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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.

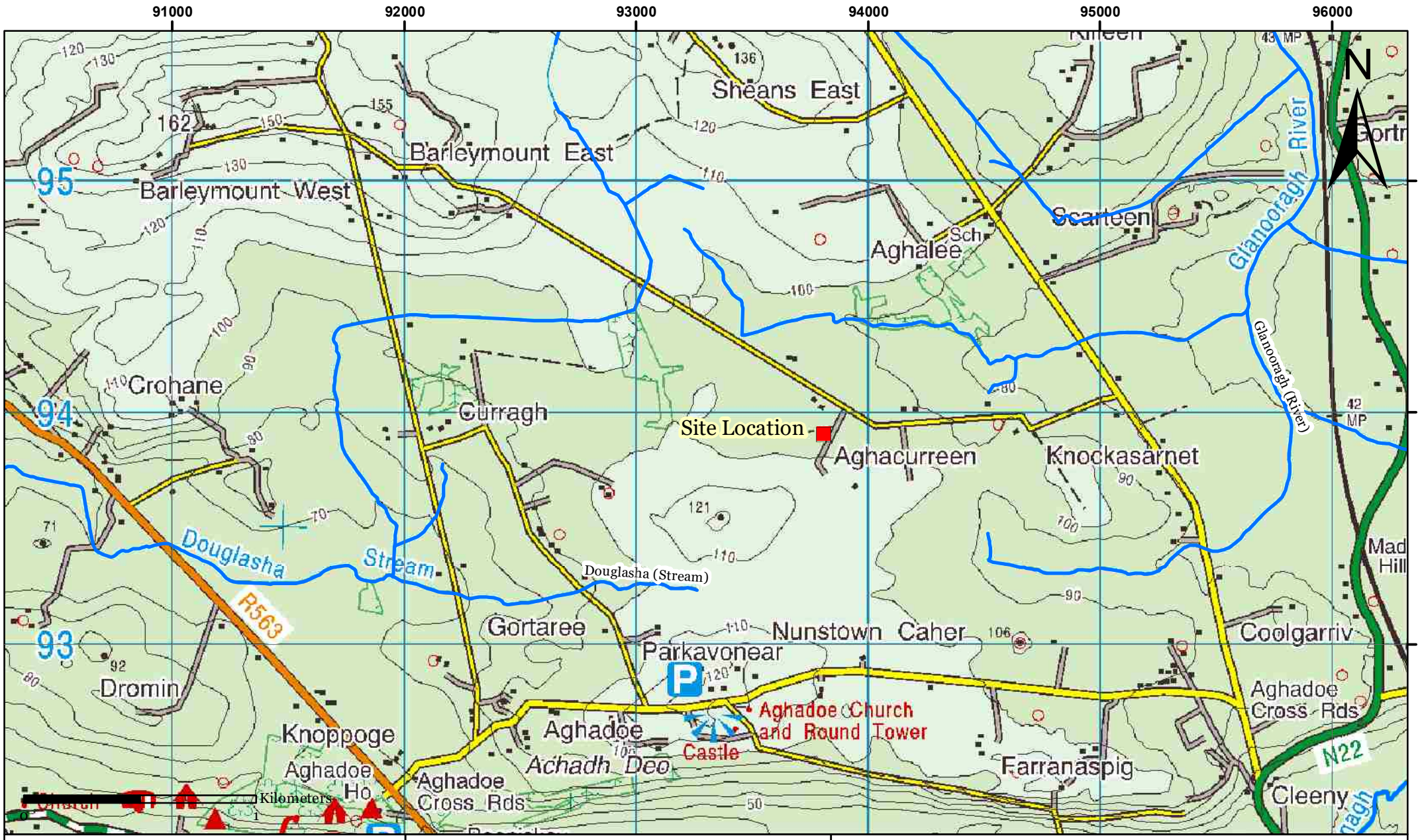
Rainwater run-off from the operational yards, where there is the potential for contamination to occur (bin washing area and compost bay), is directed to holding tanks where it is stored pending removal from the site for off-site treatment in the Irish Water Wastewater Treatment Plant (WWTP) in Killarney.

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

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)

Site Area = 2.202 HA

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

New 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.

Glass Reed Bed

Solids Separator

stream

New Puraflo System

Existing Septic Tank No Longer In Use

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

Post and Wire Fence

Lagoon Reed Bed 0.5m Freeboard

SW 2

SW 1

Storm water (SW 1) drains to percolation ditch

Existing Metal Shearing Yard

100mm pipe

ESB Pole

Proposed Borehole 1

Baled Plastic Shed

Water drains from wooded area to 400mm land drain

Timber Shredding Yard

Proposed Borehole 2

Proposed new holding tank

750mm Pipe under track

Weigh Bridge

Entrance

Roof Water (R2) discharges to drain.

Proposed Gulley

Heat Exchangers

Proposed Offices

Proposed Gulley

Dryer

Two Air Compressors

New effluent holding tank

Private access road

Baling Shed

MRF Building

R1

Roof stormwater(R1) discharges to roadside drain

Diesel Generator

4.55 cubic metre holding tank

Foul Sewer Pipe

Storm Drainage off Roc

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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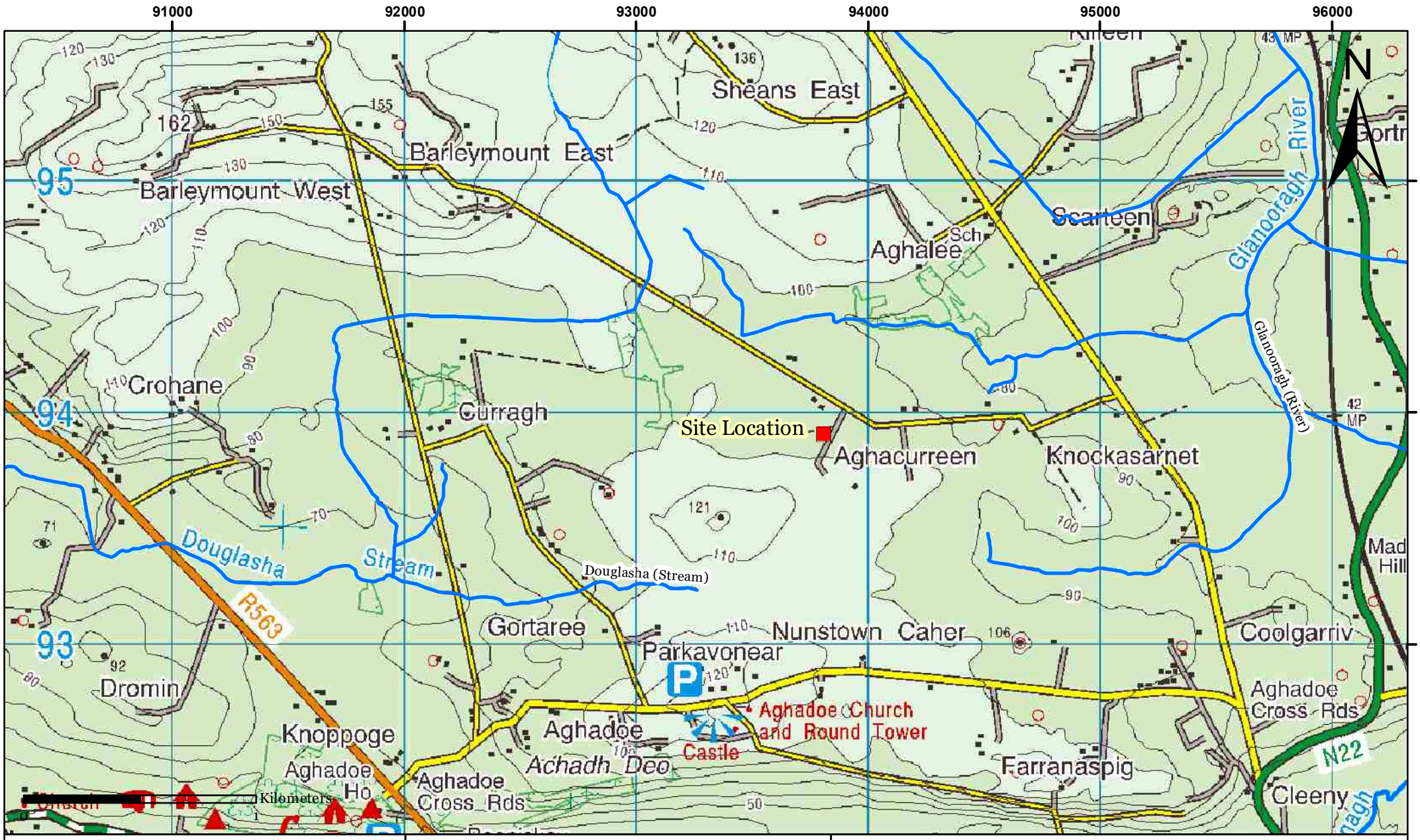
CLIENT
Killarney Waste Disposal

TITLE
Surrounding Land Use

Details:
Site Location

Figure 2.2



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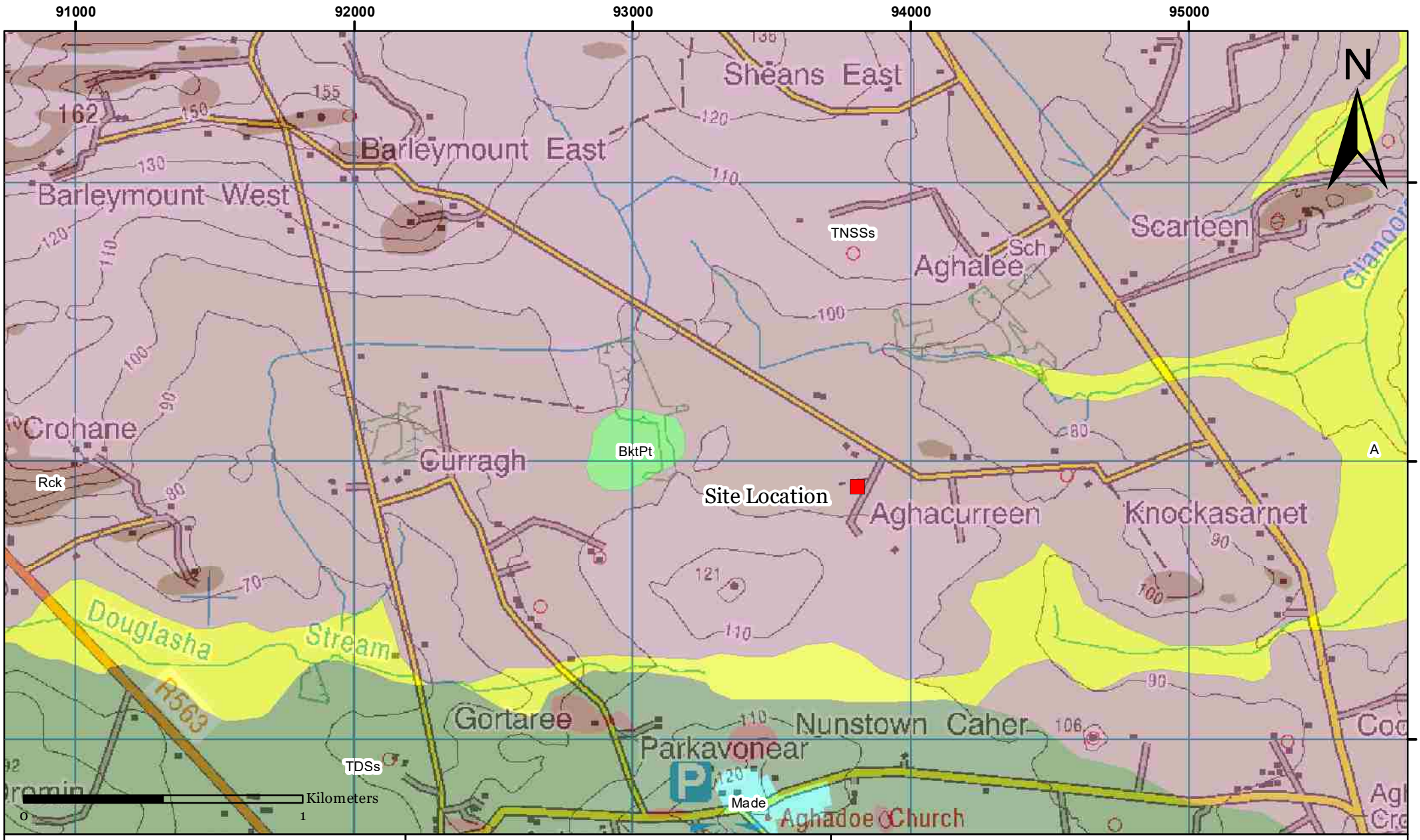
CLIENT
Killarney Waste Disposal

TITLE
Hydrology

Details:
- Site Location
- Rivers

Figure 2.3



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CLIENT
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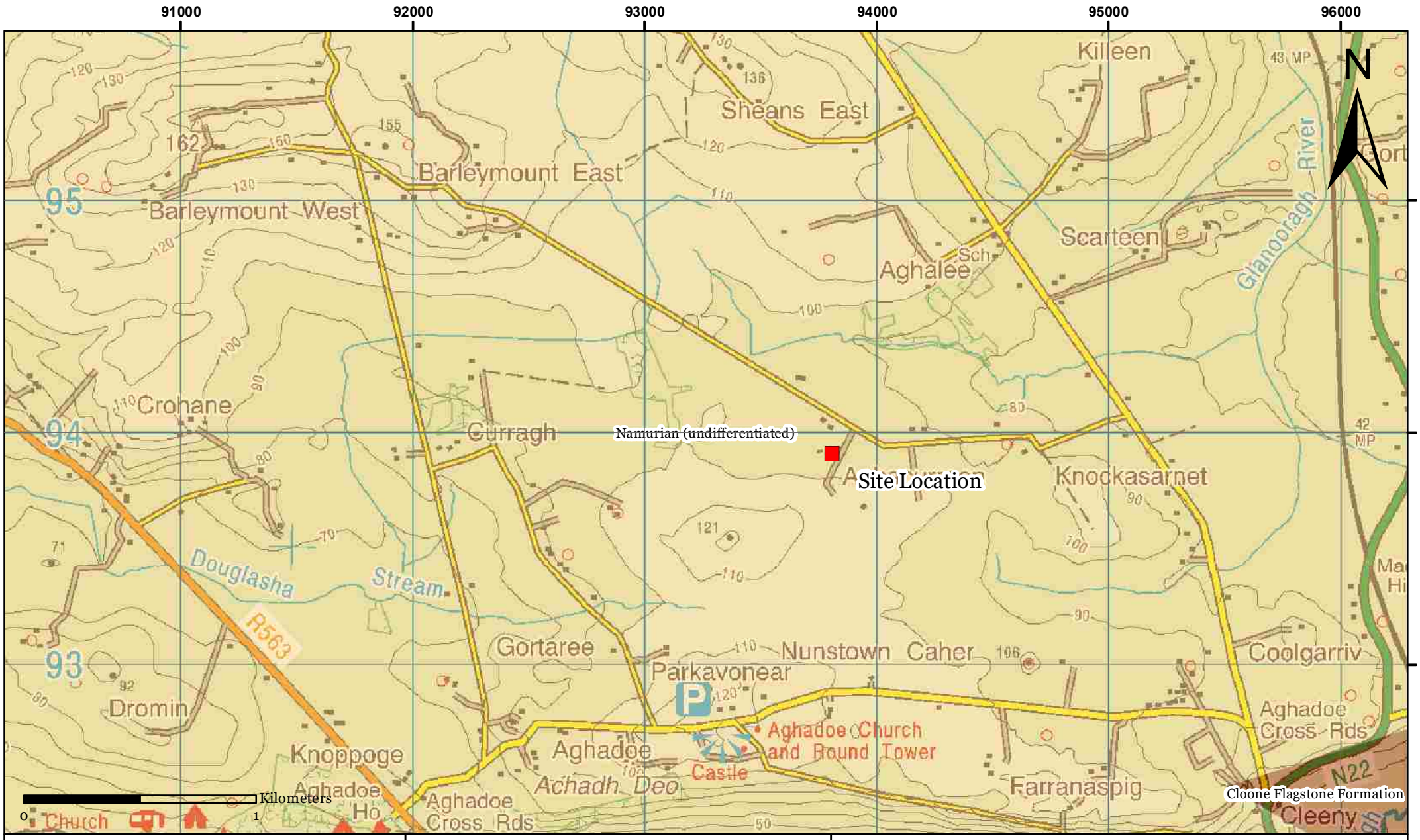
TITLE
Subsoils

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
Killarney Waste Disposal

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**.

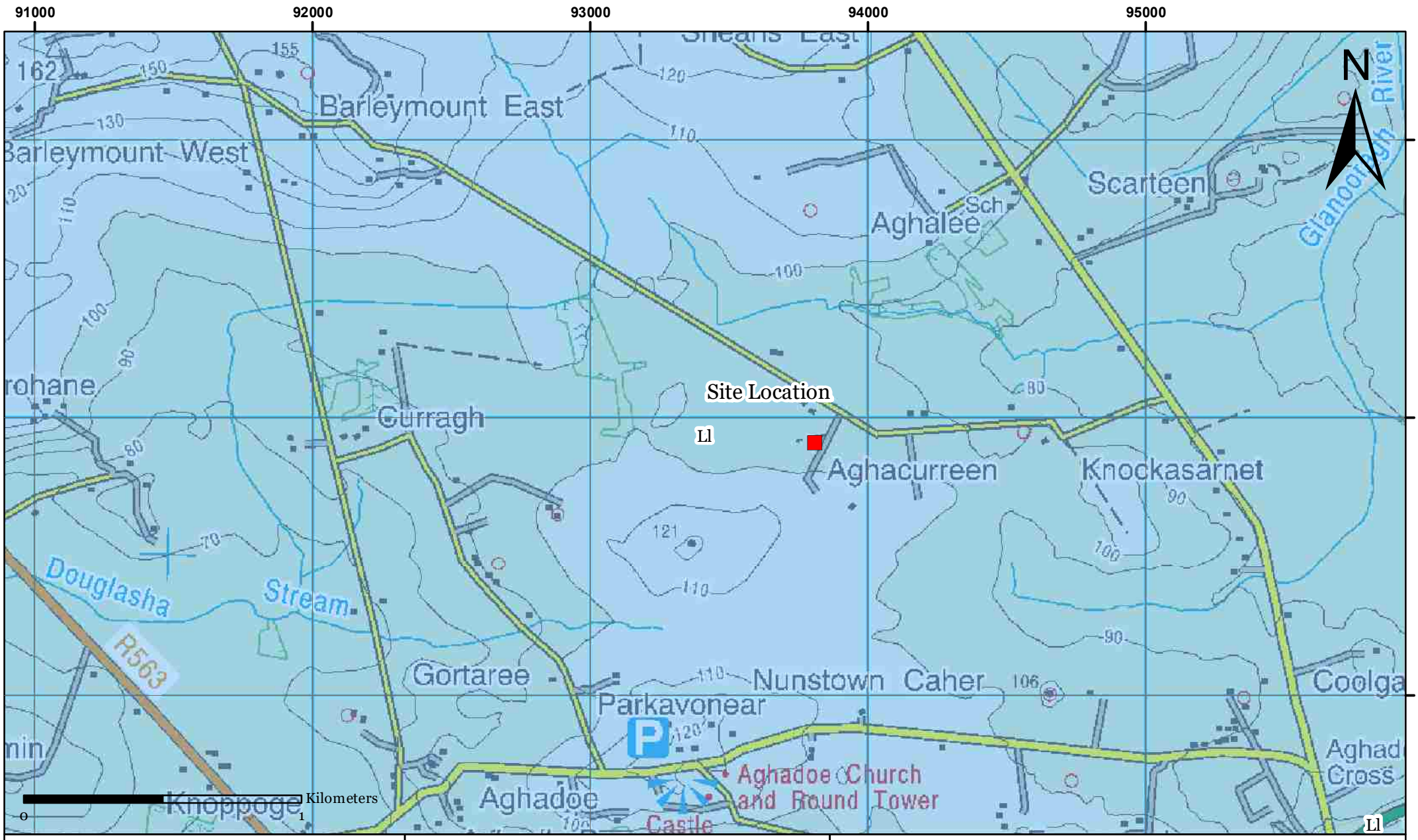
2.6.3 Groundwater Flow Paths and Direction

