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HYDROGEOLOGICAL SURVEY REPORT

KILLARNEY WASTE DISPOSAL LTD

AUGHACURREEN

WASTE LICENCE NO. W0217-01

Prepared For: -

Killarney Waste Disposal Ltd,
Aughcureen,
Killarney,
County Kerry.

Prepared By: -

O' Callaghan Moran & Associates,
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February 2017

Project	Groundwater Quality Assessment			
Client Licence	Killarney Waste Disposal Ltd W0217-01			
Report No	Date	Status	Prepared By	Reviewed By
1602330201	14/07/2017	Draft Client Review	Jim O'Callaghan MSc, CEnv, MCIWM, IEMA	Sean Moran MSc, PGeol, Euro Geol MCIWEM

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EXECUTIVE SUMMARY

Killarney Waste Disposal Ltd (KWD) operates its facility at Aughacureen under Waste Licence Reg. No. W0217-01. In 2008 KWD commissioned OES to carry out a Hydrogeological Survey of the site in compliance with Condition 3.21 of the licence. The survey included the installation of four on-site groundwater wells (MW-1, MW-2, MW-3 and MW-4) and the collection and analysis of groundwater samples. Elevated ammonia levels were detected in three of the wells (MW-1, MW-2 and MW-3) and OES concluded that the source was off site agricultural and forestry land use.

The Agency, based on the continued detection of elevated ammonia levels in a number of the wells, requested KWD to submit an up-to-date hydrogeological investigation report that examined the reasons for the high concentrations. KWD commissioned O'Callaghan Moran & Associates (OCM) to update the OES report.

The facility encompasses 2.2 hectares (ha) and consists of a material recovery building (3,223m^2), concrete yards, weighbridge and administration building. Ancillary infrastructure includes fuel storage, storm water drainage system and reed bed, and a sanitary effluent treatment system.

The soils and subsoils at the site comprise peat overlying till and the combined thickness ranges from 3m in the east to the site to 5m in the west. The underlying bedrock is shale and sandstone, the upper 3 to 5m of which is weathered. The bedrock is classified as a locally important aquifer, which is moderately productive only in local zones. It is not used locally as a water supply source. The aquifer vulnerability to pollution from the ground surface ranges from Moderate to High. The direction of groundwater flows is from the south-west to north-east.

During the installation of the monitoring wells water strikes were encountered between 10 and 20m below ground level. Subsequently the water levels in all of the wells rose above the top of the weathered bedrock, indicating confined conditions. This is confirmed by the water level data recorded during the routine monitoring and OCM field observations of artesian conditions in one of the wells.

The on-site potential sources of groundwater contamination are a leachate sump inside the materials recovery building; a sump at the timber and metal storage area; an oil storage tank, oil interceptor; the reed beds and percolation area, and the percolation area associated with the 'puraflo' sanitary waste treatment system installed in 2016. The sumps, oil interceptor and oil tank bund are subjected to routine integrity tests. The most recent were completed in 2016 and confirmed the structures were fit for purpose. Testing of the treated sanitary effluent has confirmed that the 'puraflo' system is functioning properly.

Past operational practices, including the discharge of surface water run-off from the bin washing area and compost bay to the reed beds; the original septic tank, and the discharge of water from the sumps at the timber storage area and at the weighbridge had the potential to cause groundwater contamination.

The site is in a rural area and the surrounding land use is primarily agricultural, with some forestry. There are approximately twenty (20) residences within 500m of the facility, the majority of which are in a 'ribbon development' along the local road to the north of the site. It is understood that the houses are served by septic tanks.

Monitoring wells MW-3 and MW-4 are up gradient of waste activities and MW-1 and MW-2 are down gradient. All of the wells are exclusively screened in the bedrock, however at MW-2 and MW-4 the screen extends into the weathered zone.

Since monitoring began in 2009, elevated ammonia has been detected in MW-1, MW-2 and MW-3. Nitrate has never been detected in any of the wells and sulphate, while present in MW-4, has only very occasionally been detected at very low levels in the other wells. The redox potential in all of the wells, in conjunction with the low nitrate and presence of dissolved iron, indicates reducing conditions, which is consistent with confined aquifer conditions.

While the wastes activities are a potential source of organic matter that typically is required to allow reducing conditions to develop, the monitoring data does not indicate this is the case, as the electrical conductivity, chloride and Chemical Oxygen Demand (COD) levels are consistent with uncontaminated groundwater.

Faecal coliforms were detected in MW-3 and MW-4 in January 2017. The headworks of both wells are damaged and there are no well caps, meaning the wells are susceptible to faecal contamination by birds and small mammals, and, in the case of MW-4, the entry of surface water run-off.

The elevated ammonia detected in MW-1, MW-2 and MW-3 is due to naturally occurring reducing conditions in the aquifer. The condition of the well heads at MW-3 and MW-4 means they are vulnerable to contamination from the ground surface and it is recommended that they be repaired and the wells disinfected.

1. INTRODUCTION

1.1 General Introduction

KWD operates its Materials Recovery Facility at Aughacureen under Waste Licence Reg. No. W0217-01 issued by the Environmental Protection Agency (Agency). In 2008 KWD commissioned OES to carry out a Hydrogeological Survey of the site in compliance with Condition 3.21 of the licence. The survey included the installation of on-site groundwater wells and the collection and analysis of groundwater samples in 2009 and 2019. Elevated ammonia levels were detected in a number of the wells and OES concluded that based on the direction of groundwater flow the sources were off-site.

Bi-annual groundwater monitoring began in 2012. The Agency, based on elevated ammonia levels persistently detected in a number of the wells requested KWD to submit an up-to-date hydrological investigation report that examined the reasons for the high concentrations. KWD commissioned O'Callaghan Moran & Associates (OCM) to update the OES report.

The revised report is based on information in the Environmental Impact Statement (EIS) prepared in 2005, the OES report, databases maintained by Teagasc and the Geological Survey of Ireland (GSI) and the results of the groundwater monitoring carried out by KWD.

1.2 Objective and Background Information

The objectives of the updated report were at a minimum to clarify the precise groundwater flow direction contours around the site based on datum levels of water within the wells; provide analysis results for the total and faecal coliforms from the well; provide integrity test results for all sumps, lagoons and underground pipelines handling effluent or sanitary waste and clarify the presence and use of any private groundwater abstraction wells at residential properties within 200m of the facility.

Site History

The site was developed as a waste management facility in 1987 on lands that had previously been used for agricultural purposes. It operated under a series of Waste Permits issued by Kerry County Council that authorised the acceptance and processing of 16,500 tonnes/annum of non-hazardous waste. In 2005 the Agency granted a Waste Licence that authorised the acceptance and processing of 40,000 tonnes of non-hazardous waste.

1.3 Summary of Previous Assessments

OES submitted the proposed scope of the hydrological survey to the Agency and, following receipt of approval, completed the assessment. It comprised a desk study of geological and hydrogeological databases maintained by the GSI the installation of four groundwater monitoring wells (MW-1, MW-2, MW-3 and MW-4); the collection and analysis of groundwater samples on three occasions and an assessment of potential on and off-site contaminant sources. A copy of the report is in Appendix 1.

OES established that the underlying bedrock is a Locally Important aquifer, bedrock which is moderately productive only in Local Zones (**Ll**) and that secondary permeability is dominant. The nearest groundwater well to the site was more than 1km upgradient, with the closest down gradient well 2.7km away.

Two of the monitoring wells (MW-1 and MW-2) were positioned to the south and down topographic gradient of the operational area, with MW-3 and MW-4 being to the north and up gradient. The wells were installed using an air rotary rig.

The borehole logs indicate the soils and subsoils comprise peat overlying 'mottled clay'. The peat was up to 2m thick and the clay was between 1 and 3m thick. The underlying bedrock is described as a weathered black shale.

The borings extended to between 18 and 24 m below ground level and water strikes were encountered in the bedrock at depths ranging from 11 to 20m below ground level (bgl). The water levels recorded in the wells during subsequent groundwater sample collection ranged from 0.1 m below the top of the well pipe in MW-1, to 1.71m in MW-3; however OES did not survey the wells to datum level. More detail on the well construction is provided in Section 4.

OES conducted groundwater quality monitoring on three occasions (04/09/2009, 26/11/2009 and 27/05/2010) for pH, electrical conductivity, total dissolved solids, ammonia, chloride, nitrate, sulphate and extractable petroleum hydrocarbons (EPH).

Elevated ammonia levels were detected in MW-1, MW-2 and MW-3 on all three occasions, with the levels in the up-gradient well (MW-3) ranging from 1.32 to 2.86 mg/l. Ammonia was not detected in the other upgradient well (MW-4). The maximum levels in the down gradient wells were 1.71 mg/l in MW-1 and 2.83 mg/l in MW-2. Nitrate and sulphate were not detected in MW-1, MW-2 and MW-3, but sulphate was detected in MW-4 on one occasion. The electrical conductivity and total dissolved solids levels in MW-4 were significantly lower than in the other wells.

OES identified two potential on-site contaminant sources for the elevated ammonia, which were the leachate holding tank in the materials recovery building and the reed beds. Off-site potential sources included septic tanks, the land application of farm animal slurry and forestry. OES concluded that the leachate tank and reed beds were not the sources of the elevated ammonia and, given its detection in the up gradient well, the source was outside the site boundary.

2. ENVIRONMENTAL SETTING

2.1 Site Location & Description

The facility is located at Aughacurren approximately 4km km to the north-west of Killarney (Figure 2.1). The site layout is shown on Drawing No. 01 Rev A. It encompasses 2.2 hectares (ha) and consists of a material recovery building (3,223m^2), concrete yards, weighbridge and administration building. Ancillary infrastructure includes fuel storage, storm water drainage system and reed bed, and a sanitary effluent treatment system.

2.2 Waste Activities

2.2.1 Surface Water Drainage

There are three separate surface water drainage systems. The first collected rainwater run-off from the roof of the materials recovery building and discharges it to a drain that runs through the site.

