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O'Callaghan Moran & Associates
ENVIRONMENTAL MANAGEMENT FOR BUSINESS

TIER 3

ENVIRONMENTAL RISK ASSESSMENT

OF A

FORMER MUNICIPAL LANDFILL

KILRUSH,

COUNTY CLARE

Prepared For: -

Clare County Council
Department of Physical Development (Environment)
Clare County Council
Áras Contae an Chláir
New Road
Ennis
Co. Clare, V95 DXP2

Prepared By: -

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Cork

September 2020

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1. INTRODUCTION

Clare County Council (the Council) completed a Tier 1 Assessment of the closed Kilrush landfill in 2009 in accordance with the "Code of Practice Environmental risk Assessment for Unregulated Waste Disposal Sites (CoP)" published by the Environmental Protection Agency (the Agency).

The Tier 1 Assessment, which is included in Appendix 1, concluded that the site was a Class B – Moderate Risk Site due to the risk of leachate migration to surface water (SPR-8). All other pathways were deemed to be Low Risk.

In 2010 the Council completed a Tier 2 Site Investigation. The site investigation works included:-

- Trial pit survey to assess the thickness and nature of the capping material and the waste;
- Collection and analyses of groundwater, surface water and leachate samples;
- Ground gas monitoring;

The findings are discussed in Section 3 of this report.

Conservation Services, Ecological & Environmental Consultants (CSEE) completed biological sampling and water quality assessment of surface waters in the vicinity of the landfill in October 2015. A copy of the survey is in Appendix 2.

1.1 Methodology

Mr Sean Moran MSc, P.Geol, was the OCM Project Manager with responsibility for the preparation of the Tier 3 Risk Assessment. Mr. Moran a hydrogeologist with more than 31 years' experience in hydrogeological assessment and is certified by the IGI as qualified person in accordance with Section 2.3 of Code of Practice: Environmental Risk Assessment for Unregulated Waste Disposal Sites (EPA, 2007).

Mr. Moran completed a site walk over with Mr Cathal Brodie of Clare County Council on May 28th 2020 to assess the site conditions and the location and condition of nearby sensitive receptors.

2. ENVIRONMENTAL SETTING

2.1 Site Location

The site is located 2.5 km to the south east of Kilrush in the townland of Dysert on the north side of the R473 Kilrush to Kilmurray McMahon Road (Figure 2.1).

2.2 Site Layout

The landfill occupies 1.9 hectares (ha) and is securely fenced and has a thin top soil cover though waste is visible at the surface in some locations. Grass and rush vegetation are present on the surface.

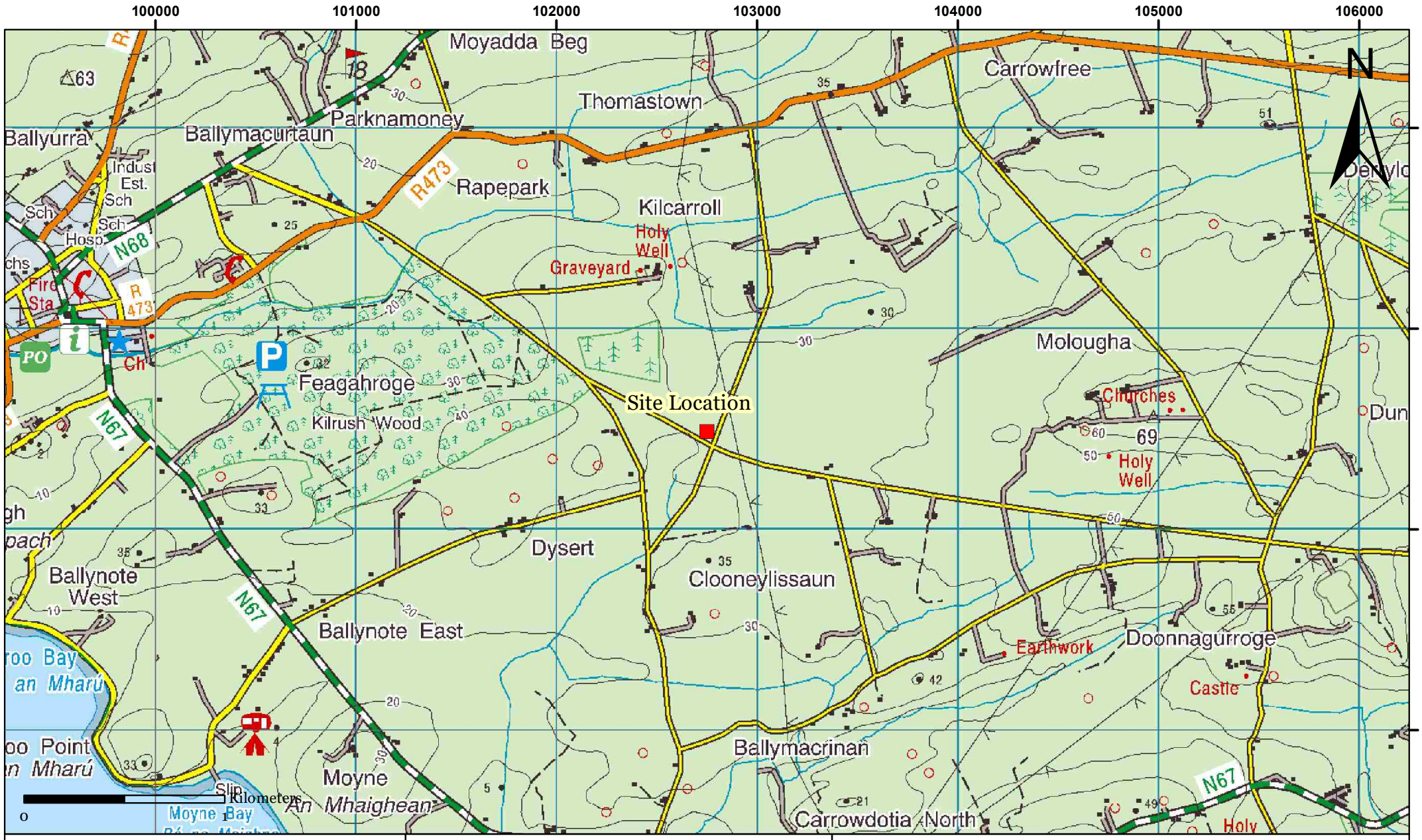
The site is slightly raised above the surrounding lands. It slopes slightly from south to north. The site is bound to the south and east by the local public road and further south and east by cut over peat bog. It is bound to the north by cut-over peat bog and to the west by agricultural grass land (Figure 2.2). There is a land drain running along the western boundary in a northerly direction. The drain most likely connects to the Moyadda Bed stream c110m to the north of the site.

2.3 Surrounding Land Use

The site is located in a rural area and the surrounding land use is shown on Figure 2.3. The landfill is in an area dominated by extensively cut over peat, most of which is now used for agriculture and forestry. The closest dwelling is c130m south of the site.

2.4 Site History

The landfill operated for approximately 11 years between 1981 and 1992. The landfill closed in 1992.



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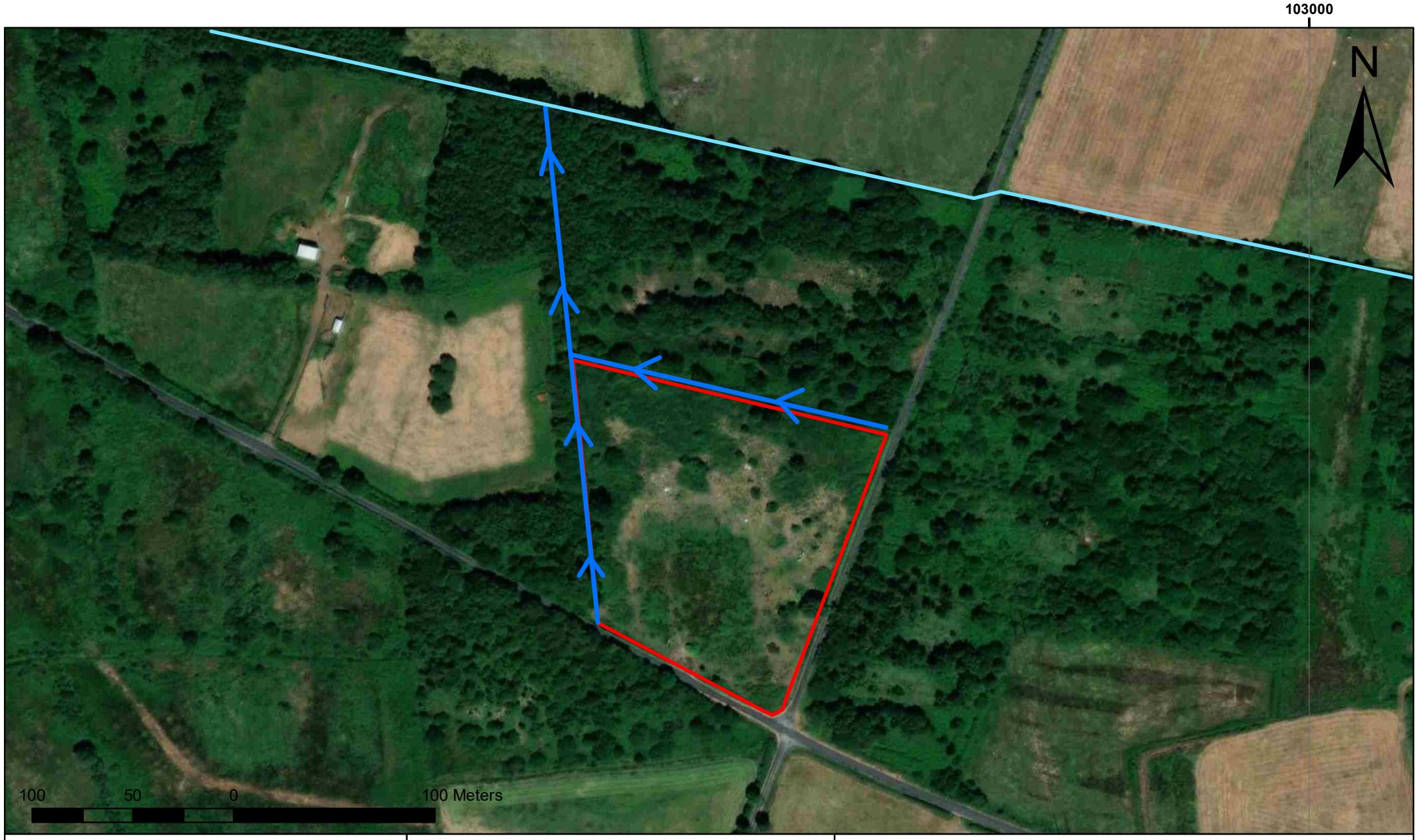
CLIENT
Clare County Council

TITLE
Site Location

Details:
Site Location

Figure 2.1



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TITLE
Site Layout

Details:
- Stream
- Field Drain
- Site Layout

Figure 2.2

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Title:

Figure 2.3 Surounding Landuse

Legend

-Site Layout

Client:

Clare County Council

2.5 Hydrology

There is a land drain running along the western boundary in a northerly direction connects to the Moyadda Bed stream c110m to the north of the site. The stream discharges to the Kilcarrol Stream 770m north of the site. The Kilcarrol stream discharges to the Wood River c490 further to the west of that confluence. The Wood River discharges to the sea at Kilrush Creek c2.5km to the west of the site (Figure 2.4).