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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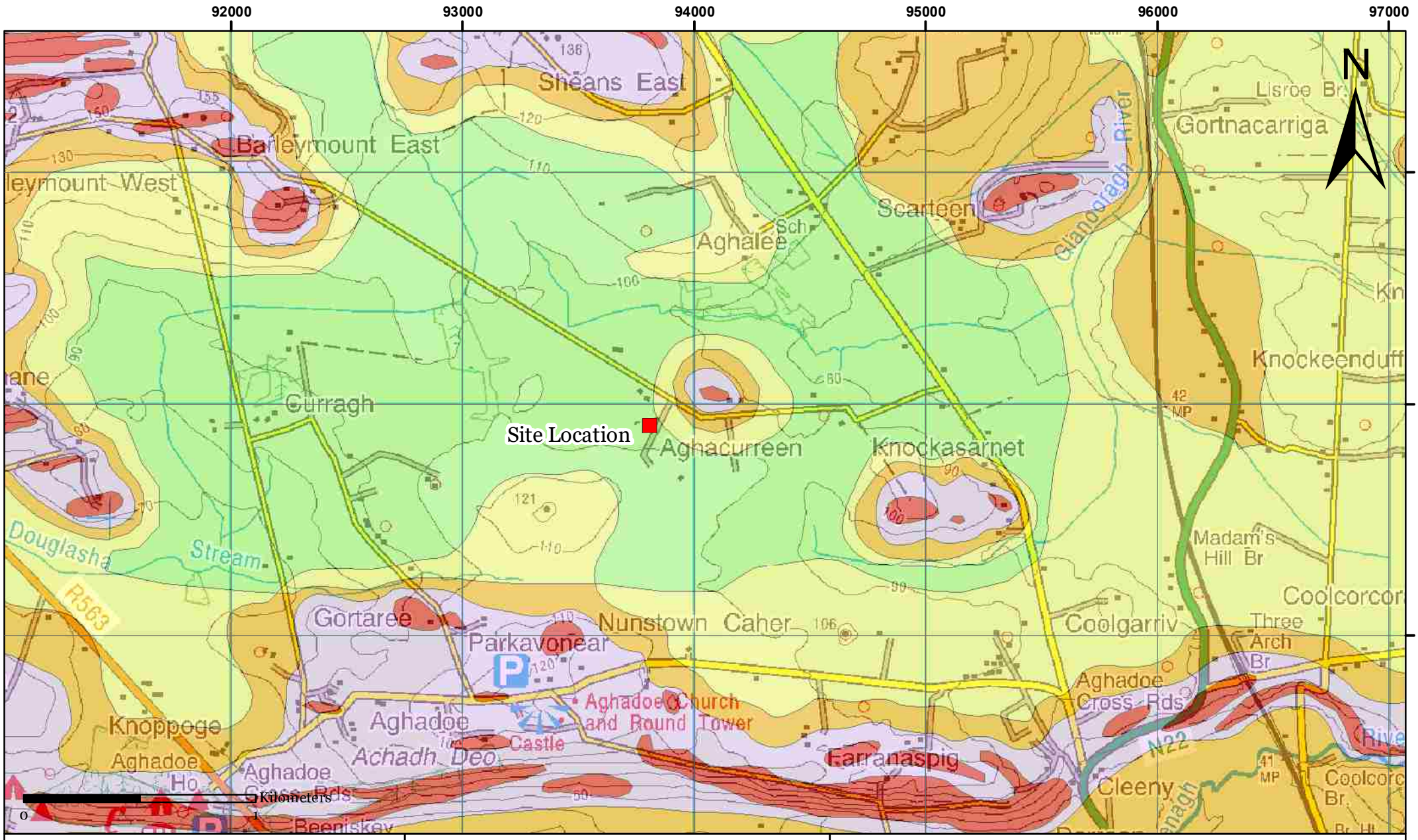
TITLE
Aquifer Classification

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

Figure 2.6



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CLIENT
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TITLE
Groundwater Vulnerability

Details:

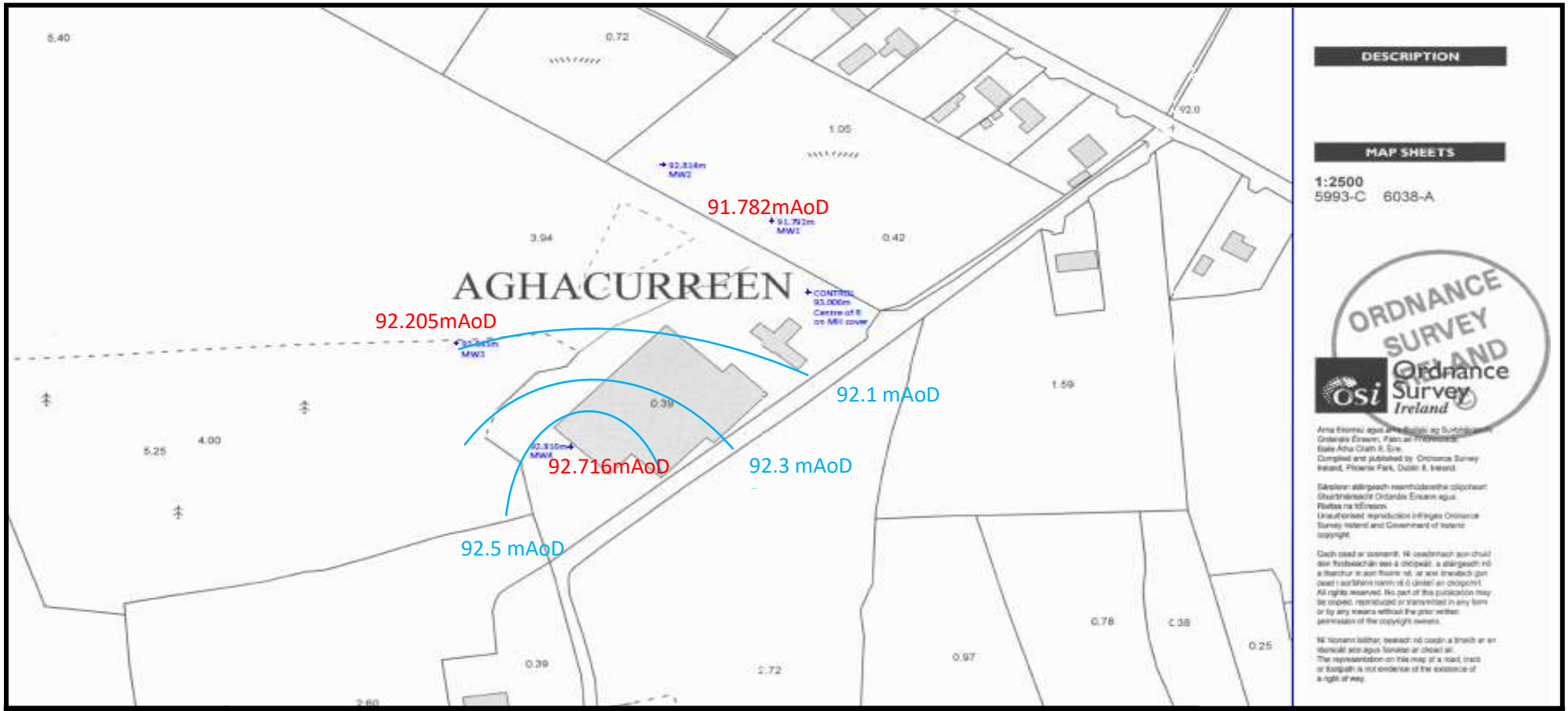
- Site Location
- Bedrock near Surface
- Extreme
- High
- Moderate
- Low

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 2.9. 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).



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Title:

Figure 2.8

Groundwater Contours November 2009

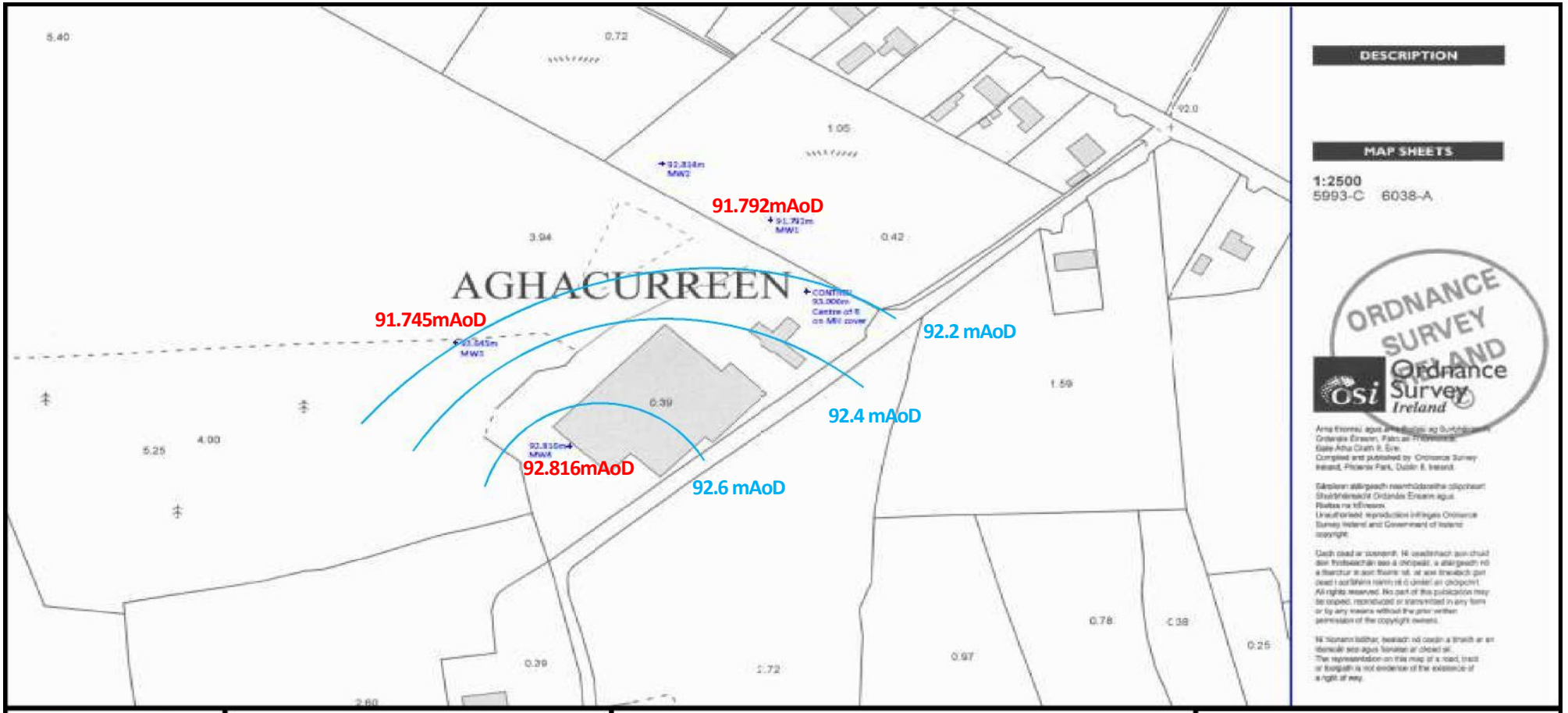
Client:

Killarney Waste Disposal Ltd.

Legend

= Groundwater Contour

92.214mAoD= Dip Levels



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Title:

Figure 2.9

Groundwater Contours June 2016

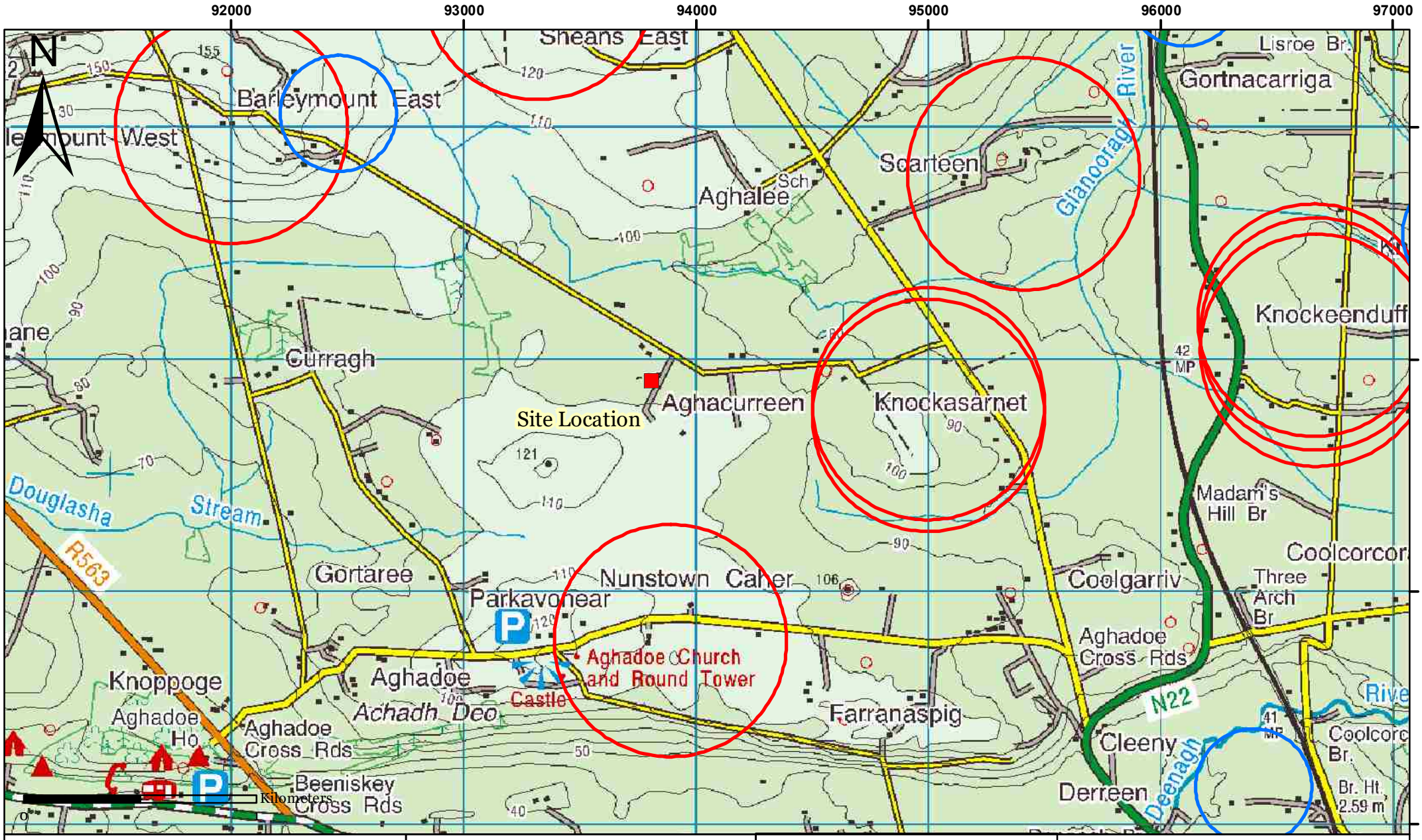
Client:

Killarney Waste Disposal Ltd.

Legend

= Groundwater Contour

92.214mAoD= Dip Levels



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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

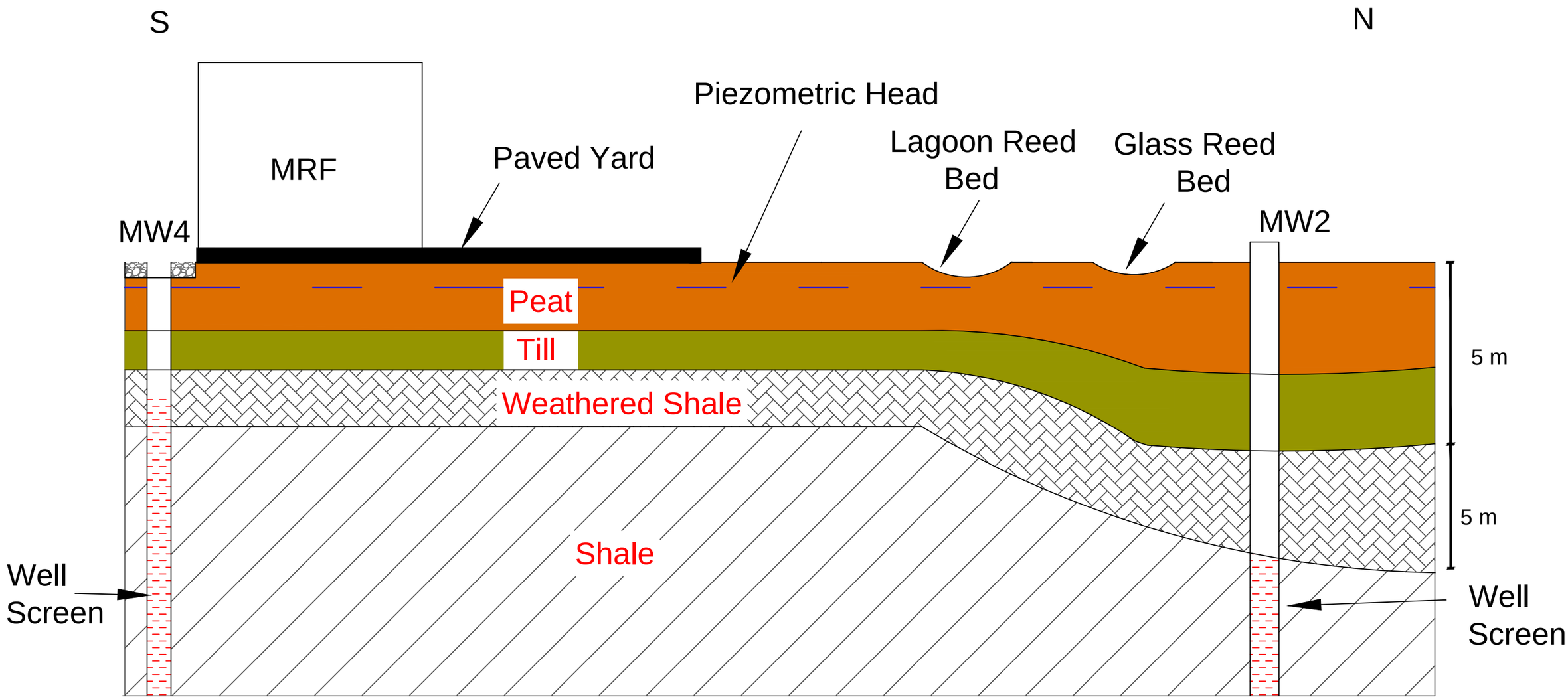
Waste Activities

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.

Photograph 4 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.

APPENDIX 1

Energy, Environment & Safety

Killarney Waste Disposal

Aughacureen, Killarney, Co Kerry

Waste Licence No. W0217-01

Report on Hydrogeological Survey

June 2010

FBD House, Fels Point, Tralee, Co. Kerry
p: 066 7128321 **w**: www.oes.ie

Killarney Waste Disposal

Hydrogeological Survey

Contents

Attachments

1. Introduction

OES were commissioned by Killarney Waste Disposal Ltd (KWD) to undertake a hydrogeological assessment of their facility at Aughacureen to determine if contaminating substances exist in groundwater as a result of site activities.

The overall objective of this assessment is to develop a valid hydrogeological conceptual model so that an effective groundwater monitoring programme can be developed for the site to the satisfaction of the Agency.

Killarney Waste Disposal (KWD) has operated a Material Recovery Facility (MRF) on a 2.2 hectare site at Aughacureen, approximately 4 km northwest of Killarney Town since 1987. The MRF is situated on a rural site and there is no significant residential or commercial development in its proximity; the primary landuse of the surrounding locale is agricultural with some of the land now being used for commercial forestry, some of which has recently been clear felled.

Under Condition 3.21 of Waste Licence W0217-01 the Agency required KWD to submit a proposal for the installation of groundwater monitoring boreholes at the site. OES submitted this proposal to the Agency on behalf of KWD in April 2008.

This report sets out the findings of the hydrogeological assessment as agreed by the Agency.

2. Local Hydrogeology

Owing to the difficulty involved in obtaining an accurate reflection of groundwater regime it was necessary to undertake a review of geology and hydrogeology in the area surrounding KWD to augment the findings of the field investigations undertaken at the site.

It was found that the underlying aquifer which KWD is situated in has been classified as an Ll (locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones) and the GSI Classification for this bedrock aquifer unit indicates it is capable of supplying locally important abstractions (e.g. smaller public water supplies, group schemes). Groundwater flow occurs predominantly through fractures, fissures and joints.

Primary permeability and porosity are no longer present in these formations and secondary permeability is dominant. Obtaining a good yield from these formations is dependent on intercepting major fracture zones and the interconnectivity of these fracture zones.

A GSI well search was undertaken to investigate if there was any domestic or public drinking groundwater sources in the vicinity of the site.

The search yielded results on fifteen (15) wells, these are presented in Table 3 below.

Table 3 Summary of the well details provided by the GSI

Townland	Depth to rock	Depth	Easting	Northing	Location Accuracy	Usage	Yield m^3d
Nunstown	15.2	61	93890	92790	to 1km	Domestic use only	21.8
Knockasarnet	30.5	35.7	95000	93810	to 1km	Agri & domestic use	21.8
Knockasarnet	30.5	35.4	95000	93760	to 1km	Agri & domestic use	21.8
Scarteen	30.5	36.6	95410	94800	to 1km	Agri & domestic use	21.8
Sheans	0.6	3.1	93320	95620	to 1km	Agri & domestic use	21.8
Barleymount	30.5	36.6	92000	95000	to 1km	Agri & domestic use	21.8
Barleymount east	30.5	32.6	92460	95060	to 500m	Domestic use only	21.8
Gortna-carriga	6.1	36.6	96100	95600	to 500m	Agri & domestic use	26.2

Townland	Depth to rock	Depth	Easting	Northing	Location Accuracy	Usage	Yield m^3d
Derreen	3.1	28.3	96400	92160	to 500m	Agri & domestic use	21.8
Lackabane			93370	91470	to 200m	Industrial use	350
Lackabane	39	91	93300	91750	to 100m	Industrial use	9
Lackabane	39	91	93300	91750	to 100m	Unknown	7

The nearest groundwater well to the site is greater than 1km up gradient with the nearest down gradient well greater than 2.7km north of the site.

