FEHILY TIMONEY

CONSULTANTS IN ENGINEERING,
ENVIRONMENTAL SCIENCE & PLANNING

TIER 2 RISK ASSESSMENT
HISTORIC LANDFILL AT LENAMORE, CO. KERRY

Prepared for: Kerry County Council

Comhairle Contae Chiarraí
Kerry County Council

Date: August 2021

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TIER 2 RISK ASSESSMENT

HISTORIC LANDFILL AT LENAMORE, CO. KERRY

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Abstract: This report represents the findings of a Tier 2 site environmental risk assessment carried out at Lenamore Historic Landfill, Co. Kerry. The risk assessment was conducted in accordance with the EPA Code of Practice for unregulated landfill sites.

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EXECUTIVE SUMMARY

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

The Lenamore Historic Landfill covers an area of approximately 0.5 hectares and is located in a rural setting. The Corine 2018 land use classification for the site is inland wetland and peat bog. The site is currently privately owned. The site is bounded to the south by a small local road. All other sides are surrounded by agricultural land (forestry) and bog. There are no dwellings located within the site boundary or immediately adjacent to the site. The nearest dwelling is located approximately 400m North-West of the site.

A Tier 1 assessment prepared by Kerry County Council (KCC) indicates that the site started accepting waste material after 1986. Available evidence suggests that landfilling activities had ceased by 1996.

The Tier 2 study, presented herein, consisted of a desktop study, intrusive site investigation works, environmental monitoring and laboratory analysis. The results of these works informed the development of the CSM (conceptual site model) and risk screening model.

The following site investigation works were undertaken at the site:

- 4 No. Trial pit excavations
- Installation and monitoring of 1 No. groundwater borehole
- Groundwater, surface water and landfill gas monitoring
- Factual reporting.

Analysis of waste samples from the trial pits excavated, when assessed against the inert waste acceptance criteria indicated that much of the waste material within the site can be classified as typically inert. The waste classification is considered to reflect the level of degradation over time since landfilling ceased. Trial pitting confirmed the waste material is near the surface with a minimal topsoil and clay cover present across the site.

Based on the findings of the site investigation, the waste footprint is calculated as covering the main body of the site over an area of approximately 5,450m^2. A volume calculation was conducted based on the existing ground level and the depth of waste, estimates indicate an interred waste volume of approximately 13,152m^3 (c.16,000 tonnes).

Landfill gas monitoring from borehole BH01 at the site indicates gas concentrations detected are below threshold levels set by the EPA CoP.

Based on the results of the Tier 2 site assessment, the site can be classified as a **Moderate Risk Classification (Class B)**. The principal risk identified on the site is the risk posed to the surface water and Surface water dependent terrestrial ecosystem from migration of leachate from the waste material encountered at the site through groundwater and surface water.

1. INTRODUCTION

1.1 Background

The Lenamore Historic Landfill covers an area of approximately 0.5 hectares and is located in a rural setting. The Corine 2018 land use classification for the site is inland wetland and peat bog. The site is currently privately owned. The site is bounded to the south by a small local road. All other sides are surrounded by agricultural land (forestry) and bog. There are no dwellings located within the site boundary or immediately adjacent to the site. The nearest dwelling is located approximately 400m North-West of the site. Available evidence suggests that landfilling commenced after 1986 and that landfilling activities had ceased by 1996.

KCC 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 unregulated waste disposal sites.

The Tier 1 Assessment completed in 2007 determined the site has a risk classification of Moderate (Class B). A subsequent Tier 1 Assessment was completed in 2013. This assessment determined the site has a risk classification of Low (Class C).

Copies of the assessments are included in Appendix 1.

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
- Site Walkover
- Intrusive Site Investigation
- Environmental Testing
- Environmental Risk Assessment (ERA)
- 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.

A copy of the site walkover checklist and photo log is presented in Appendix 2.

FT appointed Causeway Geotech Limited (CGL) to conduct the intrusive site investigation which included; excavation of 4 No. trial pits and the installation of 1 No. groundwater monitoring borehole.

A full geotechnical report is included in Appendix 3 to this document.

Laboratory analysis of waste encountered during trial pitting was undertaken results are presented in Appendix F, CGL Site Investigation Report. (See Appendix 3 this report) Surface and groundwater monitoring were conducted to assess and quantify any potential or ongoing environmental impacts from the site. The results of surface and groundwater monitoring are provided in Appendix 4.

The information gathered from the desk study, intrusive site investigation and geophysical survey were used to inform the development of 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: http://gis.epa.ie/Envision
- National Parks and Wildlife Service Map Viewer: www.npws.ie
- DoHPLG/EPA/Local Authority maps: www.catchments.ie
- BS 10175: 2000, Investigation of Potentially Contaminated Sites – Code of Practice
- EPA - Assessing and Developing Natural Background Levels for Chemical Parameters in Irish Groundwater (2017)

A desktop review of available documentation for the site was conducted followed by a site walkover on 14th February 2019.

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 Lenamore Historic Landfill covers an area of approximately 0.5 hectares and is located in a rural setting. The Corine 2018 land use classification for the site is inland wetland and peat bog. The current land use is a deciduous plantation (alder). Classification for surrounding land is primarily agricultural area and pastures with areas of forestry.

The site is bounded to the south by a small local road. All other sides are surrounded by agricultural land (forestry) and bog. There are no dwellings located within the site boundary or immediately adjacent to the site. The nearest dwelling is located approximately 400m north-west of the site.

The location of the site is shown in Figure 2.1.

2.2.2 Previous Studies

A Tier 1 Risk Assessment was completed by KCC, utilising the EPAs online Tier 1 Environmental Risk Assessment tool. A site walkover was also conducted in 2007.

The Tier 1 assessment 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 the available information, the Tier 1 Assessment determined that the overall risk score for Lenamore Landfill was 50%, resulting in a risk classification of Moderate (Class B).

A subsequent Tier 1 Assessment was completed in 2013 by KCC. This assessment determined that the overall risk score for Lenamore Landfill was 11%, resulting in a risk classification of Low (Class C).

Copies of the assessments are included in Appendix 1.

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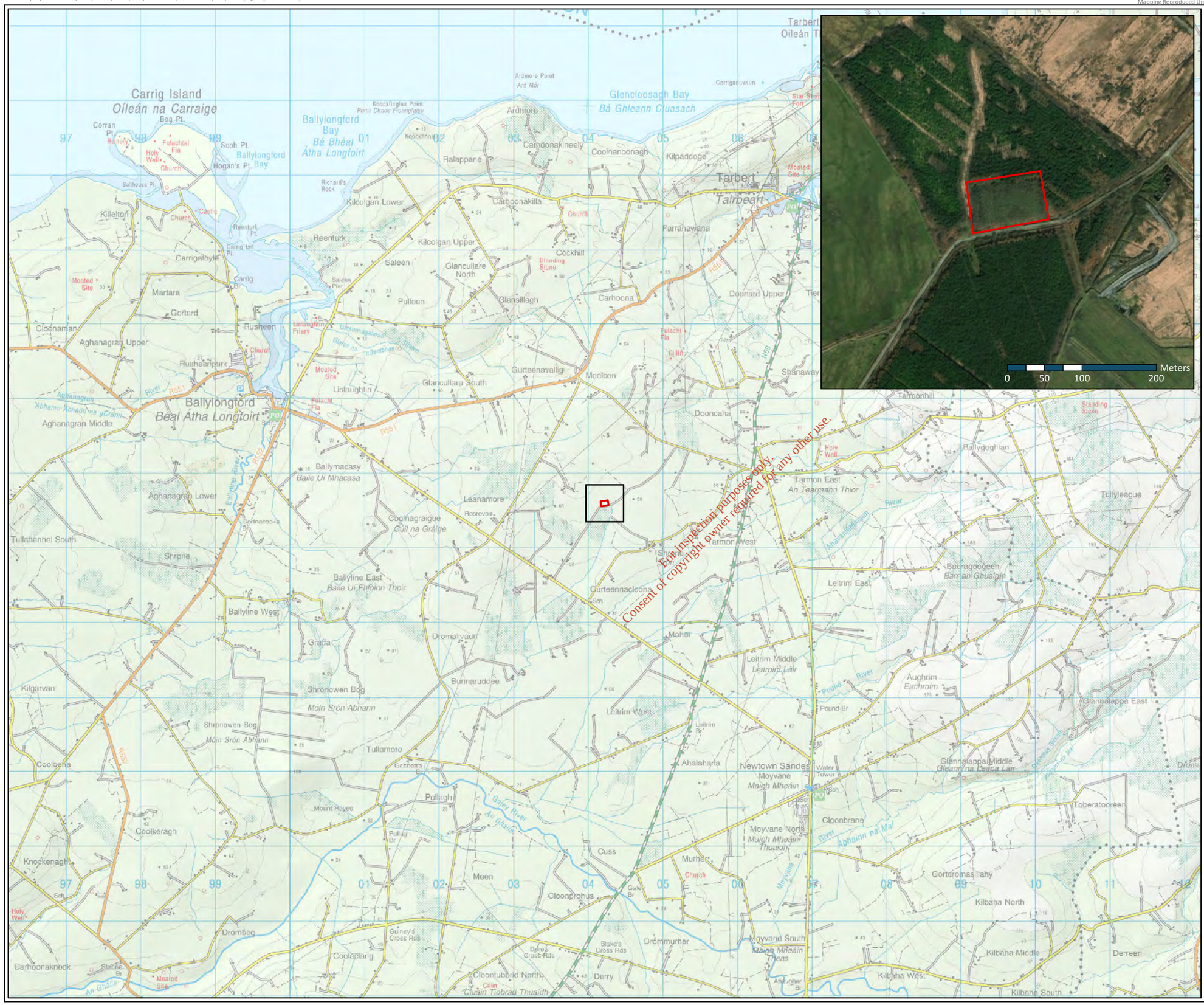

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FIGURE NO:	2.1
CLIENT:	Kerry County Council
SCALE:	1:50000
REVISION:	0
DATE:	29/10/2019
PAGE SIZE:	A3

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2.2.3 Topography

The landfill is located within a rural, agricultural area in north Kerry, south of the Shannon Estuary. Regional topography is undulating with the topography generally sloping to the west and north towards the town of Ballylongford and towards the Shannon estuary. The site is located on of the slopes of a low-lying hill with elevations increasing immediately north of the site.

2.2.4 Geology

Drift/Quaternary Geology

The Quaternary Map provided by GSI Online identifies the quaternary sediments at the site as 'Cut over raised peat'. Lands immediately surrounding the site are also described as peat. Beyond this area of peat, the soil is characterised as 'Till derived from Namurian sandstones and shales'.

The quaternary geology is presented in Figure 2.2.