The landfill is in the catchment of the Wood River IE_SH_27W010200. Reports have been prepared on the 'Status' of each water body. Status means the condition of the water in a watercourse and is defined by its ecological and chemical status. Water bodies are ranked in one of five classes, High, Good, Moderate, Poor and Bad. The current status of the Water Body is Poor due to poor macroinvertebrate status.

2.6 Geology & Hydrogeology

OCM established the local geological and hydrogeological conditions from a review of databases maintained by the Geological Survey of Ireland (GSI), Teagasc and the site investigation findings.

2.6.1 Soils and Subsoils

The Tier 2 site investigation established that the landfill is overlain by a thin layer of top soil c200mm but this is not continuous and there is no capping in some areas.

Figure 2.5, which is derived from the Teagasc Maps, shows the subsoils beneath the site and in the surrounding area comprise cut over peat.

The 2010 Tier 2 investigations confirmed the presence of peat underlying the waste across the site. Peat was encountered in each of the nine trial pits. The thickness of the peat was not established.

2.6.2 Bedrock

The site is underlain entirely by mudstone, siltstone and sandstone form the Clare Group (Figure 2.6).

2.6.3 Hydrogeology

Figure 2.7, which is derived from the GSI Aquifer Map, shows the aquifer characteristics. The Clare Group rock is classified as a locally important aquifer that is productive in local zones (Ll). Groundwater flow paths are typically 10s to 100s of metres with discharge to local streams and rivers. Groundwater yields are usually very poor.

Vulnerability is defined by the GSI as the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.

The vulnerability rating for the bedrock aquifer underlying the peat in the area is classified as High indicating the presence of up to 5m of subsoils above the bedrock (Figure 2.8).

OCM conducted a review of the GSI database to identify the location of any nearby wells or springs. There are no public water supply wells within 20km of the site. There are no wells or springs identified within 500m radius of the site (Figure 2.9). The closest well identified by the Council is 610m to the north and was in use as a farm well at the time of the investigation.

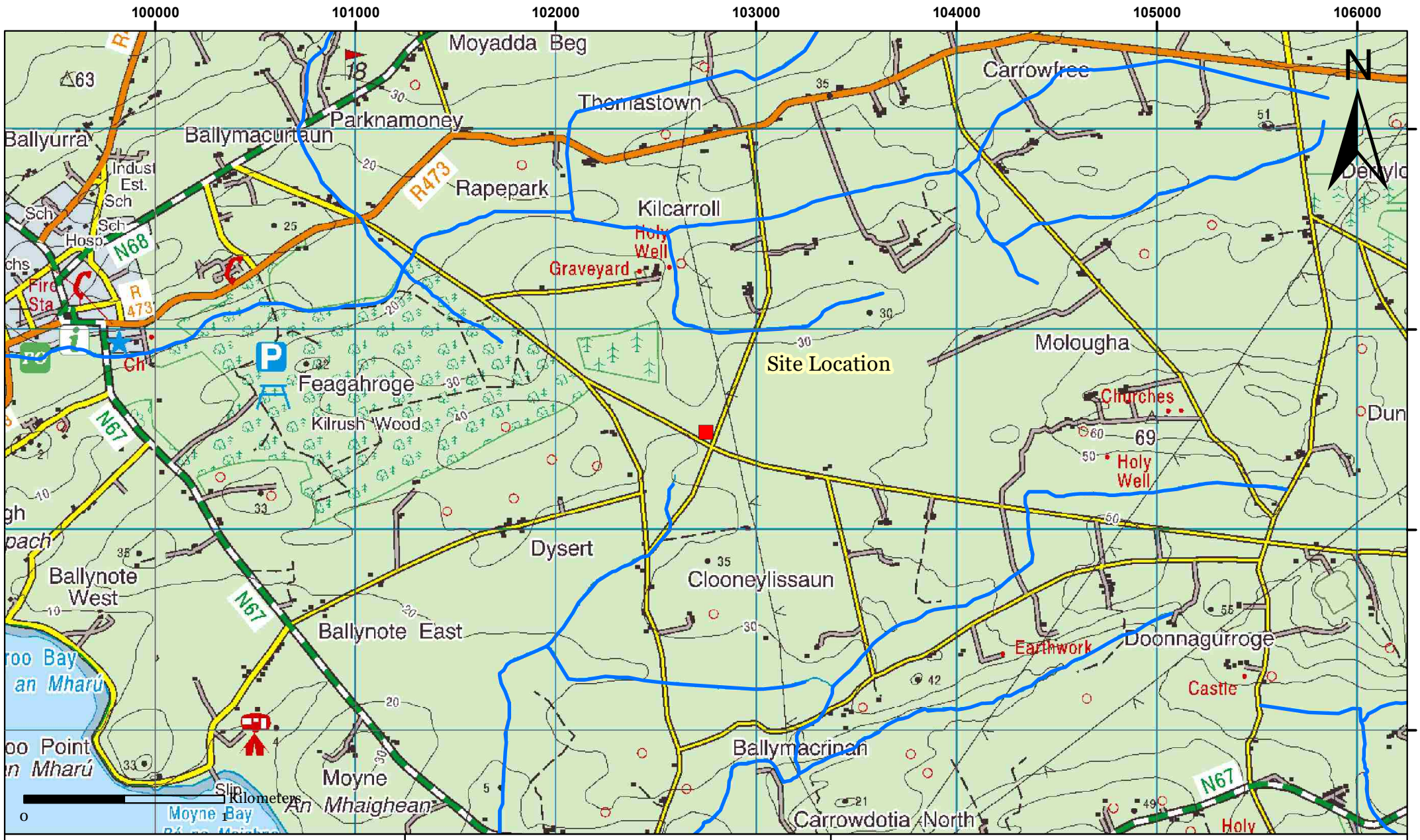
The site lies within the Kilrush Groundwater Body (GWB) (IE_SH_G_123). The GWB status is rated as 'Good'.

It is likely that shallow groundwater beneath the site discharges to the stream to the north of the site.

2.7 Biodiversity

The site is not located in or adjacent to a Natura 2000 site. The closest designated site is the Lower River Shannon Special Area of Conservation (SAC) and the River Shannon and River Fergus Estuaries Special Protection Area (SPA) which are located c4km to the west of the site (Figure 2.10).

A biological quality survey was undertaken at four locations in the vicinity of the landfill. CSEE concluded that while there may be some deterioration in biological quality (reducing from Q3 to Q2/3 between sites 1 and 2) close to the landfill that the reduction of biological quality seen further downstream was not associated with the landfill because the Q value from a contributing stream upgradient of the landfill was already at Q2.



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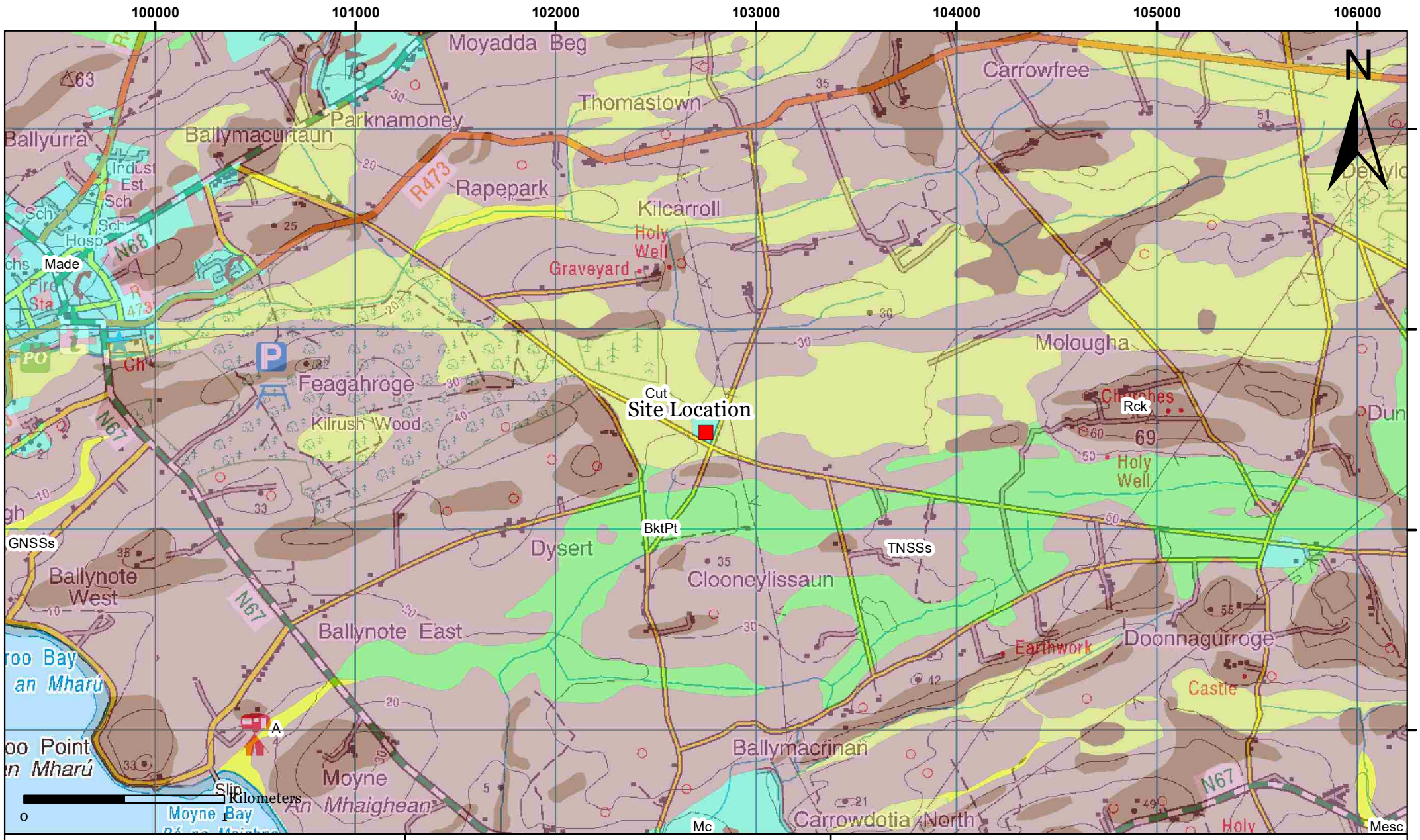
TITLE
Hydrology