Each of the monitoring boreholes installed at KWD are described in section 3 of this report.

3. Installation of Monitoring Boreholes

KWD engaged the services of Southern Pumps Ltd to install monitoring boreholes at their facility in early July 2009. In total four wells were constructed at locations agreed with the Agency. A map detailing the locations of each of the monitoring boreholes installed at the site is appended with this report as figure 2 in Attachment A.

Each of the borehole monitoring wells was levelled to site datum so that groundwater flow direction could be obtained. A summary of each of the wells is presented in following sections of this report.

3.1 Monitoring Well 1 (MW1)

MW 1, as can be seen in Figure 2 (Attachment A) is positioned down gradient of the MWF. This well was constructed with the use of an air rotary rig. A summary of the drilling and well installation is outlined below. A schematic log of this monitoring well is appended with this document as Figure 4 of Attachment A.

Drilling

- Drilling was initiated using a 140 millimetre hole, this was continued to a depth of 7.5 metres;
- Overburden was found to be topsoil from 0 to 0.5 metres with subsoil encountered from 0.5 to 5 metres;
- Soft black shale was encountered from 5 to 7.5 metres.
- Drilling continued to 18 metres below ground surface at a hole diameter of 120 millimetres.

Well Installation

- 10.5 metres of slotted 50 millimetre uPVC casing was installed from 7.5 metres to 18 metres;
- A gravel filter pack was installed in the annular space between the uPVC screen from 7.5m to 18 m below ground level;
- Bentonite seal was installed from 7.5m to ground level to seal the monitoring well from surface water intrusion;
- Raised headwork's were installed at this well to provide well security and groundwater protection of the well and
- A concrete plinth was placed around the top of the well for further groundwater protection.

In terms of the geological sequences encountered, the shale encountered between 5.0 and 7.5 metres was found to be a very fine black powder and slightly weathered and finely laminated.

During drilling, water strikes were recorded at 10 and 15 metres, while the well demonstrated artesian characteristics on the day of drilling.

3.2 Monitoring Well 2 (MW2)

MW2, as can be seen in Figure 2 (Attachment A) is positioned down gradient of the MWF. This well was constructed with the use of an air rotary rig. A summary of the drilling and well installation is outlined below. A schematic of this monitoring well is appended with this document as Figure 5 of Attachment A.

Drilling

- Drilling was initiated using a 150 millimetre hole, this was continued to a depth of 6 metres;
- Overburden was found to be topsoil from 0 to 1 metres with bedrock (black shale) encountered from 1 to 3 metres;
- Steel casing from 0 to 6 metres was installed to stop the hole from caving in;
- Drilling continued to 24metres below ground surface at hole diameter of 120 millimetres.

Well Installation

- Slotted uPVC casing was installed from 6 to 24 metres;
- A gravel filter pack was installed in the annular space between the uPVC screen from 6m to 24m below ground level;
- Bentonite seal was installed from 6m to ground level to seal the monitoring well from surface water intrusion;
- Raised headwork's were installed at the at this well to provide security and protection of the well; and
- A concrete plinth was placed around the top of the well for further groundwater protection.

Whilst the well was being drilled, a minor water strike was encountered at 20 metres below ground level. Similar to MW 1 the drill cuttings were reported as being fine black powder which would indicate that the shale was weathered.

3.3 Monitoring Well 3 (MW3)

MW3, as can be seen in Figure 2 (Attachment A) is positioned up gradient of the MWF. This well was constructed with the use of an air rotary rig. A summary of the drilling and well installation is outlined below. A schematic of this monitoring well is appended with this document as Figure 6 of Attachment A.

Drilling

- The monitoring borehole drilling was initiated using a 140 millimetre hole, this was continued to a depth of 6 metres;
- Overburden of topsoil and subsoil was encountered from 0 to 5 metres.

- Soft weathered black shale was encountered from 5 to 8 metres and 6 metres of steel casing was inserted from 0 to 6 metres to stop the borehole from caving in;
- Drilling continued to 18metres below ground surface at a hole diameter of 120 millimetres.

Well Installation

- 50 millimetre uPVC casing was installed from 0 metres to 7.5 metres below ground level;
- A gravel filter pack was installed around the uPVC from 6 to 18 metres;
- A Bentonite seal was installed from 6m to ground level to seal the monitoring well from surface water intrusion;
- Raised headwork's were installed at the at this well to provide security and protection of the well; and
- A concrete plinth was placed around the top of the well for further groundwater protection.

A minor water strike was encountered at 11m below ground level. Once the steel screen was installed in the upper 6 metres of the borehole the hole remained open for the duration of drilling.

3.4 Monitoring Well 4 (MW4)

MW4, as can be seen in Figure 2 (Attachment A) is positioned up gradient of the MWF. This well was constructed with the use of an air rotary rig. A summary of the drilling and well installation is outlined below. A schematic of this monitoring well is appended with this document as Figure 6 of Attachment A

Drilling

- The monitoring borehole drilling was initiated using a 140 millimetre hole, this was continued to a depth of 6 metres;
- Overburden of topsoil and clay was encountered from 0 to 3 metres.
- Soft weathered black shale was encountered from 3 to 8 metres and 6 metres of steel casing was inserted from 0 to 6 metres to stop the borehole from caving in;
- Drilling continued to 18metres below ground surface at a hole diameter of 120 millimetres.

Well Installation

- 50 millimetre uPVC casing was installed from 6 metres to 18 metres below ground level;
- A gravel filter pack was installed in the annular space between the uPVC screen from 6m to 18m below ground level;
- A Bentonite seal was installed from 6m to ground level to seal the monitoring well from surface water intrusion;

- Raised headwork's were installed at the at this well to provide security and protection of the well; and
- A concrete plinth was placed around the top of the well for further groundwater protection.

Similarly to MW3 a water strike was detected at 11 metres.

4. Water Quality

OES undertook groundwater monitoring at KWD on the 25th of November 2009. Water samples were taken from the four groundwater monitoring wells at the site and were analysed for the parameters set out in Schedule C of licence W0217-01. The parameters required to be analysed and the frequency for analysis is presented in table 1 below.

Table 1 Groundwater monitoring parameters

Parameter	Monitoring frequency	Analysis method/Technique
Total Ammonia (as N)	Biannually	Standard method
Nitrates (as N)	Biannually	Standard method
Conductivity	Biannually	Standard method
Chloride	Biannually	Standard method
Sulphates	Biannually	Standard method
Diesel range organics	Biannually	To be agreed by agency

4.1 Methodology

Sampling of the groundwater monitoring wells at KWD was undertaken by a Hydrogeologist from OES.

Separate tubing was used in each well to prevent cross contamination during sampling. Each of the groundwater monitoring wells was purged by at least 5 times its water volume; samples were taken when the electrical conductivity readings and pH of the groundwater stabilised to ensure that the sample was representative of groundwater in the area.

The water samples were preserved where necessary and sent to Alcontrol Laboratories in Dublin for analysis.

The results of analysis from the four Monitoring wells were interpreted with reference to the standards set out in EC (Drinking Water) Regulations 2000 Standards (SI 439 of 2000).

Three rounds of water sampling were undertaken in order to obtain a representative indication of the groundwater quality both upgradient , side gradient and down gradient of the facility.

Samples were taken on the 04/09/09, 26/11/2009 and on the 27/05/2010.

4.2 Monitoring Results

Hydrochemistry results returned from Alcontrol Laboratories are appended with this report as Attachment B. A breakdown of the results from the three monitoring rounds are outlined below.

Diesel Range Organics

The results for diesel range organics (DRO) were all less than the detectable limits for all 4 on site wells for the three rounds of sampling undertaken. All results for diesel range organics in all monitoring wells were non detectable.

Nitrate as (NO_3^-)

The results for Nitrate were all less than the detectable limits for the 4 on site wells for the three monitoring rounds. All results for Nitrate were all less non detectable.

Sulphate

The results for sulphate were less than the detectable limit for the monitoring rounds undertaken in September 2009 and for November 2009. Minor amounts of sulphate were detected in both MW3 and MW4 during the May 2010 monitoring round. The levels were 4.4mg/l and 21.9mg/l respectively. This is in line with the natural background levels for sulphate for this type of bedrock. The results are well below the drinking water limits.

Chloride

The results for chloride were well below the drinking water limits. The results are in line with natural background limits. The average value for Chloride was 22.87mg/l. The drinking water standards are 250mg/l.

Electrical conductivity

The results for electrical conductivity ranged from 377µs/cm to 764µs/cm. The results were well below the drinking water limits set at 2,500µs/cm

Ammonia

The results for ammonia were elevated in MW1, MW2 and MW3 for the three sampling rounds. The result for MW4 was below the detectable limit fro the three sampling rounds.

MW3 is an upgradient well and has elevated Ammonia levels. Clear felling of forestry has occurred beside MW3 (as shown in the photolog attachment C). This clear felling occurred during early 2009.

Source of Ammonia

Investigation into the source of the elevated ammonia suggests that it may be from one of three sources.

1) Leachate storage tank in the centre of the MRF

The leachate storage tank is located in the centre of the MRF and is equipped with a volume alarm (see Figure 2). This storage tank was hydrostatically tested in March 2009 to check for integrity. The storage tank passed the integrity test. The bund integrity certificate is attached in Attachment D. This proves that there is no leachate being released into the environment as a point source from the leachate storage tank.

In addition, chemical analysis results from the leachate storage tank shows elevated levels of ammonia as well as very elevated levels of sulphate and chloride in the leachate storage tank. The levels of both sulphate and chloride are found at low concentrations in the groundwater samples taken in all three monitoring rounds.

In the case of sulphate it is non detectable in MW1 and MW2 and found at natural background levels or below natural background levels in the monitoring wells MW3 and MW4. Chloride is at natural background levels in all wells. The difference in the chemical signatures suggests that possible leachate contamination from the leachate storage tank is not the cause of the elevated ammonia.

2) Wetland treatment area

The wetland area treats runoff from the site and effluent from the on site toilets and wash area. The treated effluent from this wetland is released into a surface drain to the west of the site (SW1- See Figure 2). From hydrochemistry comparison it does not appear to mix with groundwater. Chemical analysis results from the treated effluent from SW1 area show high levels of sulphate (>100mg/l) which has not been detected in the groundwater, confirming that this surface water is not interacting with the groundwater at this location. The difference in chemical signatures from the surface water samples when compared to the groundwater results show different results and suggests that the wetland treatment area is not the cause of the elevated ammonia found in the groundwater.

3) Surrounding landscape

From the discussion above it is evident that the high ammonia results could be from the surrounding landscape, due in part to the known groundwater flow direction and the activities occurring hydraulically upgradient of the facility. (See Figure 2 and 8)

The levels of Ammonia in MW1, MW2 and MW3 are likely to be a result of possible septic tank discharges, leakage from underground livestock slurry pits, the recent clear felling of forestry or the landspreading of agricultural waste material from the higher grounds to the south of the facility.

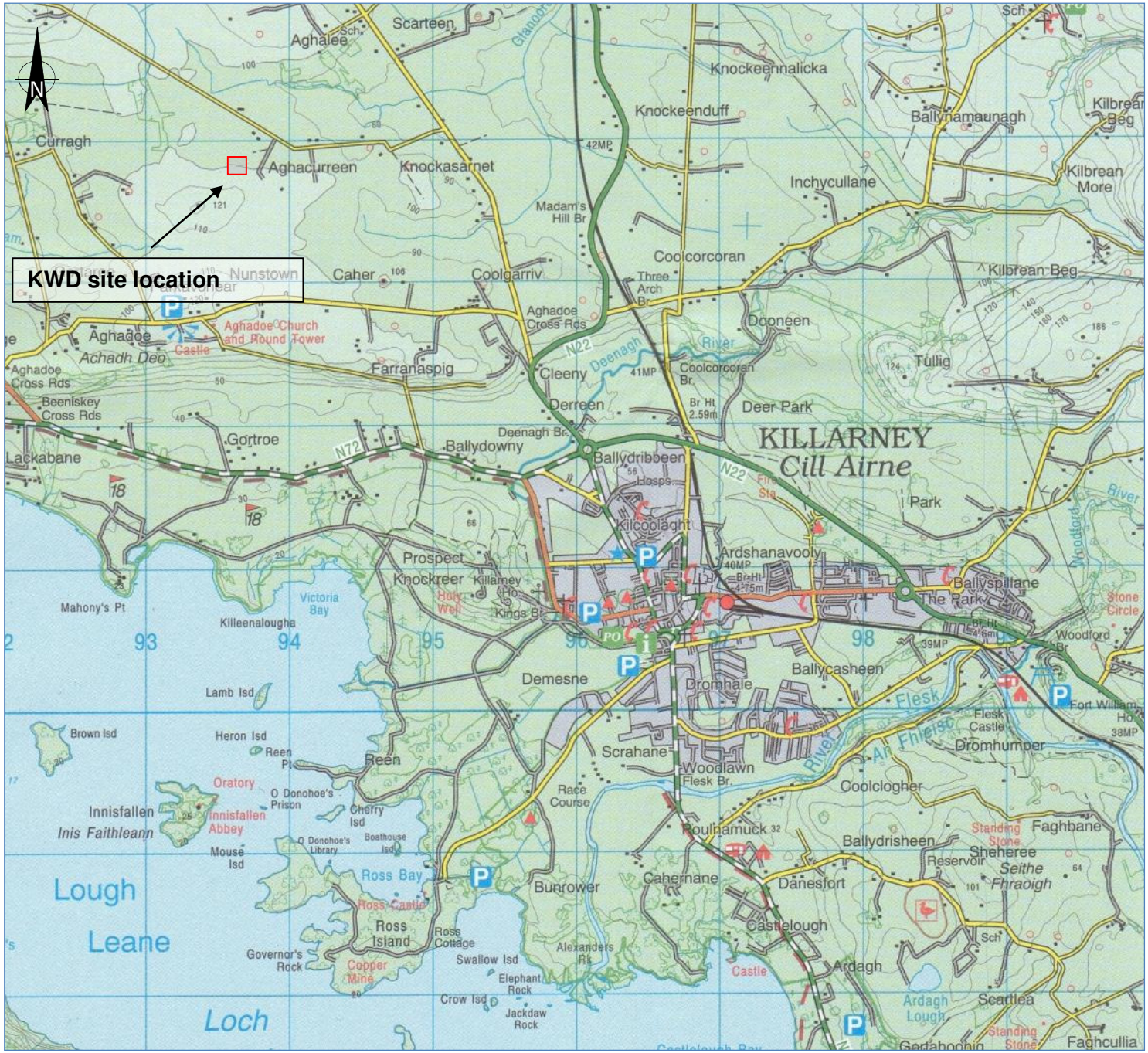
5. Conclusion

The detailed hydrochemistry results obtained from the sampling undertaken at KWD from September 2009 through to May 2010 demonstrate that groundwater quality beneath the site is well within the standards set out in the EC (Drinking Water) Regulations 2000 Standards (SI 439 of 2000) with the exception of Total Ammonia in some of the wells.

Total Ammonia, represented as N was found to be in exceedence of the drinking water standard set out in the EC (Drinking Water) Regulations 2000 Standards at monitoring points MW1, MW2 and MW3. The highest concentration recorded at the site was at MW2 and MW3 which are located close to clear felled forestry plantation and agricultural lands close to the MRF facility. Groundwater flow direction has been demonstrated to flow from south west to north east, which suggests that the source of the ammonia is from outside the site boundary.

Future monitoring of the groundwater monitoring wells at KWD undertaken in accordance with the requirements of W0217-01 will enhance understanding of the fate of ammonia in groundwater at KWD.

Attachment A
Figures



Site location

Client: Killarney Waste Disposal
Project Code:1059_08
Title: Site Location

Drawing No: 1
Issue Date: 30/06/10
Revision:1
Scale: Not to Scale

OES
FBD House, Fels Point,
Tralee, Co. Kerry Ireland
P: 066-712 83 21 W: oes.ie

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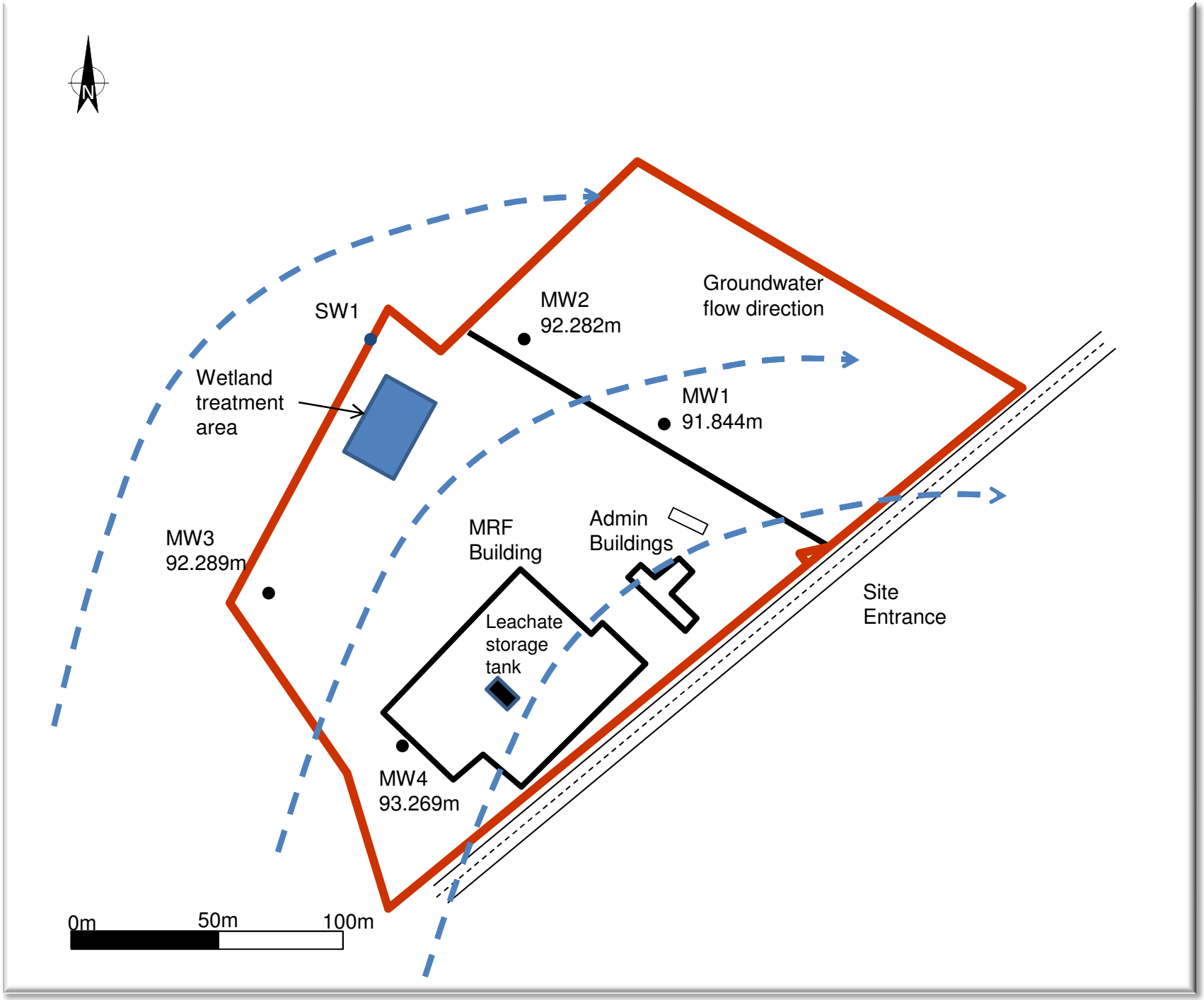

