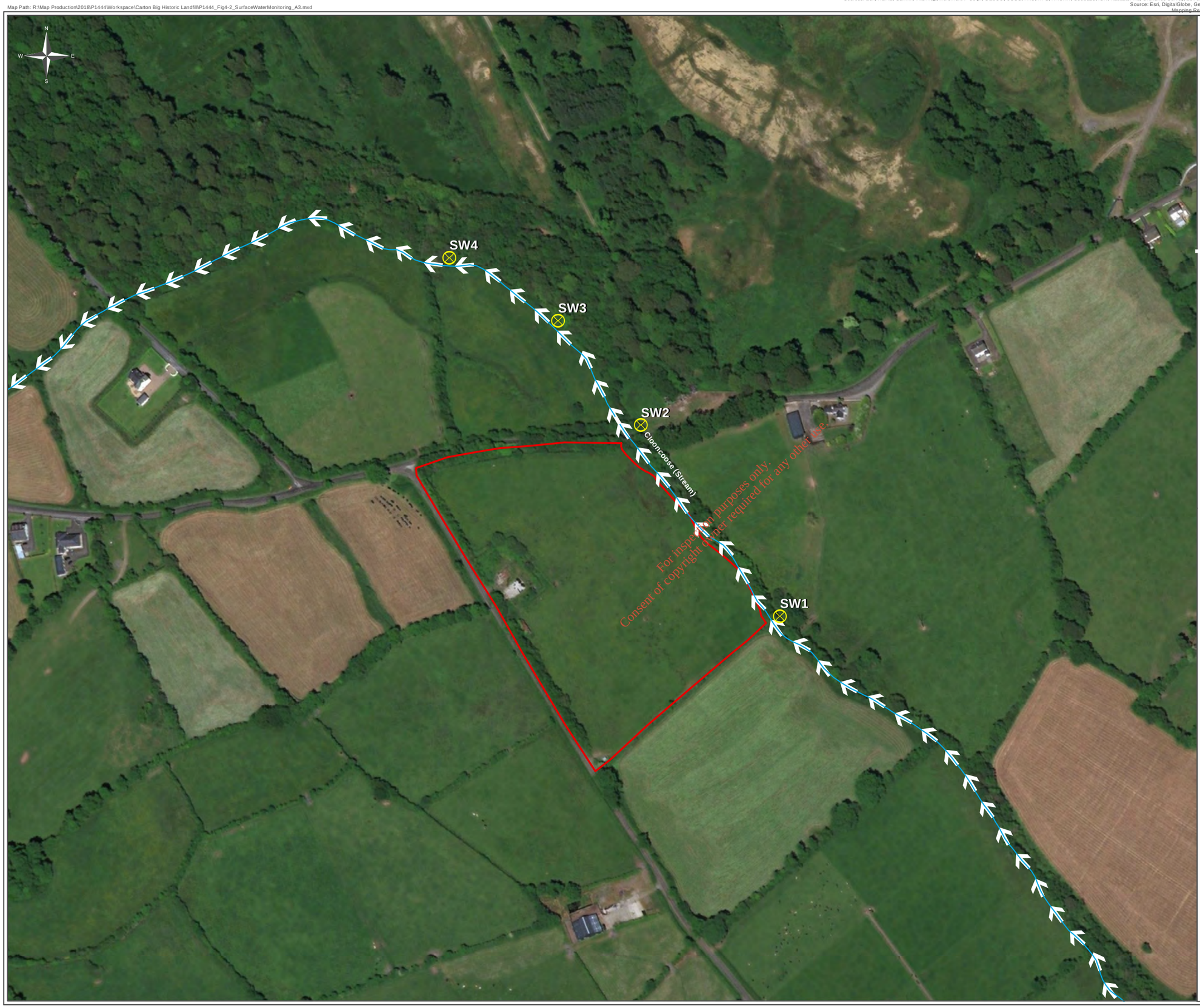
The results of the surface water monitoring from SW1 – SW4 show 1 No. exceedances of the EQS (2009) guideline limit values for ammonia. Results from sampling location SW4 detected an ammonia concentration of 0.842 mg/l. The detection of ammonia at surface water location SW4 indicates to the presence of a pathway, possibly a man-made sub-surface drainage channel flowing north / north-west, from the landfill as depicted on historical mapping (see Figure 2.8). Monitoring location SW4 is located downstream of this discharge location where the presence of an iron precipitate was identified during the site walkover.