Details:
- Site Location
- Rivers

Figure 2.4



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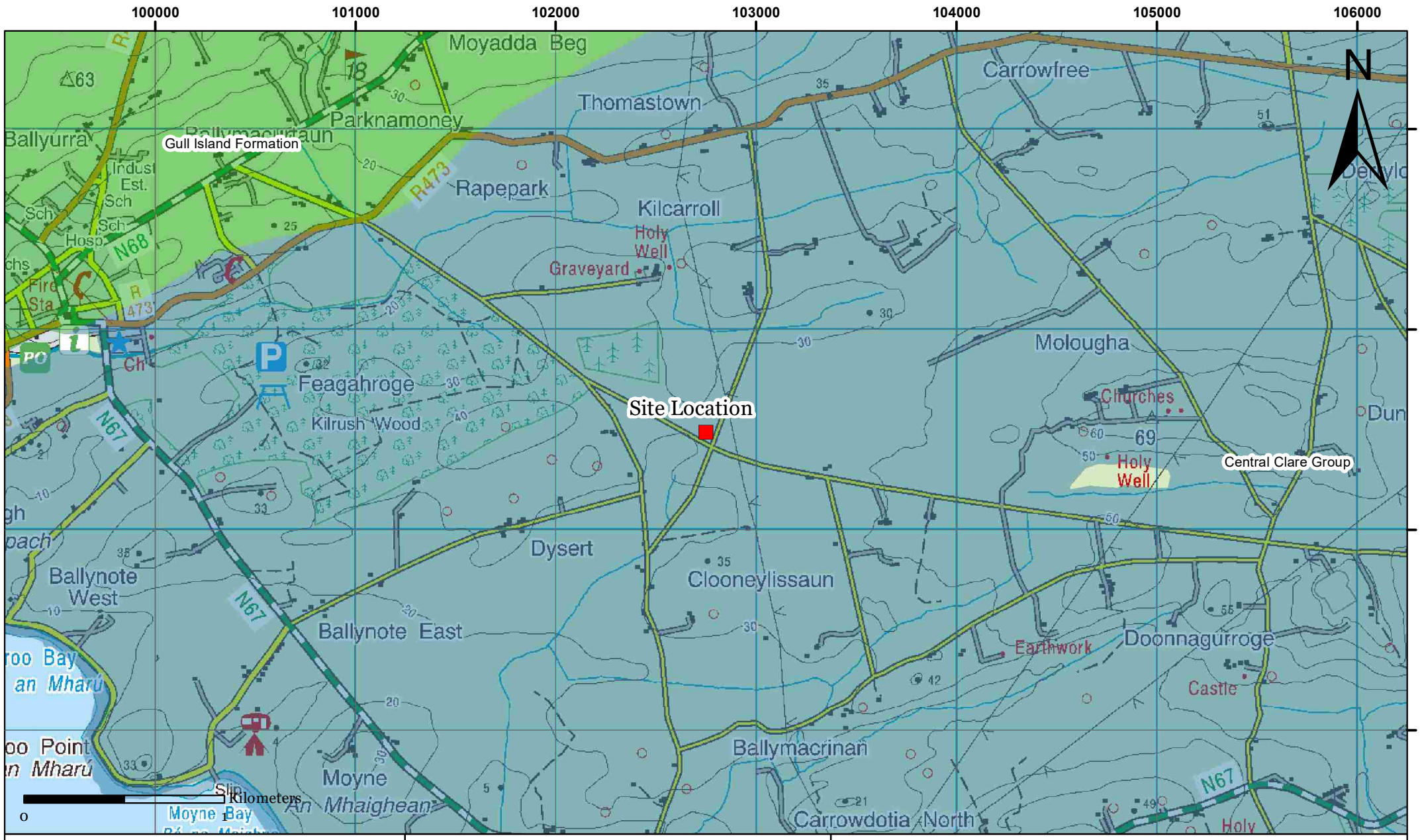
TITLE
Subsoils

Details:
- Site Location
- A - Alluvium undifferentiated
- BktPt - Blanket peat
- Cut
- GNSSs
- Made - Made Ground
- Rck - Bedrock at surface
- TNSSs - Shales and sandstones till (Namurian)

Figure 2.5



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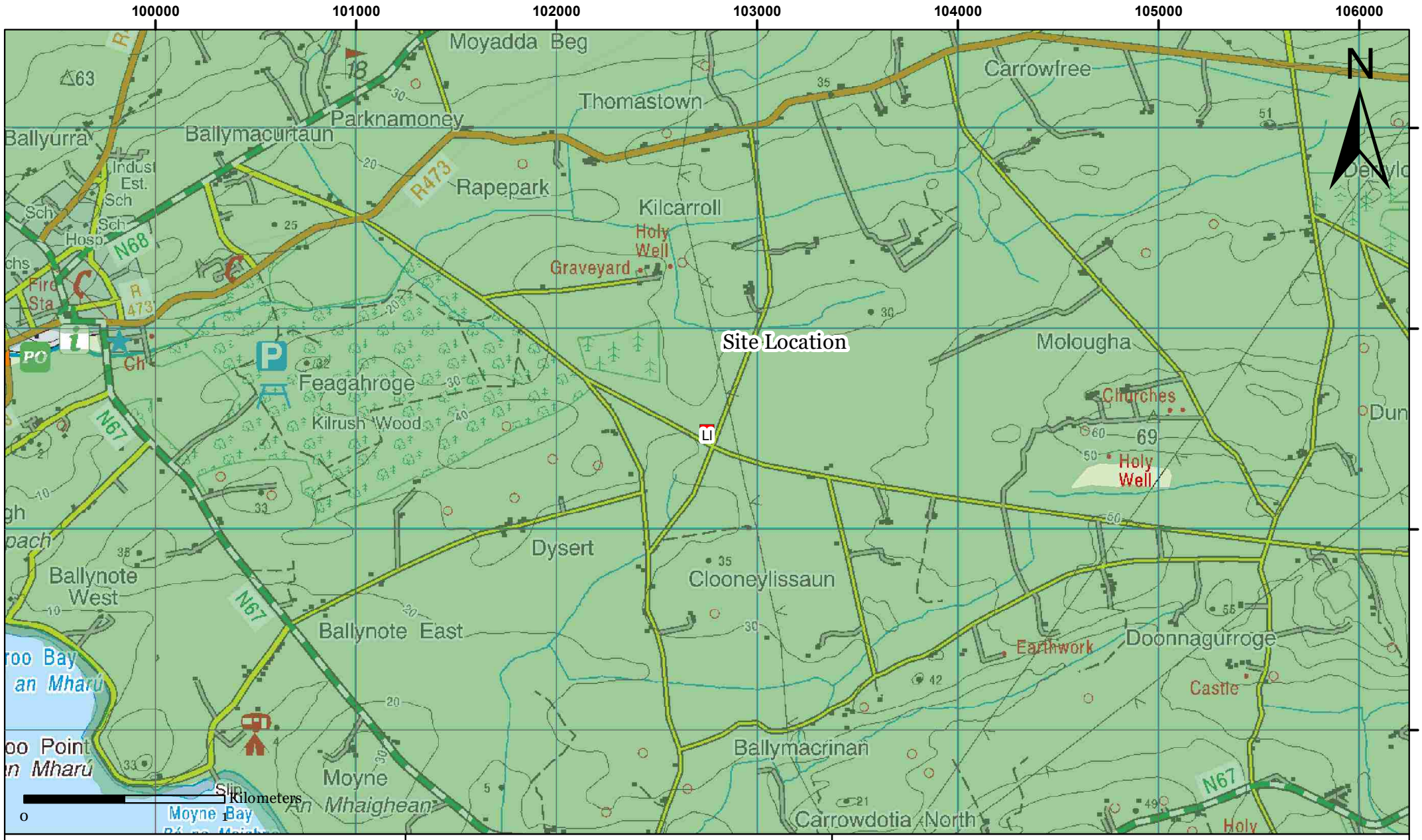
TITLE
Bedrock Geology

Details:
- Site Location
- Central Clare Group - Sandstone, Siltstone and Mudstone
- Gull Island Formation - Grey Siltstone and Sandstone

Figure 2.6



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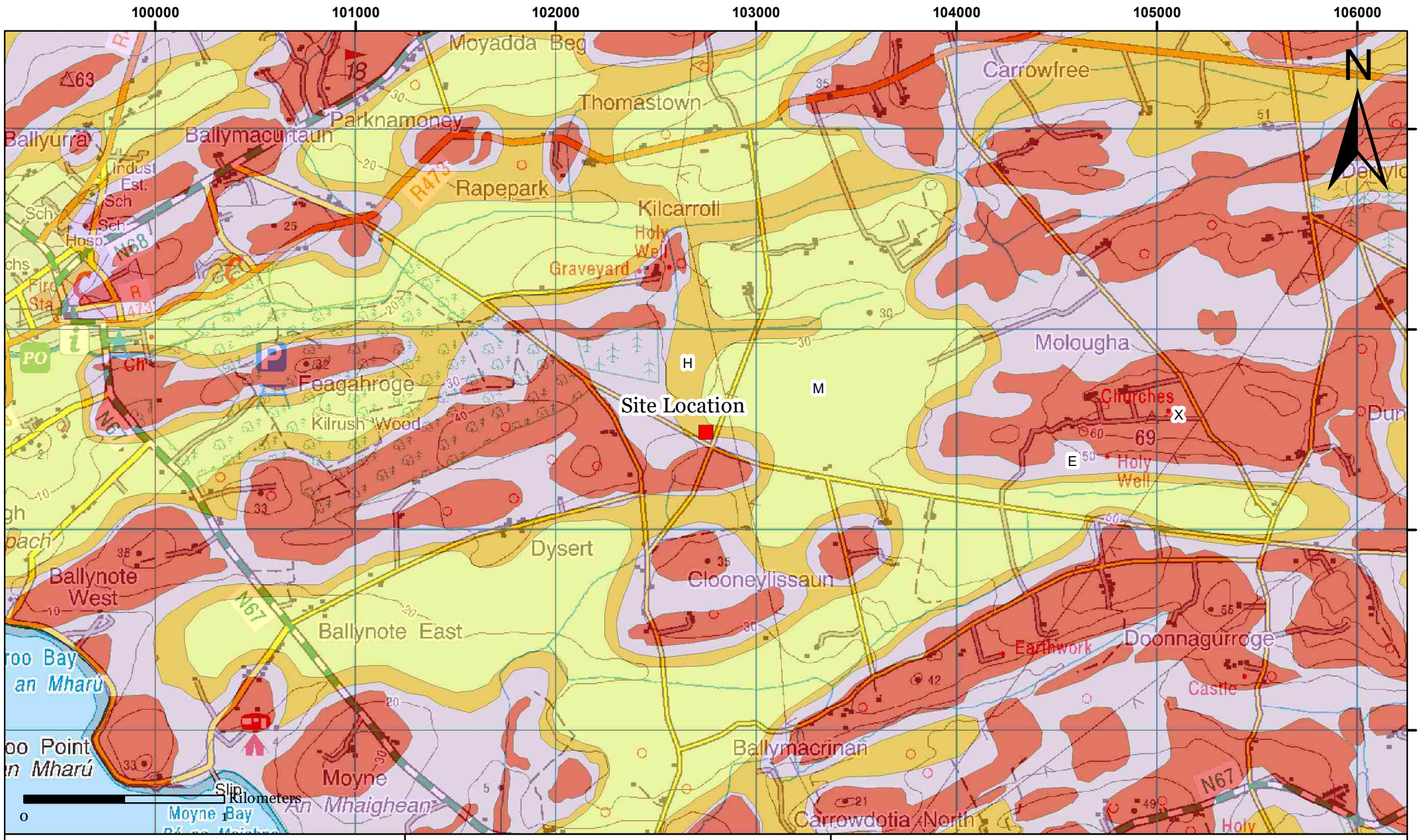
TITLE
Aquifer Classification

Details:
Site Location
LI - Locally Important Aquifer. Moderately Productive only in Local Zones