Client: Killarney Waste Disposal
Project Code:1059_08
Title: MW Locations

Drawing No: 2
Issue Date: 30/06/10
Revision:1
Scale: See map

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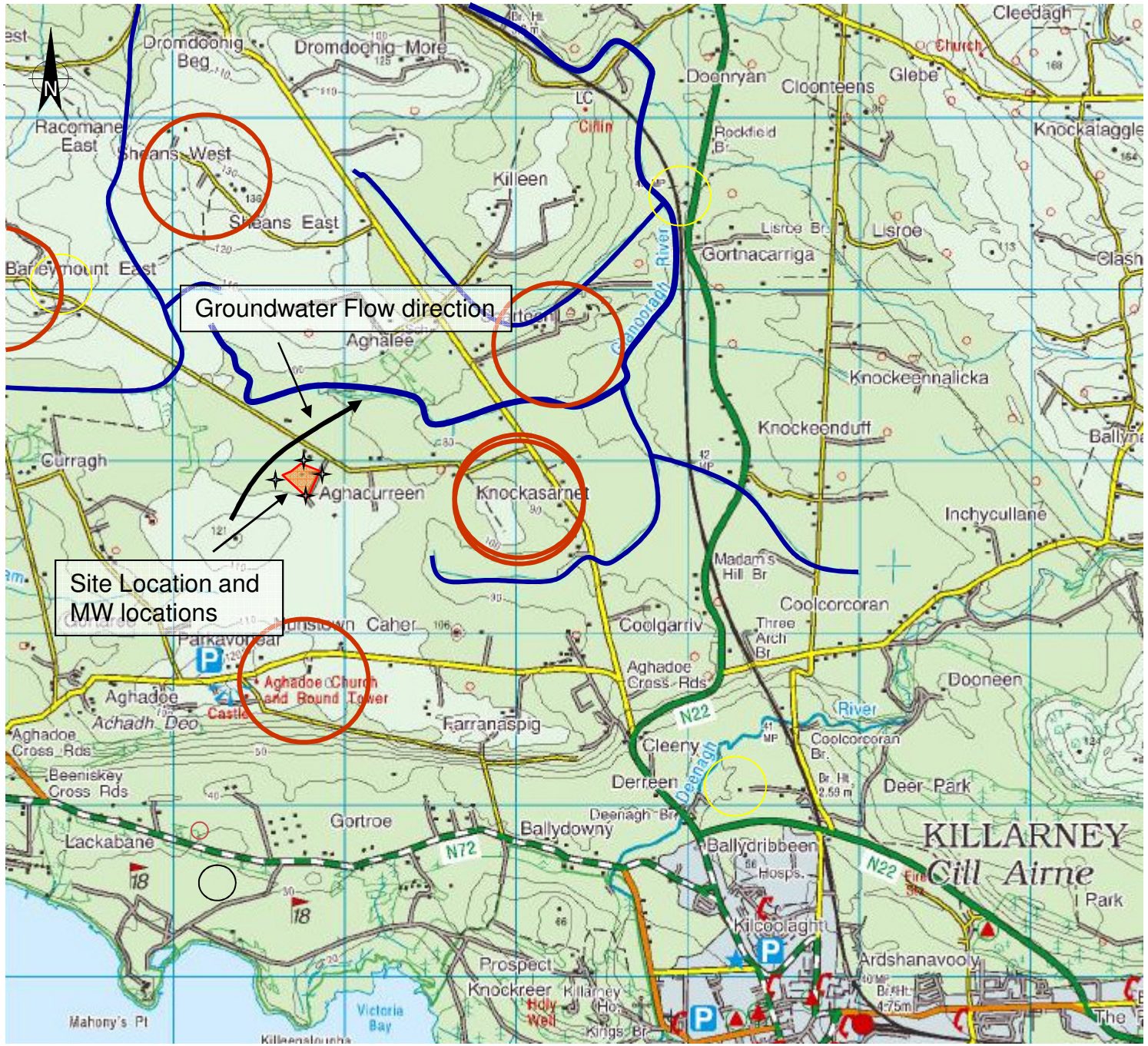

Client: Killarney Waste Disposal
Project Code:1059_08
Title: GSI well search results

Drawing No: 3
Issue Date: 30/06/10

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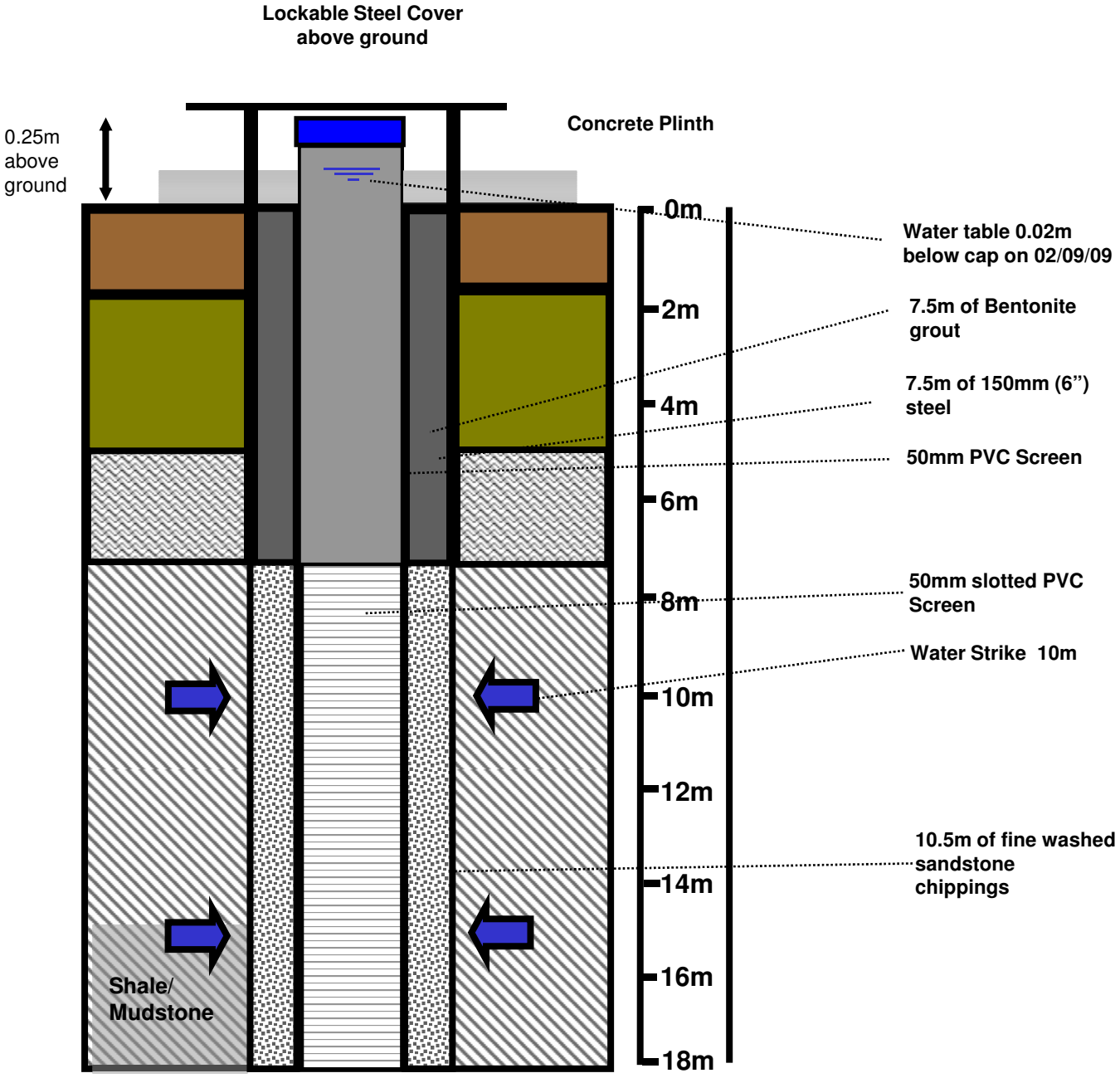
MW1



Legend

- Bedrock
- Weathered Bedrock
- Bentonite
- Concrete
- PEAT
- Mottled CLAY

Monitoring Well 1
NGR E93688 N93994
Drill Date : 01/07/09

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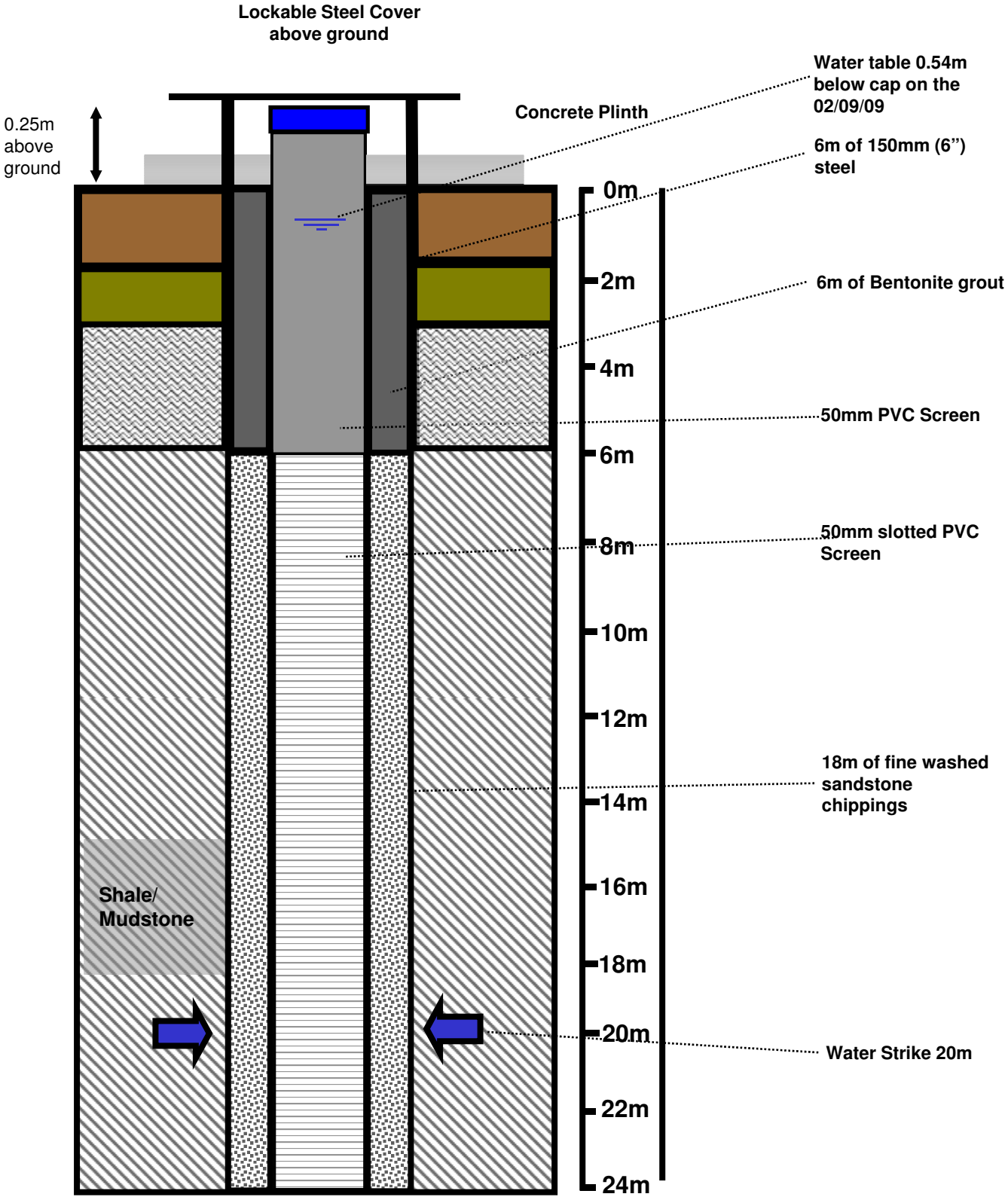
Client	Killarney Waste Disposal		
Title	MW1 – Borehole Construction		
Scale.	NTS	Project No.	1059-08
Figure	Figure 4	Rev.	A

MW2



Legend

- Bedrock
- Weathered Bedrock
- Bentonite
- Concrete
- PEATY Topsoil
- Mottled CLAY

Monitoring Well 2
NGR E93639 N94024
Drill Date : 01/07/09

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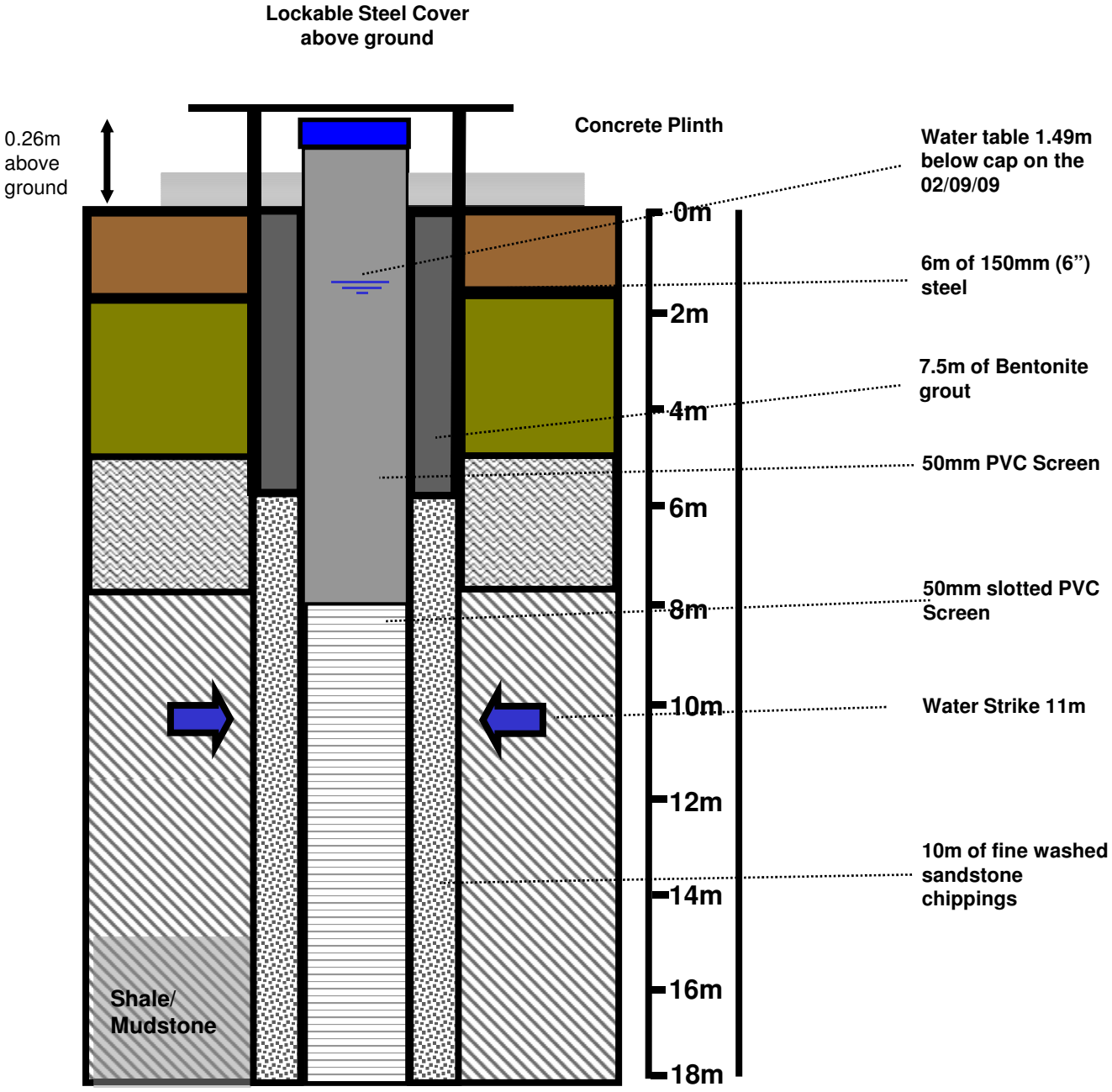
Client	Killarney Waste Disposal
Title	MW2 – Borehole Construction
Scale. NTS	Project No. 1059-08
Figure Figure 5	Rev. A

MW3



Legend

- Bedrock
- Weathered Bedrock
- Bentonite
- Concrete
- PEAT
- Mottled CLAY

Monitoring Well 3
NGR E93546 N93931
Drill Date : 01/07/09

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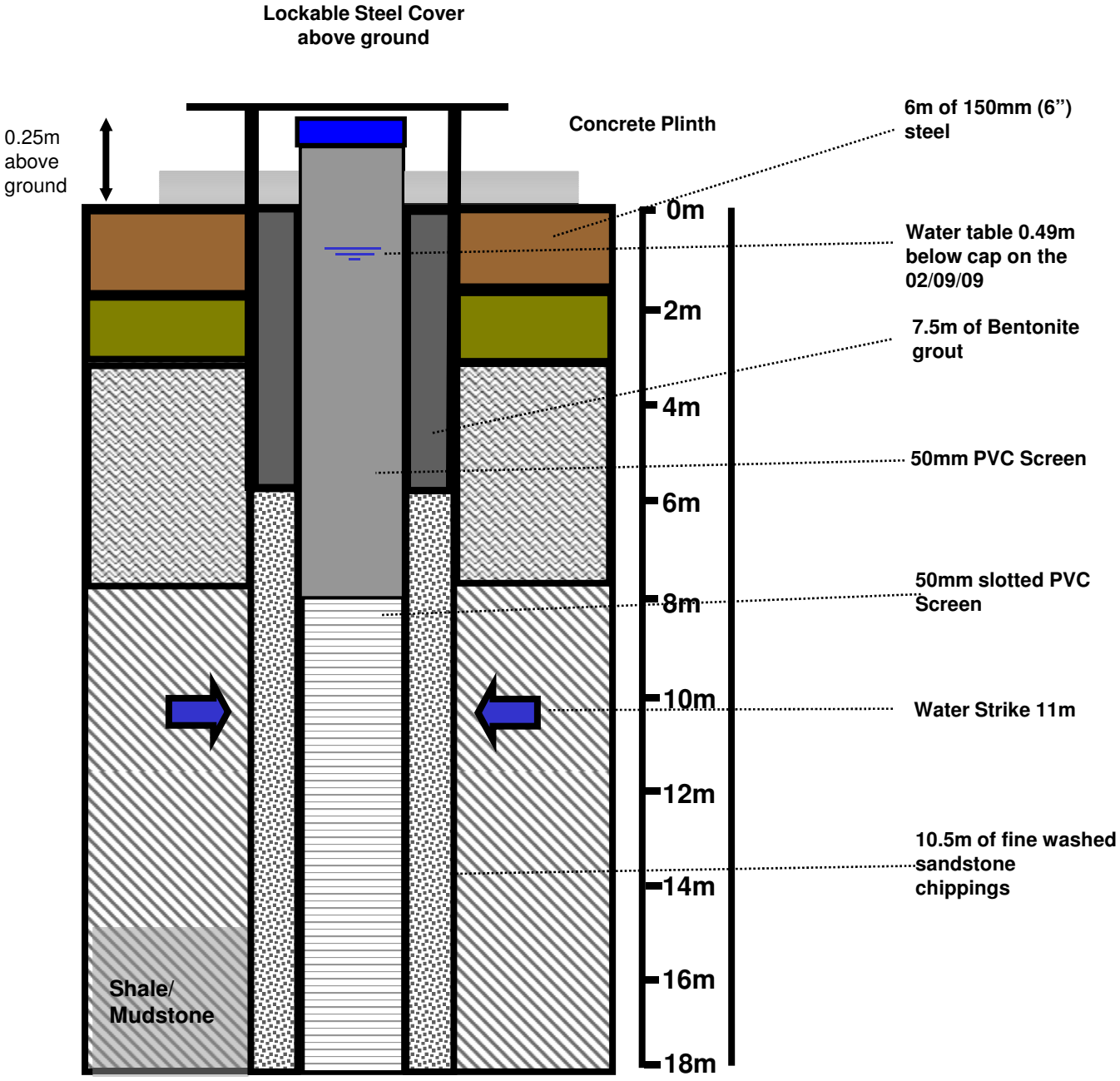
Client	Killarney waste Disposal .
Title	MW3– Borehole Construction
Scale. NTS	Project No. 1059-08
Figure Figure 6	Rev. A