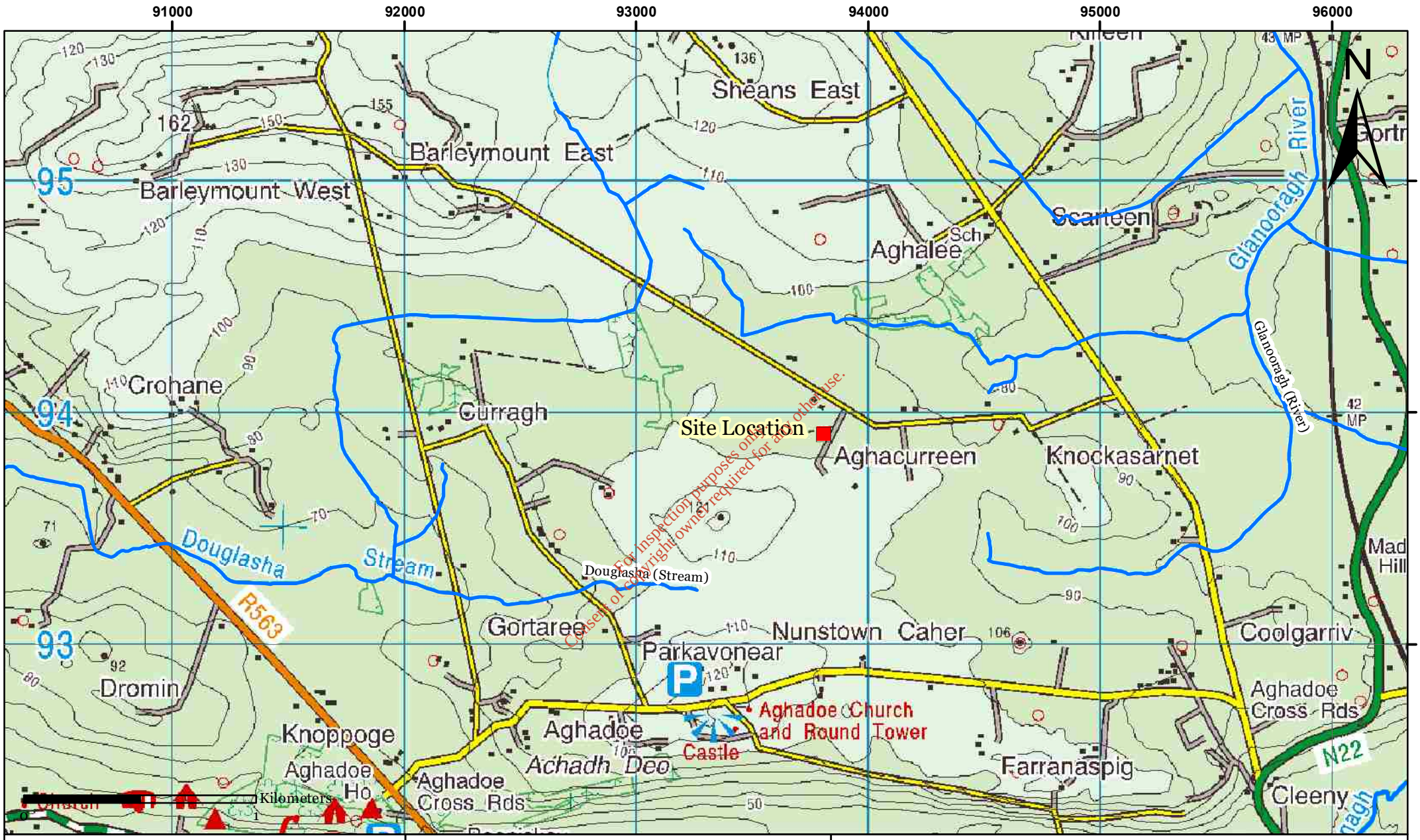
Rainwater run-off from the operational yards, where there is the potential for contamination to occur (bin washing area and compost bay), is directed to holding tanks where it is stored pending removal from the site for off-site treatment in the Irish Water Wastewater Treatment Plant (WWTP) in Killarney.

Rainwater run-off from the yards where the risk of contamination is low, including the area around the office and the timber storage area, is collected and directed via a Class 1 Oil Interceptor and three settlement tanks to the on-site reed beds. The reed beds comprise an initial 'glass' bed followed by a 'lagoon' bed. The outflow from the 'lagoon' bed is to an on-site percolation area in the north-west of the site.

2.2.2 Foul Water Drainage

Liquid seeps from the waste handled inside the materials recovery building is collected in an underground effluent holding tank (6,92m^3). The tank is made of pre-cast concrete and sits in a second underground concrete tank that provides secondary containment (bund). The wastewater accumulating in the tank is removed for treatment at the Irish Water WWTP.

Sanitary wastewater is treated in an on-site proprietary wastewater treatment system (puraflo) located close to the northern site boundary, with the treated effluent pumped to an on-site percolation area located to the north of the reed bed percolation area. The system was installed and certified in 2016 to replace a former septic tank located to the north-west of the weighbridge that has now been decommissioned.



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CLIENT
Killarney Waste Disposal

TITLE
Site Location

Details:
Site Location

Figure 2.1

NOTES:

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DO NOT SCALE FROM THIS DRAWING.
WORK ONLY FROM FIGURED DIMENSIONS.
ALL ERRORS AND OMMISIONS TO BE REPORTED TO THE ARCHITECT.

N

Site Area = 2.202 HA

New Pump Main From Puraflo System To Wastewater Treatment Area. Of 4No. Pods On A Polishing Filter.

R 2 & SW 2 drain to external land drain

Glass Reed Bed

Existing Storm Water Settling Tanks x3No.

New Wastewater Treatment Area. Of 4No. Pods On A Polishing Filter.

SEE DRAWING K-W-D-04-2016-REV-A SEW (SPECIFIED ENGINEERING WORKS)

SEE DRAWING K-W-D-03-2016-REV-A SEW (SPECIFIED ENGINEERING WORKS)

SEE DRAWING K-W-D-03-2016-REV-A SEW (SPECIFIED ENGINEERING WORKS)

SEE DRAWING K-W-D-02-2016-REV-A SEW (SPECIFIED ENGINEERING WORKS)

Post and Wire Fence

Lagoon Reed Bed 0.5m Freeboard

SW 2

SW 1

Storm water (SW 1) drains to percolation ditch

Water drains from wooded area to 400mm land drain

Proposed Borehole 2

Proposed new holding tank

750mm Pipe under track

Timber Shredding Yard

Baled Plastic Shed

Existing Metal Shearing Yard

Solids Separator

stream

New Puraflo System

Existing Septic Tank No Longer In Use

Area of Paving served by Reed Bed = 2550 sq. m

100mm pipe

ESB Pole

Proposed Borehole 1

Weigh Bridge

Entrance

Proposed Gulley

Proposed Offices

Heat Exchangers

Dryer

Roof Water (R2) discharges to drain.

New effluent holding tank

Baling Shed

MRF Building

Diesel Generator

Roof stormwater(R1) discharges to roadside drain

R1

4.55 cubic metre holding tank

Private access road

Foul Sewer Pipe

Storm Drainage off Roo

Yard Drainage Pipe

750mm Proposed Drainag

Proposed New Building

Designated Parking Are

Concrete Area

Existing Material Recov

REV	DATE	REVISION INFO.
A	03/10/16	INFORMATION.

CLIENT: KWD RECYCLING LTD
MRF FACILITY AT AUGHACUREEN.

PROJECT: SEW (SPECIFIED ENGINEERING WORKS)

DRAWING: SITE LAYOUT PLAN.

DONAL MOYNIHAN
B.E, C.ENG., M. IEI.
CHARTERED ENGINEER

SCALE: 1:500 | DATE: 03.10.2016

DWG NO.: 01

2.3 Surrounding Land Use

The facility is located in a rural area and the surrounding land use is primarily agricultural, with some forestry (Figure 2.2). There are approximately twenty (20) residences within 500m of the facility, the majority of which are in a 'ribbon development' along the local road to the north of the site. These residences obtain their water supply from the Irish Water mains.

2.4 Hydrology

There is a local high point (121mOD) approximately 500 m to the south-west of the site, from where the ground falls away in all directions (Figure 2.3). This high point forms a watershed between tributaries of the Glanooragh River to the north of the site and the Douglasha Stream to the west. Both watercourses are tributaries of the River Laune. The site is in the catchment of the Glanooragh River, which is a tributary of the Gweestin River.

A surface water drain flows through the site in a south-west to north-east direction. At the north-eastern boundary, the drain changes direction to flow south-east along the boundary to the access road, where it turns in a north-easterly direction and joins a tributary of the Glanooragh River, approximately 250m from the site.

2.5 Geology

2.5.1 Subsoils

The Teagasc maps (Figure 2.4) indicate that the subsoils are till derived from Namurian shales and sandstones. The logs of the boreholes installed by OES (refer to Appendix 1) indicate the soils comprise peat overlying tills. The combined thickness ranges from 3m in the east of the site to 5m in the west.

2.5.2 Bedrock

The GSI bedrock map (Figure 2.5) indicates the site is underlain by Namurian shales and sandstones. The OES borehole logs indicate the bedrock comprises a black shale, the upper 3 to 5m of which is weathered.

2.6 Hydrogeology

2.6.1 Aquifer Classification

The subsoils are not significantly water bearing. The underlying bedrock is characterised by the GSI as a Locally Important aquifer, which is moderately productive only in Local Zones (**Ll**) (Figure 2.6). Permeability in the bedrock is highest in the upper few metres but generally decreases rapidly with depth. In general, groundwater flow is concentrated in the upper 15 m of the aquifer, although deeper inflows from along fault zones or connected fractures can be encountered.

The OES borehole logs show water strikes at between 11 and 20m below ground level. The water levels recorded by OES in the wells in 2009 and 2010 were all significantly above the top of the bedrock, indicating confined conditions.

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CLIENT
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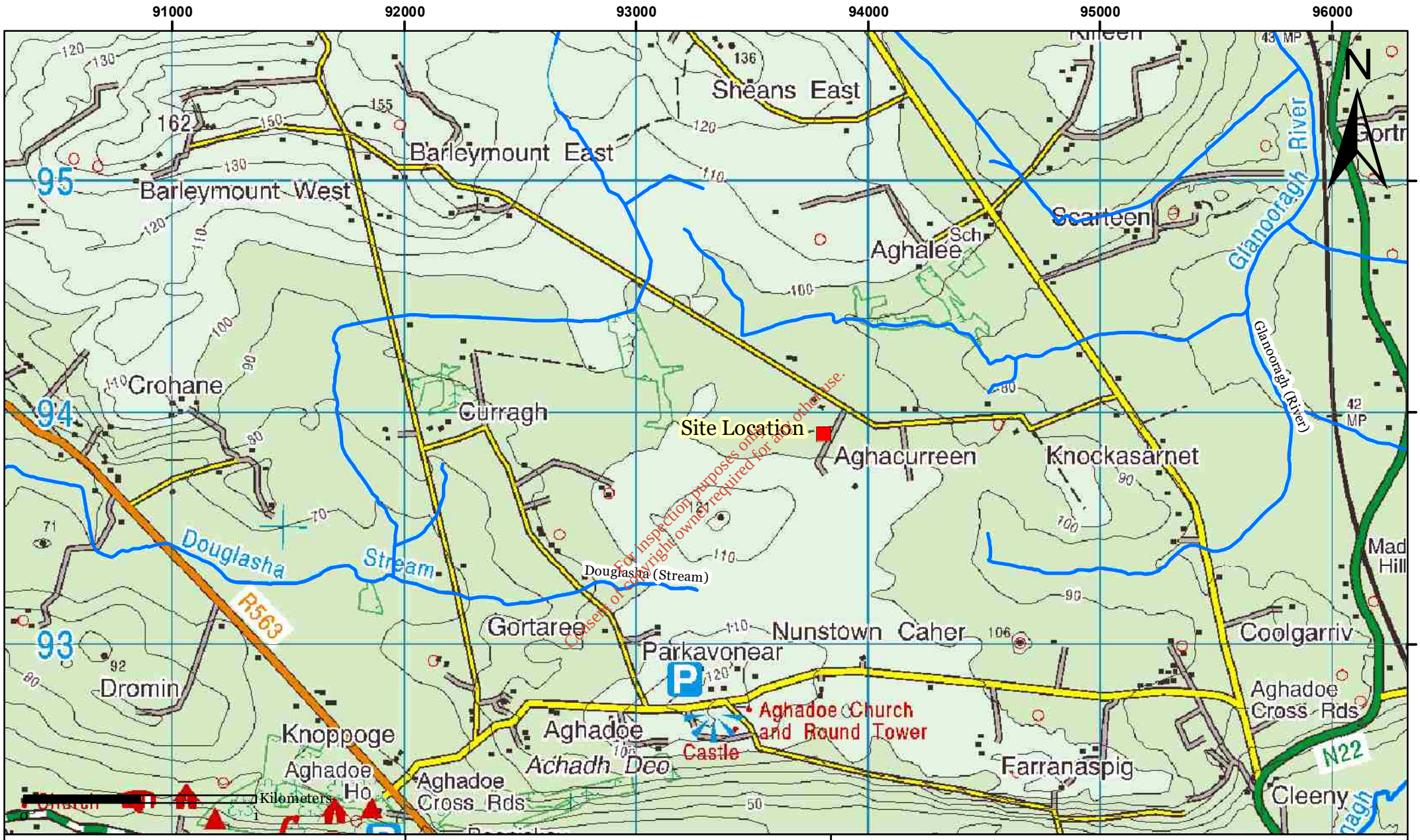
TITLE
Surrounding Land Use