During the installation of boreholes during the site investigation, the presence of peat and grey sandy gravelly clay are described in the driller's logs to a depth of approximately 8.5m BGL at borehole BH01. The CGL borehole logs are presented in Appendix 3.

Solid or Bedrock Geology

The GSI online 1:100,000 scale bedrock geology map, shows the bedrock beneath to be found on a single formation. The entirety of the site and surrounding area are underlain by the Shannon Group formation (CNSHG) which is generally made up of Namurian, undifferentiated mudstone, siltstone and sandstone. No areas of bedrock outcrop are shown within or in the immediate vicinity of the site.

The bedrock geology is presented in Figure 2.3.

No bedrock was encountered during intrusive site investigations.

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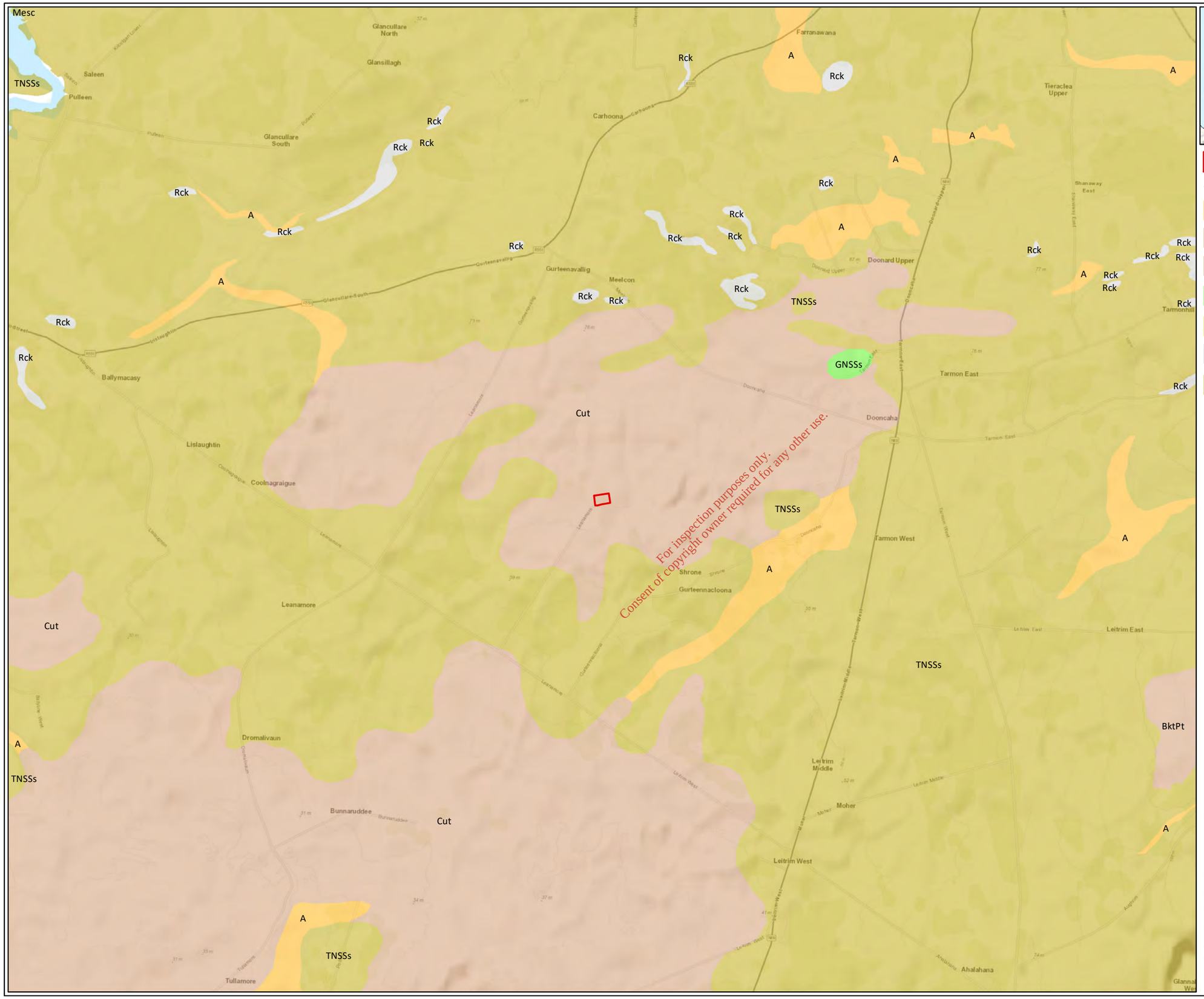

Site Boundary

Quaternary Sediments

- A, Alluvium
- BktPt, Blanket
- Cut, Cut over raised
- GNSSs, Gravels derived from Namurian sandstones and shales
- Mesc, Esturine silts and clays
- Rck, Bedrock outcrop or subcrop
- TNSSs, Till derived from Namurian sandstones and shales

N W E S

0 0.5 1 2 Kilometers

TITLE:	Quaternary Geology		
PROJECT:	Environmental Risk Assessment for Lenamore Landfill, Co. Kerry		
FIGURE NO:	2.2		
CLIENT:	Kerry County Council		
SCALE:	1:25000	**REVISION:**	0
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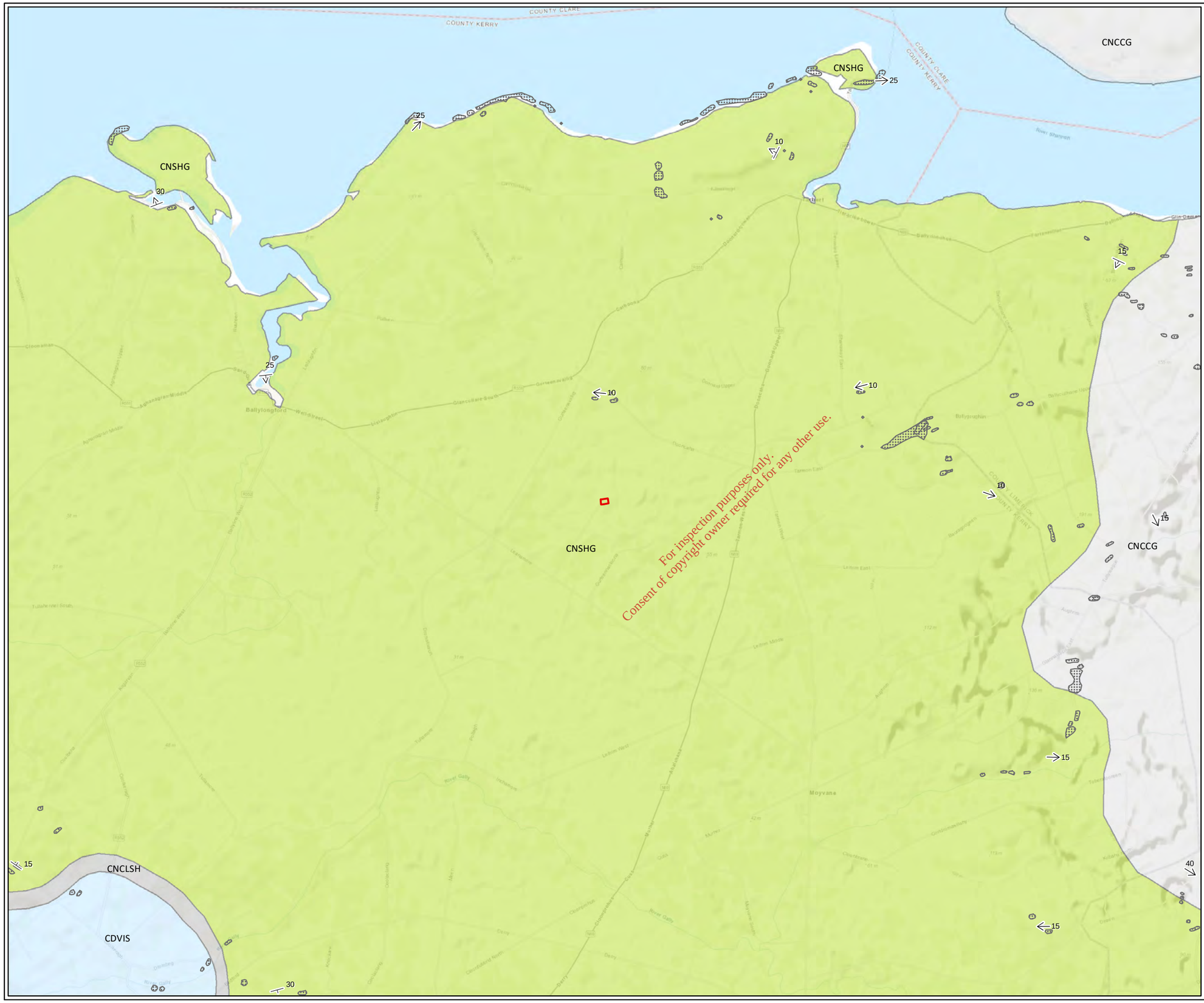

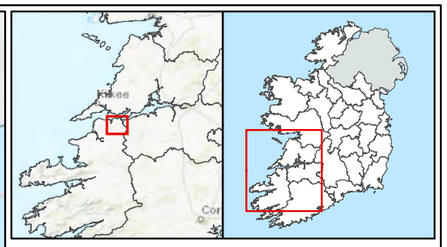

Site Boundary

Dip of bedding or main foliation, old GSI data

Strike and dip of bedding, right way up

Strike and dip of bedding, way up unknown

Bedrock Outcrop

Bedrock Geology

Visean Limestones (undifferentiated

Central Clare Group

Clare Shale Formation

Shannon Group

N
W E
S

0 0.5 1 2 Kilometers

TITLE:	Bedrock Geology		
PROJECT:	Environmental Risk Assessment for Lenamore Landfill, Co. Kerry		
FIGURE NO:	2.3		
CLIENT:	Kerry County Council		
SCALE:	1:50000	**REVISION:**	0
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2.2.5 Hydrogeology

An examination of the national bedrock aquifer map on the GSI online mapping classifies the Shannon formation as a 'Locally important aquifer – bedrock which is moderately productive only in Local Zones'. The bedrock aquifer mapping is presented in Figure 2.4.

There are no karst landforms within the site boundary or in the immediate vicinity.

Historical mapping for the area shows no springs in the immediate vicinity of the site or the surrounding area. The nearest residence is located approximately 350m away. There are a number of other single, stand-alone dwellings in the wider environment where unregistered private wells may be present.

Table 2.1 presents the details of the GSI registered boreholes and springs within 1km of the site. It is noted that all wells listed below have location accuracies of 1 – 2km and maybe located outside of the 1km radius.