MW4



Legend

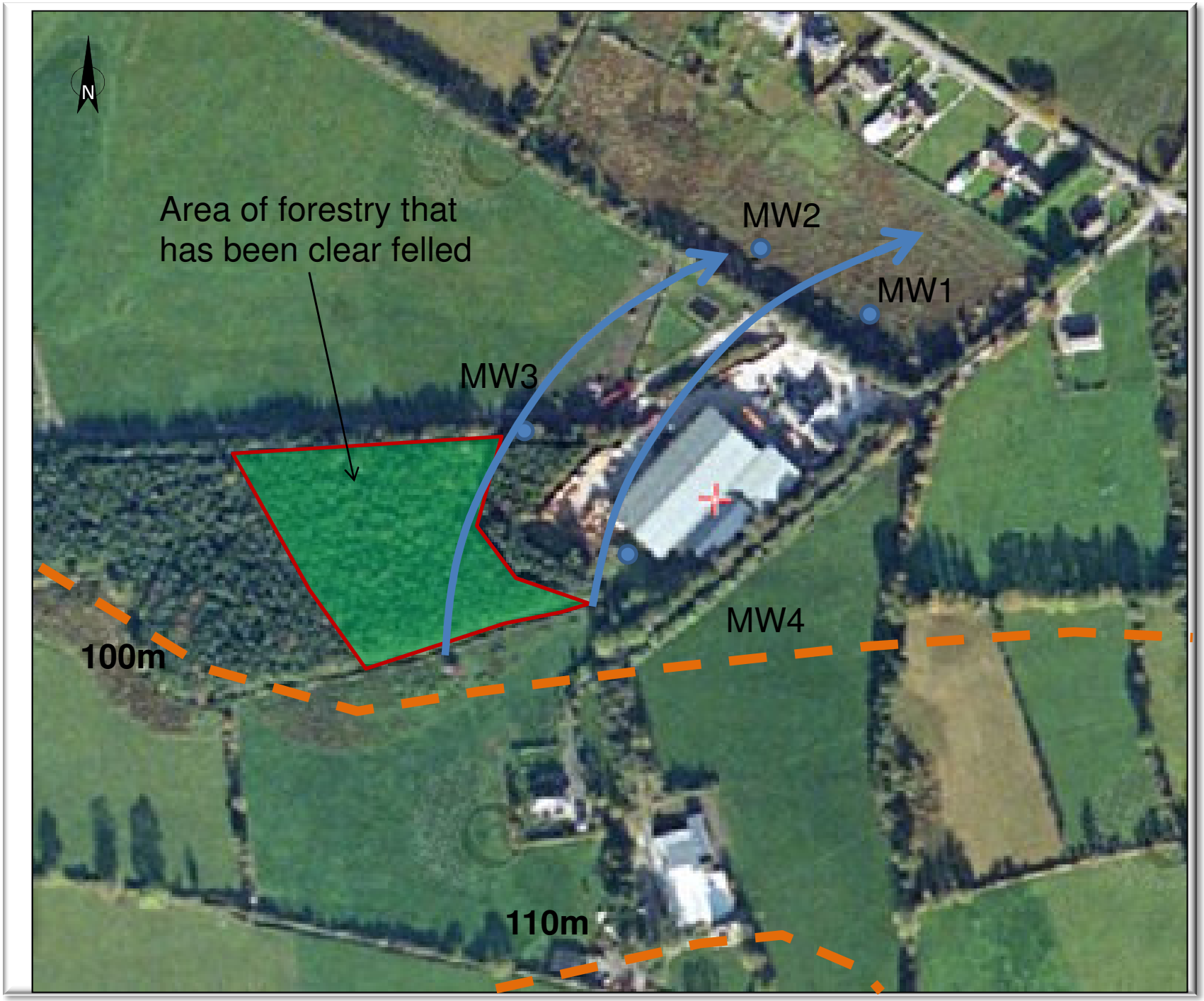
- Bedrock
- Weathered Bedrock
- Bentonite
- Concrete
- PEAT
- Mottled CLAY

Monitoring Well 4
NGR E93597 N93877
Drill Date : 01/07/09

Energy, Environment & Safety
environmental health and safety engineering project management

Tel: 353 (0)667128321 Fax: 353 (0)66 7180061 Email: info@oes.ie

Client	Killarney Waste Disposal
Title	MW4 – Borehole Construction
Scale. NTS	Project No. 1059-08
Figure Figure 7	Rev. A



Monitoring well locations
And water level

Contour line

Groundwater
flow direction

Client: Killarney Waste
Disposal
Project Code:1059_08
Title: Aerial Photo

Drawing No: 8
Issue Date: 30/06/10
Revision:1
Scale: See map

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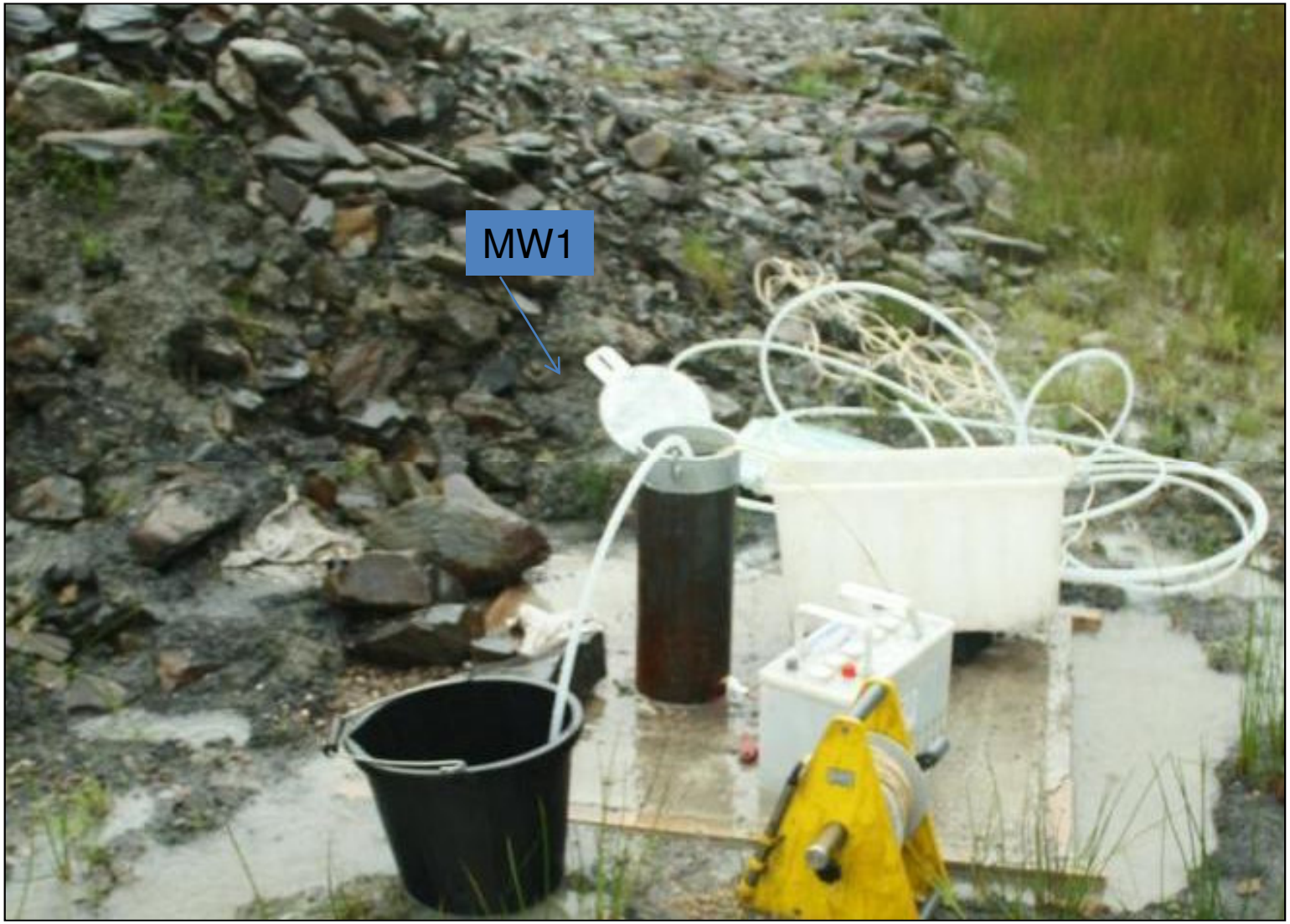
Attachment B
Hydrochemical results

Field parameters- 04/09/2009	Units	MW1	MW2	MW3	MW4	Drinking water limit
Depth to Water	m	0.02	0.54	1.49	0.49	
Depth of Well	m	18	19.32	18.16	19.9	
Conductivity	ug/l	649	772	544	400	2500
Total dissolved solids	ppm	325	385	272	203	
pH	pH units	7.04	7.08	7.01	6.86	6.5-9.5
Temperature	°C	10.4	10.4	10.3	10.9	
Colour	Visual inspection	Slighly milky	Slighlty Milky	Milky	Black in colour	
Laboratory results						
Ammoniacal Nitrogen as (N)	mg/l	1.77	2.83	2.86	<0.2	0.3
Chloride	mg/l	22.4	24.2	20.6	24.1	250
Nitrate	mg/l	<0.0677	<0.0677	<0.0677	<0.0677	50
Sulphate	mg/l	<3.0	<3.0	<3.0	<3.0	250
Conductivity	us/cm	618	728	508	396	2500
EPH Range Organics (C10-C40) Aqueous	ug/l	<10	<10	<10	<10	

Field parameters 26/11/2009	Units	MW1	MW2	MW3	MW4	Drinking Water Limit
Depth to Water	m	0.01	0.43	1.44	0.1	
Depth of Well	m	18	19.32	18.16	19.9	
Conductivity	ug/l	649	772	556	407	2500
Total dissolved solids	ppm	325	385	278	203	
pH	pH units	7.04	7.08	6.81	6.86	6.5-9.5
Temperature	°C	10.4	10.4	10.5	10.9	
Colour	Visual inspection	Slighly milky	Slighlty Milky	Milky	Black in colour	
Laboratory results						
Ammoniacal Nitrogen as (N)	mg/l	1.0	1.86	1.32	<0.2	0.3
Chloride	mg/l	23.6	24.7	21.6	24.8	250
Nitrate	mg/l	<0.0677	<0.0677	<0.0677	<0.0677	50
Sulphate	mg/l	<3.0	<3.0	<3.0	<3.0	250
Conductivity	us/cm	621	741	514	377	2500
EPH Range Organics (C10-C40) Aqueous	ug/l	<10	<10	<10	<10	

Field parameters 27/05/2010	Units	MW1	MW2	MW3	MW4	Drinking Water Limit
Depth to Water	m	0.2	0.98	1.71	0.27	
Depth of Well	m	18	19.32	18.16	19.9	
Conductivity	ug/l	663	828	583	410	2500
Total dissolved solids	ppm	336	412	286	203	
pH	pH units	6.67	6.9	6.64	6.28	6.5-9.5
Temperature	°C	10	10.5	11	11.2	
Colour	Visual inspection	Slighly milky	Slighlty Milky	Milky	Milky becoming Black	
Laboratory results						
Ammoniacal Nitrogen as (N)	mg/l	0.9	0.578	2.54	<0.2	0.3
Chloride	mg/l	21.6	21.4	19.6	22.4	250
Nitrate	mg/l	<0.0677	0.0799	<0.0677	<0.0677	50
Sulphate	mg/l	<3	<3	4.4	21.9	250
Conductivity	us/cm	605	764	508	379	2500
EPH Range Organics (C10-C40) Aqueous	ug/l	<46	<46	<46	<46	

Attachment C
Photolog



Client: Killarney Waste Disposal
Project Code:1059_08
Title: Photo 2

Photo No: 1
Issue Date: 03/12/09
Revision:1

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Client: Killarney Waste Disposal
Project Code:1059_08
Title: Photo 2

Photo No: 2
Issue Date: 03/12/09
Revision:1

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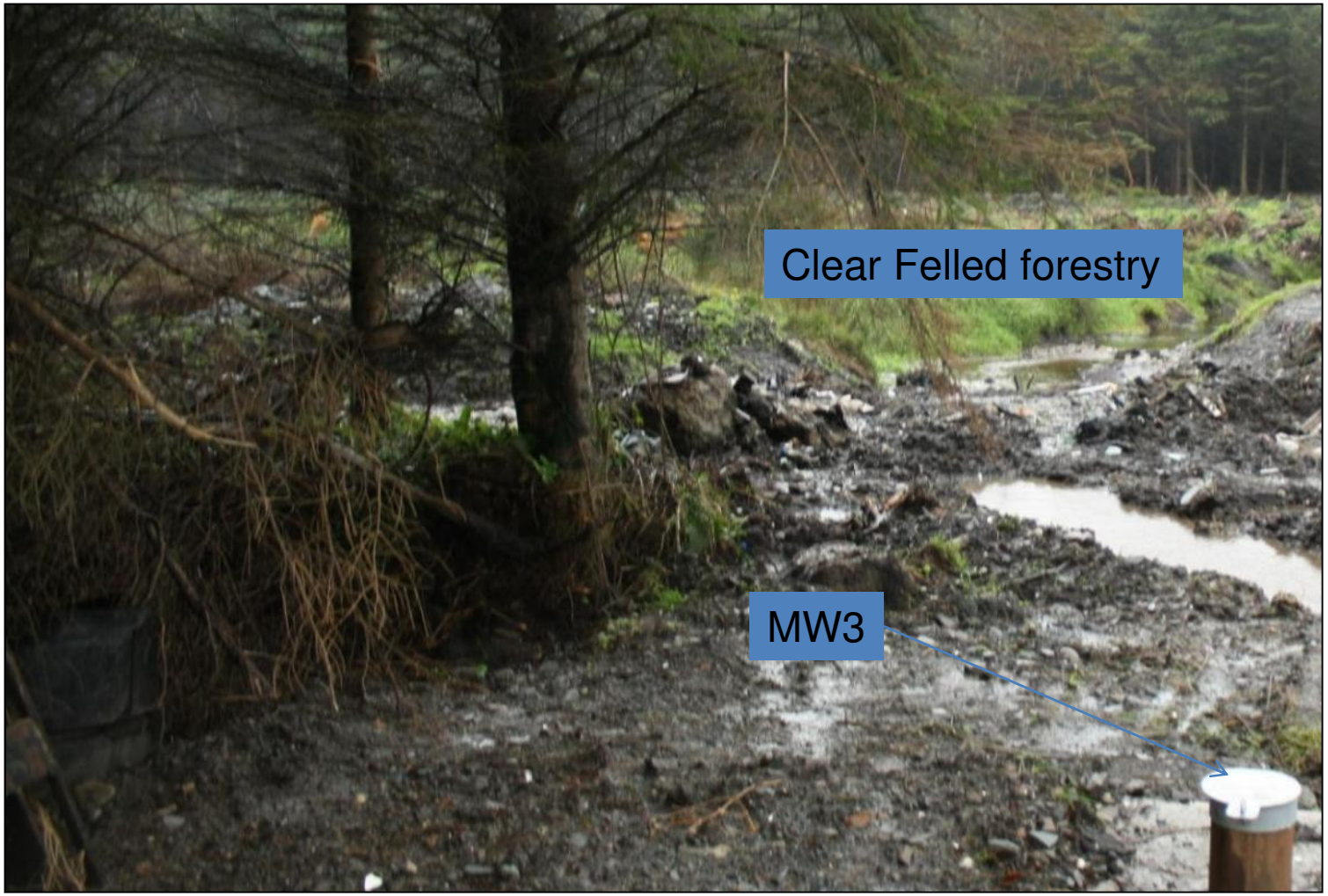

Client: Killarney Waste Disposal
Project Code:1059_08
Title: Photo 3

Photo No: 3
Issue Date: 03/12/09
Revision:1

OES
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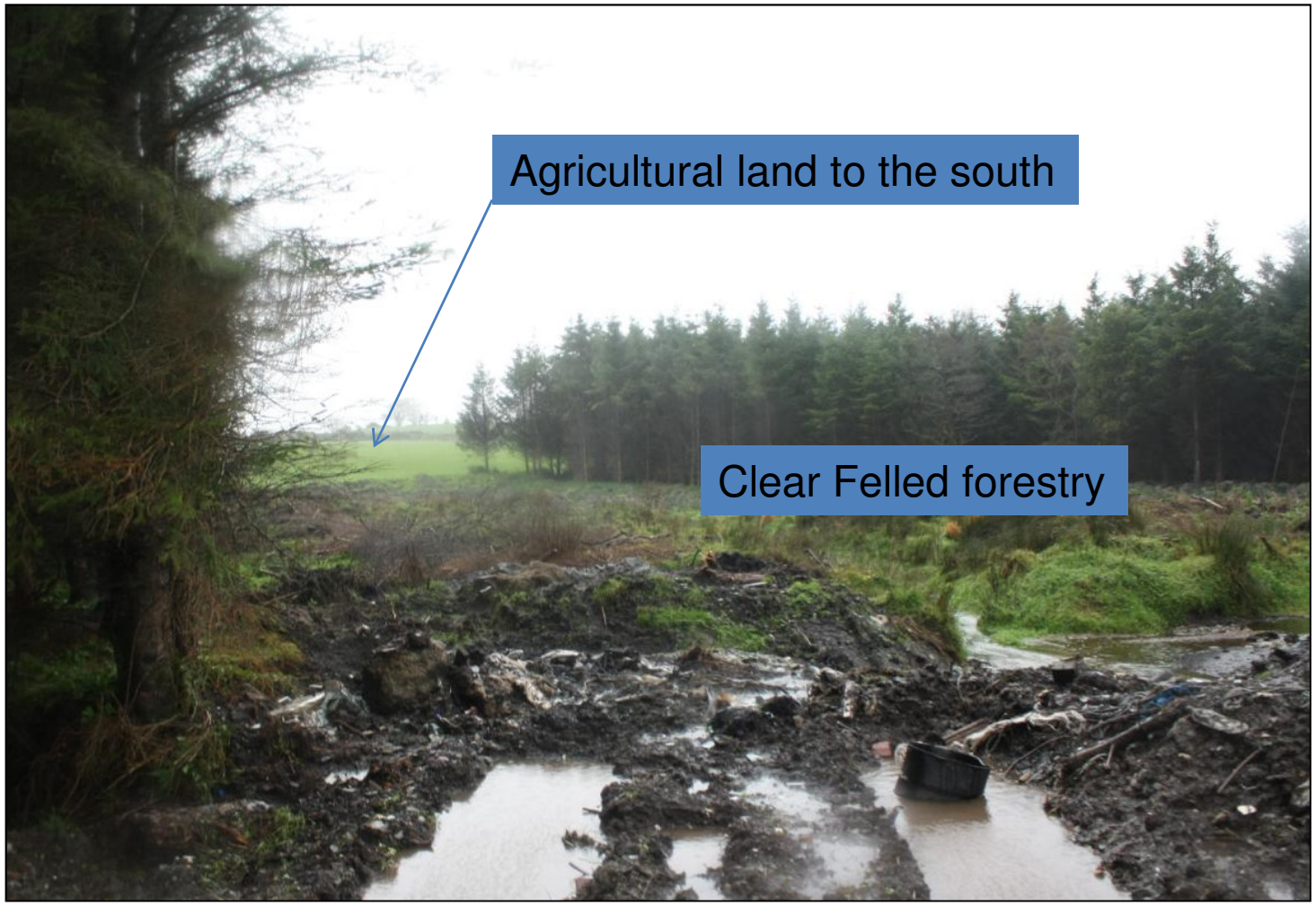

Client: Killarney Waste Disposal
Project Code:1059_08
Title: Photo 4

Photo No: 4
Issue Date: 03/12/09
Revision:1

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Energy, Environment & Safety

Client: Killarney Waste Disposal
Project Code:1059_08
Title: Photo 5

Photo No: 5
Issue Date: 03/12/09
Revision:1

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Attachment D
Bund Integrity Certificate

Energy, Environment & Safety

Bund Test Sheet- Hydrostatic and Visual Assessment

Leachate Storage Tank

Company: Killarney Waste Disposal (KWD)	**Grid Reference:**
Date: 02/03/09	
Bund Ref. No.: Leachate Storage Tank	**Bund Type – Concrete**
Bund Location: Located within the Materials recovery building	
Bund Dimensions: Unknown	**Primary Vessels – Materials of Construction:** N/A
Bund Materials of Construction: Bund constructed from cast concrete	**Primary Vessels** – Unknown- there is an active warning light that flashes once bund is nearly full. This light is working
Bund Lining Material: none- Cast Concrete Design	**Primary Vessels –** N/A
Bund Retention Volume (Local): 9,100L	**Weather conditions-** N/A
Deemed practicable/safe to conduct hydrostatic test: Yes	
If no, give reasons:	
Date of Hydrostatic test: 02/03/09	

Description and results of Hydrostatic Test:
Water was filled to 170mm of the top of the Bund. The Bund test was started at 08.00am and finished at 17.00 on the 02/03/09.

Test interval (hrs)	Depth to water	Reference depth
0-1	0.17	0.17
1-2	0.17	0.17
2-3	0.17	0.17
3-4	0.17	0.17
4-5	0.17	0.17
5-6	0.17	0.17

Pass ✓ Fail

Date of Visual Inspection: Visual inspection was undertaken on the 26/02/09

Description and Results of Visual Inspection:
The bund is located underground. The results from the bund test show that the structural integrity of the bund is sound. The warning light is working.

Recommendations: Retest in three Years and undertake regular visual assessments and inspections of the warning light.

Signed: **Eamon O'Loughlin** _____	**Title/Position:** **Environmental Engineer**	**Date: 02/03/09**

APPENDIX 2

Scartaglin GWB: Summary of Initial Characterisation.