Details:
Site Location

Figure 2.2



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CLIENT
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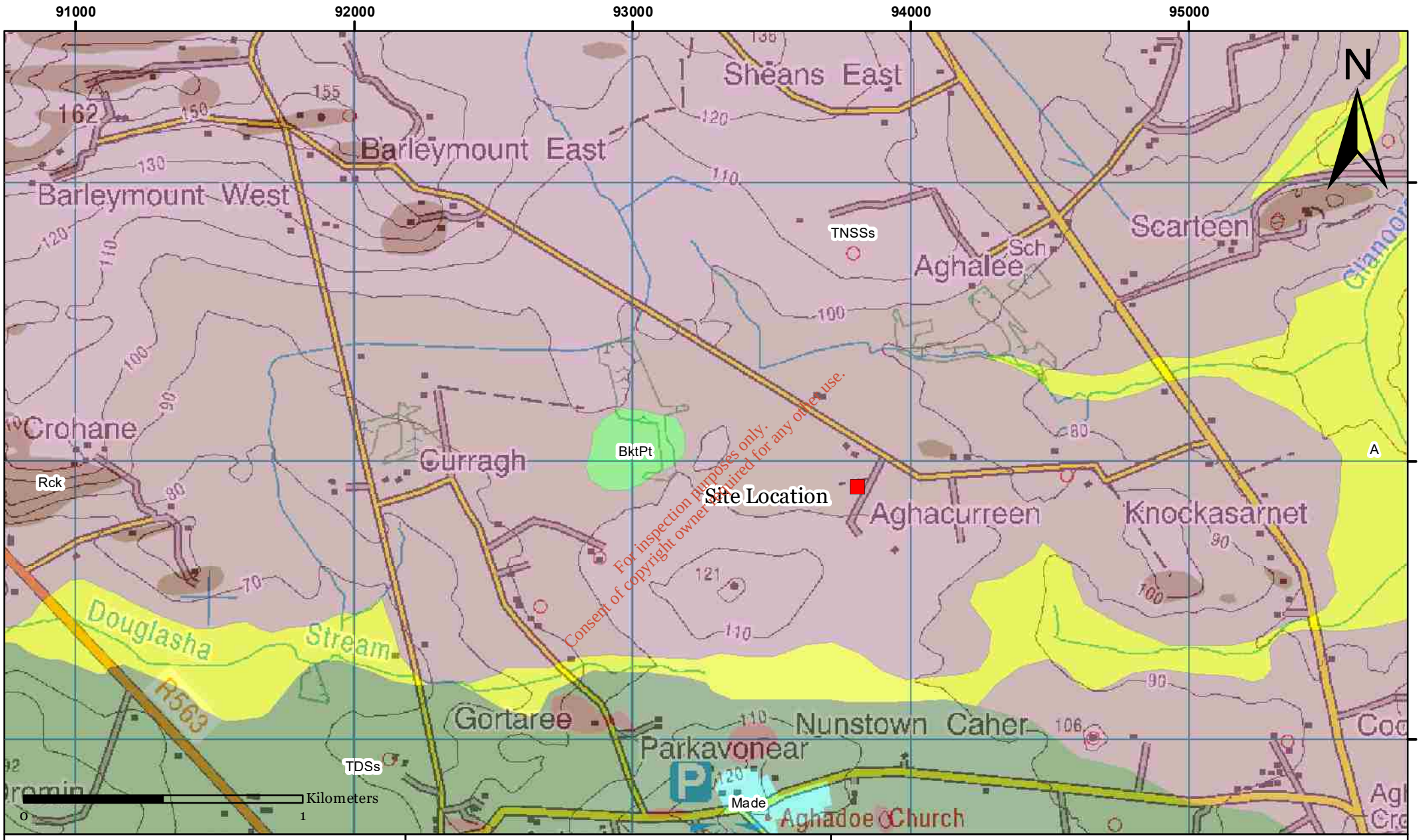
TITLE
Hydrology

Details:
- Site Location
- Rivers

Figure 2.3



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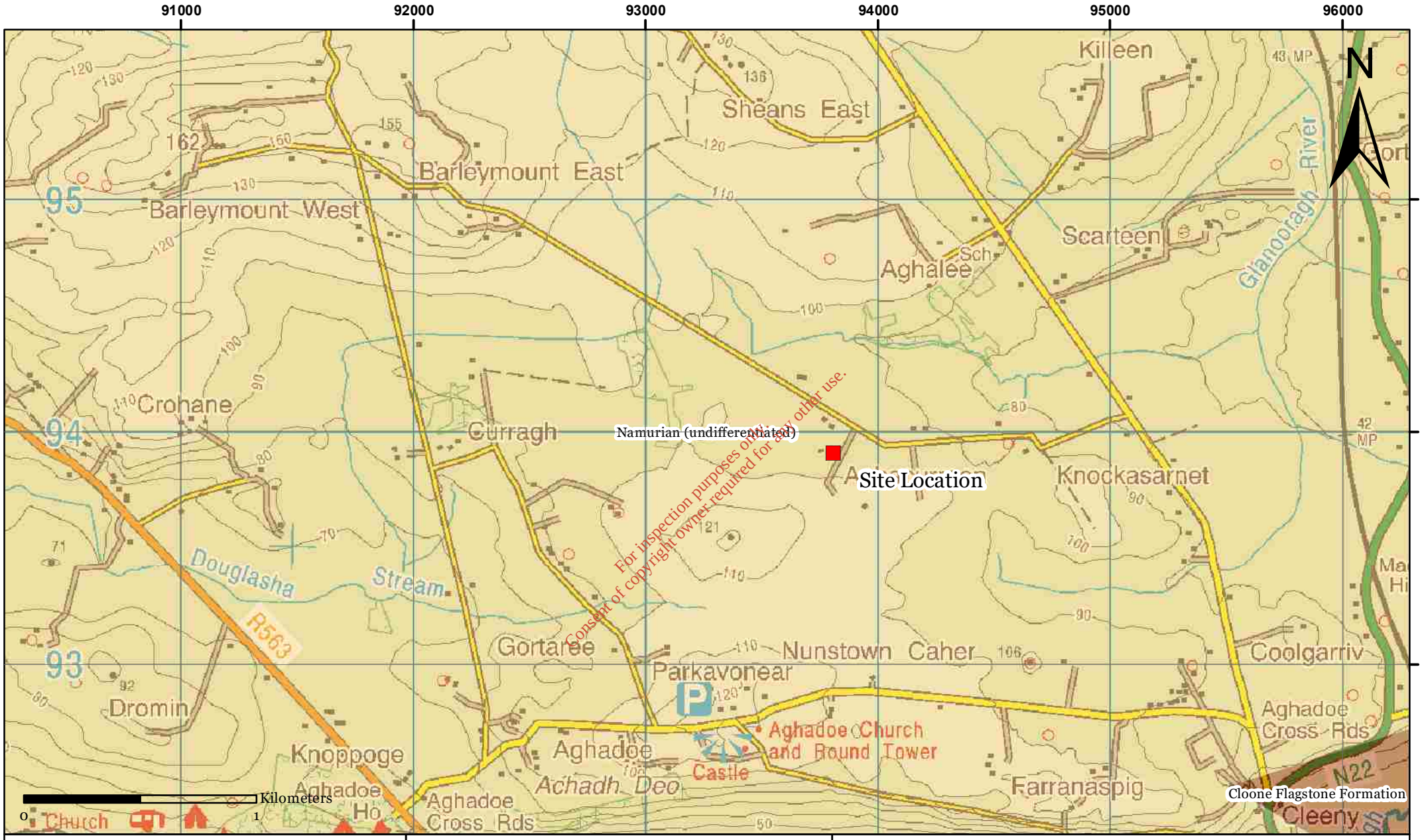
TITLE
Subsoils

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

Figure 2.4



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CLIENT
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TITLE
Bedrock Geology

Details:
- Site Location
- Cloone Flagstone Formation-Greywacke,Siltstone & Shale
- Namurian (undifferentiated)-Shale & Sandstone

Figure 2.5

Significant yields can sometimes be obtained from this formation type where boreholes are drilled into known fault zones; however, the yields are not necessarily sustainable, as the fracture networks are generally not extensive or well connected, but primarily concentrated in the vicinity of the fault zones.

The aquifer is part of the Scartaglin Groundwater Body. The GSI's initial characterisation of this water body (Appendix 2) states that the sandstone beds in the bedrock formation have a slightly higher permeability than the shales due to their greater ability to fracture and that there are a number of artesian supplies where the sandstone beds are confined by the shales and mudstones.

2.6.2 Aquifer Vulnerability

Vulnerability is defined as the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. Vulnerability categories range from Extreme (rock close to surface) to **Extreme** to **High** to **Moderate** to **Low** and are dependent on the nature and thickness of subsoils above the water table.

The Namurian till has a low permeability and although in some areas it has a stony matrix there is still generally a high clay content due to the weathering of shale clasts. The GSI Vulnerability Map (Figure 2.7) indicates that the vulnerability across the site is **Low** however the borehole logs describe the soil and subsoil (peat and till) thickness as ranging from 3 to 5m, indicating the vulnerability ranges from **Extreme to High**.