Table 2.1: Borehole and Spring Descriptions near the Project Site

BH/Spring	Yield class	Yield (m^3/day)	Use	Depth (m)	Depth to Rock confidence (m)	Distance from site (km)	Date
0813NEW024	Poor	22	Agri & domestic	12.2	24.4	0.6	1974
0813NEW085	Poor	22	Agri & domestic	16.8	18.3	0.3	1974
0813NEW079	Poor	22	Agri & domestic	-	10.7	0.3	1974
0813NEW034	Poor	31	Agri & domestic	10.1	18.3	0.65	1972
0813NEW035	Moderate	71	Agri & domestic	9.4	17.4	0.65	1971
0813NEW056	Poor	21.8	Agri & domestic	24.4	28	0.66	1969
0813NEW057	Poor	22	Agri & domestic	-	2.1	0.7	1973
0813NEW068	Poor	28	Agri & domestic	20.1	31.7	0.75	1973
0813NEW069	Poor	22	Agri & domestic	5.5	5.5	0.8	1973

There are no Groundwater Drinking Water Protection Areas within the site boundaries according to GSI. The nearest groundwater protection zone is located approximately 9km north-east of the site.

The GSI shows that the groundwater body (GWB) is named Abbeyfeale GWB and is classified as poorly productive bedrock and is defined as being at *Good Status* under the Water Framework Directive (WFD). The WFD risk to groundwater quality is currently 'Not at Risk'.

There are no recorded groundwater dependent ecosystems in the area.

GSI mapping shows groundwater recharge to be variable in the region. The GSI national recharge map defined the annual recharge for the site as 29 mm/yr. The effective rainfall for the area is 731 mm/yr, returning a recharge coefficient of 4%.

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

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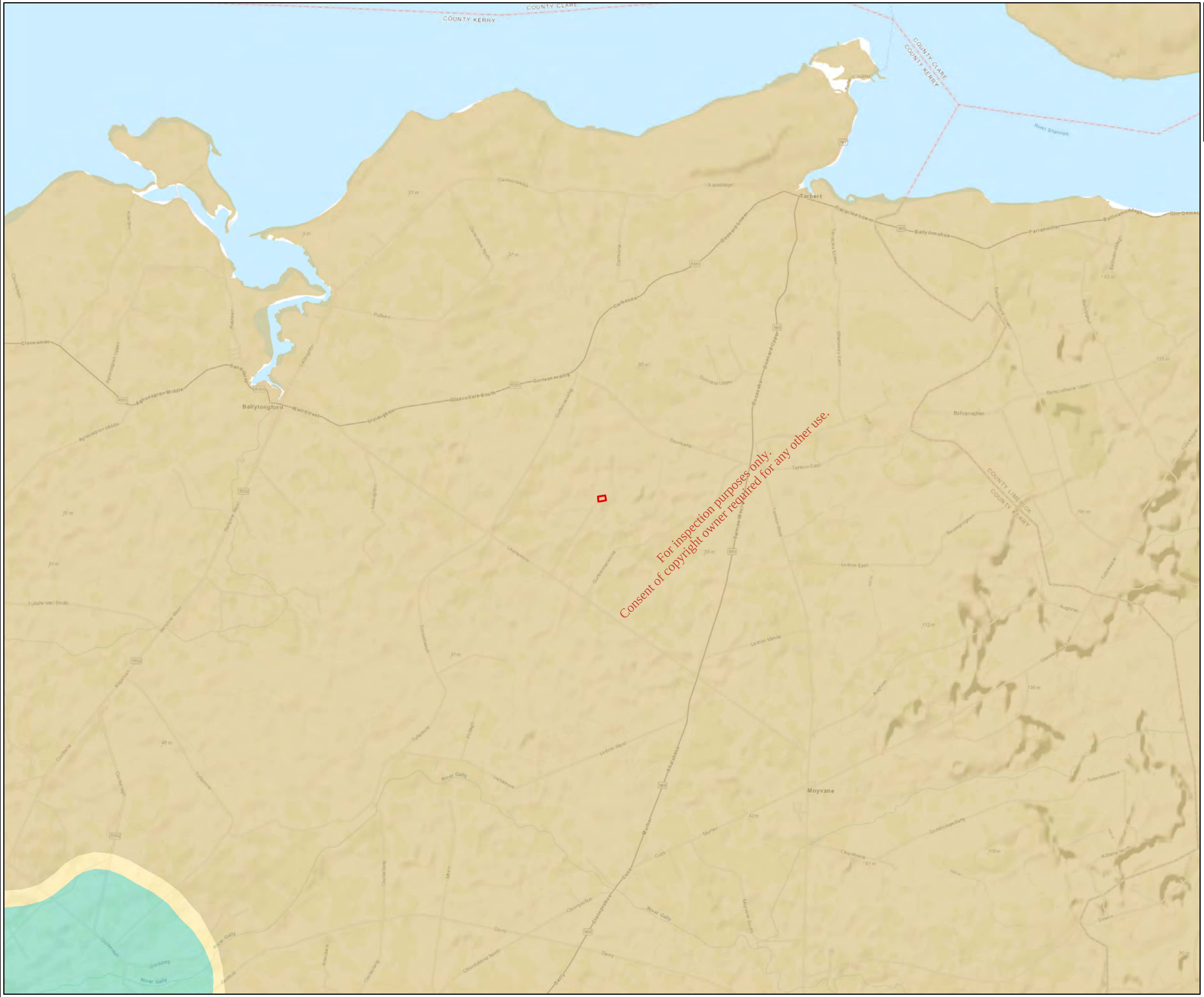

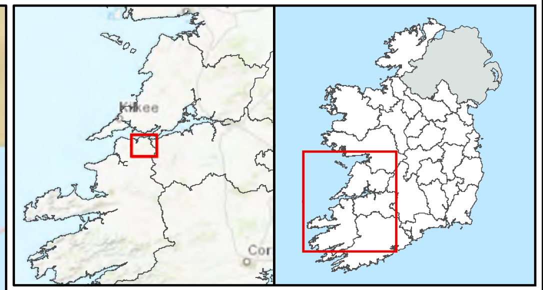

Site Boundary

Bedrock Aquifers

LI: Locally Important Aquifer - Bedrock Mod Productive Locally

Pu: Poor Aquifer Bedrock Generally Unproductive

Rkd: Regionally Important Aquifer - Karstified (diffuse)

TITLE: Aquifer Classification	
PROJECT: Environmental Risk Assessment for Lenamore Landfill, Co. Kerry	
FIGURE NO: 2.4	
CLIENT: Kerry County Council	
SCALE: 1:50000	**REVISION:** 0
DATE: 29/10/2019	**PAGE SIZE:** A3

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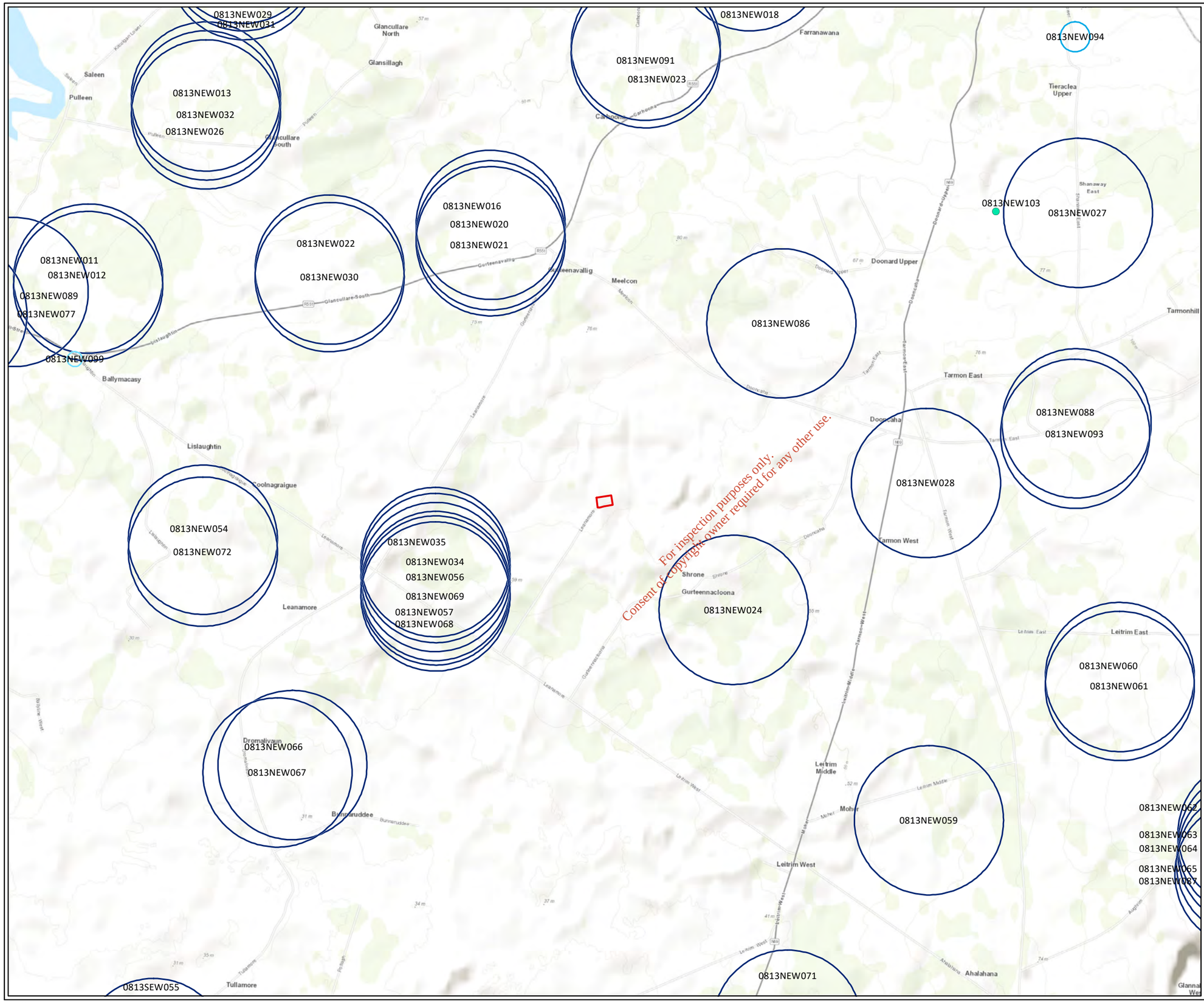

N
W E
S

0 0.5 1 2 Kilometers

TITLE:	GSI Wells and Springs		
PROJECT:	Environmental Risk Assessment for Lenamore Landfill, Co. Kerry		
FIGURE NO:	2.5		
CLIENT:	Kerry County Council		
SCALE:	1:25000	**REVISION:**	0
DATE:	29/10/2019	**PAGE SIZE:**	A3

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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 2.2. 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 Low. The Groundwater Vulnerability mapping is presented in Figure 2.6.