Figure 2.7



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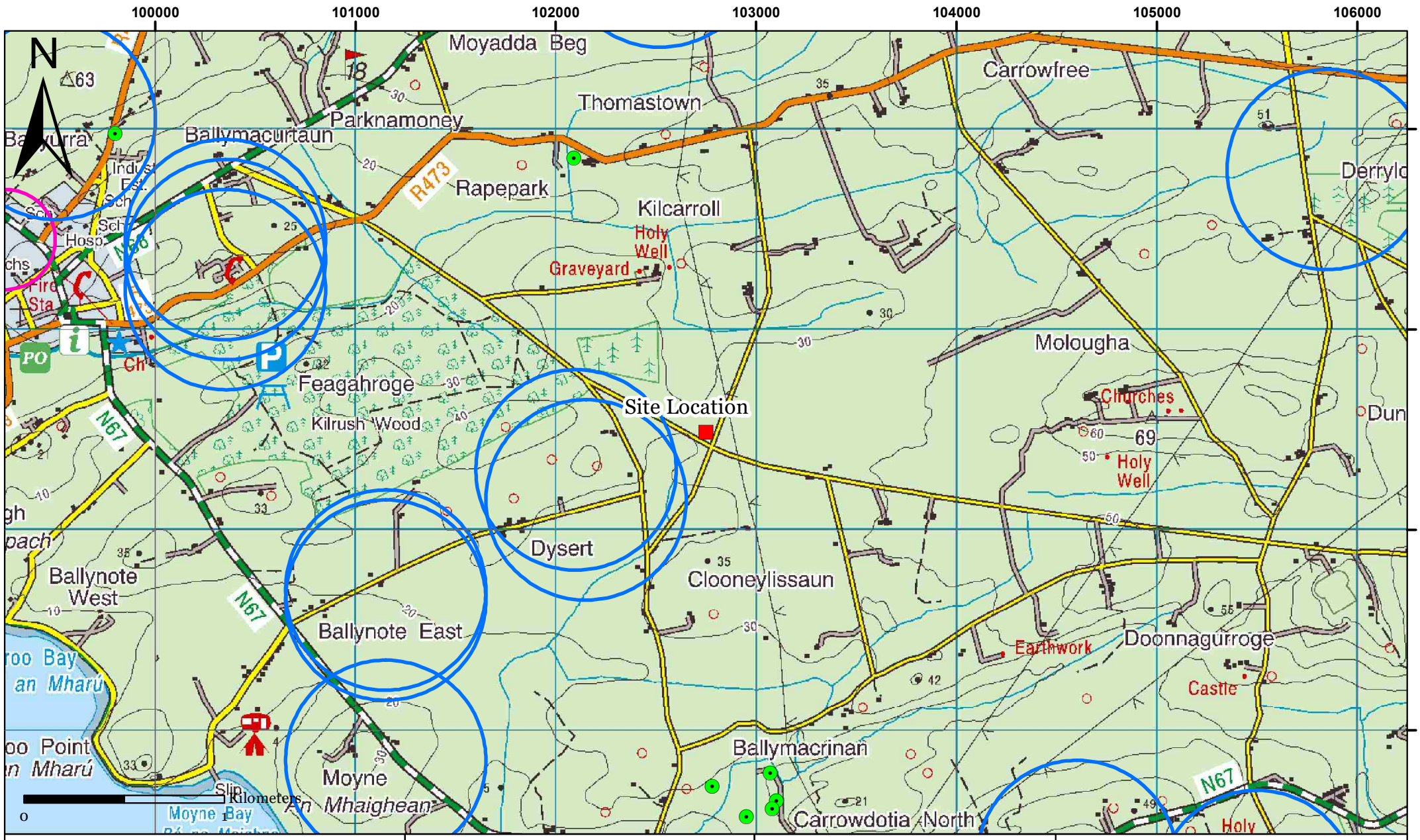
TITLE
Groundwater Vulnerability

Details:
- Site Location
- X - Bedrock near Surface
- E - Extreme
- H - High
- M - Moderate
- L - Low

Figure 2.8



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TITLE
GSI Well Location Data

Details:
Unfortunately many of the borehole logs in the GSI database do not contain accurate location information. The size of the circles shown above is inversely proportional to the accuracy of the well location (i.e. small circles represent high accuracy, where relatively larger circles represent lower accuracy).

- Site Location
- Well Accuracy 10m to 50m
- Well Accuracy 500m to 1km
- Well Accuracy 250m to 500m

Figure 2.9

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CLIENT
Clare County Council

TITLE
NPWS

Details:
- Site Location
- SPA
- SAC

Figure 2.10

3. TIER 2 SITE INVESTIGATION SUMMARY

3.1 Objectives

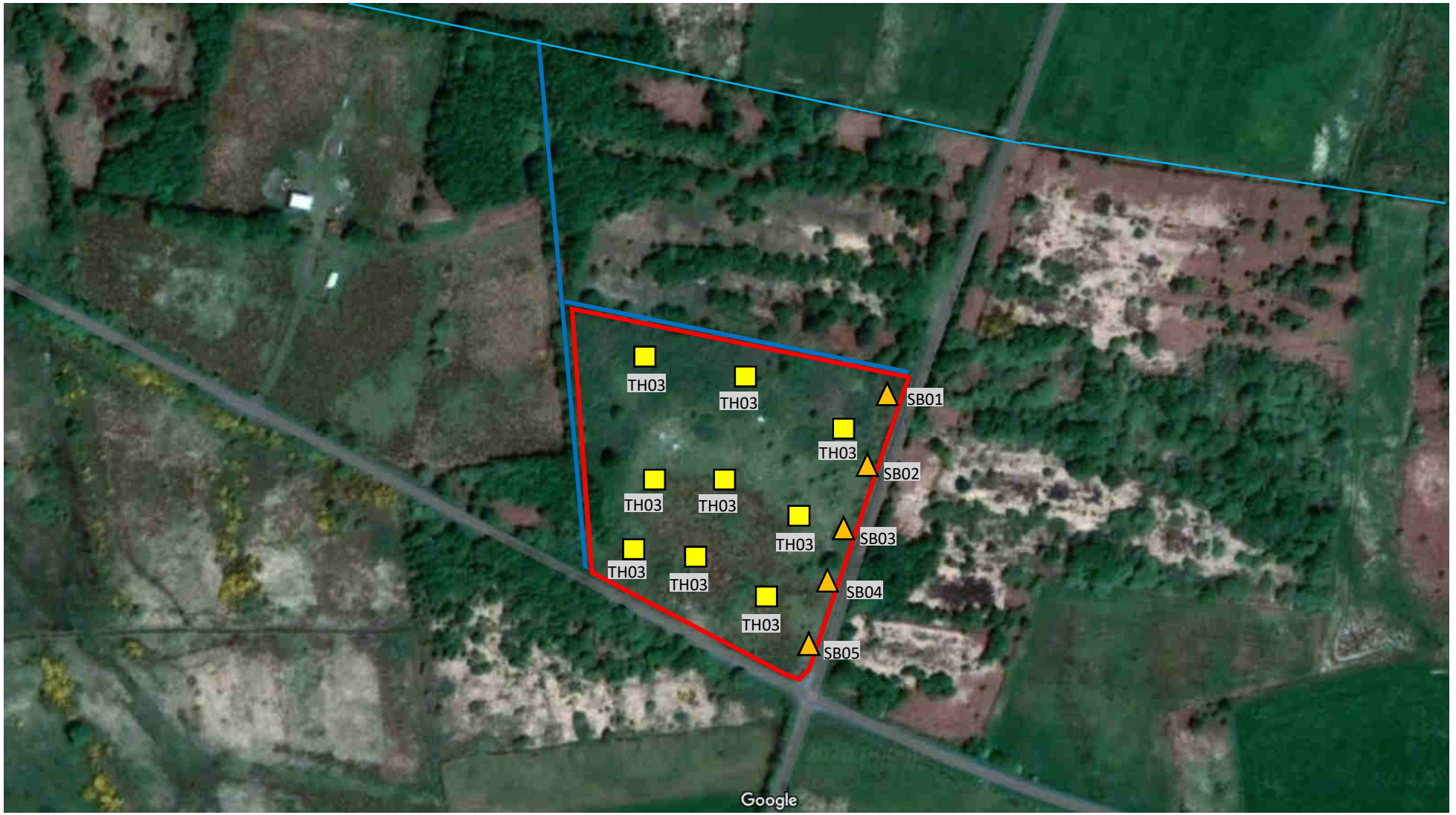
The objective of the Tier 2 assessment were to establish if the risk ranking assigned during the Tier 1 assessment was correct.

3.2 Site Investigation Scope

Clare County Council staff completed the Tier 2 Investigation in 2010. The full Tier 2 Report is in Appendix 3. The assessment included;

- Site and local area reconnaissance
- Trial pit survey to assess the thickness and nature of the capping material and the waste;
- Collection and analyses of groundwater, surface water, leachate and waste samples;
- Ground gas monitoring;

The locations of the trial pits and groundwater sampling points are shown on Figure 3.1.



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Title:

Figure 3.1 Sample Locations

Client:

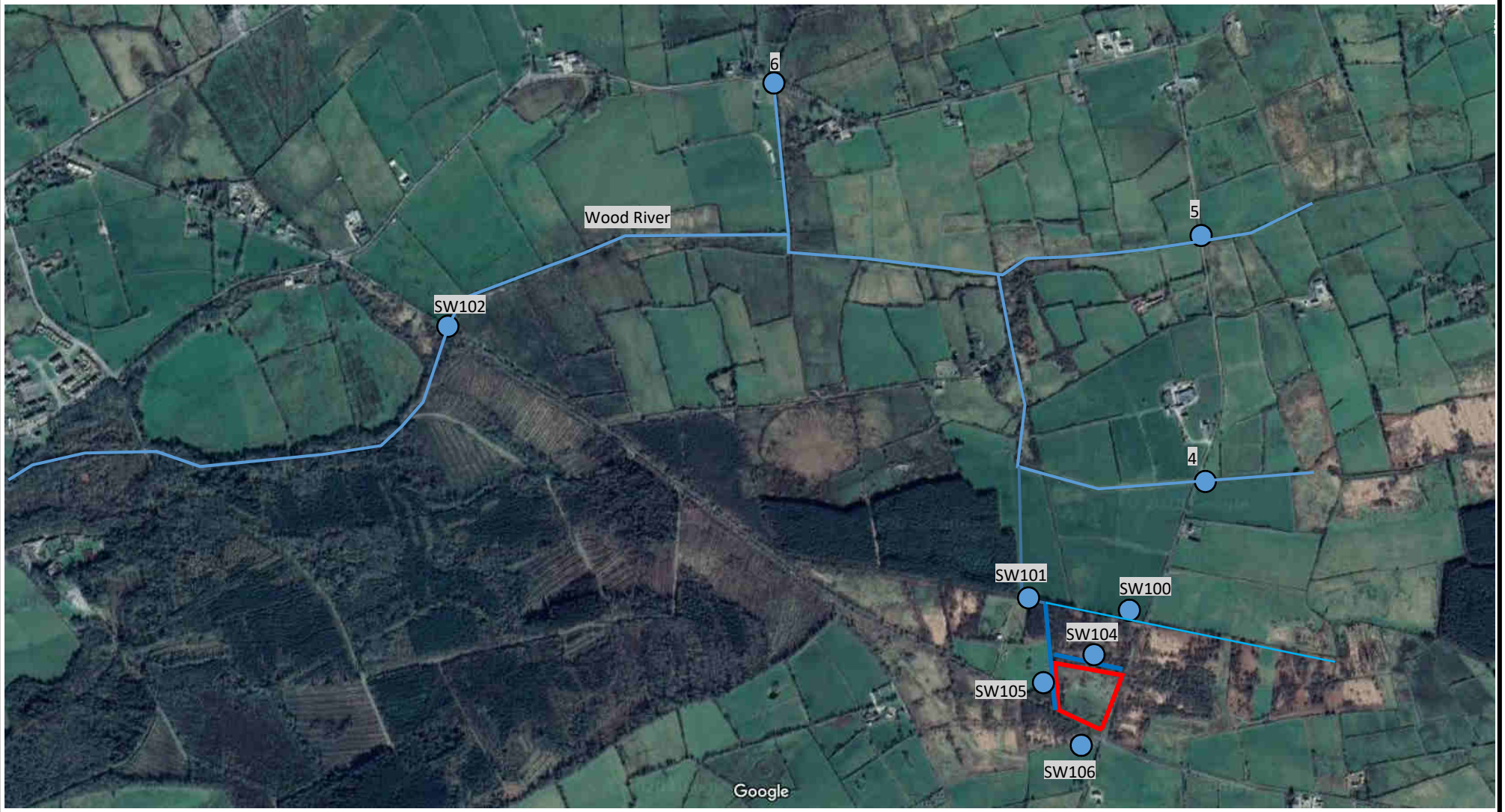
Clare County Council

Legend

-Trial Pit

-Scrapeback Sample

-Field Drain



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Title:

Figure 3.2 Surface Water Sample Locations

Legend

-Surface Water Sample

-Field Drain

Client:

Clare County Council

3.3 Ground Conditions

Nine trial pits (TH-1 TH-9) were opened across the site which confirmed the presence of thin c200mm capping layer comprising top soil though it was not present continuously across the site. In some locations waste was visible at the surface. Waste is present across the entire site area and averages 3.5m in thickness and is 4.5m at its deepest. It is underlain in all trial pit locations by peat.