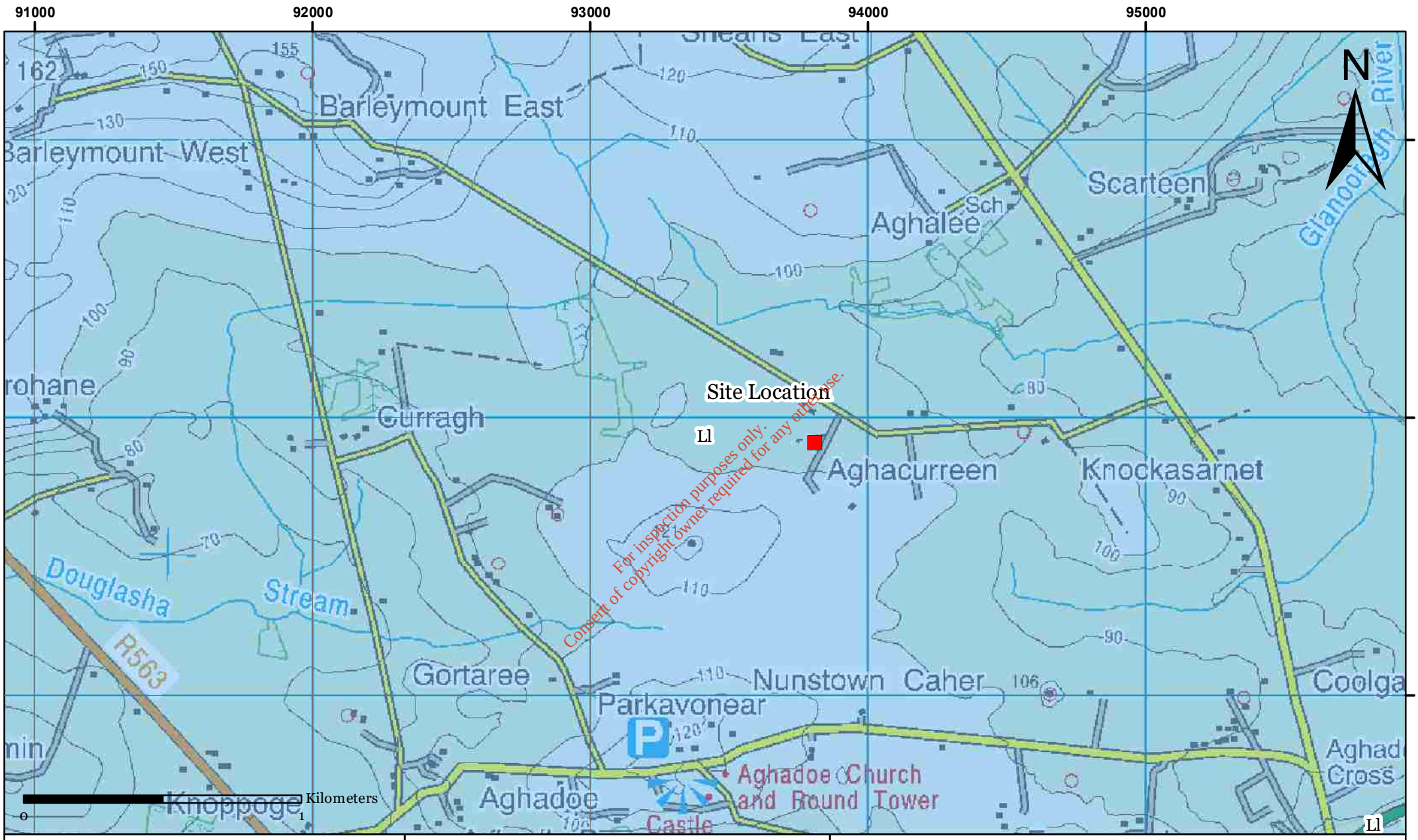
2.6.3 Groundwater Flow Paths and Direction

Groundwater flow paths in the bedrock beneath the site are generally short, typically 30-300 m, with groundwater typically discharging to small springs, or to the streams and rivers that traverse the aquifer. Flow directions are expected to mirror the local surface water catchments. The local direction of groundwater flow is likely to be influenced by the topography and be the north-east, towards the tributary of the Glanooragh Stream.

OES recorded the groundwater levels on three occasions in 2009 and 2010; however they did not survey the wells to a datum level and therefore they estimated the direction of groundwater flow as being to the north-east based on the local topography. In October 2016 KWD surveyed the wells to Ordnance Datum (OD) and the level of the top of the casing at each of the wells is shown in Table 2.1.

Figure 2.1 Monitoring Well Levels

Well	Easting	Northing	OD Top of Casing (m)
MW-1	493661	594052	91.792
MW-2	493612	594086	92.814
MW-3	493519	593989	93.645
MW-4	493570	593933	92.816



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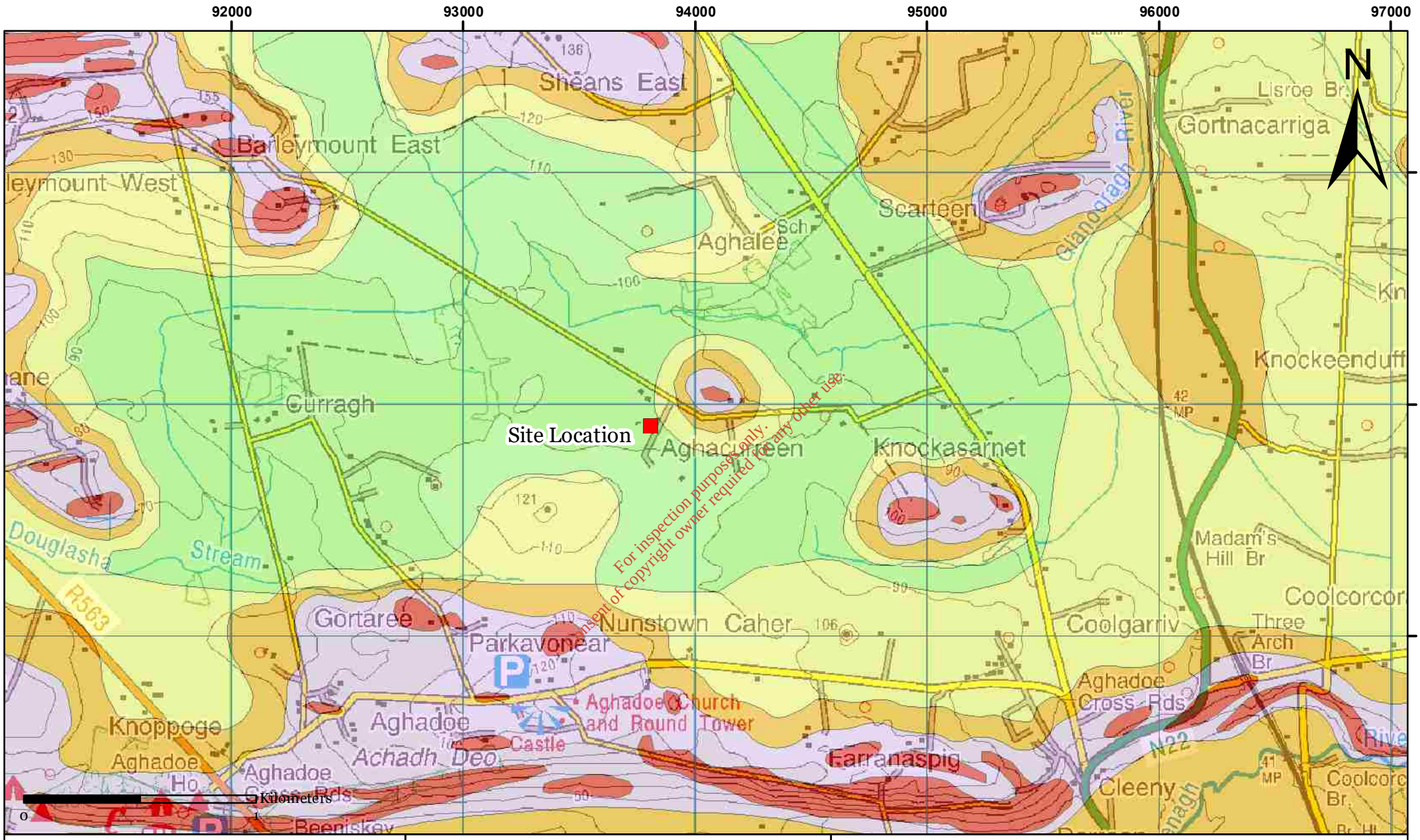
TITLE
Aquifer Classification

Details:
- Site Location
- Ll-Bedrock which is moderately productive only in Local Zones

Figure 2.6



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Environmental Management for Business

CLIENT
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TITLE
Groundwater Vulnerability

Details:

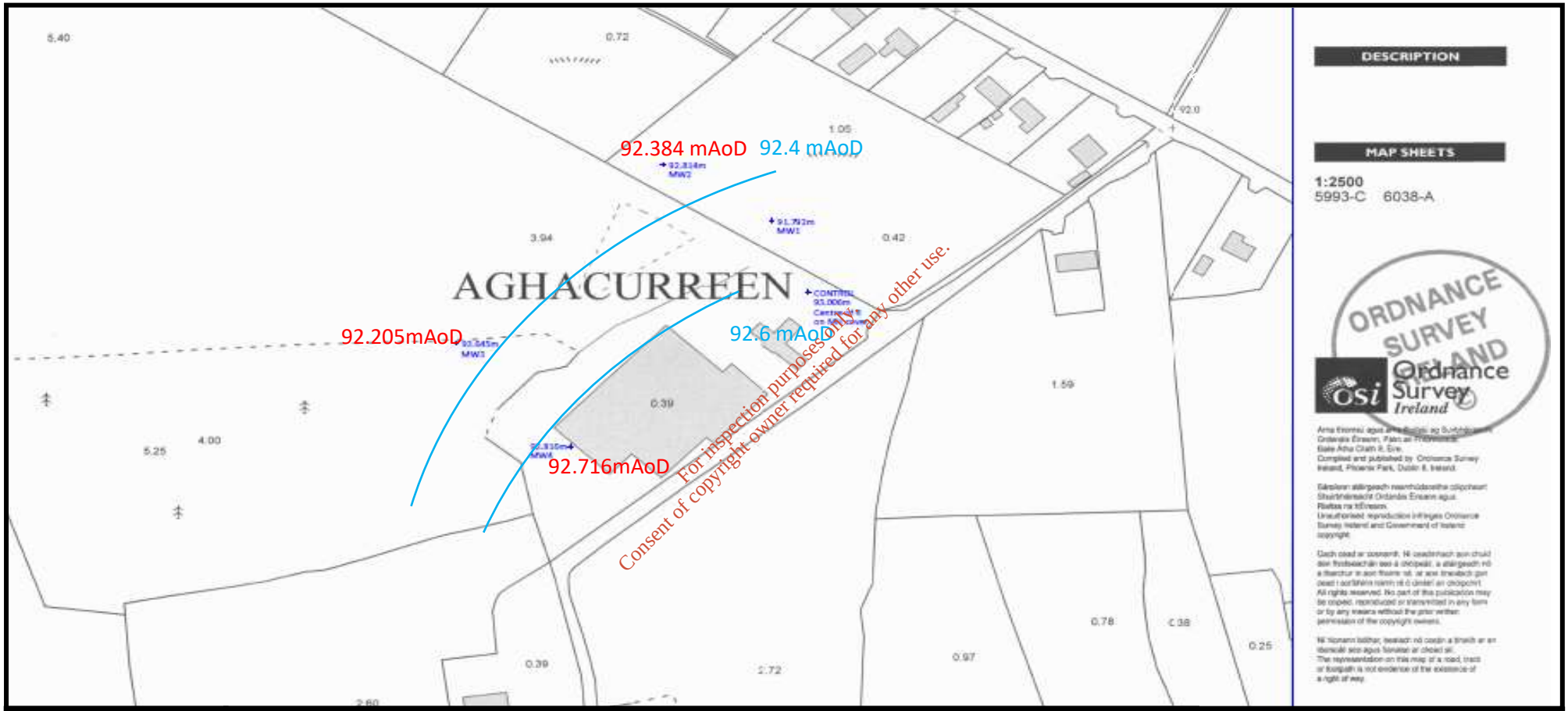
- Site Location
- Bedrock near Surface
- Extreme
- High
- Moderate
- Low