Table 2.2: 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

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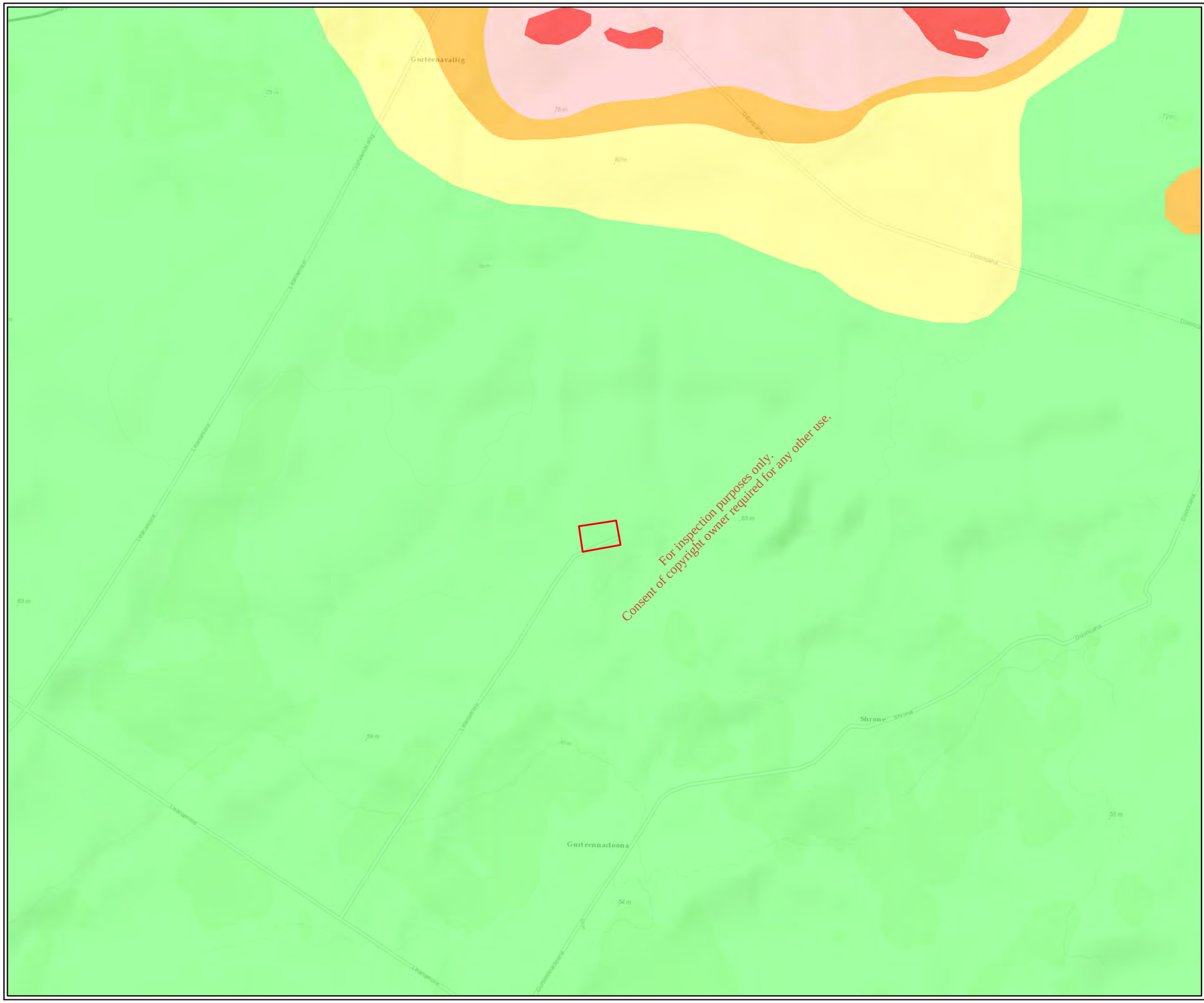

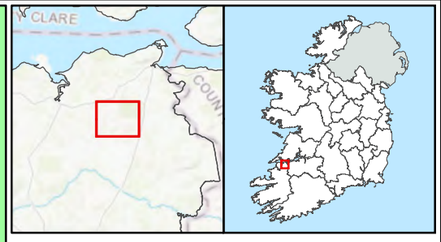

Legend

- Site Boundary

Groundwater Vulnerability

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

N
W E
S

0 0.25 0.5 1 Kilometers

TITLE:	Groundwater Vulnerability		
PROJECT:	Tier 2/3 Assessment for Leanamore Landfill		
FIGURE NO:	2.6		
CLIENT:	Kerry County Council		
SCALE:	1:10000	**REVISION:**	0
DATE:	20/04/2021	**PAGE SIZE:**	A3

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2.2.7 Hydrology

The site is located within the catchment of the Tralee Bay-Feale, Sub-catchment Galey and Tarmon Stream river sub-basin. The nearest surface water feature is the Gurteenacloona stream located approximately 30m south-east of the site. The Gurteenacloona stream flows in a south/south-westerly direction meeting another stream (the Leanamore). The Leanamore stream eventually meets the River Tyshe c. 2.1km south-west of the site. The site is surrounded by drainage ditches.

2.2.8 Ecology

The site is not within or directly adjacent to any Natural Heritage Area (NHA), proposed NHA (pNHA), Special Area of Conservation (SAC) or Special Protection Area (SPA). The nearest protected site is SAC is Bunnaruddee Bog NHA (Site Code: 0013520). There are no other protected sites in the vicinity of the site or any sites that would be considered likely to be at risk.

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. The OSI identifies the land within the site boundary was likely to be for agricultural use. There are no distinct features noted within the site boundary or in the vicinity, on the map series. Previously a gravel pit and arable land, with the surrounding area previously arable land. As with the 1837-1842 map series review of the 1888 – 1913 historical map shows no specific use or historical function of the site. Symbology shown indicates that the site was described as marshy.

The OSI Historical Mapping is presented in Figure 2.8.

Historical aerial imagery from 1995 (Figure 2.10) shows evidence of filling activities, while on the 2000 imagery (Figure 2.11) it is possible to see vegetation, indicating that the filling has ceased.

2.2.10 Existing Geological Heritage

The GSI holds no records of areas of Geological Heritage within the site boundary or in the immediate vicinity of the site.

The geological heritage mapping is presented in Figure 2.9.

2.2.11 Existing Geotechnical Stability

The GSI landslides database indicates that there are no recorded geo-hazards within the site boundary or in the surrounding area or region.

2.2.12 Archaeological Heritage

There are archaeological or historical features of interest within or in the vicinity of the site boundary.

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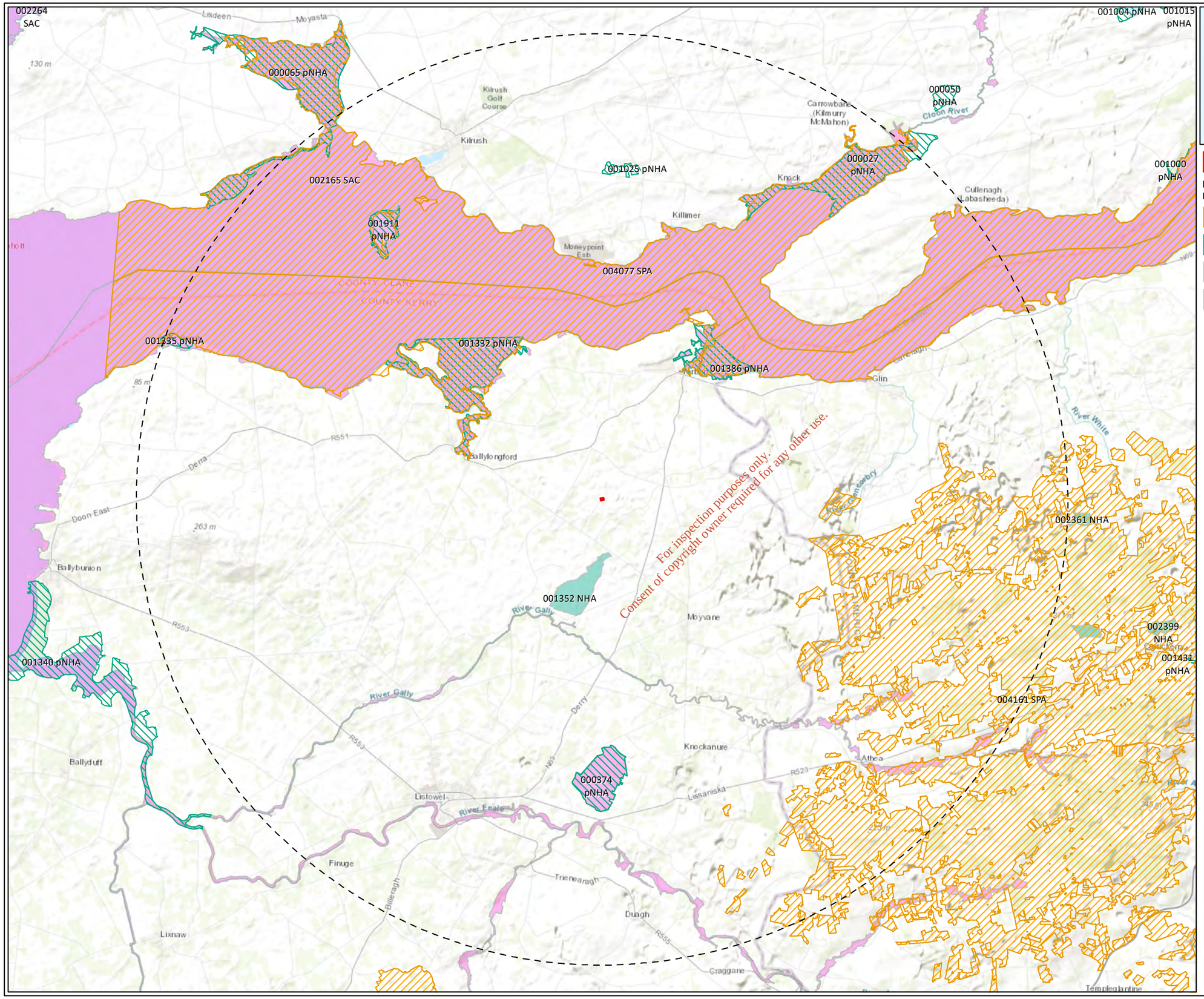