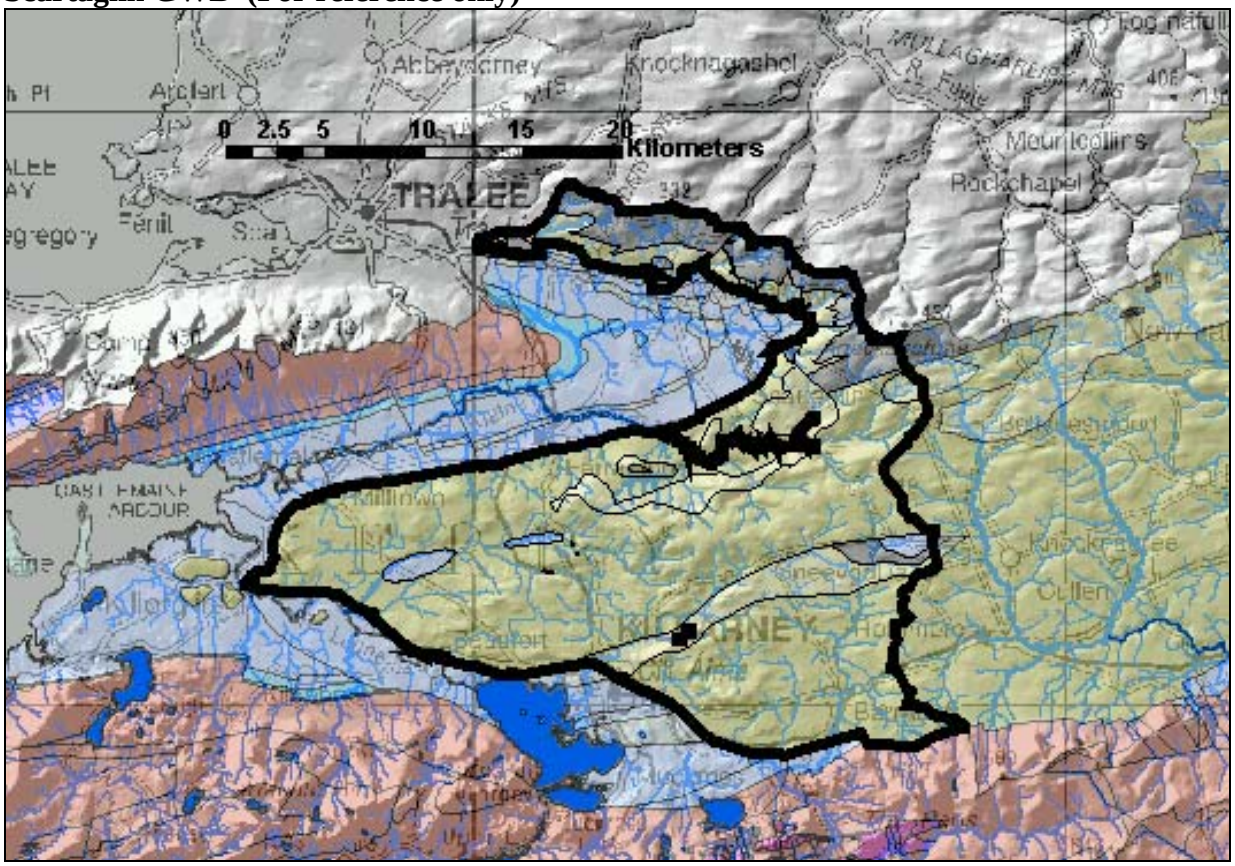
Hydrometric Area Local Authority	Associated surface water features	Associated terrestrial ecosystem(s)	Area (km^2)
22 Kerry Co. Co.	**Rivers:** Fahaduff, Little Maine, Croaghane, Brown Flesk, Dogue, Quagmire, Gweestin, Laune, Deenagh, Beheenagh, Owneykeagh, Glantane, Oughreagh, Longfield, Glanateenty. **Lakes:** Doolig, Lockagh, Kilbrean.	Killarney National Park, Macgillycuddys Reeks and Caragh River Catchment (000365)	472

Topography	Most of this GWB is a dissected upland plateau with general elevations of 160 to 240 metres OD. Highest elevations are in the northeast at over 400 metres. Lowest elevations, in the west, are about 50 metres OD.	
Geology and Aquifers	**Aquifer categories**	**Ll:** Locally important aquifer which is moderately productive only in local zones (96%). **Pu:** Poor aquifer which is generally unproductive (2%). **Rkd*/Pending Classification:** * Where these rocks occur in other areas they area classified as Rkd. In this GWB they may be karstified but are unlikely to be regionally important due to their small size (<10km^2) – a new classification code to represent these areas is pending (2%).
	Main aquifer lithologies	Namurian Undifferentiated (73%), Namurian Sandstones (16%), Namurian Shales (10%), Dinantian Pure Unbedded Limestones (1%) and a tiny area of Dinantian Upper Impure Limestones (<0.1%)
	Key structures	The Namurian and Dinantian rocks have been folded by the Variscan Orogeny into a series of east-west trending anticlines and synclines, with associated systems of faults and joints which created some pathways for groundwater movement.
	Key properties	The Namurian rocks are composed of a variety of thin sandstones, siltstones, flagstones, mudstones and shales. Hydrogeological data are poor for all formations except the Upper Namurian Beds. The sandstone beds within the rock groups have a slightly higher permeability than the shales due to their greater ability to fracture. Water levels have been recorded at depths of more than 20 m but in general the water table is close to the surface reflecting the low permeability of the rock. There are a number of artesian supplies where the sandstone beds are confined by the shales and mudstones. Wells are generally low yielding although some have recorded yields of more than 100 m^3/d. Specific capacities are usually low being less than 5 m^3/d/m.
	Thickness	The rock units themselves are extremely thick, but the depth of active groundwater circulation is probably limited to about 120 metres. The sole exception to this is the groundwater system in the Gneevgullia limestone aquifer, where a spring water temperature of up to 17 degrees Celsius implies groundwater circulation down to at least 500 metres.
Overlying Strata	**Lithologies**	*Subsoil Types identified in Scartaglin GWB by Teagasc Parent Material Mapping (Draft): Alluvium (A); Blanket Peat (BktPt); Karstified Limestone bedrock at surface (KaRck); Lake sediments (undifferentiated) (L); Made Ground (Made); Rock outcrop and rock close to surface (Rck); Till – Devonian Sandstone Till (TDSs), Limestone Till (TLs), Namurian Sandstone & Shale Till (TNSSs).* Large areas of peat occur as blanket bogs on the higher ground in the west on the poorly drained Namurian shales and sandstones.
	Thickness	Depth to bedrock has not been mapped in this GWB.
	% area aquifer near surface	
	Vulnerability	Vulnerability has not been mapped in this GWB. Namurian till is classed as having a low permeability as, although in some areas it has a stony matrix, there is still generally a high clay content due to the weathering of shale clasts.
Recharge	**Main recharge mechanisms**	Apart from the tiny area of karstic limestone around Gneevgullia, there are no aquifers with regional flow systems which might include losing streams, so recharge will be diffuse, from rainfall percolating through the subsoil or areas of outcropping rock. The proportion of the effective rainfall that will recharge the aquifer is determined by the permeability of the soil and subsoil, and by the slope.
	Est. recharge rates	To be assessed.

Discharge	**Large springs and high yielding wells (m^3/d)**	*Note: The following data need to be checked and updated by RBD Project Consultants.* Data from GSI Well Database: Excellent BHs: Scrahanaveal (436 m^3/d) Cordal East (641 m^3/d) Good BHs: Beheenagh (218 m^3/d) Gortacappul (218 m^3/d) Tullagubbeen (164 m^3/d) Kilcummin GWSS (>100 m^3/d) Ballyhar Creamery (190 m^3/d) Springs: Gneevgullia WSS (545 m^3/d) = abstraction rate, (intermediate yield) ***NB: This warm spring issues from a small karstic limestone unit and represents in part a deeper groundwater system, although at times it also includes shallow cold water.*** Coolcorcan Spring (455 m^3/d)= abstraction rate, (intermediate yield) Additional data from EPA Groundwater Sources List:
	Main discharge mechanisms	Due to the generally low permeability of the aquifers within this GWB and the high slopes, a high proportion of the recharge will discharge rapidly to surface watercourses via the upper layers of the aquifer, effectively reducing the available groundwater resource in the aquifer.
	Hydrochemical Signature	The hydrochemical signature is Calcium Bicarbonate, and the water is generally soft to slightly hard (<150 mg/l as $CaCO_3$). The pH ranges between 5.5 and 8; low pH (<6.5) is quite a common problem. The main groundwater quality problems due to the natural conditions in the ground and the natural chemistry of groundwater are caused by iron (Fe). A high proportion of wells in the Namurian rocks have high iron concentrations and to a lesser extent manganese (Mn). Nitrate levels do not appear to be elevated much above background.
Groundwater Flow Paths		These rocks have no intergranular permeability; groundwater flow occurs in fractures and faults. Permeability 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. Significant yields can be obtained where boreholes are drilled into known fault zones. However, 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. Springs occur in some instances on fault zones. Groundwater levels are about 1.5-15 m below ground level, and will generally follow the topography. Close to the rivers and streams, water levels will be near ground level. Surface water features are considered to be in hydraulic continuity with the water table. Groundwater flow will be local. Groundwater flow paths are generally short, typically 30-300 m, with groundwater discharging to small springs, or to the streams and rivers that traverse the aquifer. Flow directions are expected to approximately follow the local surface water catchments. Groundwater is generally unconfined.
Groundwater & Surface water interactions		Groundwater will discharge locally to streams and rivers crossing the aquifer and also to small springs and seeps. Owing to the poor productivity of the aquifers in this body it is unlikely that any major groundwater - surface water interactions occur. Baseflow to rivers and streams is likely to be relatively low. ***Carraundulkeen Quarry Spring (Gneevgullia WSS) is an exception to this general picture, and represents (in part) a different flow system in a karstic limestone aquifer at depth.***

Conceptual model	• The groundwater body is bounded to the east and south by the topographic high and surface water divide which forms the boundary with Rathmore and other GWBs. • The topography of this body is mainly upland, with ground level rising from about 50 metres OD to the highest elevations of 400 metres OD on the catchment boundary. • The groundwater body is comprised of rocks with low transmissivity and storativity, although localised zones of enhanced permeability occur along fault zones. • Flow occurs along fractures, joints and major faults. Flows in the aquifer are generally concentrated in a thin zone at the top of the rock, although deeper groundwater flows along faults and major fractures. • Diffuse recharge occurs across the GWB through the subsoils and rock outcrops. Due to the generally low permeability of the aquifers within this GWB and the high slopes, a high proportion of effective rainfall will runoff, or discharge rapidly to surface water courses via interflow and shallow flow. Where water levels within the unconfined aquifer are high, potential recharge will also be rejected. • The water table can vary between a few metres up to more than 10 m below ground surface, depending upon topography. Groundwater is generally unconfined. Flow path lengths are generally short, ranging 30-300 m. Local groundwater flow directions are controlled by local topography. Overall, groundwater flows to south and east from the topographic highs. • Groundwater discharges to the numerous streams and rivers crossing the aquifer, which are gaining, and to springs. A small volume of groundwater may cross-flow into the adjacent GWBs.
Attachments	Hydrochemical Signature (Figure 1); Groundwater Hydrograph (Figure 2)
Instrumentation	**Stream gauges:** 22002, 22029, 22033, 22043, 22044, 22045, 22046. **EPA Water Level Monitoring boreholes:** Kilcummin GWS (KER 41) **EPA Representative Monitoring points:** Quirke's Sand Pit (Killarney) (KER 112)
Information Sources	Pracht M (1997) *Geology of Kerry-Cork: a geological description, to accompany bedrock geology 1:100,000 scale map, Sheet 21, Kerry - Cork.* Geological Survey of Ireland. 70pp
Disclaimer	Note that all calculation and interpretations presented in this report represent estimations based on the information sources described above and established hydrogeological formulae

Scartaglin GWB (For reference only)



List of Rock units in Scartaglin GWB

Rock unit name and code	Description	Rock unit group	Aquifer Classification
Ballydeenlea Formation (BL) –three tiny areas	*White fine-grained limestone breccia*	*Cretaceous*	*Ll (as surrounding rocks)*
Namurian (undifferentiated) (NAM)	Black shale & sandstone	Namurian Undifferentiated	Ll
Feale Sandstone Formation (FS)	Sandstone, siltstone & shale	Namurian Sandstones	Ll
Glenoween Shale Formation (GN)	Grey silty mudstone	Namurian Shales	Ll
Cloone Flagstone Formation (CF)	Greywacke, siltstone & silty shale	Namurian Sandstones	Ll
Clare Shale Formation (CS)	Mudstone, cherty at base	Namurian Shales	Pu
Dinantian limestones (undifferentiated) (DIN)	Undifferentiated limestone	Dinantian Pure Unbedded Limestones	*Rk^d*/Pending Classification*
Dirtoge Limestone Formation (DI)	Bioclastic cherty grey limestone	Dinantian Upper Impure Limestones	Ll
Cracoean Reef Member (CLcr)	Unbedded calcilutite limestone	Dinantian Pure Unbedded Limestones	*Rk^d*/Pending Classification*

APPENDIX 3

Irish Drain services
Farranfore
Co.Kerry
Tel: 00353669763070, Fax:

Project-information

Project name:	Contract number:	Contact:	Date:
KWD Rcycling	**1402**	**Sean Murphy**	**13/05/2014**

Client	**KWD Rcycling**
Contact:	**Sean Murphy**
Position:	**Managing Director**
Road	
Town	**Killarney**
County	
Telephone:	
Fax:	
Mobile:	
E-Mail:	

Site	**KWD Rcycling**
Contact:	**Sean Murphy**
Position:	**Managing Director**
Road	
Town	**Killarney**
County	
Telephone:	
Fax:	
Mobile:	
E-Mail:	

Contractor	**Irish Drain services**
Contact:	**Mary B Teehan**
Position:	**M.D**
Road	**Tralee Rd.**
Town	**Farranfore**
County	**Co.Kerry**
Telephone:	**00353669763070**
Fax:	
Mobile:	**0868290839**
E-Mail:	**info@irishdrainservices.ie**

Irish Drain services
Farranfore
Co.Kerry
Tel: 00353669763070, Fax:

Defect Grade Description

Project name:	Contract number:	Contact:	Date:
KWD Rcycling	**1402**	**Sean Murphy**	**13/05/2014**

1:

Brick: No Structural Defects
Pipe: No Structural Defects

Acceptable Structural Condition

2:

Brick: Minor cracking, Surface mortar loss, Spalling slight, wear slight
Pipe: Circumfrential crack, Moderate joint defects, Spalling slight, Wear slight

Minor collapse risk in short term but potential for further deterioration

3:

Brick: Total mortorloss without other defects, single brick displaced, Deformation up to 5%, Spalling medium, Wear medium
Pipe: Fractures with deformation up tp 5%, Longitudinal cracking or mulitlpe cracking, Minor loss of level, More severe joint defects, Spalling medium, Wear medium

! Collapse unlikely in near future but future deterioration likely !

4:

Brick: Total mortorloss with deformation greater than 10%, Deformation up to 10% and fractured, Displaced/hanging brickwork, Small number of missing bricks
Pipe: Broken, Deformation up to 10% and broken,, Fractured with deformation 5 - 10%, Multiple fractures, Serious loss of level, spalling large, wear large

!! Collapse likely in foreseeable future !!

5:

Brick: Already Collapsed, Missing invert, Deformation over 10% and fractured, Displaced/hanging brickwork and deformation over 10%, Extensive missing bricks
Pipe: Already collapsed, Deformation over 10% and broken, Extensive areas of fabric missing, Fractured with deformation over 10%

!!! Collapsed or collapse imminent !!!

Irish Drain services
Farranfore
Co.Kerry
Tel: 00353669763070, Fax:

Inspection report

Date:	Job N°:	Weather:	Operator:	section number:	PLR:
13/05/2014	**1402**	**Showers**	**Danny**	**1**	**F1B X**
Present:	Vehicle: **Mercedes Vito**	Camera: **Pearpoint Crawler**	Preset:	Cleaned: **Yes**	Grade:

Road:	**KWD Recycling**	Division:		start MH:	**F1**
Place:	**Killarney**	District:		end MH:	**F1A**
Location:		Tape No.:	**DVD**	Total length:	**2.1 m**

Purpose:		Shape/Size:	**Circular dia 150 mm**
Use:	**Foul**	Material:	**Polyvinyl chloride** Pipe length: **6m**
Catchment:		Lining:	
		Category:	

Comment:

Location details:

1:25 position	code	observation	MPEG	photo	grade
F1					
0.00	ST	Start of Survey	00:00:00		0
0.00	MH	Manhole Remark: F1A	00:00:00		0
0.00	WL	Water level, 0 % height/diameter	00:00:00	3_3a	0
1.80	DC	Dimension of sewer changes, new dimension dia 100 mm	00:00:00	4_4a	0
2.10	MH	Manhole Remark: F1A	00:00:00	5_5a	0
F1A					
2.10	FH	Finish Survey	00:00:00		0

Irish Drain services
Farranfore
Co.Kerry
Tel: 00353669763070, Fax:

Inspection report

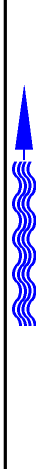
Date:	Job N°:	Weather:	Operator:	section number:	PLR:
13/05/2014	**1402**	**Showers**	**Danny**	**2**	**F1B X**
Present:	Vehicle: **Mercedes Vito**	Camera: **Pearpoint Crawler**	Preset:	Cleaned: **Yes**	Grade:

Road:	**KWD Recycling**	Division:		start MH:	**F1A**
Place:	**Killarney**	District:		end MH:	**F1B**
Location:		Tape No.:	**DVD**	Total length:	**1 m**

Purpose:		Shape/Size:	**Circular dia 150 mm**
Use:	**Foul**	Material:	**Polyvinyl chloride** Pipe length: **6m**
Catchment:		Lining:	
		Category:	

Comment:

Location details:



1:25 position	code	observation	MPEG	photo	grade
F1A					
0.00	ST	Start of Survey	00:00:00		0
0.00	MH	Manhole Remark: F1A	00:00:00		0
0.00	WL	Water level, 0 % height/diameter	00:00:00	9_3a	0
0.50	WL	Water level, 5 % height/diameter	00:00:00	2_4a	0
1.00	MH	Manhole Remark: F1B	00:00:00	12_5a	0
F1B 1.00	FH	Finish Survey	00:00:00		0

Irish Drain services
Farranfore
Co.Kerry
Tel: 00353669763070, Fax:

Inspection report

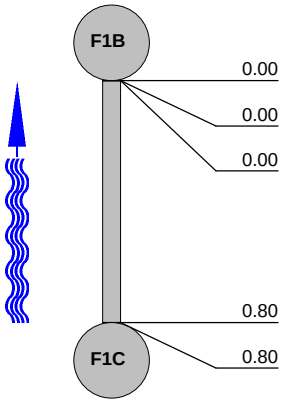
Date:	Job N°:	Weather:	Operator:	section number:	PLR:
13/05/2014	**1402**	**Showers**	**Danny**	**3**	**F1C X**
Present:	Vehicle: **Mercedes Vito**	Camera: **Pearpoint Crawler**	Preset:	Cleaned: **Yes**	Grade:

Road:	**KWD Recycling**	Division:		start MH:	**F1B**
Place:	**Killarney**	District:		end MH:	**F1C**
Location:		Tape No.:	**DVD**	Total length:	**0.8 m**

Purpose:		Shape/Size:	**Circular dia 150 mm**
Use:	**Foul**	Material:	**Polyvinyl chloride** Pipe length: **6m**
Catchment:		Lining:	
		Category:	

Comment:

Location details:



1:25 position	code	observation	MPEG	photo	grade
0.00	ST	Start of Survey	00:00:00		0
0.00	MH	Manhole Remark: F1B	00:00:00		0
0.00	WL	Water level, 5 % height/diameter	00:00:00	16_3a	0
0.80	MH	Manhole Remark: F1C. Top of line	00:00:00	17_4a	0
0.80	FH	Finish Survey	00:00:00		0

Irish Drain services
Farranfore
Co.Kerry
Tel: 00353669763070, Fax:

Inspection report

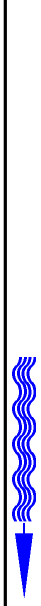
Date:	Job N°:	Weather:	Operator:	section number:	PLR:
13/05/2014	**1402**	**Showers**	**Danny**	**4**	**F1 X**
Present:	Vehicle: **Mercedes Vito**	Camera: **Pearpoint Crawler**	Preset:	Cleaned: **Yes**	Grade:

Road:	**KWD Recycling**	Division:		start MH:	**F1**
Place:	**Killarney**	District:		end MH:	**F2**
Location:		Tape No.:	**DVD**	Total length:	**5.7 m**

Purpose:		Shape/Size:	**Circular dia 150 mm**
Use:	**Foul**	Material:	**Polyvinyl chloride** Pipe length: **6m**
Catchment:		Lining:	
		Category:	

Comment:

Location details:



1:50 position	code	observation	MPEG	photo	grade
F1					
0.00	ST	Start of Survey	00:00:00		0
0.00	MH	Manhole Remark: F1	00:00:00		0
0.00	WL	Water level, 0 height/diameter	00:00:00	21_3a	0
0.60	CN	Connection, at 02 o´clock, dia 100 mm	00:00:00	22_4a	0
1.20	CN	Connection, at 02 o´clock, dia 100 mm	00:00:00	23_5a	0
3.90	CN	Connection, at 02 o´clock, dia 100 mm	00:00:00	24_6a	0
4.70	CN	Connection, at 02 o´clock, dia 100 mm	00:00:00	25_7a	0
5.70	MH	Manhole Remark: F2	00:00:00	26_8a	0
F2 5.70	FH	Finish Survey	00:00:00		0

Irish Drain services
Farranfore
Co.Kerry
Tel: 00353669763070, Fax:

Inspection report

Date:	Job N°:	Weather:	Operator:	section number:	PLR:
13/05/2014	**1402**	**Showers**	**Danny**	**5**	**F2 X**
Present:	Vehicle: **Mercedes Vito**	Camera: **Pearpoint Crawler**	Preset:	Cleaned: **Yes**	Grade:

Road:	**KWD Recycling**	Division:		start MH:	**F2**
Place:	**Killarney**	District:		end MH:	**F3**
Location:		Tape No.:	**DVD**	Total length:	**21 m**

Purpose:		Shape/Size:	**Circular dia 150 mm**
Use:	**Foul**	Material:	**Polyvinyl chloride** Pipe length: **6m**
Catchment:		Lining:	
		Category:	

Comment:

Location details:

1:175	position	code	observation	MPEG	photo	grade
F2	0.00	ST	Start of Survey	00:00:00		0
	0.00	MH	Manhole Remark: F2	00:00:00		0
	0.00	WL	Water level, 0 % height/diameter	00:00:00	30_3a	0
	1.40	WL	Water level, 5 % height/diameter	00:00:00	31_4a	0
	6.90	WL	Water level, 0 % height/diameter	00:00:00	32_5a	0
	21.00	MH	Manhole Remark: F3	00:00:00	33_6a	0
F3	21.00	FH	Finish Survey	00:00:00		0

Irish Drain services
Farranfore
Co.Kerry
Tel: 00353669763070, Fax:

Inspection report

Date:	Job N°:	Weather:	Operator:	section number:	PLR:
13/05/2014	**1402**	**Showers**	**Danny**	**6**	**F3 X**
Present:	Vehicle: **Mercedes Vito**	Camera: **Pearpoint Crawler**	Preset:	Cleaned: **Yes**	Grade:

Road:	**KWD Recycling**	Division:		start MH:	**F4**
Place:	**Killarney**	District:		end MH:	**F3**
Location:		Tape No.:	**DVD**	Total length:	**8.9 m**

Purpose:		Shape/Size:	**Circular dia 150 mm**
Use:	**Foul**	Material:	**Polyvinyl chloride** Pipe length: **6m**
Catchment:		Lining:	
		Category:	

Comment:

Location details:

1:75	position	code	observation	MPEG	photo	grade
F4	0.00	ST	Start of Survey	00:00:00		0
	0.00	MH	Manhole Remark: F4	00:00:00		0
	0.00	WL	Water level, 0 % height/diameter	00:00:00	37_3a	0
	4.70	WL	Water level, 5 % height/diameter	00:00:00	38_4a	0
	6.70	WL	Water level, 0 % height/diameter	00:00:00	39_5a	0
	8.90	MH	Manhole Remark: F3	00:00:00	40_6a	0
F3	8.90	FH	Finish Survey	00:00:00		0

Irish Drain services
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Co.Kerry
Tel: 00353669763070, Fax:

Inspection report

Date:	Job N°:	Weather:	Operator:	section number:	PLR:
13/05/2014	**1402**	**Showers**	**Danny**	**7**	**F4 X**
Present:	Vehicle: **Mercedes Vito**	Camera: **Pearpoint Crawler**	Preset:	Cleaned: **Yes**	Grade:

Road:	**KWD Recycling**	Division:		start MH:	**F5**
Place:	**Killarney**	District:		end MH:	**F4**
Location:		Tape No.:	**DVD**	Total length:	**10.2 m**

Purpose:		Shape/Size:	**Circular dia 150 mm**
Use:	**Foul**	Material:	**Polyvinyl chloride** Pipe length: **6m**
Catchment:		Lining:	
		Category:	

Comment:

Location details:

1:75	position	code	observation	MPEG	photo	grade
F5						
	0.00	ST	Start of Survey	00:00:00		0
	0.00	MH	Manhole Remark: F5	00:00:00		0
	0.00	WL	Water level, 0 % height/diameter	00:00:00	44_3a	0
	10.20	MH	Manhole Remark: F4	00:00:00	45_4a	0
	10.20	FH	Finish Survey	00:00:00		0
F4						

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Tel: 00353669763070, Fax:

Inspection report

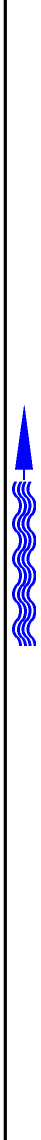
Date:	Job N°:	Weather:	Operator:	section number:	PLR:
13/05/2014	**1402**	**Showers**	**Danny**	**8**	**F6 X**
Present:	Vehicle: **Mercedes Vito**	Camera: **Pearpoint Crawler**	Preset:	Cleaned: **Yes**	Grade:

Road:	**KWD Recycling**	Division:		start MH:	**F4**
Place:	**Killarney**	District:		end MH:	**F6**
Location:		Tape No.:	**DVD**	Total length:	**6.3 m**

Purpose:		Shape/Size:	**Circular dia 150 mm**
Use:	**Foul**	Material:	**Polyvinyl chloride** Pipe length: **6m**
Catchment:		Lining:	
		Category:	

Comment:

Location details:



1:50 position	code	observation	MPEG	photo	grade
0.00	ST	Start of Survey	00:00:00		0
0.00	MH	Manhole Remark: F4	00:00:00		0
0.00	WL	Water level, 0 % height/diameter	00:00:00	49_3a	0
5.20	CN	Connection, at 03 o´clock, dia 100 mm	00:00:00	50_4a	0
6.30	DC	Dimension of sewer changes, new dimension dia 100 mm	00:00:00	51_5a	0
6.30	MH	Manhole Remark: F6	00:00:00	52_6a	0
6.30	FH	Finish Survey	00:00:00		0

Irish Drain services
Farranfore
Co.Kerry
Tel: 00353669763070, Fax:

Inspection report

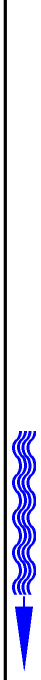
Date:	Job N°:	Weather:	Operator:	section number:	PLR:
13/05/2014	**1402**	**Showers**	**Danny**	**9**	**INTC Line X**
Present:	Vehicle: **Mercedes Vito**	Camera: **Pearpoint Crawler**	Preset:	Cleaned: **Yes**	Grade:

Road:	**KWD Recycling**	Division:		start MH:	**INTC Line**
Place:	**Killarney**	District:		end MH:	**Downstream**
Location:		Tape No.:	**DVD**	Total length:	**30 m**

Purpose:		Shape/Size:	**Circular dia 150 mm**
Use:	**Foul**	Material:	**Polyvinyl chloride** Pipe length: **6m**
Catchment:		Lining:	
		Category:	

Comment:

Location details:



1:225 position	code	observation	MPEG	photo	grade
INTC Line					
0.00	ST	Start of Survey	00:00:00		0
0.00	MH	Manhole Remark: INTC Line	00:00:00		0
0.00	CU	Camera Underwater	00:00:00		0
30.00	GO	Camera could not continue	00:00:00		0
30.00	FH	Finish Survey	00:00:00		0
Downstream					

KWD Recycling

Aghacurreen, Killarney, Co. Kerry

Bund Integrity Inspections

In compliance with condition 3.11.5 of Waste Licence W0217-01

May 2016

Client: -	KWD Recycling Ltd, Aughacurreen, Killarney, County Kerry
Address of Facility: -	Aughacurreen, Killarney, County Kerry
Townland: -	Aughacurreen
ITM Coordinates: -	E 493640, N 593990
Date of Report: -	May 2016
Revision No: -	01
Prepared by: -	**Donal Moynihan BE, C. Eng, M.IEI,** **CHARTERED ENGINEER,** **Donal Moynihan Consulting Engineers Ltd,** **Boolacullane,** **Farranfore,** **Co. Kerry** **V93 XN22**

INTRODUCTION

Donal Moynihan Consulting Engineers Ltd has been employed by KWD Recycling to carry out visual inspections and 24 Hour Hydrostatic integrity tests on the bunded areas within the waste facility at Aughacurreen.

The tests are to be carried out to ensure compliance with condition 3.11.5 of Waste Licence W0217-01

The bunded areas which were assessed during the inspections can be identified as follows:-

- Sump 1 Leachate Sump located internally within the materials recovery facility
- Sump 2 Near Office area
- Sump 3 Near Timber Shredder
- Sump 4 Oil Bund
- Sump 5 Oil Water Interceptor near Diesel Shed

Locations of the individual Sumps are shown on enclosed site layout plan in Appendix A

METHODOLOGY

The following describes the methodology used to assess the integrity of the bunds.

The bund integrity tests were performed in accordance with the Environmental Protection Agency (EPA) guidelines '*The Storage and Transfer of Materials for Scheduled Activities*' (2004) which provides guidance for the inspection and testing of bund structures.

The main guidelines are:

- The sealed surface providing the retention must be impermeable to the liquid being retained. This applies also to any connecting elements, such as pipes, penetrating the structure, the sealing of which must provide the same level of retention as the bund itself;
- There must be no adverse chemical reaction that could occur between different liquids in a bund that would impact on the integrity of the bund or the safety of personnel in its vicinity;
- In general bund walls should not exceed 1.5 m in height so that:
  - Fire-fighting operations are not hindered
  - Egress from a bunded area in event of an emergency is relatively easy.
  - Natural ventilation of the bunded area is encouraged.
- It is important that, where practicable, pumps, valves, couplings, delivery nozzles and other items associated with the operation of a tank are located inside the bund, although health and safety implications must be taken into account where pumps and other electrical equipment operate in bunds where flammable vapours may collect.
- Items not connected with the operation of the tanks should not be located within the bunded area;
- The overflow vent from a storage tank being overfilled should be contained within the bund;
- It is strongly recommended that all pipe work leading to or from tanks within a bund is routed over the top of the bund in order to avoid the need to breach the walls;
- Bunds may be filled with liquid in event of a spillage or may be deliberately filled with liquid during testing; electrical equipment should therefore ideally be placed above the maximum liquid height or designed for submersion;
- Bulk chemical storage bunds should be designed to contain 110% of the capacity of the largest storage vessel located within the bund;
- Bund design should take into account the capture of spigot flow from ruptured tanks;
- Valved drainage from bunds should be avoided;
- Individual bunding is preferred to common bunding;

Where two or more tanks are installed within the same bund, the recommended capacity of the bund is the greater of:

- 110% of the capacity of the largest tank within the bund, or
- 25% of the total capacity of all of the tanks within the bund, except

Where tanks are hydraulically linked in which case they should be treated as if they were a single tank

SITE INSPECTION

A preliminary site visit was arranged on the 17th of May 2016 to perform a visual inspection of the bunds and to ensure the bunds were filled for a 24-hour period. Two of the bunds (Oil bund, Leachate tank) were both roofed and hence protected from rainwater ingress. The other areas were covered for the 24 hour period to ensure no rain water entered.

Photographs were taken of the bunds and are enclosed in Appendix B.

Before the bunds were filled with water to test for water tightness and any possible leaks, the following potential defects were looked for around each of the bunds:

- **Holes for Pipes:** All holes in bunds to facilitate pipes have been properly plugged.
- **Electrical Equipment:** None of the bunds on site have electric equipment devices inside the bund that need to be raised for a bund integrity assessment.
- **Tank Retention:** Care was taken that any tanks partially emerged by the test water would not float. To guard against this any tank that would be partially submerged during the test was filled.
- **Other Defects:** All debris and spillages were removed from bunds before the bund integrity assessment.

The effective capacities of the bunds, where applicable, were also calculated at this stage.

The bunds were generally filled to 150mm from the top of the bund on the 17th of May and the level of the water was monitored to allow for adsorption by the concrete of the water. The bunds were then topped up and checked after a 24 Hour period. On the 18th of May the Inspections were undertaken.

Weather conditions were good for the test, calm day with light showers. All the bunding integrity tests were carried out simultaneously over a twenty four hour period. Containers were placed near the bunds to determine the evaporation rate of the water, (i.e. four separate containers were filled with water to a level of 30mm and were monitored over the testing period to calculate relative rates of evaporation and rainfall ingress).

RESULT OF INTEGRITY TESTS

All bunds tested were found to be without defects. No leakage was observed from any of the bunds and sumps tested. Allowing for the ingress of rainfall there was no drop in water level recorded across the site.

After the test was complete all bunds were emptied. The test showed that the walls were impervious to water and could adequately retain the required volume without danger of leakage or collapse. Therefore the bunds on-site conform to Condition 3.11.5 of the Waste licence W0217-01.

A summary of the findings of the visual and hydrostatic tests are provided below. Copies of the test record sheets in Accordance with EPA Guidance Note on Storage & Transfer of Materials for Scheduled Activities are enclosed as Appendix C.

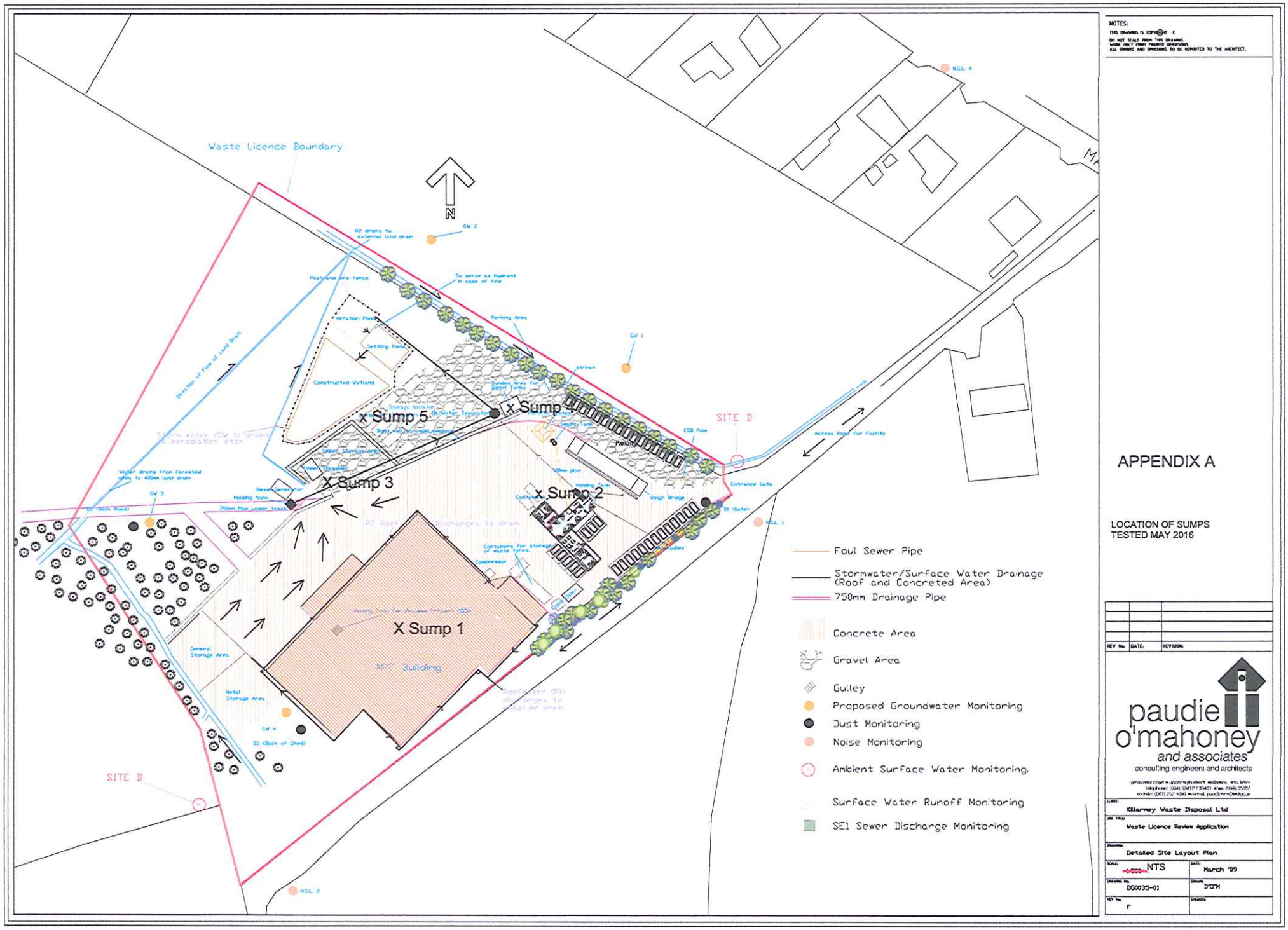
SUMMARY OF RESULTS

SUMP NUMBER	Date of Testing	Result	Comment
Sump No.1 (Leachate Sump)	17/5/2016-18/5/2016	Passed	Reinforced Concrete in good condition.
Sump No.2 (Near Office)	17/5/2016-18/5/2016	Passed	Reinforced Concrete in good condition.
Sump No.3 (Near Timber Shed)	17/5/2016-18/5/2016	Passed	Reinforced Concrete in good condition.
Sump No.4 (Oil Bund)	17/5/2016-18/5/2016	Passed	Reinforced Concrete in good condition.
Sump No.5 (Oil/Water Interceptor near Diesel Shed)	17/5/2016-18/5/2016	Passed	Reinforced Concrete in good condition.

APPENDICES

Appendix A	Site Layout showing positions of Bunds/Sumps tested
Appendix B	Photographic Record
Appendix C	Record Sheets of Bund Tests

Appendix A Site Layout showing positions of Bunds/Sumps tested



NOTES:
THIS DRAWING IS COPYRIGHT ©
DO NOT SCALE FROM THIS DRAWING.
WORK ONLY FROM FIGURED DIMENSIONS.
ALL ERRORS AND OMISSIONS TO BE REPORTED TO THE ARCHITECT.

APPENDIX A

LOCATION OF SUMPS
TESTED MAY 2016

REV No.	DATE:	REVISION:

paudie o'mahoney and associates
consulting engineers and architects
Kilarney Waste Disposal Ltd

Waste Licence Review Application

Detailed Site Layout Plan

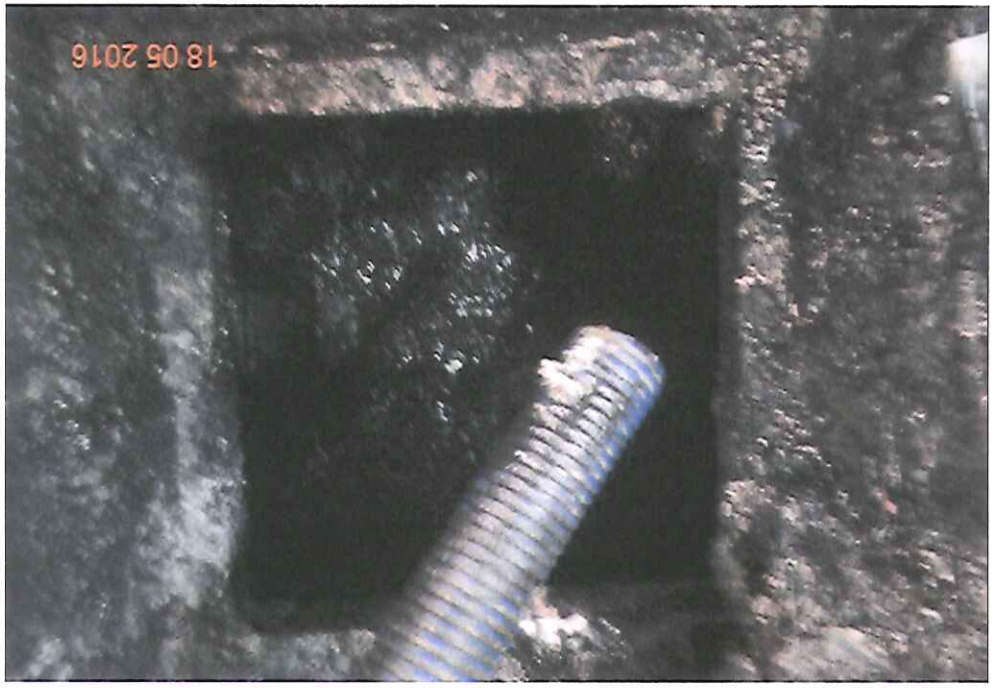
SCALE:	DATE:
NTS	March '09
DRAWING No.: DG0035-01	DRAWN: D'OM
REV No.: F	CHECKED:

Appendix B Photographic Record

Sump 1


18 05 2016

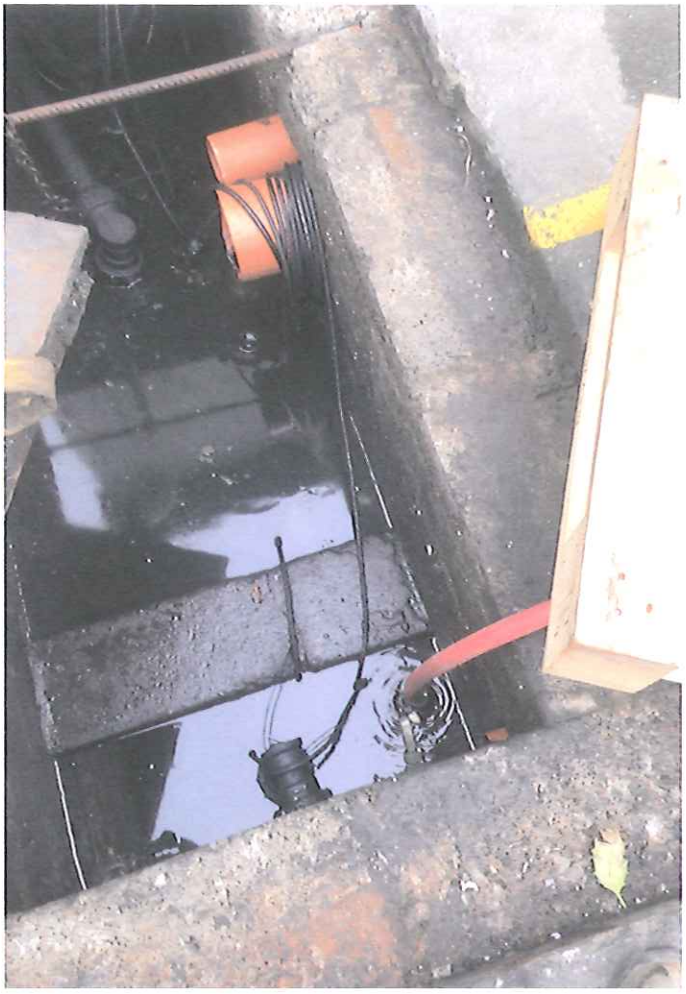

18 05 2016


18 05 2016


18 05 2016


ENVIRODRAIN
Septic Tank &
Bio Unit Cleaning
087-9206206
18 05 2016

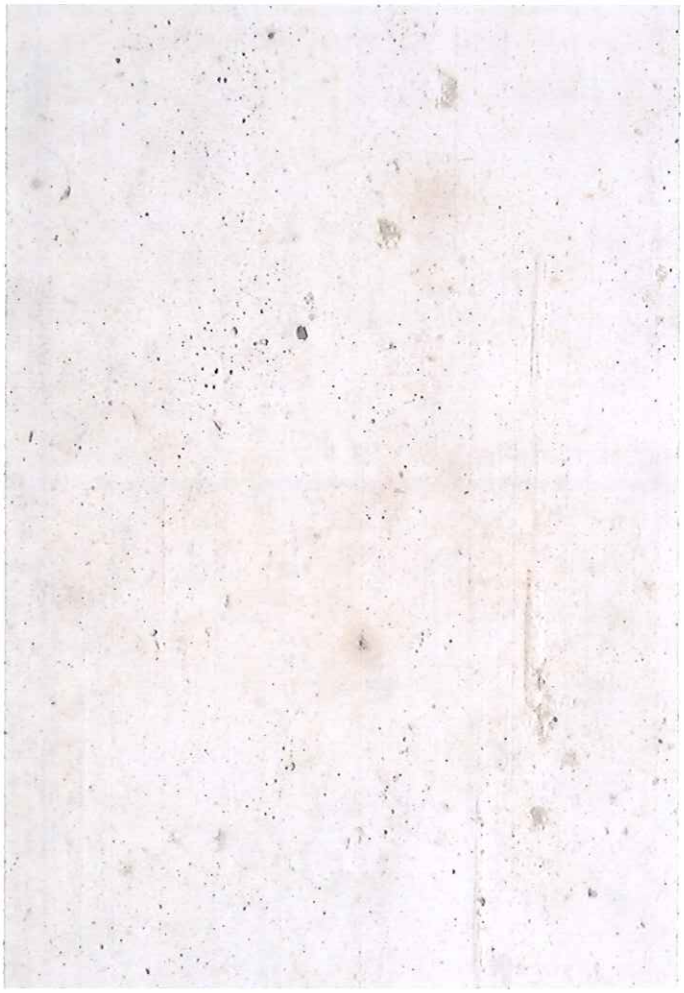
Sump 2



Sump 3


19 05 2016

Sump 4



Sump 5

Appendix C Record Sheets of Bund Tests

RECORD SHEET FOR BUND TESTING

(In Accordance with EPA Guidance Note on Storage & Transfer of Materials for Scheduled Activities)

Hydrostatic & Visual Assessment

Sump 1 Leachate Storage Tank

Company: KWD Recycling Ltd	**IPPC Reference: W0217-01**
Date: 17/05/2016-18/05/2016	**Bund Location:** Located internally within the Materials recovery Facility.
Bund Ref. No.: Sump 1 Leachate Storage Tank	**Bund Type** – Concrete
Bund Dimensions: Unknown	**Primary Vessels – Materials of Construction:** N/A
Bund Materials of Construction: Bund constructed from cast concrete	**Primary Vessels** – Unknown- there is an active warning light that flashes once bund is nearly full. This light has been tested and is currently working.
Bund Lining Material: None- Cast Concrete Design.	**Primary Vessels** – N/A
Bund Retention Volume (Local): 9,100L	**Weather conditions-** Dry Light Showers.
Deemed practicable/safe to conduct hydrostatic test: Yes	
If no, give reasons: Not Applicable	
Date of Visual Inspection:	**17/05/2016-18/05/2016**

Description & Results of Visual Inspection:
The bund was constructed between 2005 and 2006. There is no evidence of cracks on the side walls of the bund. The bund is located underground. On visual inspection the structural integrity of the bund appears sound. The warning light is working.

Description and Results of Hydrostatic testing:
24 Hour Test: The bund was filled to a mark 150mm from the top of the bund. This was allowed to stabilise for a 24 hour period on the 18/05/2016. The Bund test was started at 09.00am on the 17/05/2016 and finished at 15.00 on the 18/05/2016.

There was no change in the water level in the container used to monitor evaporation and rainfall ingress. The water level was checked on the 18/05/2016 over a six hour period. The results of the test are shown below:

Date & Time	Level below top of Bund Wall
17/05/2016 9:00	150mm
18/05/2016 9:00	150mm
18/05/2016 10:00	150mm
18/05/2016 11:00	150mm
18/05/2016 12:00	150mm
18/05/2016 13:00	150mm
18/05/2016 14:00	150mm
18/05/2016 15:00	150mm

Pass √ **Fail**

Recommendations: Re-test in three years time (2019) and undertake regular visual assessments and inspections of the warning light.

Signed:	**Title/Position:**	
Donal Moynihan BE, C. Eng M.IEI	**CHARTERED ENGINEER**	**Date: 19/05/2016**

RECORD SHEET FOR BUND TESTING

(In Accordance with EPA Guidance Note on Storage & Transfer of Materials for Scheduled Activities)

Hydrostatic & Visual Assessment

Sump 2 near Office Area

Company: KWD Recycling Ltd	**IPPC Reference: W0217-01**
Date: 17/04/2016-18/04/2016	**Bund Location:** Located internally within the Materials recovery Facility.
Bund Ref. No.: Sump 2 Near Office Area	**Bund Type** – Concrete
Bund Dimensions: Unknown	**Primary Vessels – Materials of Construction:** N/A
Bund Materials of Construction: Bund constructed from cast concrete	**Primary Vessels** – Unknown- there is an active warning light that flashes once bund is nearly full. This light has been tested and is currently working.
Bund Lining Material: None- Cast Concrete Design.	**Primary Vessels** – N/A
Bund Retention Volume (Local): 9,100L	**Weather conditions-** Dry Light Showers.
Deemed practicable/safe to conduct hydrostatic test: Yes	
If no, give reasons: Not Applicable	
Date of Visual Inspection:	**17/05/2016 - 18/04/2016**

Description & Results of Visual Inspection:

The bund was constructed between 2005 and 2006. There is no evidence of cracks on the side walls of the bund. The bund is located underground. On visual inspection the structural integrity of the bund appears sound. The warning light is working.

Description and Results of Hydrostatic testing:

24 Hour Test: The bund was filled to a mark 150mm from the top of the bund. This was allowed to stabilise for a 24 hour period on the 17/05/2016. The Bund test was started at 09.05am on the 17/05/2016 and finished at 15.05 on the 18/05/2016.

There was no change in the water level in the container used to monitor evaporation and rainfall ingress. The water level was checked on the 09/04/2016 over a six hour period. The results of the test are shown below:

Date & Time	Level below top of Bund Wall
17/05/2016 9:05	150mm
18/05/2016 9:05	150mm
18/05/2016 10:05	150mm
18/05/2016 11:05	150mm
18/05/2016 12:05	150mm
18/05/2016 13:05	150mm
18/05/2016 14:05	150mm
18/05/2016 15:05	150mm

Pass √ **Fail**

Recommendations: Re-test in three years time (2019) and undertake regular visual assessments and inspections of the warning light.

Signed:	**Title/Position:**	
Donal Moynihan BE, C. Eng M.IEI	**CHARTERED ENGINEER**	**Date: 19/05/2016**

RECORD SHEET FOR BUND TESTING

(In Accordance with EPA Guidance Note on Storage & Transfer of Materials for Scheduled Activities)

Hydrostatic & Visual Assessment

Sump 3 near Timber Shredder

Company: KWD Recycling Ltd	**IPPC Reference: W0217-01**
Date: 17/05/2016-18/05 /2016	**Bund Location:** See Appendix A / Sump located nesr timber shredding area.
Bund Ref. No.: Sump 3 near Timber Shredder	**Bund Type** – Concrete
Bund Dimensions: 2.4m x 1.5m x 2.4m Deep	**Primary Vessels – Materials of Construction:** N/A
Bund Materials of Construction: Bund constructed from cast concrete	**Primary Vessels** – N/A
Bund Lining Material: None- Cast Concrete Design.	**Primary Vessels** – N/A
Bund Retention Volume (Local): 8,640L	**Weather conditions-** Dry Light Showers.
Deemed practicable/safe to conduct hydrostatic test: Yes	
If no, give reasons: Not Applicable	
Date of Visual Inspection:	**17/05/2016-18/05/2016**

Description & Results of Visual Inspection:

The bund was constructed between 2005 and 2006. There is no evidence of cracks on the side walls of the bund. The bund is located underground. On visual inspection the structural integrity of the bund appears sound.

Description and Results of Hydrostatic testing:

24 Hour Test: The bund was filled to a mark 150mm from the top of the bund. This was allowed to stabilise for a 24 hour period on the 18/05/2016. The Bund test was started at 09.10am on the 17/05/2016 and finished at 15.10 on the 18/05/2016.

There was no change in the water level in the container used to monitor evaporation and rainfall ingress. The water level was checked on the 18/05/2016 over a six hour period. The results of the test are shown below:

Date & Time	Level below top of Bund Wall
17/05/2016 9:10	150mm
18/05/2016 9:10	150mm
18/05/2016 10:10	150mm
18/05/2016 11:10	150mm
18/05/2016 12:10	150mm
18/05/2016 13:10	150mm
18/05/2016 14:10	150mm
18/05/2016 15:10	150mm

Pass √ **Fail**

Recommendations: Re-test in three years time (2019) and undertake regular visual assessments and inspections of the warning light.

Signed:	**Title/Position:**	
Donal Moynihan BE, C. Eng M.IEI	**CHARTERED ENGINEER**	**Date: 19/05/2016**

RECORD SHEET FOR BUND TESTING

(In Accordance with EPA Guidance Note on Storage & Transfer of Materials for Scheduled Activities)

Hydrostatic & Visual Assessment

Sump 4 Oil Bund

Company: KWD Recycling Ltd	**IPPC Reference: W0217-01**
Date: 17/05/2016-18/05/2016	**Bund Location:** Located as shown on Site Layout Plan Appendix A / To North of the site/ located internally.
Bund Ref. No.: Sump 4 Oil Bund	**Bund Type** – Concrete
Bund Dimensions: 5.25m x 3.3m x 0.9m High	**Primary Vessels – Materials of Construction:** Plastic Storage Tank
Bund Materials of Construction: Bund constructed from cast concrete	**Primary Vessels** – Main Diesel Tank 5,000L and smaller Tank is 1,000L.
Bund Lining Material: None- Cast Concrete Design.	**Primary Vessels** – 110% of the volume of the largest vessel.
Bund Retention Volume (Local): 15,600L	**Weather conditions-** Dry Light Showers.
Deemed practicable/safe to conduct hydrostatic test: Yes	
If no, give reasons: Not Applicable	
Date of Visual Inspection:	**17/05/2016-18/05/2016**
Description & Results of Visual Inspection: The bund was constructed in 2007. There is no evidence of cracks on the side walls of the bund. The bund is located underground. On visual inspection the structural integrity of the bund appears sound.	

Description and Results of Hydrostatic testing:

24 Hour Test: The bund was filled to a mark 150mm from the top of the bund. This was allowed to stabilise for a 24 hour period on the 17/05/2016. The Bund test was started at 09.15am on the 17/05/2016 and finished at 15.15 on the 18/05/2016.

There was no change in the water level in the container used to monitor evaporation and rainfall ingress. The water level was checked on the 18/05/2016 over a six hour period. The results of the test are shown below:

Date & Time	Level below top of Bund Wall
17/05/2016 9:15	150mm
18/05/2016 9:15	150mm
18/05/2016 10:15	150mm
18/05/2016 11:15	150mm
18/05/2016 12:15	150mm
18/05/2016 13:15	150mm
18/05/2016 14:15	150mm
18/05/2016 15:15	150mm

Pass √ **Fail**

Recommendations: Re-test in three years time (2019) and undertake regular visual assessments and inspections of the warning light.

Signed:	**Title/Position:**	
Donal Moynihan BE, C. Eng M.IEI	**CHARTERED ENGINEER**	**Date: 19/05/2016**

RECORD SHEET FOR BUND TESTING

(In Accordance with EPA Guidance Note on Storage & Transfer of Materials for Scheduled Activities)

Hydrostatic & Visual Assessment

Sump 5 Oil/Water Interceptor near Diesel Tank

Company: KWD Recycling Ltd	**IPPC Reference: W0217-01**
Date: 08/04/2016-09/04/2016	**Bund Location:** See Appendix A.
Bund Ref. No.: Sump 5 Oil/Water Interceptor near Diesel Tank	**Bund Type** – Concrete
Bund Dimensions: 0.9m Diameter x 1.0m deep x 2 number	**Primary Vessels – Materials of Construction:** N/A
Bund Materials of Construction: Bund constructed from cast concrete	**Primary Vessels** – N/A
Bund Lining Material: None- Cast Concrete Design.	**Primary Vessels** – N/A
Bund Retention Volume (Local): 1,271L	**Weather conditions-** Dry Light Showers.
Deemed practicable/safe to conduct hydrostatic test: Yes	
If no, give reasons: Not Applicable	
Date of Visual Inspection:	**17/05/2016- 18/05/2016**

Description & Results of Visual Inspection:

The bund was constructed between 2005 and 2006. There is no evidence of cracks on the side walls of the bund. The bund is located underground. On visual inspection the structural integrity of the bund appears sound.

Description and Results of Hydrostatic testing:

24 Hour Test: The bund was filled to a mark 50mm from the top of the bund. This was allowed to stabilise for a 24 hour period on the 17/05/2016. The Bund test was started at 09.20am on the 17/05/2016 and finished at 15.20 on the 18/05/2016.

There was no change in the water level in the container used to monitor evaporation and rainfall ingress. The water level was checked on the 18/05/2016 over a six hour period. The results of the test are shown below:

Date & Time	Level below top of Bund Wall
17/05/2016 9:20	50mm
18/05/2016 9:20	50mm
18/05/2016 10:20	50mm
18/05/2016 11:20	50mm
18/05/2016 12:20	50mm
18/05/2016 13:20	50mm
18/05/2016 14:20	50mm
18/05/2016 15:20	50mm

Pass √ **Fail**

Recommendations: Re-test in three years time (2019) and undertake regular visual assessments and inspections of the warning light.

Signed:	**Title/Position:**	
Donal Moynihan BE, C. Eng M.IEI	**CHARTERED ENGINEER**	**Date: 19/05/2016**

APPENDIX 4

ANALYSIS REPORT

CUSTOMER:	**KILLARNEY WASTE DISPOSAL**	**SAMPLE TYPE:**	**GROUND WATER**
ADDRESS:	Aughacureen, Killarney, County Kerry	**CONDITION OF SAMPLE ON RECEIPT:**	Satisfactory
		DATE SAMPLED:	17 January 2017
REPORT TO:	**BRIAN BRUTON**	**DATE RECEIVED:**	17 January 2017
SAMPLED BY:	Danny O Leary, Southern Scientific Services Ltd	**DATE ANALYSED:**	17 January – 07 February 2017
SAMPLING PT:	**BH 1 – BH 4**	**DATE REPORTED:**	07 February 2017
ORDER NO:	N/A	**WORK NO.:**	**36986 C | 11P-043 |**

TABLE OF RESULTS

Method:		Parameter	Units	C17-Jan 332	C17-Jan 333	C17-Jan 334	C17-Jan 335
				BH 1	**BH 2**	**BH 3**	**BH 4**
		Chemical Analysis: (F)					
SCP 052		pH	pH Units	7.0	7.2	7.1	7.2
SCP 052		Conductivity	µS/cm @ 20^{0}C	645	751	548	405
SCP 027a		Total Ammonia	mg/L as N	1.99	1.76	2.80	0.06
SCP 027g		Nitrate	mg/L N	<0.25	<0.25	<0.25	<0.25
SCP 027c		Orthophosphate	mg/L P	0.03	0.01	0.03	0.01
SCP 027i		Total Hardness	mg/L $CaCO_3$	363	421	289	190
SCP 027h		Alkalinity	mg/L $CaCO_3$	369	440	311	1405 Note 5
SCP 027b		Chloride	mg/L	24.2	23.3	22.7	67.8
SCP 027d		Sulphate	mg/L SO_4	<0.5	<0.5	<0.5	63.9
SCP 038		Iron, Dissolved	mg/L	2.01	4.19	3.64	0.13
SCP 038		Manganese, Dissolved	mg/L	0.10	0.15	0.13	0.07
**5520F	*	DRO	µg/L	<10	<10	<10	<10
		Microbiological Analysis: (D)					
SMP 019		Coliforms	MPN/100 mL	<1	<1	11	2
SMP 124	*	*Faecal Coliforms*	MPN/100 mL	<1	<1	1	64
		On site Monitoring:					
-	*	Depth to Water	m	0.35	0.08	1.7	1.0
-	*	Redox Potential	mV	-86.0	-119.1	-79.6	-41.6
-	*	DO	mg/L	1.55	3.35	3.0	2.7
-	*	Temperature	°C	11.5	10.7	10.9	11.3

Ruth Murphy
Chemistry Laboratory Manager

Index to symbols used:

*	Analysis is not INAB accredited.
**	Adapted from Standard Methods for the Examination of Water and Wastewater.
(F)	Analysis carried out at our Farranfore Laboratory.
(D)	Analysis carried out at our Dunrine Laboratory.
Note 5	Result outside scope of accreditation for Alkalinity (5-800 mg/L $CaCO_3$)

- **The results relate only to the items tested.**
- **Opinions and interpretations expressed herein are outside the scope of INAB accreditation.**
- **The analysis report shall not be reproduced except in full without written approval of the laboratory.**

southern scientific services ltd.

OUR REF: RP **2016** | KILLARNEY WASTE DISPOSAL | **36151 C (Rev 00)**

ANALYSIS REPORT

CUSTOMER:	**KILLARNEY WASTE DISPOSAL**	**SAMPLE TYPE:**	**GROUND WATER**
ADDRESS:	Aughacureen, Killarney, County Kerry	**CONDITION OF SAMPLE ON RECEIPT:**	Satisfactory
REPORT TO:	**BRIAN BRUTON**	**DATE SAMPLED:**	23 September 2016
SAMPLED BY:	Danny O Leary Southern Scientific Services Ltd	**DATE RECEIVED:**	23 September 2016
SAMPLING PT:	**BH 3**	**DATE ANALYSED:**	23 - 29 September 2016
ORDER NO:	N/A	**DATE REPORTED:**	03 October 2016
		WORK NO.:	**36151 C**

TABLE OF RESULTS

Method:		Parameter	Units	C16-Sep 473 After Well Volume	C16-Sep 474 1 Hr After Well Volume	C16-Sep 475 2 Hr After Well Volume	C16-Sep 476 3 Hr After Well Volume	C16-Sep 477 3 Hr 45 Min After Well Volume
		Chemical Analysis: (F)						
SCP 027a		Total Ammonia	mg/L as N	3.04	3.13	3.22	3.28	3.28
SCP 016		COD	mg/L	<10	<10	<10	<10	<10
SCP 027g		Nitrate	mg/L N	<0.25	<0.25	<0.25	<0.25	<0.25
SCP 027f		Nitrite	mg/L N	<0.005	<0.005	<0.005	<0.005	<0.005
Note 6		TOC	mg/L					
SCP 038		Ferrous Irons	mg/L	4.18	4.60	4.26	4.20	4.20
SCP 038		Ferric Iron	mg/L	4.77	4.94	5.17	5.32	5.29
Hach 8131	*	Sulphide	µg/L	<5	<5	<5	<5	<5
		On Site Monitoring:	-					
-	*	DO	mg/L	1.5	2.1	2.9	2.9	3.4
	*	Redox	mV	-132.8	-78.0	-93.5	-115.9	-106.4

Conor Murphy

Dr Conor Murphy
Deputy Chemistry Laboratory Manager

Index to symbols used:

*	Analysis is not INAB accredited.
(F)	Analysis carried out at our Farranfore Laboratory.

- **The results relate only to the items tested.**
- **Opinions and interpretations expressed herein are outside the scope of INAB accreditation.**
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