Figure 2.7

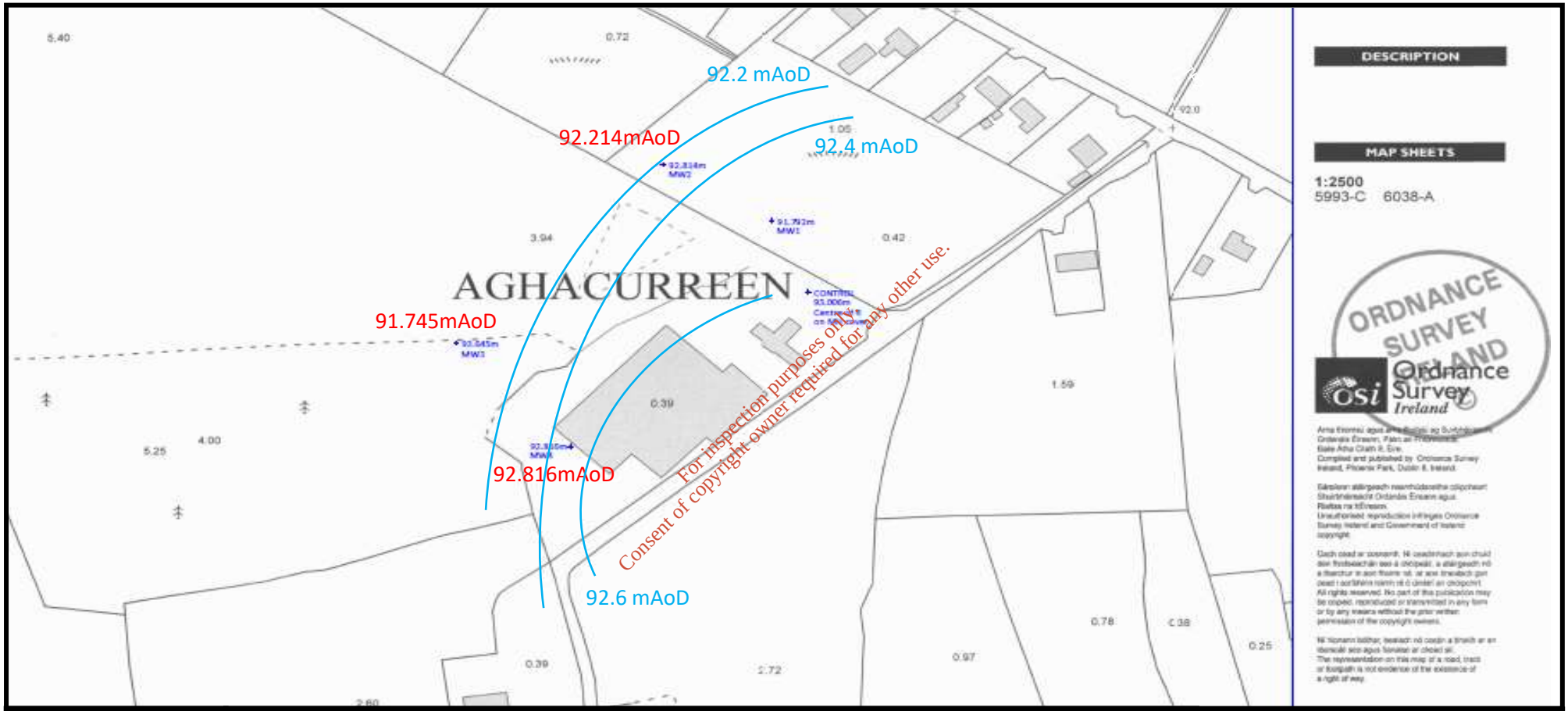
Although the groundwater wells have been routinely monitored since 2012 groundwater level data has only been recorded since June 2016. OCM used the water levels recorded in wells MW-1, MW-3 and MW-4 in November 2009 and June 2016 to calculate the groundwater flow direction to compare with the OES estimated direction of flow and the current position and these are shown on Figures 2.8 and 2.10. The flow is from south to north, meaning that wells MW-4 is up gradient and MW-3 Is side gradient of the operational area, while wells MW-1 and MW-2 are downgradient.

2.6.4 Groundwater Abstraction Wells

KWD informed OCM that the private residences to the north of the site obtain their water supplies from the Irish Water mains. A review of the GSI water well database did not identify any additional wells to those described in the OES and the nearest recorded well is 1km up gradient of the site, with the closest down gradient well 2.7km away (Figure 2.10).



O'Callaghan Moran & Associates	O'Callaghan Moran & Associates, Unit 15 Melbourne Business Park, Model Farm Road, Cork. Tel. (021) 4345366 Email: info@ocallaghanmoran.com	**Title:** **Figure 2.8** **Groundwater Contours November 2009**	**Legend** = Groundwater Contour 92.214mAoD= Dip Levels
This drawing is the property of O'Callaghan Moran & Associates and shall not be used, reproduced or disclosed to anyone without the prior written permission of O'Callaghan Moran & Associates and shall be returned upon request.		**Client:** **Killarney Waste Disposal Ltd.**	



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Title:

Figure 2.9

Groundwater Contours June 2016

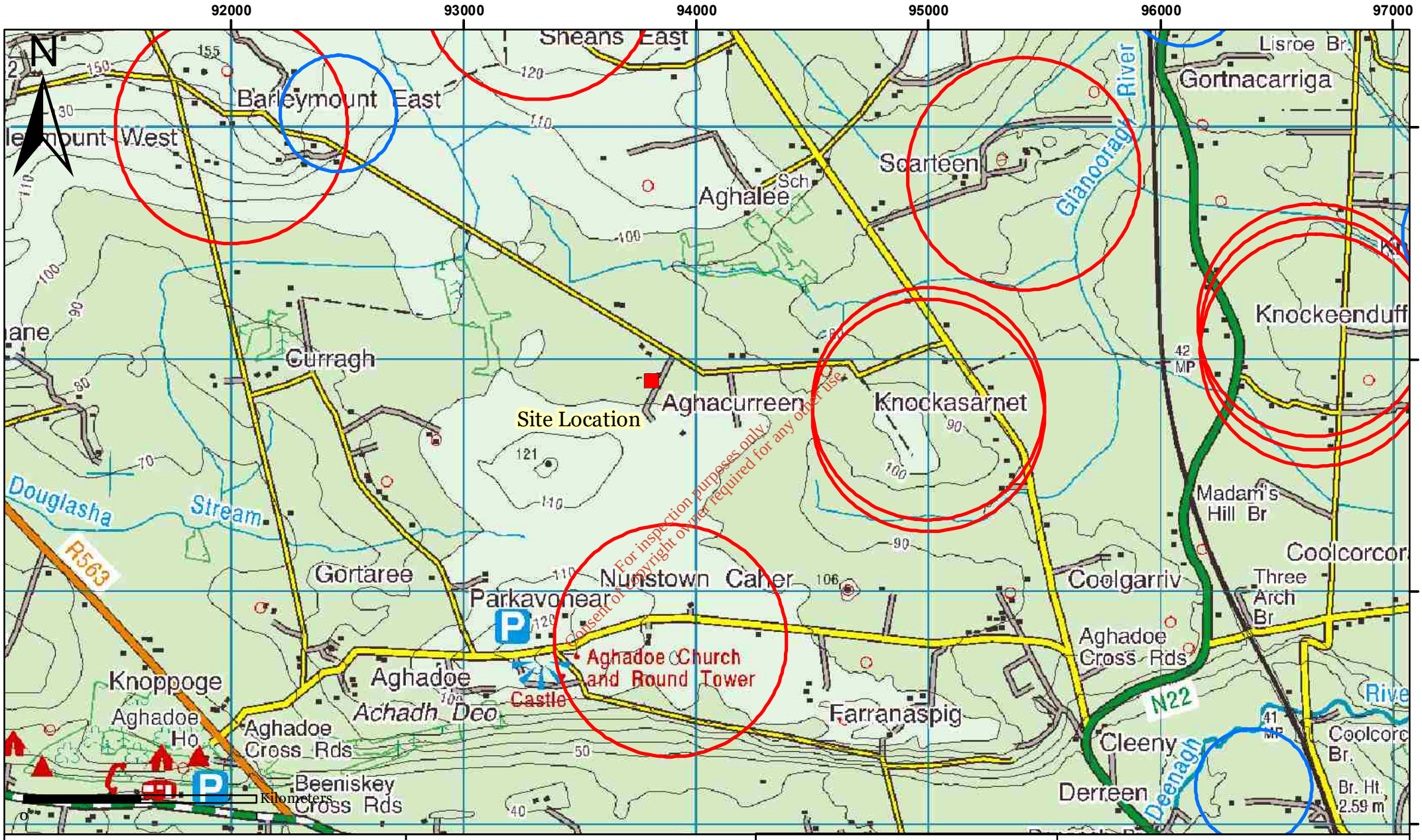
Legend

= Groundwater Contour

92.214mAoD= Dip Levels

Client:

Killarney Waste Disposal Ltd.



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CLIENT
Killarney Waste Disposal

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
- 250m-500m
- 500m-1km

Figure 2.10

3. CONCEPTUAL SITE MODEL

A Conceptual Site Model (CSM) is shown on Figure 3.1. The site is underlain by a peat and low permeability till that range in thickness from 3 in the east to 5m in the west of the site. The subsoils are not significantly water bearing and the underlying bedrock is classified as a 'Locally Important aquifer, bedrock which is moderately productive only in Local Zones'.

In MW-1, MW-3 and MW-4 the depth to water ranges from 0.35 to 1.9m below the top of the well casing, with discernible seasonal variation in MW-3. There are artesian conditions in MW-1, with water overflowing the top of the well pipe in the winter. The water levels indicate that bedrock aquifer is confined, with the piezometric head above the top of the weathered bedrock. The direction of groundwater flow is from the south-west to the north east.

The operational area is entirely covered by buildings or concrete paving, but the reminder of the site is unpaved. There are two reed beds in the northern unpaved area that treat rainwater run-off from clean paved areas, with the treated water discharging to an on-site percolation area. Sanitary wastewater is treated in the 'puraflo' system and the treated effluent discharges to ground.