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PROJECT:	Environmental Risk Assessment for Lenamore Landfill, Co. Kerry
FIGURE NO:	2.7
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REVISION:	0
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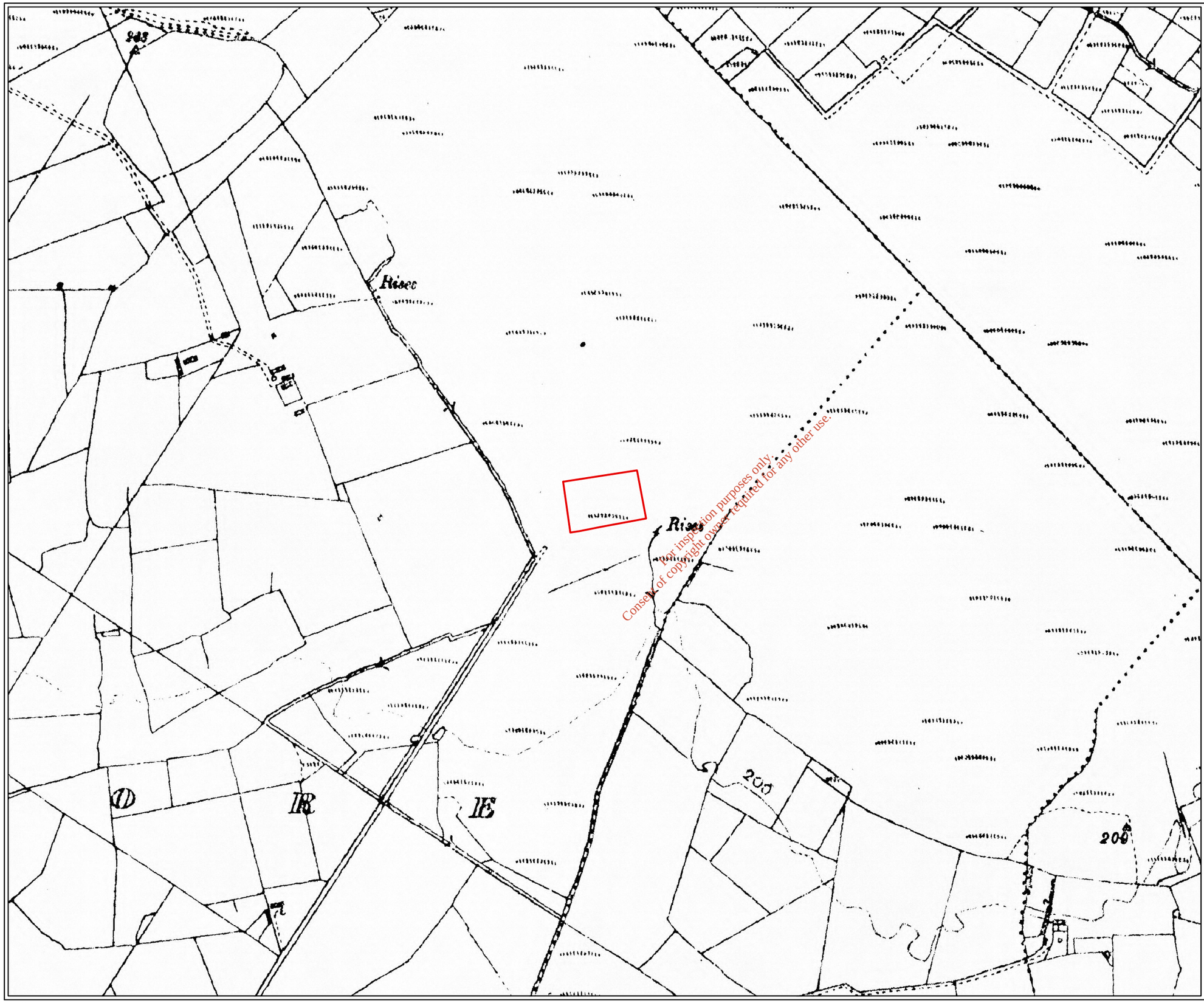

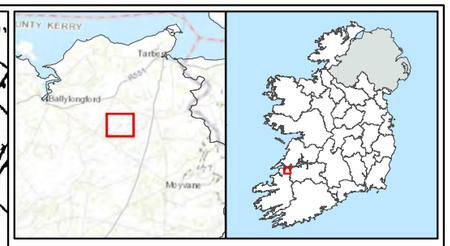

Site Boundary

N W E S

0 50 100 200 Meters

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PROJECT:	Environmental Risk Assessment for Lenamore Landfill, Co. Kerry		
FIGURE NO:	2.8		
CLIENT:	Kerry County Council		
SCALE:	1:5000	**REVISION:**	0
DATE:	29/10/2019	**PAGE SIZE:**	A3

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Foohagh Point

Gull Island, Tullig Point and Trusklieve section

Doonaha

Lixnaw Quarry

Foynes Island

Foynes road section and inland outcrop

St. Bridget's (Newcastle West)

Tobergal

Geological Heritage Sites

Geological Heritage Sites (Audited)

Site Boundary

TITLE:	Geological Heritage
PROJECT:	Environmental Risk Assessment for Lenamore Landfill, Co. Kerry
FIGURE NO:	2.9
CLIENT:	Kerry County Council
SCALE:	1:175000
REVISION:	0
DATE:	29/10/2019
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N W E S

0 1 2 4 Kilometers

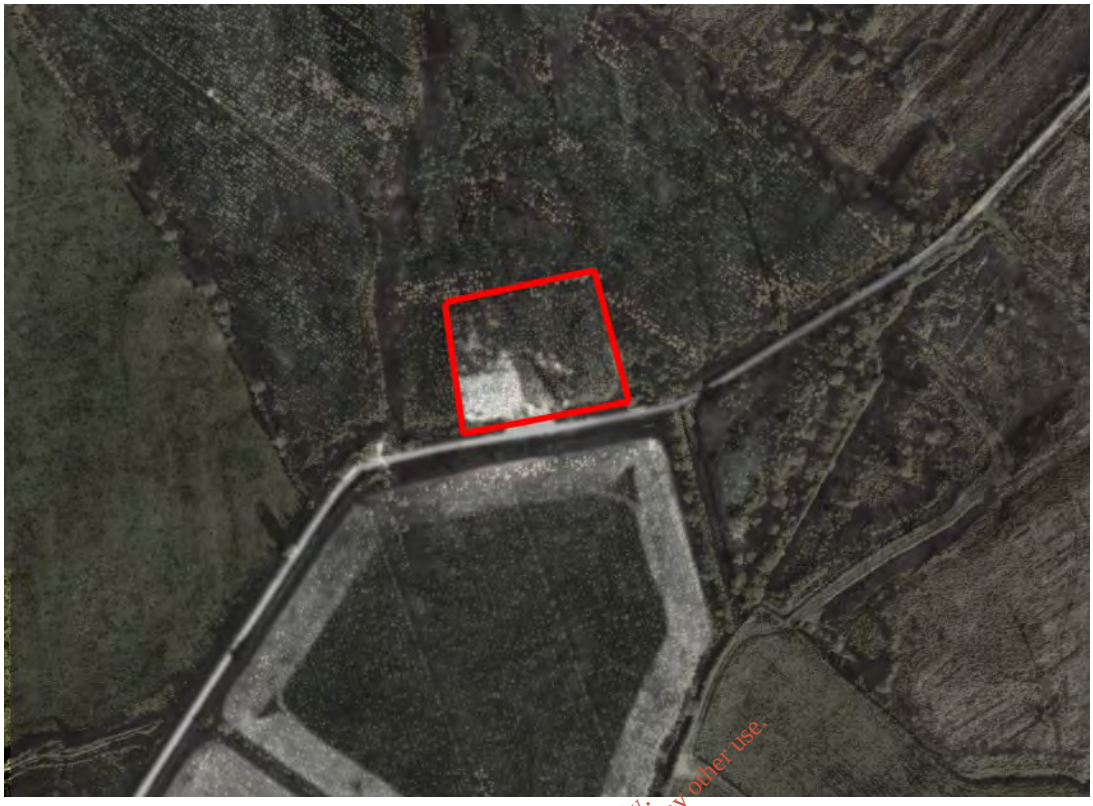


Figure 2.10: Historical Aerial Imagery (1995)[1]

Figure 2.11: Historical Aerial Imagery (2000)[2]

[1] *Source:* http://map.geohive.ie/

[2] *Source:* http://map.geohive.ie/

3. TIER 2 SITE INVESTIGATION

3.1 Site Investigation Works

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

The scope of site investigation works included:

- Site Walkover
- 4 No. Trial pit excavations
- Installation and monitoring of 1 No. groundwater borehole
- Factual reporting

The locations of the intrusive works at the site are presented in **Error! Reference source not found.**. There was limited access to the site due to extensive vegetation/tree planting.

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)
- 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

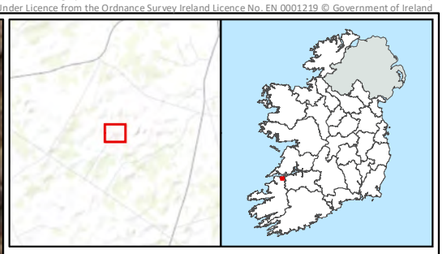
A site walkover was conducted prior to site investigation works by an FT Engineer on the 14th February 2019. During the site walkover the scope of the investigative works were evaluated based on the findings in the Tier I assessment.

The scope was agreed based on the site walkover assessment, historic aerial photography and other information received by KCC.

The current land use is forestry and an access road, same as its surroundings, however there is a bog 100m to the north.

The Gurteenacloona stream is located approximately 30m south-east of the site. The Gurteenacloona stream flows in a south/south-westerly direction meeting another stream (the Leanamore). Drainage ditches are present around the site boundary. Bogland was identified to the North of the site.

The site walkover checklist and photo log are included in Appendix 2.



Borehole

Trial Pit

Site Boundary

TITLE:	Site Investigation Location Plan		
PROJECT:	Lenamore Landfill, Co. Kerry		
FIGURE NO:	3.1		
CLIENT:	Kerry County Council		
SCALE:	1:1500	**REVISION:**	0
DATE:	13/11/2019	**PAGE SIZE:**	A3

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3.1.2 Trial Pitting

A Causeway Geotech (CGL) Engineering Geologist supervised the advancement of 4 No. trial pits, shown in Figure 3.1, on the 6th June 2019.

The trial pits (TP01, TP02, TP04 and TP05) were excavated to depths of 2.50m to 2.60m below existing ground level (BGL) using a JCB 3CX excavator fitted with a 600mm wide bucket.

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 2.