3.3.1 Waste Characterisation

Based on the trial pit logs the waste is predominantly municipal with c10% commercial/industrial waste and small amounts of farm plastic.

3.3.2 Extent of Waste Body

Based on a combination of the trial pits and some excavation along the boundaries the waste extends close to the site perimeters on all sides. It is on averages 3.5m thick and is 4.5m at its deepest. The Tier 2 Investigation established that there is c66,500m^3 of waste present on the site and it is present across the entire site footprint. Using a conversion ratio of 0.5 tonne/m3 this indicates the presence of 33,250 tonnes

3.3.3 Groundwater

Groundwater was not encountered in any of the trial pits but some perched water/leachate was present in several of the trial pits with samples collected for laboratory analysis from TH-8 and TH-9 where sufficient water was present for the collection of samples.

3.4 Groundwater

There are no public water supply wells within 20km of the site. The closest well to the site is 610m to the north and was in use as a farm well at the time of the investigation. A groundwater sample was collected from the well in August 2010 as part of the Tier 2 assessment.

3.4.1 Laboratory Analysis

The sample was shipped to City Analysts Laboratories in an ILAB accredited laboratory.

The samples were analysed for an indicator range of parameters which include some of the parameters specified in Table C2 of the EPA Manual on Landfill Monitoring (2003). The parameters analysed were pH and electrical conductivity, ammonia, potassium, sodium, chloride, sulphate and COD.

3.4.2 Groundwater Quality

The full laboratory test report is in the Tier 2 report in the Tier 2 Report in Appendix 3 and the results are presented in Table 4.1. The table includes Interim Guideline Values (IGV) published by the EPA and the Groundwater Threshold Values (GTV) set out in the European Communities Environmental Objectives (Groundwater) Regulations (S.I. 9 of 2010).

The IGVs are not statutory, but were developed to assist in the assessment of impacts on groundwater quality. The IGVs are based on, but are more conservative than the Drinking Water quality standards. GTVs have only been established for core indicator parameters.

Table 4.1 Groundwater Results

Sample I.D. Sample Date	Units	upgradient well	IGV	GTV
Potassium	mg/l	<2.34	5	NE
Sodium	mg/l	30.7	150	150
Electrical Conductivity	mS/cm	0.376	1000	1,875
Chloride	mg/l	40.3	30	187.5
Sulphate	mg/l	13.2	200	187.5
Ammonia	mg/l	0.629	0.15	0.175
COD (Settled)	mg/l	<7	NE	NE
pH	units	8.56	>4>9	

Ammonia exceeded the GTV while chloride exceeded the IGV. The well is located north of the Moyadda Beg Stream while the site is to the south of the stream. It is considered therefore that the site is not hydraulically linked to the landfill site. The elevated ammonia and chloride are not therefore considered to be associated with the landfill site.

3.5 Leachate Quality

Leachate samples were collected by the Council from trial pits TH-2 and TH-4. The samples were also sent to Alcontrol Laboratories for analysis for the parameters in Table C2 of the EPA Landfill Monitoring Manual 2003. The results are presented in Table 4.2, with the full laboratory report in the Tier 2 Report. The Table includes for comparative purposes, the results ranges specified in Table 7.2 EPA Landfill Site Design, 2000. The results are indicative of a moderate to weak leachate in the landfill.

Table 4.2 Leachate Results

Sample I.D. Sample Date	Units	TH-2	TH-4	EPA Landfill Design Manual Range
Arsenic	µg/l	9.07	2.83	<1 - 6,700
Boron	µg/l	690	203	-
Cadmium	µg/l	<1	<1	<10 - 80
Copper	µg/l	<0.85	<0.85	20 - 620
Mercury	µg/l	<0.1	<0.1	<0.1 - 0.8
Nickel	µg/l	12.4	4.29	<30 - 600
Lead	µg/l	0.102	0.042	<40 - 1,900
Zinc	µg/l	50.3	5.82	<30 - 6,700
Manganese	µg/l	1810	1170	40 - 3,590
Sulphate	mg/l	<3	<3	<5 - 322
Chloride	mg/l	145	36.7	570 - 4,710
Total Cyanide	µg/l	<0.05	<0.05	-
Chromium - diss.	µg/l	27.4	15.1	-
Phosphorous - total	µg/l	304	97.7	-
Potassium	mg/l	88	24.8	100 - 1,580
Sodium	mg/l	108	27.7	474 - 3,650
Total Oxidised Nitrogen	mg/l	NA	NA	-
Ammonia	mg/l	30.8	18.9	283 -- 2,040
BOD settled	mg/l	NA	NA	110 - 1,900
COD	mg/l	434	71.8	622 - 8,000
VOCs				
Vinyl Chloride	µg/l	<2	<2	-
Benzene	µg/l	<2	<2	-
Toluene	µg/l	<2	<2	-
Ethylbenzene	µg/l	<2	<2	-
p/m-xylene	µg/l	<2	<2	-
o-xylene	µg/l	<2	<2	-
Trimethylbenzene	µg/l	<2	<2	-
4-Isopropyltoluene	µg/l	<2	<2	-
sVOCs				
4-Methylphenol	µg/l	<2	<2	-
Phenols (total)	mg/l	<1	<1	
PAH	µg/l	<2	<2	-
Pesticides	µg/l	<0.1	<0.1	-

NA denotes Not Analysed

3.6 Surface Water

Surface water sampling locations are shown on Figure 3.2. In 2010 surface water samples were collected from SW-100 is a first order stream upstream of the landfill and SW-101 a sample point in this stream downstream of the landfill. SW-102 is a sample from the Wood River downstream of the landfill beyond the point where the first order stream discharges into it.

It was also proposed to collect a sample at SW-103 which is 540m downstream of SW-101 on a first order stream coming from upstream and east of the landfill but this location is no longer connected along the drainage system.

It had been intended to collect samples at sample points SW-104 along the northern landfill boundary, SW-105 along the drain bounding the west of the site and at SW-106 along a drain to the south of the landfill. All of these locations were dry at the time sampling was completed.

Following a site walk over on May 28th 2020 OCM recommended the completion of an updated round of surface water sampling to include the above sampling points if and where water was present. OCM also recommend sampling surface water coming from first order streams upstream of where they enter the Wood River (sample points 4, 5 and 6). This was to establish water quality entering the Wood River upstream of the confluence with water entering the Wood River from the stream into which the landfill was draining. As was the case in 2010 sample points SW-3, 4, 5 and 6 were dry. But samples were obtained from sample points 4, 5 and 6.

3.6.1 Laboratory Analysis

The samples were placed in laboratory prepared containers and stored in coolers at below 4^{o}C prior to shipment to City Analysist laboratory. Chain of custody (C.O.C.) documentation was included with the samples.

3.6.2 Surface Water Quality

The samples analysed for List 1 and II substances and the parameters specified in Table C2 of the EPA Manual on Landfill Monitoring (2003) which included pH, electrical conductivity, ammonia, nitrate, orthophosphate, potassium, sodium, chloride, sulphate, heavy metals to include(arsenic, antimony, barium, cadmium, chromium, copper, fluoride, mercury, manganese, molybdenum, nickel, lead, selenium and zinc), cyanide Volatile Organic Compounds (VOC), Semi-Volatile Organic Compounds (SVOC), herbicides and pesticides.

The laboratory test report is contained in Appendix 4 and the results are presented in Table 4.5. The table includes for comparative purposes the 2009 Surface Water Regulations Environmental Quality Standards (EQS).

Table 4.5 Surface Water Monitoring Results – August 2010 – June 2020

Parameter	Units	SW-100			SW-101			SW-102			4	5	6	AA -EQS	EU MAC*
		30/08/2010	13/05/2020	11/06/2020	30/08/2010	13/05/2020	11/06/2020	30/08/2010	13/05/2020	11/06/2020	11/06/2020	11/06/2020	11/06/2020		
pH	pH Units	7.84	7.63	7.5	7.41	7.46	7.36	8.09	7.49	7.62	6.93	7.56	7.51	4.5-9	
Electrical Conductivity	mS/cm	0.178	0.248	0.168	0.28	0.248	0.171	0.23	0.259	0.198	0.27	0.286	0.24	1	NE
Arsenic	mg/l	0.00147	0.0008	< 0.0002	0.00141	0.0008	0.0012	NA	0.0005	< 0.0002	0.0013	0.0008	0.0004	0.025	0.01
Boron	mg/l	0.0179	0.03	0.04	0.0369	0.03	0.03	NA	0.03	0.03	0.03	0.03	0.02	NE	NE
Cadmium	mg/l	<0.0001	< 0.0001	< 0.0001	<0.0001	< 0.0001	< 0.0001	NA	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0015/0.0025*	0.9/1.5*
Copper	mg/l	0.0009	0.003	0.008	<0.00085	< 0.003	0.008	NA	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	0.03	NE
Lead	mg/l	0.000165		0.0004	0.000531		0.0004	NA	< 0.0003	0.0004	< 0.3	< 0.3	< 0.3	0.0072	NE
Manganese	mg/l	0.087	0.16	< 0.001	0.31	0.11	0.25	NA	0.008	0.036	0.27	0.076	0.033	NE	NE
Magnesium	mg/l	4.04	7.3	5	6.23	7.3	5.2	NA	7.5	5.7	7.7	9.1	5.7	NE	NE
Mercury	mg/l	<0.00001	0.00002	0.00003	<0.00001	0.00002	0.00007	NA	< 0.00002	< 0.00002	0.00002	< 0.00002	< 0.00002	0.00005	0.00007
Nickel	mg/l	0.0016	0.0018	0.0022	0.00109	0.002	0.0008	NA	0.0017	0.002	0.0037	0.0031	0.0013	0.02	0.02
Total Cyanide	mg/l	<0.05	< 0.010	< 0.010	<0.05	< 0.010	< 0.010	NA	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.01	NE
Chromium	mg/l	0.0016	< 0.001	< 0.001	0.00183	< 0.001	< 0.001	NA	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.0047	0.032
Zinc	mg/l	0.00563	0.002	0.0059	0.00747	0.004	0.0093	NA	0.0016	0.0059	0.0035	0.0022	< 0.001	0.1	NE
Sulphate	mg/l	<3	< 20.000	< 20.000	NA	< 20.000	< 20.000	12.2	< 20.000	< 20.000	< 20.000	< 20.000	< 20.000	NE	NE
Chloride	mg/l	30.3	41.708	40.037	NA	43.142	40.018	34.2	39.635	37.28	39.938	38.909	39.223	NE	NE
Calcium	mg/l	13.2	19.6	15.6	35.3	20.1	16.6	NA	20.7	20.7	20.9	22.8	14.7	NE	NE
Total P	mg/l	0.175	< 0.200	< 0.200	NA	< 0.200	< 0.200	NA	< 0.200	< 0.200	< 0.200	< 0.200	< 0.200	NE	NE
TON	mg/l	NA			NA			NA						NE	NE
Total Suspended Solids	mg/l	NA	3	4	NA	2	30	NA	3	8	< 2	< 2	2	NE	NE
BOD	mg/l	NA	< 2	< 2	NA	< 2	< 2	NA	< 2	< 2	< 2	< 2	< 2	NE	NE
COD	mg/l	54.5	47	50	310	49	52	36.2	30	31	87	40	22	NE	NE
Potassium	mg/l	2.64	< 0.2	1.7	5.46	1.4	1.7	<2.34	2.4	2.5	0.9	3.1	1.7	NE	NE
Sodium	mg/l	18.3	25.6	20.1	22.1	25.9	20.1	21.2	26.3	19.9	25.4	25.5	24.5	NE	NE
Ammonia*	mg/l	0.352	0.033	0.01	1.59	0.037	0.041	0.289	0.023	0.088	0.094	0.034	0.036	0.065	NE
Pesticides	mg/l	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	NA	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	Various	NE
BTEX	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NA	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	Various	Various
PAH	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	NA	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	Various	Various
sVOC	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	NA	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	NE	NE
VOC	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	NA	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	Various	