3.1 Contaminant Sources

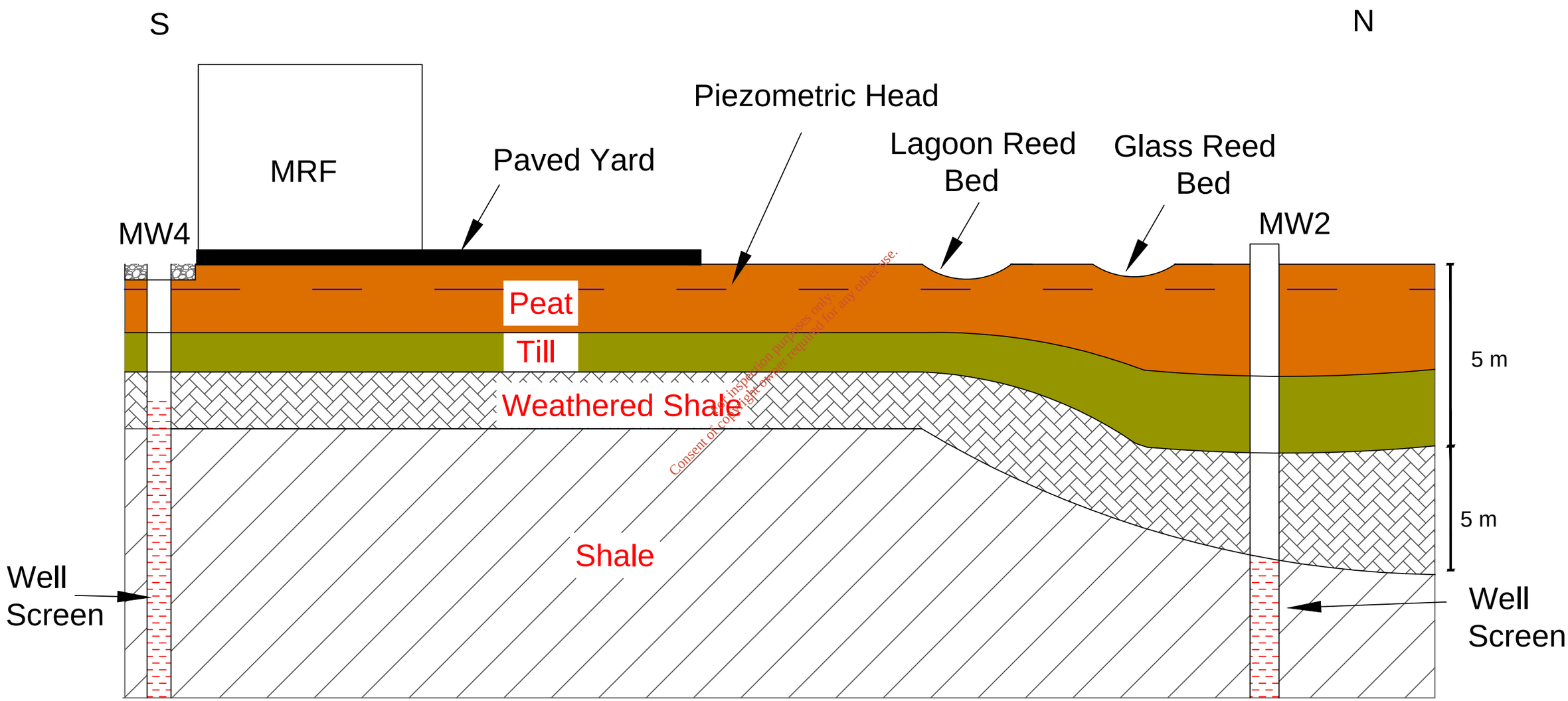
Waste Activities

All wastes other than timber and metal are off loaded and processed/transferred inside the materials recovery building. Liquid seeps from the waste is collected in an underground effluent holding tank (6,92m^3). The tank is made of pre-cast concrete and sits in a second underground concrete tank that provides secondary containment (bund). The wastewater is removed for treatment at the Irish Water WWTP.

Metal and timber wastes were handled in open paved areas where the timber was shredded and the metal cut. Rainwater run-off from the area is collected in an underground sump. In 2016 KWD ceased the external processing of the timber and metal, but the external storage of the timber and metal continues.

Originally rainwater run-off from all the paved open yard areas discharged via an oil interceptor and settling tanks to the on-site reed beds. The outfall from the 'lagoon' reed bed discharges to ground. In 2016 the run-off from the operational yards, where there was the potential for rainwater run-off to become contaminated (including the bin washing area and compost bay), was diverted from the reed beds and into a holding tank, where it is stored pending removal for off-site treatment.

Sanitary wastewater was previously discharged to an on-site septic tank and associated percolation area located in the north-west of the site. In 2016 the 'puraflo' system and a new percolation area were installed and the original septic tank was decommissioned. Testing of treated effluent before it enters the percolation area is carried out and the results confirm that system is operating satisfactorily and meeting the performance standards set in the Agency's Code of Practice: Wastewater Treatment and Disposal Systems Serving Single Houses.



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environmental management for business

CLIENT

Killarney Waste Disposal

FIGURE No.

3.1

TITLE

Conceptual Site Model

SCALE

NTS

REV.

A

Due to high groundwater levels in the vicinity of the weighbridge, which were attributed to a spring, KWD installed a sump from which groundwater was pumped to the drain that runs along the north-eastern site boundary. Following concerns raised by the Agency on the quality of the water, the discharge was stopped.

Rainwater accumulating in the sump beneath the weighbridge use to overflow to the drain along the north-eastern boundary. In 2016 this overflow was sealed and the water is now removed from the tank using a vacuum tanker and stored in the wastewater tank in the materials recovery building.

All underground sumps, the oil tank bund and the oil interceptor are subject to regular integrity tests, as required by the licence conditions. The foul water pipe network was surveyed in 2014 and no defects were found. The most recent tests on the sumps, bund and interceptor were completed in 2016 and all of the structures were found to be fit for purpose. Copies of the underground line survey and sump test report are in Appendix 3.

Off-Site Sources

The facility is located in a rural area and the land use in the vicinity of the site is primarily agricultural, with some forestry. There are approximately twenty (20) residences within 500m of the facility, the majority of which are in a 'ribbon development' along the local road to the north of the site. It is understood that the houses are served by septic tanks.

3.2 Pathways

The operational areas where wastes are handled are either paved with concrete or covered with buildings, which prevents the direct infiltration of rainfall on the site to the subsoils and eliminates the pathway by which any contaminants at the ground surface can move towards the bedrock.

The north-western part of the licensed area is not paved and contains the reed beds and associated percolation area and the percolation area for the recently installed 'puraflo' system. The reed beds and percolation areas provide pathways for rain-water run-off from the yards and the treated sanitary wastewater effluent to the bedrock aquifer. However the confined conditions means there is an upward groundwater pressure head, which would inhibit the entry of contaminants into the aquifer.

The confined conditions in the aquifer means that groundwater does not provide baseflow to the drain and with the exception of MW-1 which is artesian, there are no pathways between the groundwater beneath the site and the drain that runs through the site.

3.3 Receptors

The known receptors that could potentially be impacted by on-site contamination sources are the groundwater in the bedrock aquifer and the surface water drain that flows through the site. However, as referred to above the confined conditions inhibit the entry of contaminants into the aquifer. The houses to the north of the site obtain their water supply from the Irish Water mains, and there is no record of any abstraction well within 1km of the site.

4. GROUNDWATER QUALITY ASSESSMENT

4.1 Groundwater Monitoring Wells

The description of the wells is based on the borehole logs in Attachment A of the OES Report. At MW-1 there is 2m of peat which is underlain by 3m of till. The top 2m of the bedrock is weathered and the total depth of the well is 18m. A water strike was encountered at 10m bgl. Slotted well pipe extends from the bottom of the hole to the base of the weathered bedrock, with plain pipe extending from there to above ground level. There is a bentonite seal from ground level to the base of the weathered bedrock. The well construction details indicate the well is screened exclusively in the competent bedrock.

The well is located in a wooded area to the north of the drain that flows along the north-eastern boundary. The headworks are intact (Photograph 1) but there is evidence of artesian conditions.

Photograph 1 MW-1

At MW-2 there is approximately 1.8m of peat, which is underlain by 1.2 m of till. The top 3m of the bedrock is weathered and the total depth of the well is 24m. A water strike was encountered at 20m below ground level. Slotted well pipe extends from the bottom of the hole to the base of the weathered bedrock, with plain pipe extending from there to above ground level. There is a bentonite seal from ground level to the base of the weathered bedrock. The well construction details indicate the well is screened exclusively in the competent bedrock.

The well is located in a wooded area to the north of the drain that flows along the north-eastern boundary. The headworks are intact.

Photograph 2 MW-2

At MW-3 there is approximately 1.8m of peat which is underlain by almost 3m of till. The top 3.5m of the bedrock is weathered and the total depth of the well is 18m. A water strike was encountered at 11m below ground level. Slotted well pipe extends from the bottom of the hole into the weathered bedrock, with plain pipe extending from there to above ground level. There is a bentonite seal from ground level to the middle of the weathered bedrock. The well construction details indicate it is possible for water in the weathered zone and the competent rock to enter the well pipe.

The well is located in the south-west of the site. The on the top of the steel casing has been removed and there is no cap on the top of the well pipe.

Photograph 3 MW-3

At MW-4 there is approximately 1.8m of peat, underlain by almost 1.2m of till. The top 5m of the bedrock is weathered and the total depth of the well was 18m. A water strike was encountered at 11m below ground level. Slotted well pipe extends from the bottom of the hole into the weathered bedrock, with plain pipe extending from there to above ground level. There is a bentonite seal from ground level to the middle of the weathered bedrock. The well construction details indicate it is possible for water in the weathered zone and the competent rock to enter the well pipe.

MW-4 is located in the south-east of the site close to the rear wall of the materials recovery building. The top of the well pipe is approximately 1m below ground level as a result of the raising of the access road to the rear of the building.

The well was protected by placing a large diameter plastic pipe on the ground and backfilling around it. However the lid on top of the casing has been remove and there is no well cap. OCM observed water had accumulated in the base of the protective pipe and the level was just below the top of the well pipe and there were leaves and litter around the well pipes. It was not possible to determine if the water in the base was overtopping groundwater or surface water.

Photograph4 MW-4

4.2 Water Quality Data

The wells were installed in 2009 and were monitored on three occasions between 2009 and 2010. Biannual monitoring for the parameters specified in the Schedule C of the licence began in 2012.

The monitoring results are presented in Tables 4.1 to 4.4, which includes the Interim Guideline Values (IGV) for Irish groundwater published by the Agency and the Threshold Values (TV) from the European Community Environmental Objectives (Groundwater) Regulations 2010.

From the start of the monitoring programme the ammonia levels in MW-1, MW-2 and MW-3 have exceeded the TV, while the level in MW-4 has been generally below the TV, with only occasional exceedances. Nitrates have not been detected, and sulphate is only consistently recorded in MW-4. The chloride level in MW-4, while initially similar to that in the other wells has increased over time, with occasional spikes.

In September 2016 KWD commissioned Southern Scientific Services Ltd to collect five samples from BH-3 over a four hour period, measure the dissolved oxygen level and check the redox potential in the field and conduct laboratory analysis for ammonia, COD, nitrate, nitrite, ferrous and ferric ions and sulphide. The laboratory report is in Appendix 4 and the results are in Table 4.2.