Table 3.1: Summary of Ground Conditions

Trial Pit ID	Depth of cover material (m BGL)	Depth to base of made ground/waste (m BGL)	Profile Description
TP01	0.0 - 0.40 (Topsoil) 0.40 – 0.80 (Clay) 0.80 – 1.90 (Clay) 1.90 – 2.5 (Clay)	2.5 (base of excavation)	Firm dark brown CLAY with rootlets. Brown sandy slightly gravelly silty CLAY. Grey sandy slightly gravelly silty CLAY. Firm brown sandy gravelly silty CLAY.
TP02	0.0 - 0.50 (Topsoil) 0.50 – 0.90 (Clay) 0.90 – 1.70 (Clay) 1.70 – 2.5 (Clay)	2.5 (base of excavation – terminated on obstruction)	Firm dark brown CLAY with rootlets. Brown sandy slightly gravelly silty CLAY. Grey sandy slightly gravelly silty CLAY. Firm brown sandy gravelly silty CLAY.
TP04	0.0 – 0.40 (Made Ground) 0.40 – 1.10 (Made Ground) 1.10 – 2.50 (Made Ground)	2.5 (base of excavation – terminated due to pit walls collapsing)	Firm dark brown sandy slightly gravelly silty CLAY with few small pieces of white plastic. Soft brown sandy slightly gravelly silty CLAY. Grey sandy gravelly silty CLAY with rubbish, including plastic bags, plastic bottles and cylindrical metal bars.
TP05	0.0 – 0.60 (Topsoil) 0.60 – 1.10 (Clay) 1.10 – 2.60 (Clay)	2.6 (base of excavation – terminated due to pit walls collapsing)	Firm dark brown CLAY with rootlets. Brown sandy slightly gravelly silty CLAY. Grey sandy slightly gravelly silty CLAY.

3.1.3 Waste Sampling

A sample of the made ground / waste at the site was collected from trial pit TP04. The sample was submitted for Waste Acceptance Criteria (WAC) testing to ALS Environmental Ltd, a UKAS/MCERTS approved laboratory. Samples were collected from site under Chain of Custody procedures.

The results are provided in Appendix F of the CGL Ground Investigation report, Appendix 3 of this report. An interpretation of the waste sampling results is detailed in Section 4.2.

3.1.4 Evidence of Historic Landfilling

The trial pit excavation works identified evidence of waste material in 1 No. trial pits location (TP04). The waste encountered was typically described as white plastic, plastic bags, plastic bottles and cylindrical metal bars. The waste material description as described by CGLs Engineering Geologist is typical of municipal solid waste (MSW).

Waste was not encountered in the perimeter trial pits TP01, TP02 and TP05 advanced at the western and southern boundaries of the site.

The base of the waste material was not reached at the termination depth of 2.5m BGL in trial pit TP04.

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

It is assumed based on historical evidence that the landfilling extends across the entire site area identified with was inaccessible to the tracked excavator at the time of the investigations.

3.1.5 Waste Delineation

A geophysical surveying was not possible due to the extensive forestry at the site is located. As such the findings of the intrusive site investigation were used to interpret the aerial extent of the waste mass.

The waste footprint is calculated as covering the main body of the site over an area of approximately 5,450m^2. A volume calculation was conducted based on the existing ground level and the depth of waste, estimates indicate an interred waste volume of approximately 13,152m^3 (c.16,000 tonnes).

3.1.6 Borehole Installation and Groundwater Sampling

One borehole (BH01) was drilled to a total depth of 8.50m BGL at the site. The borehole was drilled for installing groundwater monitoring installations.

Groundwater monitoring was undertaken in boreholes BH01 during July and September 2019. Prior to sampling, the standpipe wells were purged and developed with Waterra groundwater sampling pipework/ foot valves and gas caps installed by CGL during June 2019 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 Section 4.3.

3.2 Geotechnical Analysis

3.2.1 In-situ Capping Permeability Testing

Bulk disturbed soil samples from TP04 (0.3m) were submitted for geotechnical analysis by Causeway Geotech Ltd for analysis of moisture content and permeability testing by triaxial compression. The results of the geotechnical analysis are included in Appendix E of the intrusive Site Investigation Report prepared by Causeway Geotech, see Appendix 3 of this report.

This testing was undertaken to assess the ability of the existing capping material to minimise rainfall infiltration and leachate generation from the waste body.

Details of permeability for samples TP04, calculated using an 11-day triaxial compression test are displayed in Table 3.2.

Table 3.2: Permeability Results

Sample ID	K (m/s)
TP04	4.7×10^{-10}

In accordance with the EPA Landfill Site Design Manual an engineered capping material should have a permeability less than or equal to 1×10^{-9} m/s to minimise infiltration of rainwater into the waste body. The permeability result of the capping material at site is lower than the EPA guidance, therefore may be suitable as a low permeability capping material.

However, the total depth and placement of the capping material is unlikely to meet the specifications set out in the Landfill Design Manual but may minimise the generation of leachate via infiltration.

4. ENVIRONMENTAL ASSESSMENT

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

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, 2019 (S.I. No. 77 of 2019).
- European Communities Environmental Objectives (Surface Waters) (Amendment) Regulations, 2015 (S.I. No. 386 of 2015).
- 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).

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 Lenamore Historic Landfill is outlined in Table 4.1 below, while the laboratory reports are presented in Appendix F of the CGL Ground Investigation report, Appendix 3 of this report and further discussed in Section 4.2 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 TP04 (2.5m)
Total Organic Carbon	%	3	5	6	1.1
Loss on Ignition	%	--	--	10	3.9
Total BTEX	mg/kg	6	--	--	< 0.010
Total PCBs (7 Congeners)	mg/kg	1	--	--	< 0.10
TPH Total WAC (Mineral Oil)	mg/kg	500	--	--	< 10
Total (Of 17) PAH's	mg/kg	100	--	--	< 2.0
pH		--	>6	--	8.2
Acid Neutralisation Capacity	mol/kg	--	To evaluate	To evaluate	0.075
Arsenic	l/kg	0.5	2	25	< 0.0010
Barium	l/kg	20	100	300	0.029
Cadmium	l/kg	0.04	1	5	< 0.00010
Chromium	l/kg	0.5	10	70	< 0.0010
Copper	l/kg	2	50	100	0.0011
Mercury	l/kg	0.01	0.2	2	< 0.00050
Molybdenum	l/kg	0.5	10	30	0.0049
Nickel	l/kg	0.4	10	40	< 0.0010
Lead	l/kg	0.5	10	50	< 0.0010
Antimony	l/kg	0.06	0.7	5	0.0016
Selenium	l/kg	0.1	0.5	7	< 0.0010
Zinc	l/kg	4	50	200	0.0039
Chloride	l/kg	800	15000	25000	1.9
Fluoride	l/kg	10	150	500	0.14
Sulphate	l/kg	1000	20000	50000	45
Total Dissolved Solids	l/kg	4000	60000	-	260
Phenol Index	l/kg	1	-	-	< 0.030
Dissolved Organic Carbon	l/kg	500	800	1000	8.0

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

4.3 Groundwater Analysis

Two rounds of groundwater quality monitoring were undertaken at the site on July and September 2019. The findings from the monitoring and an interpretation of the results is presented in the following sections.

4.3.1 Groundwater Depth Analysis

Groundwater depth analysis was undertaken during both monitoring rounds. The average static groundwater level from July and September 2019 is presented in Table 4.2.

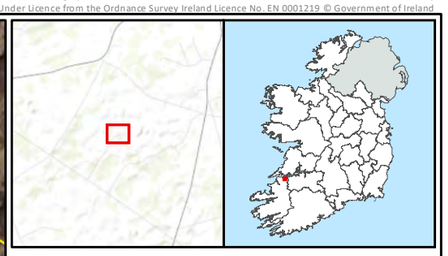
Table 4.2: Groundwater Depth Analysis

Borehole ID	Location Gradient	Top of Casing (mAOD)	Dip (m) Jul/19	Dip (m) Sep/19	Groundwater Level (mAOD)
BH01	Cross-gradient	64.396	3.1	2.56	61.566

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

Based on the above field survey measurements, groundwater levels were present below the surface at over 2.5m below ground level (m bgl). Therefore, based on this standalone measurement, it is assumed that the potentiometric groundwater surface intersects the waste body further upgradient. This was confirmed where shallow groundwater was encountered within trial pit TP04.

Path: R:\Map Production\2019\P1766\Workspace\Leanamore\Tier 2 ERA Report\P1766_Fig4-1_GWFlowDirection_A3.mxd



Borehole Locations

Site Boundary

1m Contours

N
W E
S

0 25 50 100 Meters

TITLE:	Groundwater Flow Direction		
PROJECT:	Lenamore Landfill, Co. Kerry		
FIGURE NO:	4.1		
CLIENT:	Kerry County Council		
SCALE:	1:1500	**REVISION:**	0
DATE:	31/10/2019	**PAGE SIZE:**	A3

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4.3.2 Groundwater Borehole Position

The results of groundwater samples analysed from BH01 at the site have been assessed against the EPAs Interim Guideline Values (IGVs) and the European Groundwater Regulations (2016) assessment criteria (amended).

A summary of the results reported selected parameters are outlined in Table 4.3 below. Only results that were shown to be above the limit of detection are shown in Table 4.3, all other results obtained were found to be below the limit of detection and therefore below the relevant groundwater quality thresholds. The complete laboratory reports with all results are presented in Appendix 4 to this report.