NE denotes Not established, NA Denotes Not Analysed

3.6.3 Discussion

The surface water monitoring programme indicates that the landfill is not having a significant impact on surface water quality downstream. While mercury marginally above the EQS was detected at SW-101 downstream of the landfill all other parameters were below the EQS. Mercury was not detected further downstream at SW-102 on the Wood River. Ammonia levels are higher upstream of the landfill than downstream of the landfill. Ammonia does exceed the EQS at SW-102 but the ammonia concentration in the tributary entering the Wood River upstream of the landfill (Sample Point4 is higher than at the Wood River indicating the landfill is not the source of elevated ammonia. The ammonia is possibly attributable to a combination of the bogland nature of the catchment and agricultural run-off.

3.7 Landfill Gas

As part of the Tier 1 assessment of the site landfill, gas monitoring was undertaking using impact bars to penetrate between 0.5 -1m into the ground. Gas levels were measured at four locations. The monitoring included the measurement of methane, carbon dioxide, oxygen and atmospheric pressure and gas flow rate using a Gas Data LSMx gas analyser. The meter was calibrated before use (confirm). The detection limit is 0.1% for methane, carbon dioxide and oxygen. No methane was detected in any of the locations and carbon dioxide levels did not exceed 2.8%. It was noted however during the survey that the ground was very wet and further monitoring was not carried out because of potential damage to the gas meter by pulling water through the probe.

Table 4.6 Landfill Gas Monitoring Results – November 12th 2008

	Atmospheric Pressure	CH_4 (Peak)	CO_2	O_2
Location	Mb	%	%	%
L1	NR	0	0	21.0
L2	NR	0	0.7	19.9
L3	NR	0	2.8	17.0
L4	NR	0	1.2	18.7

NR denotes not recorded

Given the high water levels in the probe holes it is unlikely that the results are indicative if landfill gas levels in the waste body. It is likely however that given the lack of cover of the waste that landfill gas vents freely to atmosphere and the risk posed to off site receptors as a result of gas migration is consequently low. Given the age of the landfill gas generation is also likely to be substantially depleted.

4. TIER 3 RISK ASSESSMENT

4.1 Conceptual Site Model

The Tier 1 Risk scores are presented in Table 4.1, with the full Tier 1 Risk scores in Appendix 1. The assessments concluded that the site is a Moderate Risk site due to the leachate migration risk to surface water.

Table 4.1 Tier 1 Risk Assessment Scores

SPR Linkage	Linkage Score	Norm Score
SPR1	84.00	28.00
SPR2	0.0	0.00
SPR3	28.00	11.67
SPR4	0.00	0.00
SPR5	84.00	21.00
SPR6	0.28	0.05
SPR7	56.00	23.33
SPR8	28.00	46.67
SPR9	0.00	0.00
SPR10	10.50	7.00
SPR11	10.50	7.00

Risk Classification: B Moderate

The Tier 1 Conceptual Site Model (CSM) is shown in Figure 4.1. It shows the waste mass on the underlying peat with waste filled close to the road bordering the southern boundary and the drain along the northern boundary.

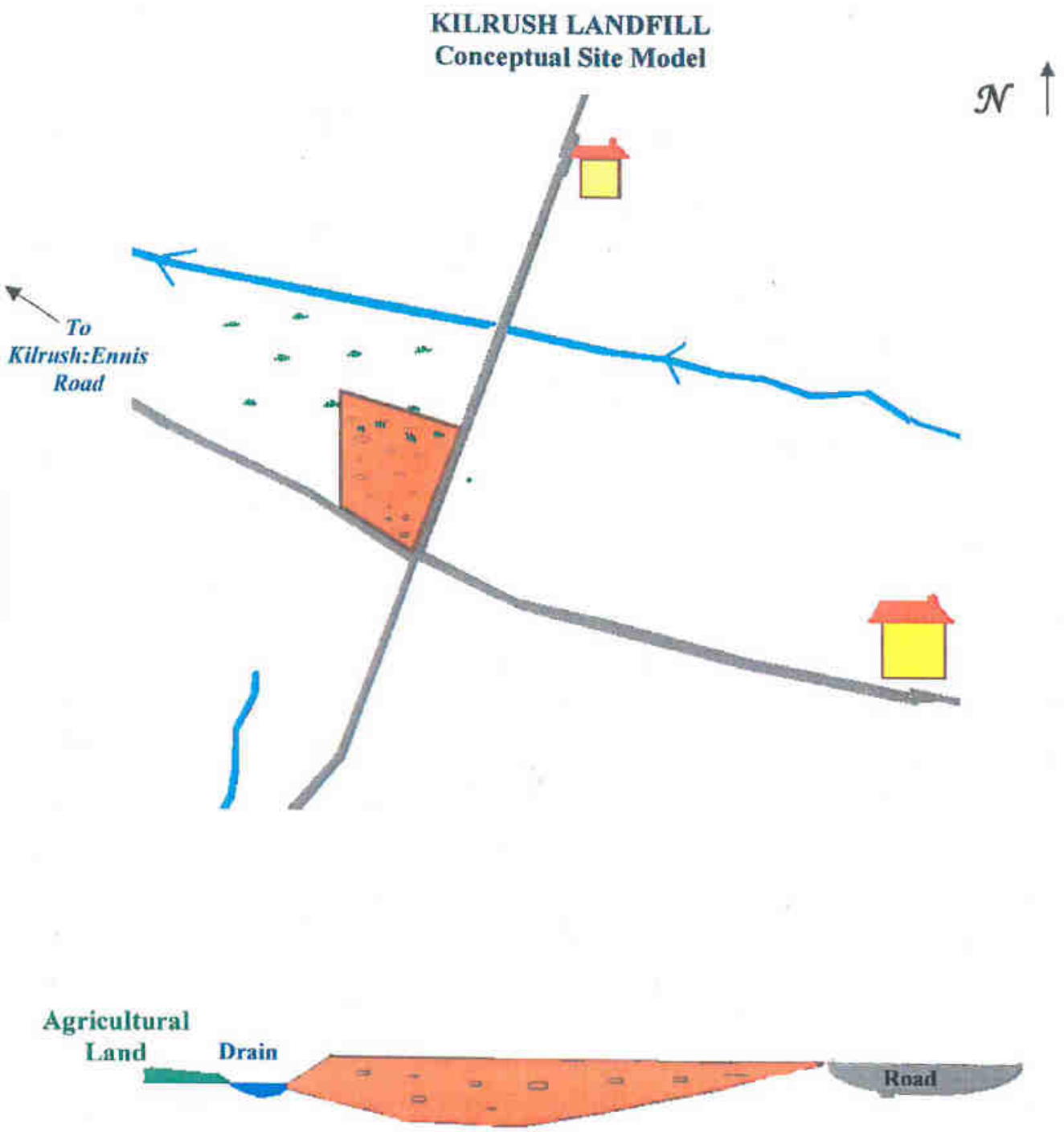

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Figure 4.1 Conceptual Site Model

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4.2 Revised CSM

The COP requires that the Conceptual Site Model (CSM) developed during Tier 1 be refined based on the findings of further site investigations. OCM refined the CSM based on the Tier 2 Investigations and the site inspection completed in May 2020. A schematic of the revised CSM is shown in Figure 4.2.

There is a thin layer of soils overlying the waste c200mm capping layer comprising top soil though it was not present continuously across the site. In some locations waste was visible at the surface. Waste is present across the entire site area and averages 3.5m in thickness and is 4.5m at its deepest. It is underlain by peat. It is likely that rainfall recharge infiltrates the waste to its base. Because of the compaction of the waste on the peat the underlying peat layer is essentially impervious resulting in preferential discharge of leachate to the surface water drains around the site. The perimeter drains appear to be shallower than the waste and it is possible that leachate collects in the base of the waste and gradually spills over to the drains when there is sufficient rainfall recharge which is likely to be in the winter months. This is also when dilution in the surface water downstream is highest.

During the site inspection the surface of the waste was firm with no evidence of differential settlement and the drains surrounding the waste mass were dry. There was no evidence of leachate break out to the drains.