Table 4.1 MW-1

Field Readings																			
BH-1 Top of Well Pipe 91.792m (mAOD)	Units	Ground Water Regs SI No 9 of 2010	EPA Interim Guidline Values	Sep-09	Nov-09	May-10	Mar-12	Jul-12	Feb-13	Sep-13	Jan-14	Jul-14	Nov-14	Jan-15	Jul-15	Jan-16	Jun-16	Aug-16	Nov-16	Jan-17
Total Depth	m	-	-	18	18	18														
Depth to Water Level	m	-	-	0.02	0.01	0.2	ND	ND	ND		ND	ND	ND	ND	ND	ND	0	0	0.35	0.35
Water Level (mAOD)	m	-	-	91.772	91.782	91.592	–	–	–		–	–	–	–	–	–	91.792	91.792	91.442	91.442
Temperature	°C	-	25	10.4	10.4	10	–	–	–		–	–	–	–	–	–				
Conductivity	µS/cm	800 – 1875	1000	618	649	663	626	627	637	639	639	640	635	647	633	650	641	661	651	645
pH	pH Units	-	6.5 - 9.5	7.04	7.04	6.67	–	–	–			–	–	–	–	–	–	–	–	–
Laboratory Results																				
Total Dissolved Solids	mg/l	NE	1000	325	325	336	–	–	–		–	–	–	–	–	–				–
Ammonia (as N)	mg/l	0.05 –0.136	0.12	1.77	1	0.9	1.78	2.46	1.81	0.97	1.84	2.07	1.64	1.85	1.11	1.85	0.99	1.06	1.79	1.99
Chloride	mg/l	187.5	30	22.4	23.6	21.6	24.9	24.6	23.7	23.7	22.1	23.6	24.1	22.6	24.3	24.9	24.1	23.5	23.8	24.2
Sulphate	mg/l	187.5	200	<3	<3	<3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.79	<0.5	<0.5	<0.5	<0.5
Nitrate as NO_3	mg/l	37.5	25	<0.06	<0.06	<0.06	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Diesel Range Organics	ug/l	10	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	110	<10
Orthophosphate	mg/l	0.03	0.03																	0.03
Total Hardness	mg/l	200	200																	363
Alkalinity	mg/l	NAC	NAC																	368
Iron Dissolved	mg/l	0.2	0.2																	2.01
Manganese Dissolved	mg/l	0.05	0.05																	0.1
Dissolved Oxygen	mg/l	NE	NE																	1.55
Redox Potential		NE	NE																	-86
Coliforms	MPN	0	0																	<1
Faecal Coliforms	MPN	0	0																	<1
NE: Not Established																				
NAC No Abnormal Change																				

Table 4.2 MW-2

Field Readings																			
BH-2 Top of Well Pipe 92.814m (mAOD)	Units	Ground Water Regs SI No 9 of 2010	EPA Interim Guidline Values	Apr-09	Nov-09	May-10	Mar-12	Jul-12	Feb-13	Sep-13	Jan-14	Jul-14	Nov-14	Jan-15	Jul-15	Jan-16	Jun-16	Aug-16	Nov-16	Jan-17
Total Depth	m	-		19.32	19.32	19.32														
Depth to Water Level	m	-		0.54	0.43	0.98	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.6	0.35	0.32	0.08
Water Level (mAOD)	m			92.274	92.384	91.834	–	–	–	–	–	–	–		–		92.214	92.464	92.494	92.736
Temperature	°C	-	25	10.4	10.4	10.5	–	–	–	–	–	–	–		–					
Conductivity	µS/cm	800 – 1875	1000	772	772	828	748	746	747	776	758	787	760	764	769	760	776	796	766	751
pH	pH Units	NE	6.5 - 9.5	7.08	7.08	6.9	–	–	–	–	–	–	–		–	–	–	–	7.2	7.2
Laboratory Results																				
Total Dissolved Solids	mg/l	NE	1000	385	385	412	–	–	–	–	–	–	–		–					–
Ammonia (as N)	mg/l	0.05 –0.136	0.12	2.83	1.86	0.578	1.84	2.11	1.84	1.19	2.07	1.47	1.23	1.16	0.65	1.7	0.53	0.73	1.42	1.76
Chloride	mg/l	187.5	30	24.2	24.7	21.4	24.8	24.1	23.3	22.5	23.1	21.6	23.1	22.1	22.1	24.3	21.9	22.3	22.8	23.3
Sulphate	mg/l	187.5	200	<3	<3	<3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.51	<0.5	<0.5	<0.5	<0.5
Nitrate as NO_3	mg/l	37.5	25	<0.06	<0.06	0.0799	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Diesel Range Organics	ug/l	10	10	<10	<10	<46	<10	<10	<10	28	<10	<10	<10	<10	<10	<10	<10	<10	149	<10
Orthophosphate	mg/l	0.03	0.03																	0.01
Total Hardness	mg/l	200	200																	421
Alkalinity	mg/l	NAC	NAC																	440
Iron Dissolved	mg/l	0.2	0.2																	4.19
Manganese Dissolved	mg/l	0.05	0.05																	0.15
Dissolved Oxygen	mg/l	NE																		3.35
Redox Potential		NE																		-119
Coliforms	MPN	0	0																	<1
Faecal Coliforms	MPN	0	0																	<1
NE: Not Established																				
NAC No Abnormal Change																				

Table 4.3 MW-3

Field Readings																				
BH-3 Top of Well Pipe 93.645m (mAOD)	Units	Ground Water Regs SI No 9 of 2010	EPA Interim Guidline Values	Apr-09	Nov-09	May-10	Mar-12	Jul-12	Feb-13	Sep-13	Jan-14	Jul-14	Nov-14	Jan-15	Jul-15	Jan-16	Jun-16	Aug-16	Nov-16	Jan-17
Total Depth	m	-		18.16	18.16	18.16														
Depth to Water Level	m	-		1.49	1.44	1.71	ND	ND	ND	ND	ND	ND	ND	ND	ND		1.9	1.4	1.6	1.7
Water Level (mAOD)	m			92.155	92.205	91.935	–	–	–	–	–	–	–				91.745	92.245	92.045	91.116
Temperature	°C	-	25	10.3	10.5	11	–	–	–	–	–	–	–							
Conductivity	µS/cm	800 – 1875	1000	544	556	583	508	515	516	525	516	531	527	528	529	541	539	558	573	548
pH	pH Units	NE	6.5 - 9.5	7.01	6.81	6.64	–	–	–	–	–	–	–			–	–	–	7.2	7.1
Laboratory Results																				
Total Dissolved Solids	mg/l	NE	1000	272	278	286	–	–	–	–	–	–	–							–
Ammonia (as N)	mg/l	0.05 –0.136	0.12	2.86	1.32	2.54	2.99	3.08	2.91	3.16	3.47	3.21	3.03	3.2	3.2	3.13	2.81	3.35	3.25	2.8
Chloride	mg/l	187.5	30	20.6	21.6	19.6	22.8	21.4	22.4	21.6	21.1	21.1	21.4	20.4	22.5	22.4	22.5	21.4	21.8	22.7
Sulphate	mg/l	187.5	200	<3	<3	4.4	<0.5	1.38	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.71	<0.5	<0.5	<0.5	<0.5
Nitrate as NO_3	mg/l	37.5	25	<0.06	<0.06	<0.06	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Diesel Range Organics	ug/l	10	10	<10	<10	<46	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Orthophosphate	mg/l	0.03	0.03																	0.03
Total Hardness	mg/l	200	200																	289
Alkalinity	mg/l	NAC	NAC																	311
Iron Dissolved	mg/l	0.2	0.2																	3.64
Manganese Dissolved	mg/l	0.05	0.05																	0.13
Dissolved Oxygen	mg/l	NE																		3
Redox Potential		NE																		-79.6
Coliforms	MPN	0	0																	11
Faecal Coliforms	MPN	0	0																	1
NE: Not Established																				
NAC No Abnormal Change																				

Table 4.4 MW-4

Field Readings																				
BH-4 Top of Well Pipe 92.816m (mAOD)	Units	Ground Water Regs SI No 9 of 2010	EPA Interim Guidline Values	Apr-09	Nov-09	May-10	Mar-12	Jul-12	Feb-13	Sep-13	Jan-14	Jul-14	Nov-14	Jan-15	Jul-15	Jan-16	Jun-16	Aug-16	Nov-16	Jan-17
Total Depth	m	-		19.9	19.9	19.9														
Depth to Water Level	m	-		0.49	0.1	0.27	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.6	0	1	1	1
Water Level (mAOD)	m			92.326	92.716	92.546	–	–	–	–	–	–	–				92.816	91.816	91.816	91.816
Temperature	°C	-	25	10.9	10.9	11.2	–	–	–	–	–	–	–							
Conductivity	µS/cm	800 – 1875	1000	400	407	410	380	389	378	388	392	392	387	397	398	398	396	407	404	405
pH	pH Units	NE	6.5 - 9.5	6.86	6.86	6.28	–	–	–	–	–	–	–			–	–	–		7.2
Laboratory Results																				
Total Dissolved Solids	mg/l	NE	1000	203	203	203	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ammonium (as N)	mg/l	0.065-0.175	0.12	<0.2	<0.2	<0.2	<0.02	0.03	0.03	0.06	<0.02	0.04	<0.02	0.08	<0.02	<0.02	0.24	0.03	<0.02	0.06
Chloride	mg/l	187.5	30	24.1	24.8	22.4	27	34.6	30.1	26.6	29.9	87.8	32.3	60.3	27	28.3	51	33.4	41	67.8
Sulphate	mg/l	187.5	200	<3	<3	21.9	20.2	34	20	22.3	28.2	70.4	27	48.3	45.7	21.6	<0.5	31.4	33.6	63.9
Nitrate as NO_3	mg/l	37.5	25	<0.06	<0.06	<0.06	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Diesel Range Organics	ug/l	-	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Orthophosphate	mg/l	0.035	0.03																	0.01
Total Hardness	mg/l	NE	200																	190
Alkalinity	mg/l	NE	NAC																	1405
Iron Dissolved	mg/l	NE	0.2																	0.13
Manganese Dissolved	mg/l	NE	0.05																	0.07
Dissolved Oxygen	mg/l	NE	NE																	2.7
Redox Potential		NE	NE																	-41.6
Coliforms	MPN	NE	0																	2
Faecal Coliforms	MPN	NE	0																	64
NE: Not Established																				
NAC No Abnormal Change																				

Although the dissolved oxygen was >1.0 mg/l, the redox potential readings (-78 mV to -132.8mV) indicated reducing conditions. Ferrous and ferric ions were present, nitrate and sulphide were not detected and the COD (<10mg/l) was low. The ammonia levels were consistent with those previously measured.