Table 4.3: Groundwater Sampling Results

Parameter	Units	EPA IGV Standards[1]	S.I. No. 9 of 2010 Standards[2]	BH01 16/07/2019	BH01 03/09/2019
Carbon					
Organic Carbon, Total	mg/l			14.9	23.9
Inorganics					
Ammoniacal Nitrogen as N	mg/l	**0.15**	**0.175**	<0.2	**0.262**
Conductivity @ 20 deg.C	mS/cm	**1**	**1.875**	0.778	0.894
Dissolved solids, Total (meter)	mg/l	**1000**		729	719
Fluoride	mg/l	**1**		<0.5	<0.5
Oxygen, dissolved	mg/l		**NAC**	8.69	8.09
pH	pH Units	**6.5-9.5**		7.83	7.41
Phosphate (Ortho as PO4)	mg/l		**0.03**	<0.05	<0.05
Chloride	mg/l	**30**	**24-187.5**	48.6	41.2
Cyanide, Total	mg/l	**0.01**	**0.0375**	<0.05	<0.05
Alkalinity, Total as CaCO3	mg/l		**NAC**	2050	1220
Suspended solids, Total	mg/l			-	-
Total Oxidised Nitrogen as N	mg/l			<0.1	<0.1
Dissolved Metals (Filtered)					
Mercury (diss.filt)	µg/l	**1**	**0.75**	<0.01	<0.01
Arsenic (diss.filt)	µg/l	**10**	**7.5**	3.06	2.39
Barium (diss.filt)	µg/l	**100**		39.6	38.2
Boron (diss.filt)	µg/l	**1000**	**750**	20.9	13
Cadmium (diss.filt)	µg/l	**5**	**3.75**	<0.08	<0.08

Parameter	Units	EPA IGV Standards[1]	S.I. No. 9 of 2010 Standards[2]	BH01 16/07/2019	BH01 03/09/2019
Chromium (diss.filt)	µg/l	**30**	**37.5**	<1	<1
Copper (diss.filt)	µg/l	**30**	**1500**	1.47	1.63
Lead (diss.filt)	µg/l	**10**	**18.75**	0.361	0.429
Manganese (diss.filt)	µg/l	**50**		2930	4290
Nickel (diss.filt)	µg/l	**20**	**15**	4.73	3.74
Phosphorus (diss.filt)	µg/l			<10	<10
Selenium (diss.filt)	µg/l			<1	<1
Thallium (diss.filt)	µg/l			<2	<2
Zinc (diss.filt)	µg/l	**100**	**75**	4.39	4.08
Sodium (Dis.Filt)	mg/l	**150**	**150**	42.7	35.7
Magnesium (Dis.Filt)	mg/l	**50**		16.8	14.1
Potassium (Dis.Filt)	mg/l	**5**		2.65	2.23
Calcium (Dis.Filt)	mg/l	**200**		166	159
Iron (Dis.Filt)	mg/l	**0.2**		0.0719	0.405
Miscellaneous Organics					
Mecoprop	µg/l	**10**	**0.075**	0.0472	<0.4

[1] IGV-Interim Guideline Values, from EPA, Towards Setting Guideline Values for the Protection of Groundwater in Ireland, 2003.
[2] OTV-Overall threshold value, European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010) as amended in 2011, 2012, 2016.
* Items shaded in **bold** are in exceedance of the EPA IGV Standards
* Items shaded in **orange** are in exceedance of the Drinking Water Regulations

4.3.3 Groundwater Quality Discussion

The results of the groundwater monitoring from BH01 have reported exceedances of the IGVs and OTV groundwater limit values in a number of parameters analysed.

Samples recovered from monitoring well BH01 during September 2019 reported an ammoniacal nitrogen (as N) concentration of 0.262 mg/l, which exceeds OTV and IGV limit values. The concentration of Ammoniacal N may be attributable to agricultural activities in the wider area around the site.

Chloride levels at 48.6mg/l and 41.2 mg/l for both dates exceed the OTV and IGV limits value and may be evidence of impact from the landfill. Reported manganese concentrations of 2930 µg/l and 4290 µg/l are significantly over the IGV limits vales during both monitoring rounds. The exceedance of the IGV and OTV limits values for Chloride and Manganese may be evidence of impact to groundwater from the historical landfill site.

A slightly elevated iron concentration of 0.405 mg/l which exceeds the IGV limit values at borehole BH01 in September is considered to be typical of the local bedrock hydrochemistry.

The results of groundwater monitoring when assessed for List 1 and List 2 substances i.e., SVOCs, pesticides, herbicides, organics shows all results are below the laboratory limit of detection at BH01 with the exception of the herbicide, Mecoprop.

Mecoprop is a common general use herbicide found in many house-hold weed killers and "weed-and-feed" type lawn fertilizers. It is often used in combination with other chemically related herbicides.

The reported value during July 2019 (0.0472 µg/l) is below the IGV and OTV limit values for Mecoprop.

A full list of all List 1 and List 2 substances analysed in presented in the groundwater laboratory report presented in Appendix 3.

Based on the presence of elevated manganese and chloride concentrations, the landfill waste body appears to be locally impacting groundwater quality in the vicinity of the site. Manganese is detected at up to 60-80 times the IGV limit.

4.4 Landfill Gas Monitoring

FT carried out monitoring of landfill gas (LFG) parameters at the monitoring borehole location (BH01) as indicated on Figure 3.1. In accordance with the EPA CoP, methane, carbon dioxide, oxygen and atmospheric pressure were analysed using a geotechnical instrument GFM5000 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 monitoring boreholes are summarised in Table 4.1.

Table 4.4: Perimeter Well Monitoring Results October 2018

Date: 23/10/19						
Sample Station	CH_4	CO_2	O_2	Atmospheric Pressure	Staff Member	Weather
	(% v/v)	(% v/v)	(% v/v)	(mbar)		
BH01	0.1	0.2	22.3	1005	Emily Archer	Overcast, heavy rain showers, 10-14°C

As can be seen in Table 4.4, concentrations of both CO_2 and CH_4 at the monitoring borehole BH01 were below the threshold values set by the CoP during the monitoring round.

4.5 Surface Water Monitoring

4.5.1 Monitoring Locations

The surface water monitoring locations are shown on Figure 4.2. Monitoring location SW01 was selected as the upstream location in the Gurteenacloona stream, to the south-east of the historical landfill. Monitoring location SW02 is located further downstream to the south-east within the Gurteenacloona stream.

Two surface water monitoring rounds were carried out on the 16th July and 3th September 2019.

4.5.2 Monitoring Parameters

The results of surface water sampling analysed from the 2 No. sampling locations (SW01 and SW02) 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 results reported selected parameters are outlined in Table 4.5 below. Only results that were shown to be above the limit of detection are shown in Table 4.5, all other results obtained were found to be below the limit of detection and therefore below the relevant surface water quality thresholds. The complete laboratory reports with all results are presented in Appendix 4 to this report.

Table 4.5: Surface Water Sampling Results

Parameter	Units	MAC[1]	EQS[2]	SW01 16.07.2019	SW02 16.07.2019	SW01 03.09.2019	SW02 03.09.2019
Inorganics							
Ammoniacal Nitrogen as N	mg/l	--	**≤0.140 (95%ile)**	<0.2	**0.456**	<0.2	<0.2
Conductivity @ 20 deg.C	mS/cm	**1**	--	0.558	0.229	0.546	0.228
Fluoride	mg/l	**0.5**	--	<0.5	<0.5	<0.5	<0.5
Dissolved Oxygen	mg/l	--	**95%ile>80% saturation, 95%ile<120% saturation**	9.12	10.1	9.58	9.07
pH	pH Units	--	**6.0-9.0**	7.86	7.32	7.86	7.54
Phosphate (Ortho as PO4)	mg/l	**0.5**	--	<0.05	<0.05	<0.05	<0.05
Chloride	mg/l	**40**	--	32.1	24.6	32.2	24.6
COD, unfiltered	mg/l	**250**	--	29.7	106	31.1	92.5
Total Cyanide	mg/l	**0.01**	--	<0.05	<0.05	<0.05	<0.05
BOD, unfiltered	mg/l	--	**≤2.6 (95%ile)**	-	-	-	-
Total Alkalinity as CaCO3	mg/l	--	--	283	63.4	278	69.7
Total Suspended Solids	mg/l	**50**	--	30.7	<6	17	4.53
Total Oxidised Nitrogen as N	mg/l	**2**	--	0.386	0.281	0.36	0.331
Sulphate (soluble) as S	mg/l	**200**	--	<1	6.8	<1	7.23
Total Organic Carbon	mg/l	**NAC****	--	11.8	37	11.1	41.9
Dissolved Metals (Filtered)							

Parameter	Units	MAC[1]	EQS[2]	SW01 16.07.2019	SW02 16.07.2019	SW01 03.09.2019	SW02 03.09.2019
Mercury (diss.filt)	µg/l	--	**0.07**	<0.01	<0.01	<0.01	<0.01
Arsenic (diss.filt)	µg/l	--	**25**	3.82	4.92	<0.5	4.35
Barium (diss.filt)	µg/l	**1**	--	15.3	8.59	2.65	6.93
Boron (diss.filt)	µg/l	**2**	--	18.6	15.1	16.8	14.9
Cadmium (diss.filt)	µg/l	**0.45**	**0.08**	<0.08	<0.08	<0.08	<0.08
Chromium (diss.filt)	µg/l	**32**	**4.7**	<1	<1	<1	<1
Copper (diss.filt)	µg/l	**100**	**30**	3.96	2.91	1.79	3.59
Lead (diss.filt)	µg/l	--	**7.2**	<0.2	1.56	1.07	0.501
Manganese (diss.filt)	µg/l	**300**	--	170	126	90.2	110
Nickel (diss.filt)	µg/l	--	**20**	3.73	3.48	0.873	3.23
Phosphorus (diss.filt)	µg/l	--	**0.075**	**10.2**	**15.5**	**25.1**	<10
Selenium (diss.filt)	µg/l	**0.01**		<1	<1	<1	<1
Thallium (diss.filt)	µg/l	--	--	<2	<2	<2	<2
Zinc (diss.filt)	µg/l	--	**100**	16.8	18.4	25.8	17.1
Sodium (Dis.Filt)	mg/l	**200**	--	26.2	16	22.6	15.4
Magnesium (Dis.Filt)	mg/l	--	--	14.5	5.46	4.1	4.93
Potassium (Dis.Filt)	mg/l	--	--	2.92	1.16	0.442	0.893
Calcium (Dis.Filt)	mg/l	--	--	88.3	42	8.4	29.3
Iron (Dis.Filt)	mg/l	**0.2**	--	0.161	**0.806**	**0.766**	0.79
Mineral Oil / Oils & Greases							

Parameter	Units	MAC[1]	EQS[2]	SW01 16.07.2019	SW02 16.07.2019	SW01 03.09.2019	SW02 03.09.2019
Mineral oil >C10 C40 (aq)	µg/l	--	--	<100	<100	<100	<100
PCB's							
All results were found to be below the LOD (refer to Appendix 4)							
Semi-Volatile Organic Compounds (SVOCs)							
All results were found to be below the LOD (refer to Appendix 4)							
Volatile Organic Compounds (VOCs)							
Dichloromethane	µg/l	--	**20**	9.43	<3	9.61	<3
Combined Pesticides / Herbicides							
All results were found to be below the LOD (refer to Appendix 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 **bold** are in exceedance of the European Communities MACs

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

** * NAC – no abnormal change

4.5.3 Surface Water Analysis Discussion

The 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 the majority of the parameters.

Exceedances of the EQS limit values for Ammoniacal Nitrogen (as N) was recorded in SW02 during sampling round one in July 2019. The subsequent monitoring round in September recorded ammonia concentrations at below laboratory detection limits at both sample locations. The presence of ammonia at these levels may be an indication of agricultural runoff from the surrounding fields, rather than direct impact from the landfill.

Elevated concentrations of Phosphorus were recorded during July 2019 at locations SW1 and SW2 at concentrations of 10.2 to 15.5 µg/l respectively. These are over the EGS limit value of 0.075 µg/l for Phosphorus. An exceedance of the EQS limit value was also recorded at SW1 during the September monitoring round.