The presence of ammonia at this location could also a result of localised slurry spreading.

The remaining results of the surface water laboratory analysis as presented in Table 4.5, when assessed against the MAC (1989) and EQS (2009) quality standards were found to be below the guideline values in all assessments.

As mentioned previously in Section 2.2.7, results for chemical surface water monitoring carried out by the EPA up to 2008 indicate that the quality of surface water in the north-eastern site corner at Cartron Bridge is not being adversely affected by the presence of the landfill. The findings of this Tier 2 assessment would appear to agree with the Good Status classification at Cartron Bridge based on the data recorded from SW-1 and SW-2. However, water quality monitoring 150m downstream of Cartron Bridge at SW4 has detected ammonia concentrations above the guideline threshold levels.

The next EPA monitoring station downstream is located at the R194 Road Bridge (RS26C200500) which is approximately 2.5 km downstream of monitoring location SW4. The water quality status at this location is classified as Good. The elevated ammonia concentrations detected at SW4 is therefore considered to have a localised impact on the Clooncoose Stream.



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Legend

- Monitoring Locations
- Rivers
- Site Boundary

Meters
0 50 100 200

Figure Title
Surface Water Monitoring

Figure No. 4.2

Project
Historical Landfills: Cartron Big

Client
Longford County Council

Scale 1:3,000 **Page Size** A3

Revision A **Date** 02/11/2018

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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 wells 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 generation of landfill gas from the degradation of the biodegradable fraction of deposited waste.

The potential pathways associated with the Cartron Big site are:

- Groundwater migration;
- Surface water infiltration; and
- Landfill gas migration.

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. 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

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

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/Occupied Residential dwellings within 250m of the waste body

It is noted that 2 No. disused derelict structures exist within the site boundary.

5.3 Conceptual Site Model

Based on the desktop investigation and site investigation works undertaken for Cartron Big 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 basic conceptual model to be produced for the site, which is presented in Figure 5.1, overleaf.