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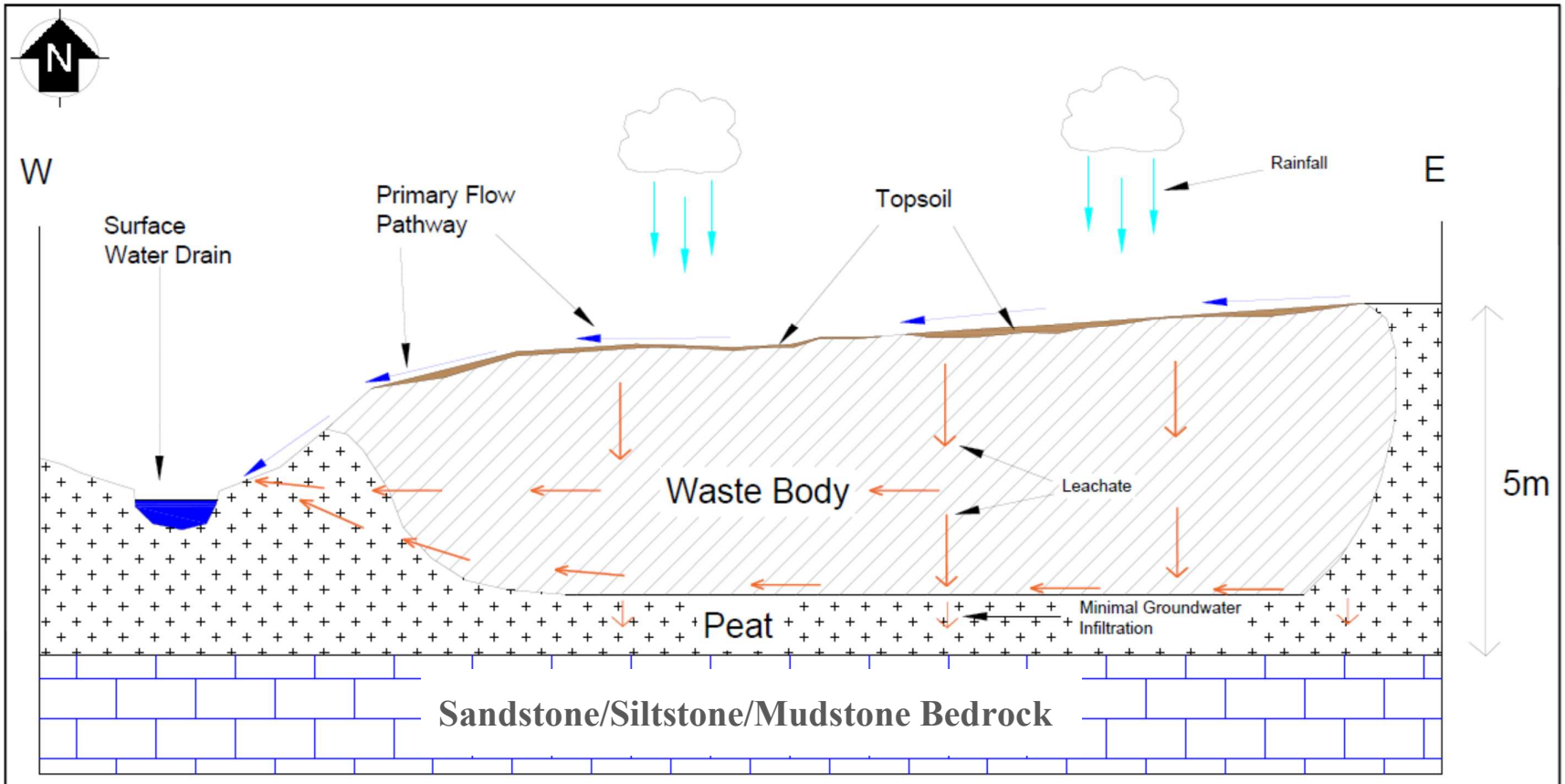

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FIGURE No.: 4.2

TITLE: Conceptual Site Model

SCALE: SCALE

REV.: A

4.3 Sources

The source is the municipal solid waste which is estimated to be in the region of c66,500m^3 (33,250 tonnes) which extend across most of the site footprint.

Leachate

The results of the analysis of the leachate sample collected from the trial pits TH-2 and TH-4 in 2010 indicate the presence of a weak and aged leachate that is present in isolated pockets in the waste mass. It is likely that the leachate gradually discharges to the surface water drains around the site primarily in the winter period.

Landfill Gas

Low levels of Landfill gas is being generated in the waste body which is freely venting to atmosphere because of the lack of consistent landfill cover.

4.4 Pathways

4.4.1 Leachate Migration Pathways

Leachate is migrating via the surface water drainage system surrounding the landfill and into the Moyadda Bed stream c110m to the north of the site. This stream discharges to the Kilcarrol Stream 770m north of the site. The Kilcarrol stream discharges to the Wood River c490 further to the west of that confluence. The Wood River discharges to the sea at Kilrush Creek c2.5km to the west of the site the Wood River.

4.4.2 Landfill Gas Migration Pathways

Landfill gas is migrating through the waste at the surface and possibly toward the surface water drains surrounding the landfill. It is likely that the landfill gas is venting to atmosphere around the margins of the landfill.

4.5 Receptors

4.5.1 Leachate Migration Receptors

The Moyadda and Kilcarool Streams and further downstream the Wood River and the Kilrush Creek are the closest water body receptors

The results of surface water quality monitoring indicates that leachate is not impacting on surface water quality downstream of the landfill

There are no public water supply wells within 20km of the site. The closest well identified by the Council is 610m to the north and this was sampled as part of the Tier 2 investigations. The results indicate that it is not impacted by the landfill. It is likely that the peat beneath the site inhibits leachate migration to the groundwater beneath the site.

Landfill Gas

Landfill gas migrates freely to atmosphere where the cover is thin and where there is cover it can migrate laterally to the surface water drains surrounding the site.

4.6 Revised Risk Scores

The revised Tier 3 risk scores are summarised on Table 5.2 and are included in full in Appendix 5. The overall risk remains moderate due to leachate migration to the surface receptor.

Table 5.2 Tier 3 Risk Scores

Groundwater & Surface Water	Groundwater only	Surface water only	Lateral & Vertical	
Calculator	**SPR Values**	**Maximum Score**	**Linkages**	**Normalised Score**
SPR 1 =	70	300	**Leachate => surface water**	**23%**
SPR 2 =	0	300	**Leachate => SWDTE**	**0%**
SPR 3 =	21	240	**Leachate => human presence**	**9%**
SPR 4 =	0	240	**Leachate => GWDTE**	**0%**
SPR 5 =	63	400	**Leachate => Aquifer**	**16%**
SPR 6 =	0	560	**Leachate => Surface Water**	**0%**
SPR 7 =	42	240	**Leachate => SWDTE**	**18%**
SPR 8 =	28	60	**Leachate => Surface Water**	**47%**
SPR 9 =	0	60	**Leachate => SWDTE**	**0%**
SPR 10 =	3.5	150	**Landfill Gas => Human Presence**	**2%**
SPR 11 =	0	250	**Landfill Gas => Human Presence**	**0%**

Risk Classification	Range of Risk Scores
Highest Risk (Class A)	**Greater than or equal to 70% for any individual SPR lingage**
Moderate Risk (Class B)	**Between 40-70% for any individual SPR linkage**
Lowest Risk (Class C)	**Less than or equal to 40% for any individual SPR linkage**
TIER 3 RATING	**Moderate**

5. REMEDIAL ACTION PLAN

The Risk Ranking for the site is Moderate and is associated with leachate migration along the surface water pathway to a surface water receptor. The landfill gas risk is considered to be Low. In preparing this Remedial Action Plan (RAP) OCM has considered the proposed future end use for the site, which will be as retained closed landfill.

Given the age of the site i.e. closed for 29 years, the weak nature of the leachate and lack of landfill gas the landfill is essentially inert.

The EPA Landfill Restoration and Aftercare Manual recommends that for Inert Landfill with low amenity use that a minimum cap of 500mm should be placed but top soil layer is not essential.

Figure 5.1 – 5.4 show an outline remedial design for the site to mitigate the environmental risk posed by the site, and to accommodate the proposed end use and EPA Landfill Restoration Manual requirements.

The waste around the sides of the landfill needs to be pulled back from the surface water drains. A low permeability clay retaining berm should be constructed in these areas between the edge of the waste and the drains.

There is currently a thin capping layer in some areas on the site but it is absent in some areas. Clean soil should be imported to site to build up the capping layer to 500mm thickness.

The capping layer should be integrated into the perimeter retaining berm and graded to achieve a fall from a central ridge running north to south to the sides of the capped site with a fall of 1:40. The finished cap should be grass seeded.

Four gas ventilation wells should be installed, one in each quadrant of the site to prevent landfill gas migration laterally once the cap has been placed. The well pipes should be 100mm slotted uPVC and should extend 150mm above the top soil layer. These wells should be fitted with cowls to prevent damage.

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FIGURE No.

5.1

TITLE

Remediation Measures

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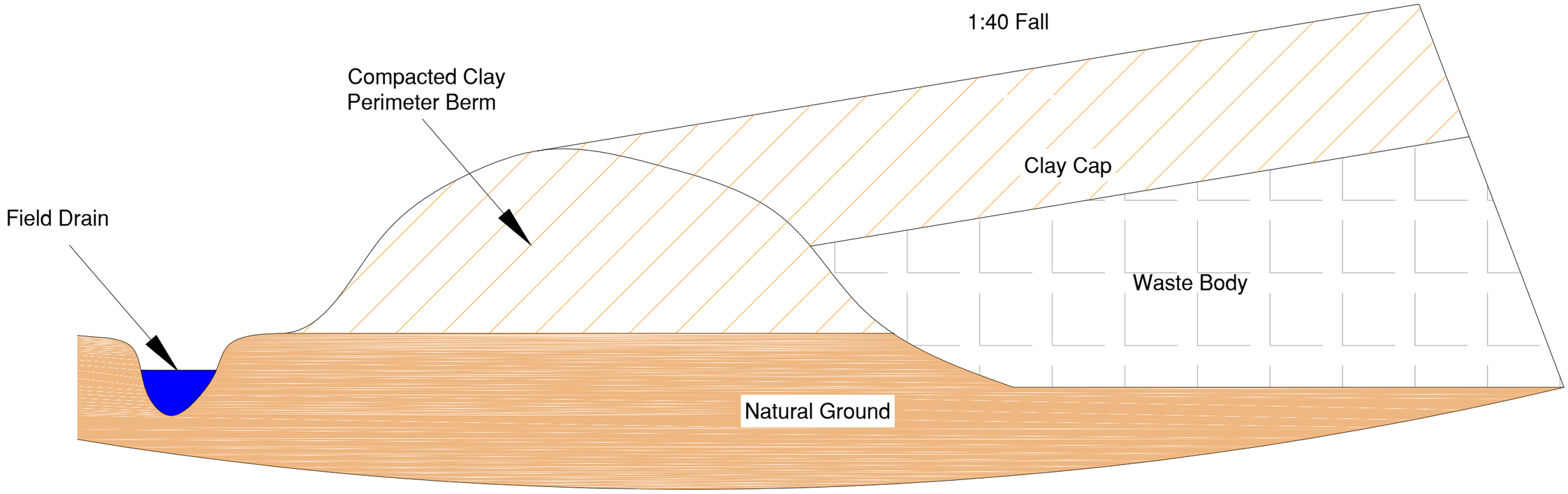