The EQS limit values for Iron were recorded at both surface water at SW2 during July 2019 and at SW1 during September 2019. The recorded exceedances of Phosphorus and Iron in surface water samples may be indicative of direct impact to surface waters from leachate generated within the waste body.

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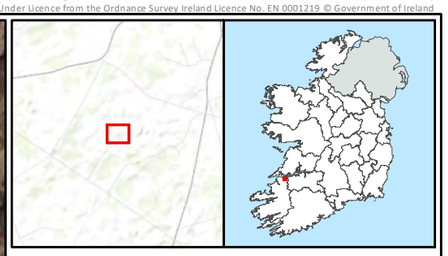

Surface Water Sampling Locations

Rivers

Site Boundary

N
W E
S

0 25 50 100 Meters

TITLE:	Surface Water Sampling Locations		
PROJECT:	Lenamore Landfill, Co. Kerry		
FIGURE NO:	4.2		
CLIENT:	Kerry County Council		
SCALE:	1:1500	**REVISION:**	0
DATE:	31/10/2019	**PAGE SIZE:**	A3

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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[3]). 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 pathways associated with the Lenamore site are:

- Groundwater migration; and
- Surface water infiltration.

5.2.1 Leachate Migration leading to Surface Water Infiltration

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.

[3] 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 assessments and site investigation works undertaken for Lenamore 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.

Landfill Gas Migration

Leachate Migration

Measured Groundwater Level

Housing Estate ~400m West

BH02 64.40mAOD

MADE GROUND / WASTE - 5450 m²

Depth of waste >2.5m BGL

Topsoil Cover 0.40 – 0.60m

Land drain – dry at the moment of collection

~62.84mAOD

WASTE BODY

60.24mAOD

River Gurteenacloona

Peat

Firm Clay

Sandy Clay

58.60 mAOD

Clayey Gravel

>55.90 mAOD

Locally important aquifer – moderately productive only in Local Zones
Vulnerability - Low

GW FLOW DIRECTION

Unknown

Glacial Till
Namurian Shale

CROSS SECTION NORTH-WEST/SOUTH-EAST

FIGURE 5.1 LEANAMORE 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 Lenamore 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 in the section below calculates the points awarded to each of the headings listed above.

Table 5.1: Risk Classification Calculation – Lenamore Landfill

EPA Ref	Risk	Points		Rationale
1a	Leachate; source/hazard scoring matrix, based on waste footprint.	Municipal ≤1ha	5	Based on a waste footprint of ≤1ha and the assumption of Municipal Waste the score should be 5.
1b	Landfill gas; source/hazard scoring matrix, based on waste footprint.	Municipal ≤1ha	5	Based on a waste footprint of ≤1ha and the discovery of typically Municipal Waste.
2a	Leachate migration: Pathway (Vertical)	0.50		GSI describes the groundwater vulnerability as Low.
2b	Leachate migration: Pathway (Horizontal)	2		GSI online mapping classifies the Shannon formation as a 'Locally important aquifer – bedrock which is moderately productive only in Local Zones (Lg)'.
2c	Leachate migration: Pathway (Surface water drainage)	2.00		There is a direct connection (land drain) between the waste body and the adjacent stream (Gurteenacloona) as verified during site walkover.
2d	Landfill gas: Pathway (Lateral migration potential)	1		The site is underlain by Low permeability Till deposits.
2e	Landfill gas: Pathway (Upwards migration potential)	0		No buildings, structures or other enclosed spaces above the waste body.
3a	Leachate migration: Receptor (Human presence)	1		Based on the presence of dwellings located 400m from the site boundary.
3b	Leachate migration: Receptor (Protected areas – SWDTE or GWDTE) (Surface water/ groundwater dependent terrestrial ecosystems)	0		Greater than 1km from the waste body.
3c	Leachate migration: Receptor (Aquifer category – Resource potential)	3		Locally important aquifers (Ll, Lm, Lg).
3d	Leachate migration: Receptor (Public water supplies – other than private wells)	0		Greater than 1km (no karst aquifer).
3e	Leachate migration: Receptor (Surface water bodies)	3		Surface waterbody (EPA Name: Gurteenacloona) located within 50m of site boundary.

EPA Ref	Risk	Points	Rationale
3f	Landfill Gas: Receptor (Human presence)	0.50	Based on the presence of dwellings located 400m from the site boundary.

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	**67.5**	300	Leachate => surface water	23%
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	**12.5**	240	Leachate => human presence	5%
SPR4	1a x (2a + 2b) x 3b	**0**	240	Leachate => GWDTE	0%
SPR5	1a x (2a + 2b) x 3c	**37.5**	400	Leachate => Aquifer	9%
SPR6	1a x (2a + 2b) x 3d	**0**	560	Leachate => Surface Water	0%
SPR7	1a x (2a + 2b) x 3e	**37.5**	240	Leachate => SWDTE	16%
Leachate migration through surface water pathway					
SPR8	1a x 2c x 3e	**30**	60	Leachate => Surface Water	50%
SPR9	1a x 2c x 3b	**0**	60	Leachate => SWDTE	0%
Landfill gas migration pathway (lateral & vertical)					
SPR10	1b x 2d x 3f	**2.5**	150	Landfill Gas => Human Presence	2%
SPR11	1b x 2e x 3f	**0**	250	Landfill Gas => Human Presence	0%
Site maximum S-P-R Score					**50%**
Risk Classification					**Class B**

As presented in Table 5.1 the maximum S-P-R scoring for the site is **50%.**

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 **Moderate Risk Classification (Class B)**. The principal risk identified on the site is the risk posed to the underlying groundwater and surface water quality from migration of leachate from the waste material encountered at the site through groundwater and surface water

6. CONCLUSION

A Tier 2 study was conducted by FT in accordance with the EPA CoP for Lenamore Historic Landfill. The study consisted of a desktop study and intrusive site investigation works. These works informed the development of the CSM and risk screening model.

A geophysical surveying was not possible due to the extensive forestry at the site, the waste delineation is calculated considering the data available, the whole site area and the depths found during trial pitting. An area of approximately 5,450m² and a volume of 13,152m³ (c. 16,000 tonnes) was calculated according to available data.

Analysis of waste samples from the trial pits excavated, when assessed against the inert waste acceptance criteria indicated that much of the waste material within the site can be classified as typically inert. The waste classification is considered to reflect the level of degradation over time since landfilling ceased. Trial pitting confirmed the waste material is near the surface with a minimal topsoil and clay cover present across the site.

Analysis of groundwater samples recovered from the monitoring well BH01 has reported ammonia concentrations which exceed guideline threshold values. Ammonia concentrations measured in September is considered representative of background levels possibly due to agricultural land spreading. The slightly elevated iron concentration in September is considered to be typical of the local bedrock hydrochemistry. Elevated manganese concentration on both months could be an indication of leachate in groundwater.

Landfill gas monitoring from perimeter well BH01 at the site indicates gas concentrations detected are below threshold levels set by the EPA CoP. Considering the low gas concentrations measured at the perimeter wells and the identified building receptors within 150m of the waste body, a low-risk score of 2% and 0% for SPR10 and SPR11, respectively, has been generated. The pathway between the waste body and the offsite building receptors will require further investigation to verify the risk, if any, to these receptors.

Analysis of surface water samples recovered from the watercourses surrounding the site indicated 1 No. exceedances of the EQS (2009) guideline limit values for ammonia. The presence of ammonia at these levels may be an indication of agricultural runoff from the surrounding fields, rather than direct impact from the landfill.

Elevated concentrations of Phosphorus were recorded during July 2019 at locations SW1 and SW2 and at SW1 during September 2019. The EQS limit values for Iron were recorded at both surface water at SW2 during July 2019 and at SW1 during September 2019. The recorded exceedances of Phosphorus and Iron in surface water samples may be indicative of direct impact to surface waters from leachate generated within the waste body.

Based on the presence of elevated dissolved metal concentrations typical of landfill leachate, the shallow soil cap is not considered suitable at preventing rainfall infiltration into the waste body. The groundwater table also appears to be intersecting the waste body and therefore contributing to leachate migration from the landfill.

Based on this, the site can be classified as a **Moderate Risk Classification (Class B)**. The principal risk identified on the site is the risk posed to the underlying groundwater and surface water quality from migration of leachate from the waste material encountered at the site through groundwater and surface water

6.1 Recommendations

Based on the results of the initial Tier II assessment the site is classified Moderate Risk Classification (Class B.

For a moderate risk site, the CoP indicates that a Waste Regularisation Certificate of Registration be acquired, and a Tier 3 Environmental risk analysis be undertaken including a Detailed Quantitative Risk Assessment (DQRA).

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.

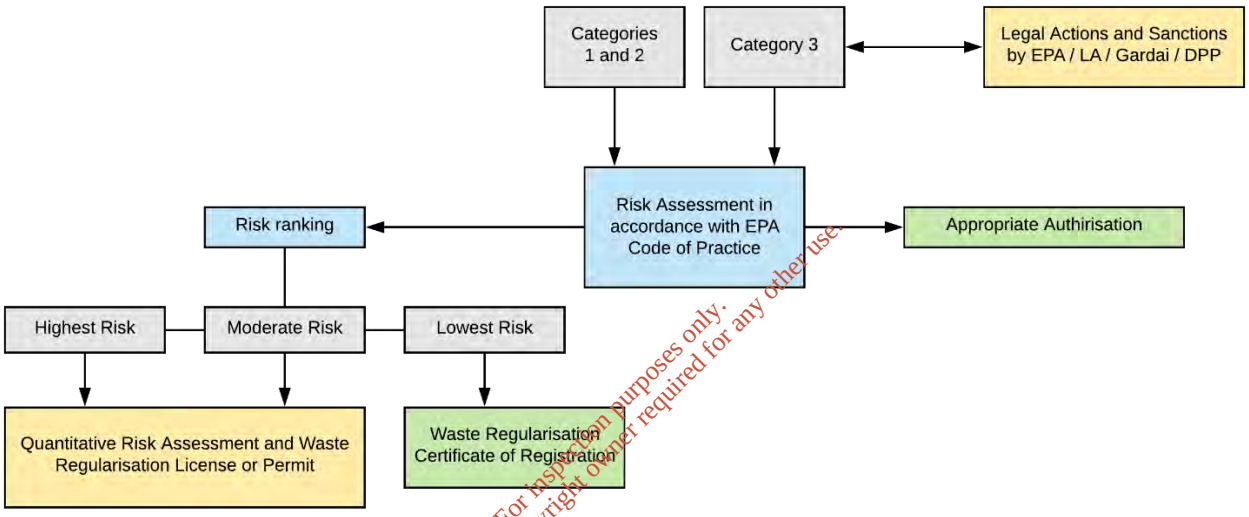

Figure 6.1: Extract from Section 1.3 of the EPA Code of Practice