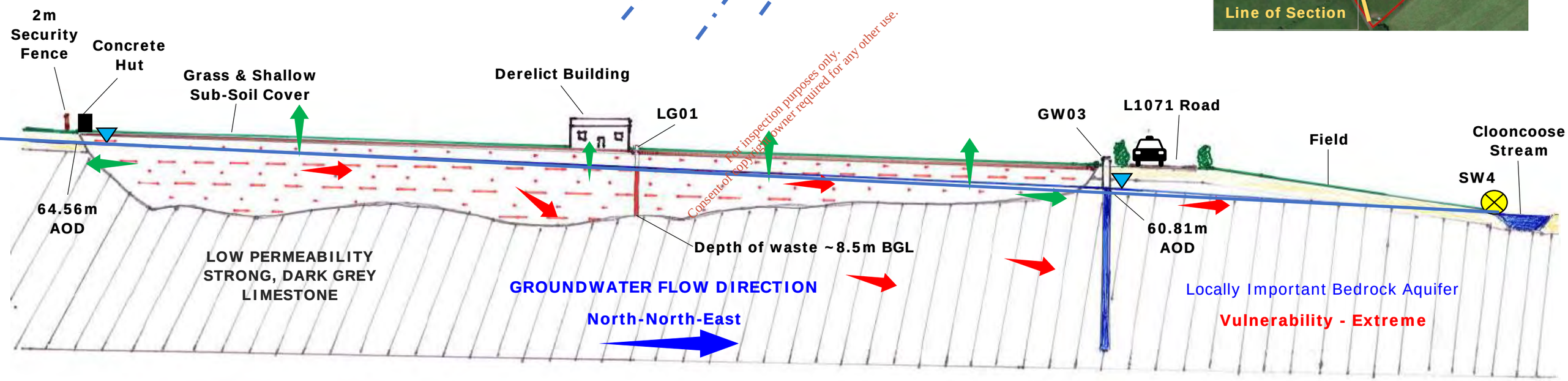
LANDFILL GAS

LEACHATE MIGRATION

Waste – Typically Municipal and Industrial

Measured Groundwater Level

Groundwater Level



S

N

CROSS SECTION SOUTH - NORTH

FIGURE 5.1 CARTRON BIG 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 Cartron Big 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 – Cartron Big Landfill

EPA Ref	Risk	Points	Rationale
1a	Leachate; source/hazard scoring matrix, based on waste footprint.	7	Based on a waste footprint of >1 & <5ha and the assumption that the waste is Municipal / Industrial the score should be in the range of 1 to 7. A score of 7 is being maintained based on an estimated waste footprint of 2.35ha, due to the presence of elevated contaminants in the groundwater samples and the limestone bedrock below the waste body.
1b	Landfill gas; source/hazard scoring matrix, based on waste footprint.	7	Based on a waste footprint of >1 & <5ha and the assumption that the waste is a mixture of Municipal / Industrial the score should be in a range of 1 to 7. A score of 7 is being maintained based on the elevated landfill gas concentrations measured at leachate boreholes LG01 and LG02.

EPA Ref	Risk	Points	Rationale
2a	Leachate migration: Pathway (Vertical)	3	GSI describes the groundwater vulnerability as Extreme to High across the site. There is no liner between the waste and the bedrock at the base of the quarry.
2b	Leachate migration: Pathway (Horizontal)	1	Bedrock beneath the site is classified as a locally important aquifer which is moderately productive only in local zones (Ll).
2c	Leachate migration: Pathway (Surface water drainage)	2	Elevated ammonia concentrations observed at monitoring location SW4 indicate the Clooncoose stream is being impacted by the landfill.
2d	Landfill gas: Pathway (Lateral migration potential)	1.5	Soil in the area is till derived either from cherts or from Carboniferous limestones and shales.
2e	Landfill gas: Pathway (Upwards migration potential)	0	There is no occupied buildings or enclosed structures above the waste body.
3a	Leachate migration: Receptor (Human presence)	2	Nearest dwelling is 135m from the site, and several residences are present within 400 m of the site.
3b	Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/ groundwater dependent terrestrial ecosystems)	0	There is no designated area within a 1 km radius of the site.
3c	Leachate migration: Receptor (Aquifer category – Resource potential)	3	Bedrock beneath the site is classified as a locally important aquifer which is moderately productive only in local zones (Ll).
3d	Leachate migration: Receptor (Public water supplies – other than private wells)	0	Groundwater flow direction is confirmed to be due north-north-east and public water supply is located 1km east of the site. The bedrock aquifer is not karstic.
3e	Leachate migration: Receptor (Surface water bodies)	3	The Clooncoose stream forms the eastern site boundary.
3f	Landfill Gas: Receptor (Human presence)	3	Nearest dwelling is approximately 135m due north-east of the site.