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FIGURE No.
5.2

TITLE

Clay Berm Detail

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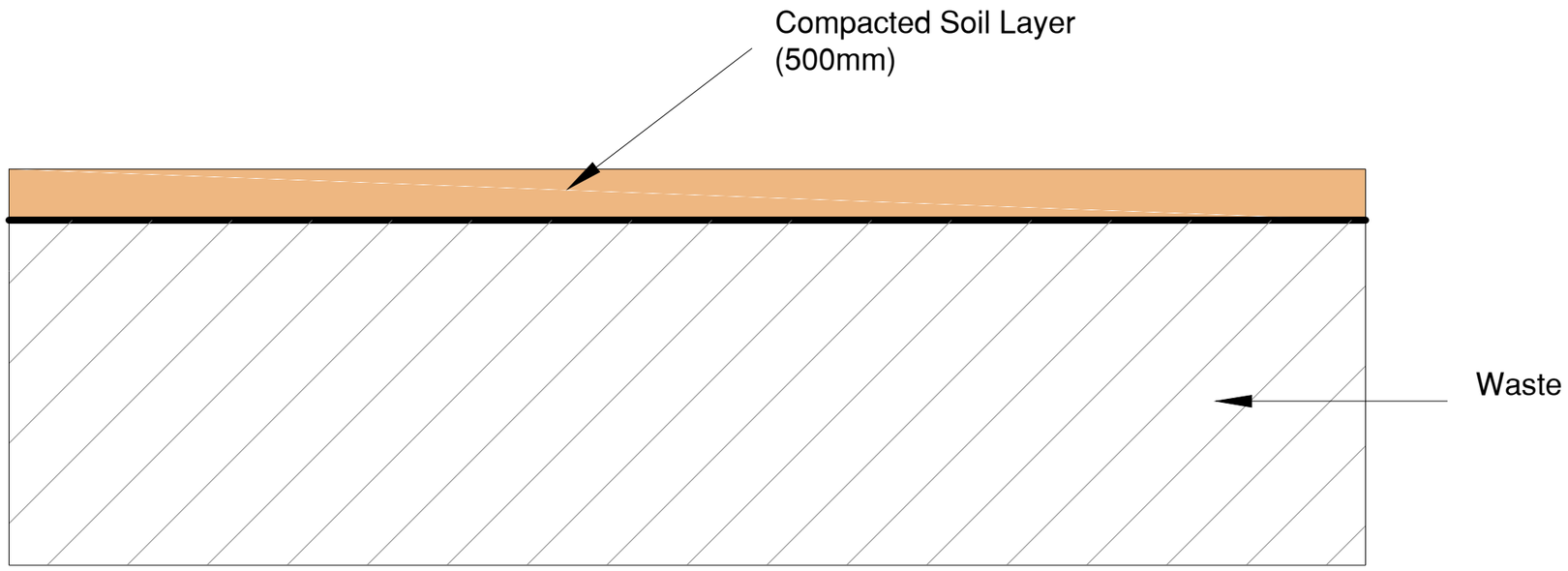

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FIGURE No.
5.3

TITLE

Landfill Capping Detail

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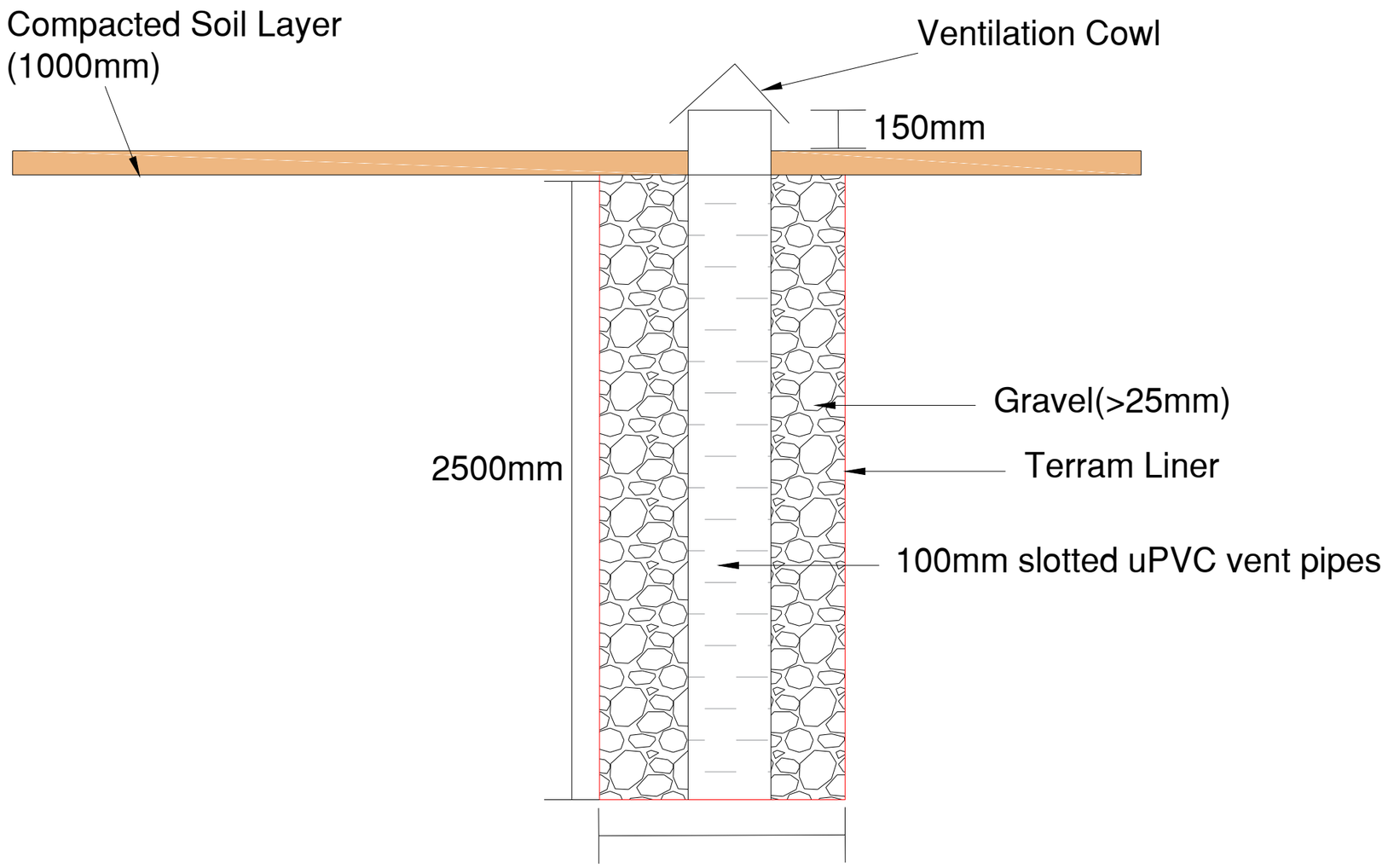

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FIGURE No.

5.4

TITLE

Landfill Gas Ventilation Pipe

SCALE

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REV.

A

6. APPROPRIATE ASSESSMENT RISK SCREENING

6.1 AA Risk Screening Process

The Habitats Directive, which is implemented under the European Communities Birds and Natural Habitats) Regulations 2011 (S.I. No 477 of 2011) requires an "appropriate assessment" of the potential impacts any works may have on the conservation objectives of any Natura 2000 site.

Article 6(3) of the Directive stipulates that *any plan or project not directly connected with or necessary to the management of a Natura 2000 site, but likely to have a significant effect thereon…shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives.*

Natura 2000 sites are those identified as sites of European Community importance and designated as such under the EU Habitats Directive (92/43/EC) (Special Area of Conservation) or the Birds Directive (Special Protection Areas).

Guidance documents issued by Department of Environment, Heritage and Local Government and the National Parks and Wildlife Services recommend that the assessment be completed in a series of Stages, which comprise:

Stage 1: Screening

The purpose of this Stage is to determine, on the basis of a preliminary assessment and objective criteria, whether a plan or project, alone and in combination with other plans or projects, could have significant effects on a Natura 2000 site in view of the site's conservation objectives.

Stage 2: Appropriate Assessment

This Stage is required if the Stage 1 Screening exercise identifies that the project is likely to have a significant impacts on a Natura 2000 site.

Stage 3: Assessment of Alternative Solutions.

If Stage 2 determines that the project will have an adverse impact upon the integrity of a Natura 2000 site, despite the implementation of mitigation measures, it must be objectively concluded that no alternative solutions exist before the plan can proceed.

Stage 4: Compensatory Measures:

Where no alternative solutions are feasible and where adverse impacts remain but imperative reasons of overriding public interest require the implementation of a project an assessment of compensatory measures that will effectively offset the damage to the Natura site 2000 is required.

The AA screening is required as it is proposed to undertake remedial measures incorporating the construction of retaining berms along the perimeter, the regarding and capping of the landfill.

6.2 Stage 1 Screening Methodology

The Stage 1 Screening was conducted in accordance with the guidance presented in the "Assessment of Plans and Projects significantly affecting Natura 2000 sites, Methodological Guidance on the provisions of Articles 6(3) and 6(4) of the Habitats Directive 92/43/EEC" (2001); The Department of Environment, Heritage and Local Government (2009, revised February 2010) Appropriate Assessment of Plans and Projects in Ireland and the National Parks and Wildlife Services (2010) Circular NPW 1/10 & PSSP 2/10 Appropriate Assessment under Article 6 of the Habitats Directive: Guidance for Planning Authorities.

Special Areas of Conservation (SAC) are selected for the conservation and protection of habitats listed on Annex I and species (other than birds) listed on Annex II of the Habitats Directive, and their habitats. The habitats on Annex I require special conservation measures. Special Protection Areas (SPA) are selected for the conservation and protection of bird species listed on Annex I of the Birds Directive and regularly occurring migratory species, and their habitats, particularly wetlands.

The closest designated site is the Lower River Shannon Special Area of Conservation (SAC) and the River Shannon and River Fergus Estuaries Special Protection Area (SPA) which are located c4km to the west of the site.
(Figure 2.11).

The limited remedial works have the potential to general dust emissions in the immediate vicinity of the site when the capping layer is being re-worked. There will also be emissions of rainfall run-off collected in the surface water drains discharging to the drains around the site.

Given the distance from the site to the designated areas and the limited connectivity the remedial works do not present any significant any risk to the SAC and SPA.

6.3 Stage 1 Conclusion

As the remedial measures will not impact on the SAC a Stage 2 Appropriate Assessment is not required.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Risk Category

The results of the Tier 3 assessment and the refined SPR conceptual model confirm that the site remains a Class B – Moderate Risk due to the risk posed by leachate migration to surface water. Leachate migration risk to groundwater is considered to be insignificant. The landfill gas migration risk to offsite receptors is Low.

Surface Water

The 2010 and 2020 surface water monitoring indicates that the landfill is not significantly impacted on surface water quality downstream of the landfill.

Groundwater

The groundwater quality at the closest well to the site (610m to the north) indicates that the site is not impacting on groundwater quality. The presence of a compacted peat layer beneath the waste means that any leachate generated in the waste will discharge laterally preferentially along the surface water pathway rather than vertically to the groundwater

There are no public supply wells within 20km of the site.

Landfill Gas

The landfill gas risk is low and the remedial measures proposed will mitigate the residual risk

Ecological Sensitive Sites

The CSEE biological quality survey completed in 2015 concluded that while there may be some deterioration in biological quality (reducing from Q3 to Q2/3 between sites 1 and 2) close to the landfill that the reduction of biological quality seen further downstream was not associated with the landfill.

The closest site to the landfill is the Lower River Shannon Special Area of Conservation (SAC) and the River Shannon and River Fergus Estuaries Special Protection Area (SPA) which are located c4km to the west of the site. Given the distance from the site the risk posed to the SAC/SPA is not considered to be significant.

7.2 Recommendations

The remedial measures described in Section 6 of the report should be implemented to mitigate the environmental risk posed by the landfill.

Following the implementation of the remedial measures surface water monitoring should be undertaken at SW-100 upstream and SW-101 and SW-102 downstream annually to establish their effectiveness. Monitoring should be undertaken for ammonia, sodium, chloride, potassium, manganese, electrical conductivity and heavy metal suite (cadmium, chromium copper, lead, mercury nickel zinc).

APPENDICES

APPENDIX 1

Tier 1 Report

See Separate Volume

APPENDIX 2

Ecology Report

See Separate Volume

APPENDIX 3

Tier 2 Report

See Separate Volume

APPENDIX 4

Surface Water Laboratory Results

See Separate Volume

APPENDIX 5

Tier 3 Risk Scores

See Separate Volume