Table 4.2 Water Quality MW-3 September 2016

Parameter	Units	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Dissolved Oxygen*	mg/l	1.5	2.1	2.9	2.9	3.4
Redox Potential (Eh)*	mV	-132.8	-78	-93.5	-115.9	-106.4
Ammonia	mg/l	3.04	3.13	3.22	3.28	3.28
COD	mg/l	<10	<10	<10	<10	<10
Nitrate	mg/l	<0.25	<0.25	<0.25	<0.25	<0.25
Nitrite	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005
Ferrous ions	mg/l	4.18	4.60	5.17	5.32	5.29
Ferric ions	mg/l	4.77	4.94	4.26	4.20	4.20
Sulphide	ug/l	<5	<5	<5	<5	<5

*Field Measurements

In January 2017, KWD requested Southern Scientific Ltd to include dissolved oxygen, redox potential, alkalinity, hardness, orthophosphate, dissolved iron, dissolved manganese, total and faecal coliforms in the range of parameters tested. The laboratory report is in Appendix 4 and the results are in Table 4.3.

Table 4.3 Water Quality MW-1 to MW-4 January 2017

Parameter	Units	MW-1	MW-2	MW-3	MW-4
Dissolved Oxygen*	mg/l	1.55	3.35	3.0	2.7
Redox Potential (Eh)*	mV	-86	-119.1	-79.6	-41.6
pH	pH Units				
Orthophosphate	mg/l	0.03	0.01	0.03	0.01
Nitrate	mg/l	<0.25	<0.25	<0.25	<0.25
Total Hardness	mg/l	363	321	289	190
Alkalinity	mg/l	369	440	311	1405
Chloride	mg/l	24.2	23.3	22.7	67.8
Sulphate	mg/l	<0.5	<0.5	<0.5	63.9
Iron**	mg/l	2.01	4.19	3.64	0.13
Manganese**	mg/l	0.10	0.15	0.13	0.07
DRO	ug/l	<10	<10	<10	<10
Coliforms	MPN	<1	<1	11	2
Faecal Coliforms	MPN	<1	<1	1	64

* Field measurement
** Dissolved

While the dissolved oxygen levels are >1mg/l, the redox reading indicates reducing conditions. Dissolved iron was detected in all wells, with the lowest level in MW-4. The sulphate level in MW-4 were significantly higher than previously recorded, while the levels in the other wells were consistent with previous results. The alkalinity in MW-4 was very high and is probably anomalous as the hardness

was lower than those in the other wells. Total and faecal coliforms were not detected in MW-1 and MW-2, but were detected in MW-3 and MW-4, with the highest levels in MW-4.

4.3 Discussion

The results of the monitoring from 2009 to January 2017 indicate that hydro chemical signature of MW-4 differs from that of MW-1, MW-2 and MW-3. The average electrical conductivity, ammonia, sulphate, chloride, hardness, and dissolved iron levels recorded in each of the wells are in Table 4.3.

Table 4.3 Mean of Indicator Parameters (2009-2017)

Parameter	Units	MW-1	MW-2	MW-3	MW-4
Electrical* Conductivity	uS/cm	643	769	537	395
Ammonia*	mg/l	1.57	1.47	2.96	0.07
Chloride*	mg/l	23.7	23	21	39
Sulphate*	mg/l	0.79	0.51	2.16	34.8
Hardness	mg/l	363	421	289	190
Dissolved Iron	mg/l	2.01	4.19	3.64	0.13

* Average level 2009 to 2017

The ammonia levels have been persistently elevated in MW-1, MW-2 and MW-3 over the monitoring period. While elevated ammonia levels can be indicative of contamination by an organic waste source(s) (e.g. animal slurries, sanitary waste water, leachate), the levels of other indicator parameters (chloride, nitrate, orthophosphate and, in the case of MW-3, COD) are not consistent with an organic waste source.

The historical monitoring data indicate the presence of reducing conditions in the aquifer. The redox potential measurements in MW-3 in September 2016, and in all of the wells in January 2017, in conjunction with the dissolved iron levels in January 2017 and the ferric oxide staining and iron bacteria slime on the headworks at MW-1[1] observed by OCM in October 2016, confirm the presence of reducing conditions.

The reduction-oxidation (redox) state of a groundwater body controls the mobilisation or sequestration of naturally occurring metals; the biodegradation or preservation of anthropogenic contaminants such as nitrates and volatile organic compounds , and the generation of compounds and organisms that affect water quality (dissolved iron and manganese, iron bacteria and hydrogen sulphide).

The redox state is the outcome of a set of electron transfer reactions facilitated by microorganisms that control the transfer of electrons from electron donors (e.g. organic matter, pyrite etc.) and electron acceptors (dissolved oxygen, nitrate, iron etc.)

Reducing conditions start with the take up of the dissolved oxygen by oxygen reducing microorganisms. This continues until all of the available dissolved oxygen is depleted, following which the next most easily exploited electron acceptor (nitrate) becomes available. The pattern of reaction preferences for inorganic compounds are:

[1] Soluble ferrous hydroxide is oxidised to ferric hydroxide when the dissolved oxygen levels increase at the top of the well pipe.

$O2 > NO_3 > Mn (iv) > Fe (iii) > SO4 > CO_2$

Groundwater redox conditions are influenced by factors such as recharge rates, local groundwater flow rates and the presence of contaminants, which means that different redox conditions can occur at varying depths, or zones, in the aquifer.

Where a well is exclusively screened in one redox state zone, the redox conditions are stable. Where a well screen straddles a number of different zones, for example when water enters the well pipe from both deep in the aquifer, where reducing conditions predominate, and from higher up where oxidising conditions are prevalent, the groundwater in the well pipe will display a mixed redox character.

This means it is possible for a groundwater sample to have indicators of both oxidising (e.g. dissolved oxygen > 1mg/l) and reducing conditions (ammonia, dissolved iron, negative Eh and low levels of nitrate and sulphate), which is the case in the MW-1, MW-2 and MW-3) and low Eh and low nitrate, ammonia and dissolved iron in MW-4. A complicating factor at MW-4 is the potential for surface water run-off to enter the well pipe, which is likely the source of the faecal coliform contamination and the elevated chloride.

As referred to above, a controlling factor on the redox state is the electron donor, which usually is organic matter. The sources of organic matter can either be naturally occurring (e.g. peatland) or anthropogenic (wastewater treatment systems, agricultural wastes, landfills, oil.).

At the KWD site the soils within and adjoining the site comprise peat, which is a natural source of organic matter. Potential on-site organic matter contamination sources include sanitary wastewater, leachate, contaminated yard run-off and oil. The only potential off-site sources are the wastewater treatment systems serving the houses to the south of the installation and possibly land spreading of farm animal slurry and manure.

If the waste activities were the source of the organic matter chemical indicator parameters (chloride, electrical conductivity and nitrate) should be elevated, but they are not. Faecal coliforms, which are an indicators of sanitary waste water and farm animal waste contamination, were detected in the two upgradient wells (MW-3 and MW-4) but not in the downgradient ones (MW-1 and MW-2).

Given that the headworks on both MW-3 and MW-4 are damaged, there are no well caps and MW-4 is approximately 0.5 m below ground level, the likely source of the coliforms is faecal contamination by birds or small mammals and not off-site sources.

5. IMPACT ON RECEPTORS

5.1 Surface Water

A biological water quality assessment carried out as part of the preparation of the 2005 EIS established that the drain was seriously polluted at the point where it enters the KWD site and that it was moderately or slightly polluted c.200m upstream of the site. Physio-chemical monitoring established elevated levels of COD, Biochemical Oxygen Demand (BOD), iron and manganese upstream of the site and elevated levels of ammonia, iron, manganese and conductivity downstream of the site. Given the confined conditions in the aquifer groundwater beneath the site does not provide baseflow into the drain and therefore is not the source of the elevated ammonia.

The licence requires annual monitoring of the drain up and downstream of the site bi-annually for pH, electrical conductivity and ammonia. The results of the monitoring conducted in 2016 are in Table 5.1. The Table includes for comparison purposes the 'average' Environmental Quality Standards (EQS) from the Surface Water Regulations 2009 for 'Good Status' waters.

Table 5.1 Surface Water Quality KWD Monitoring

Parameter	Units	16/11/2016 Upstream	16/11/2016 Downstream	16/12/2016 Upstream	16/12/2016 Downstream	EQS
Conductivity	uS/cm	266	261	268	312	
pH	pH Units	6.9	7.3	6.7	7.1	6-9
Ammonia	mg/l	0.07	0.06	0.18	0.27	0.065-0.140
BOD				2.3	1.2	<1.5 (Mean)
COD				136	52	

In February and March 2016 the Agency monitored the quality in the drain up and downstream of the site and the results are in Table 5.2.

Parameter	Units	16/02/2016 Upstream	16/02/2016 Downstream	07/03/2016 Upstream	07/03/2016 Downstream	EQS
Conductivity	uS/cm	-	-	218	306	-
pH	pH Units	-	-	6.7	7.1	6-9
Suspended Solids	mg/l	9	8	<4	4	-
Ammonia	mg/l	0.038	0.51	0.18	0.27	0.065-0.140
Chloride	mg/l	30.4	37.8	30.1	32	
Orthophosphate	mg/l	0.047		0.029	0.022	
Nitrite	mg/l	-	-	0.0183	0.0056	
BOD	mg/l	-	-	<1	1	<1.5 (Mean)
COD	mg/l	78	45	57	46	
TON	mg/l	<0.2	0.49	0.49	0.34	
Coliforms	MPN	-	-	-	687	
Faecal Coliforms	MPN	-	-	-	261	

While faecal coliforms were detected in the downstream sample, in the absence of any results for the upstream sample it is not possible to comment on the significance of this. The results of the chemical tests indicate that facility operations are not impacting on the water quality in the drain.

5.2 Groundwater

There is no evidence that waste activities are impacting on groundwater beneath the site. The condition of the well heads and MW-3 and MW-4 means there is the potential for contaminants from the ground surface to enter the well pipes.

6. CONCLUSIONS & RECOMMENDATIONS

6.1 Conclusions

Monitoring wells MW-4 is up gradient and MW-3 is side gradient of waste activities and MW-1 and MW-2 are down gradient.

Since monitoring began in 2009, elevated ammonia has been detected in MW-1, MW-2 and MW-3. Nitrate has never been detected in any of the wells and sulphate, while present in MW-4, has only very occasionally been detected at very low levels in the other wells. The redox potential in all of the wells, in conjunction with the low nitrate and presence of dissolved iron, indicates reducing conditions.

The wastes activities are a potential source of organic matter that typically is required to allow reducing conditions to develop; however the physiochemical data does not indicate this is the case, as the electrical conductivity, chloride and orthophosphate levels in MW-1, MW-2 and MW-3 are typical of uncontaminated groundwater. The peat, which underlies the site, is a recognised source of organic matter, which is a controlling factor in a redox state.

Faecal coliforms were detected in up gradient wells MW-3 and MW-4. The headworks on MW-3 and MW-4 wells are damaged and there are no well caps making both wells vulnerable to faecal contamination by birds and small mammals and in the case of MW-4, where the well pipe is below ground level, the entry of surface water run-off.

The source of the ammonia detected in MW-1, MW-2 and MW-3 is the naturally occurring reducing conditions in the bedrock aquifer.

6.2 Recommendations

It is recommended that the headworks at MW-3 be repaired and a well cap provided. At MW-4, the well pipe should be extended above ground-level, fitted with a well cap and a steel headworks installed. Following the repairs both wells should be disinfected.