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	7 x (3+1+2) x 3 = **126**	300	Leachate => surface water	42%
SPR2	1a x (2a + 2b + 2c) x 3b	7 x (3+1+2) x 0 = **0**	300	Leachate => SWDTE	0%

Calculator		S-P-R Values	Maximum Score	Linkage	Normalised Score
Leachate migration through groundwater pathway					
SPR3	1a x (2a + 2b) x 3a	7 x (3+1) x 2 = **56**	240	Leachate => human presence	23.3%
SPR4	1a x (2a + 2b) x 3b	7 x (3+1) x 0 = **0**	240	Leachate => GWDTE	0%
SPR5	1a x (2a + 2b) x 3c	7 x (3+1) x 3 = **84**	400	Leachate => Aquifer	21%
SPR6	1a x (2a + 2b) x 3d	7 x (3+1) x 0 = **0**	560	Leachate => Surface Water	0%
SPR7	1a x (2a + 2b) x 3e	7 x (3+1) x 3 = **84**	240	Leachate => SWDTE	35%
Calculator	**S-P-R Values**		**Maximum Score**	**Linkage**	**Normalised Score**
Leachate migration through surface water pathway					
SPR8	1a x 2c x 3e	7 x 2 x 3 = **42**	60	Leachate => Surface Water	**70%**
SPR9	1a x 2c x 3b	7 x 2 x 0 = **0**	60	Leachate => SWDTE	0%
Landfill gas migration pathway (lateral & vertical)					
SPR10	1b x 2d x 3f	7 x 1.5 x 3 = **31.5**	150	Landfill Gas => Human Presence	21%
SPR11	1b x 2e x 3f	7 x 3 x 3 = **63**	250	Landfill Gas => Human Presence	25.2%
Site maximum S-P-R Score					**70%**
Risk Classification					**A – High Risk**

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 principal risks identified on the site are the migration of leachate from the site to the groundwater aquifer and the risk posed to the Clooncoose Stream from the migration of landfill leachate from the waste material encountered at the site.

6 CONCLUSIONS & RECOMMENDATIONS

A Tier 2 study was conducted by FT in accordance with the EPA CoP for Cartron Big Historic Landfill. The study consisted of a desktop study, site walkover, intrusive site investigation works, geophysical survey and associated environmental monitoring. These works informed the development of the CSM and risk screening model.

The findings of the intrusive works suggest the waste material is deposited in a single infill area tending north-west to south-east and between 210m in length and 140m in width. Based on this interpretation, the maximum waste footprint is calculated to be 5.80 acres or 2.35 hectares.

A volume calculation was conducted based on the results of the geophysical survey of the existing ground level and the base of waste as interpreted, with estimates indicating an interred waste volume of approximately 206,000 m^3 at the site.

Analysis of waste samples from the trial pits excavated indicate that the waste material encountered within the site is typically non-hazardous. Based on the 5 No. waste acceptance criteria (WAC) tests completed and the representative spread across the Cartron Big site, the site investigation suggests that approximately 80% of the interred waste material tested may be classified as non-hazardous.

Analysis of groundwater samples obtained from monitoring wells GW01, GW02 (upgradient) and GW03 (down gradient) indicate concentration differences between upgradient and downgradient monitoring locations suggests that the landfill is contributing locally to a slight deterioration groundwater quality north of the site boundary.

Groundwater analysis also indicates the presence of elevated ammonia and coliform concentrations in all monitoring wells. This may be evidence of local impact from agricultural land spreading or poorly functioning septic tanks in the area.

Notwithstanding the range of groundwater threshold exceedances recorded, the low infiltration results from the in-situ permeability testing of the limestone bedrock suggest that rapid vertical leachate migration into the bedrock aquifer may be minimised by the dense nature of the rock mass. Therefore, the low permeability limestone bedrock underlying the waste body is potentially confining the contaminated leachate at the bedrock surface.

Despite the risk to the County Council's public water supply borehole (ID: 2027SEW013) located 1km east of the site boundary as identified in the Tier 1 assessment, the determined groundwater flow direction is north-north-east of the site which suggests that any leachate plume migrating north from the landfill will not impact on abstracted water quality.

Surface water results recorded at SW1 and SW2 would appear to concur with the Good Status chemical surface water quality at Cartron Bridge as indicated from available EPA water quality data up to 2008. However, water quality monitoring 150m downstream of Cartron Bridge (RS26C200300) at SW4 has detected ammonia concentrations above guideline threshold levels. The detection of ammonia at this location indicates the presence of a pathway, possibly a man-made drainage channel flowing north / north-west, from the landfill, as depicted in historical mapping for the area.

The next EPA monitoring station downstream is located at the R194 Road Bridge (RS26C200500) which is approximately 2.5 km downstream of monitoring location SW4. The water quality status at this location is classified as Good. The elevated ammonia concentrations detected at SW4 is therefore considered to have a localised impact on the Clooncoose Stream.

The results of the Tier 2 assessment and risk model indicate that the site is being maintained as a **High-Risk Classification (Class A)**. The principal risks identified on the site are the migration of leachate from the site to the groundwater aquifer and the risk posed to the Clooncoose Stream from the migration of landfill leachate from the waste material encountered at the site.

6.1 Recommendations

Based on the results of this Tier 2 assessment the site is classified as High Risk. The site is therefore: "considered to pose a significant risk to the environment or human health." For a high-risk site, the CoP indicates that a Tier 3 environmental risk analysis be undertaken including a Detailed Quantitative Risk Assessment. Further the site be regularised/authorised in accordance with current waste management legislation.

It is therefore recommended by FTC that a Tier 3 DQRA be undertaken for the site in conjunction with an application for a Certificate of Registration for this site.

FT further recommended that further groundwater, surface water monitoring and landfill gas monitoring and analysis be undertaken at each monitoring location GW01 to GW03 and SW1 to SW4 inclusive. The results of this analysis should be used to confirm the conclusion of the Tier 3 report and inform works.

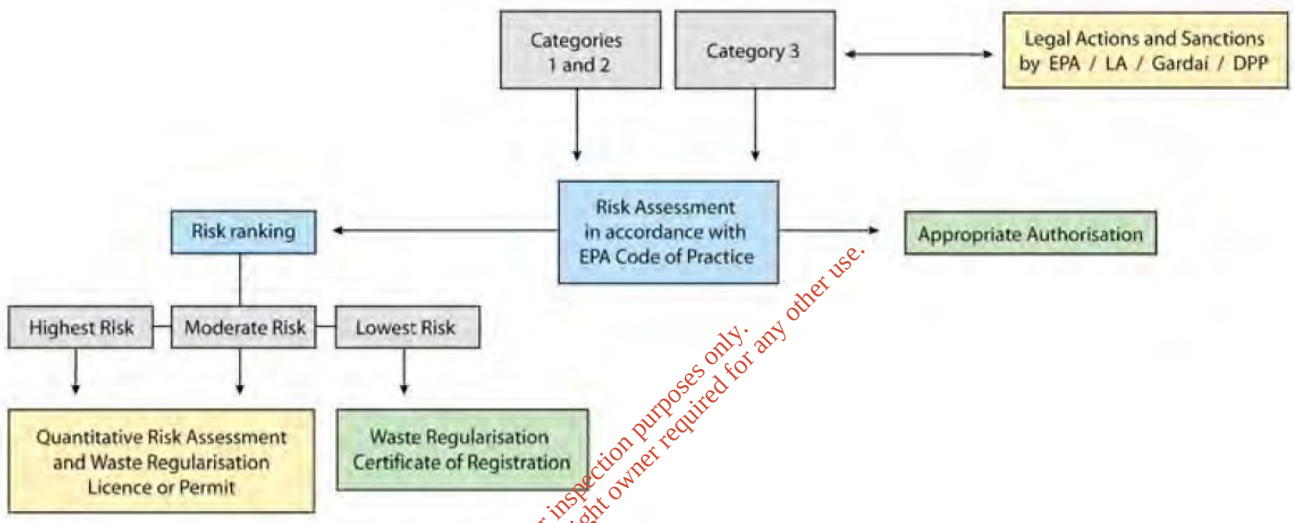

Figure 6.1: Extract from Section 1.3 of the EPA Code of Practice