



6.0 WATER

6.1 Introduction

This chapter of the EIAR provides an assessment of the hydrological and hydrogeological aspects of the proposed restoration works at Ballinderry sand and gravel quarry (the 'Site'), including pre-restoration 'baseline' conditions and consideration of the potential impacts of restoration upon the surrounding surface water and groundwater environments. The restoration proposes to import and backfill uncontaminated soil and stone (comparable to virgin material) to a ground level in keeping with the surrounding environment and pre-extraction topography.

Hydrological and hydrogeological aspects considered within this chapter include: characterisation of the local hydrological system; identification of any hydrological receptors; surface water quality; characterisation of the underlying hydrogeological regime at the Site; groundwater vulnerability; aquifer status; and groundwater quality. The potential hydrogeological impacts have been assessed for impacts associated with restoration activities (i.e. backfilling) at the Site. Appropriate mitigation measures are proposed to offset any possible negative impacts associated with the proposed works.

6.2 Study Methodology

The hydrogeological and hydrological impacts associated with the proposed restoration works at the Site were assessed by means of a desk study of the Site (review of available information), a number of freely available technical references (e.g. Geological Survey of Ireland (GSI) on-line publications) and fieldwork (e.g. drilling and monitoring of four groundwater monitoring boreholes - refer to Table 5.1) carried out at the Site. A list of the information referenced as part of the desk study is presented in Section 6.8.

6.3 Existing Environment

The Site is a former sand and gravel quarry which has ceased extraction activities and requires restoration. The Site is bounded by other mineral extraction sites to the west, and to the north and south by predominantly arable land. The Site is immediately bounded to the east by a tributary to the River Glash and arable land beyond that. Roads also run close to the north and east boundaries of the Site.

There are a number of residential properties listed within 500 m of the Site (refer to Figure 2.2) and there are two private estates located to the immediate north-east and north-west of the site, each with a private water supply well. A public supply borehole providing water for 14 properties is located in Clonuff, with waste water from these properties licenced to discharge to the River Glash.

Carbury Bog is noted to be within 2 km south of the Site, and the Rover Boyne runs within 5 km to the north-west.

Further land use in the area includes the EPA licenced site, Moyvalley Meats, which is located 500 m east of the Site (EPA Licence reference number P0192-02). The site is a slaughterhouse, processing greater than 50 tonnes of carcasses per day. Moyvalley Meats discharges treated waste water to a tributary of the River Glash.

6.3.1 Sub-soils

The GSI subsoils map (www.gsi.ie) shows that the area is mainly underlain by limestone derived gravels (GLs), with some minor alluvial and lacustrine deposits located under the footprint of local surface water features. The depth of overburden across the Site is quite variable, with reported thicknesses of up to 17 metres (refer to Chapter 5, Soils and Geology).

6.3.2 Bedrock

The GSI bedrock 1:500,000 map (www.gsi.ie) shows that the regional geology of the area is mainly comprised of Carboniferous marine basinal facies ("Calp") of dark-grey argillaceous & cherty limestone & shale. GSI mapping identifies an unnamed fault (11F1-2) which runs approximately east-west, terminating within 0.5 km of the north-western corner of the Site boundary; no known fractures or fault structures have been identified within the footprint of the Site.



The local geology 1:100,000 map (Figure 5.4) shows that the Site area is underlain by the Lucan Formation which is described as comprises dark-grey to black, fine-grained, occasionally cherty, micritic limestones that weather paler, usually to pale grey. There are rare dark coarser grained calcarenitic limestones, sometimes graded, and interbedded dark-grey calcareous shale.

6.3.3 Surface Water - Hydrology

The Site is located within the Eastern River Basin District and falls within the Water Framework Directive ('WFD') catchment area for the River Boyne (SAC). The eastern edge of the Site is bounded by the River Glash and the Balrinnet Stream runs within 100 m of the western Site boundary (which flows north to act as a tributary to the River Glash). The River Glash continues to flow north until its eventual confluence with the River Boyne, approximately 6.5 km downstream of Site (Figure 6.1). The River Boyne continues to flow north-east, eventually discharging into the Irish Sea.

There are three on-site ponds located within the footprint of the Site; Ponds A, B and C, as shown on Figure 2.3. Pond A is located in an area where no mineral extraction has occurred and is considered to comprise surface water, intermittently noted as 'dry'. Ponds B and C are located in the deepest areas of mineral extraction and are considered to be primarily groundwater fed, but also act as a runoff / drainage sink for surface waters at the Site. A surface water drain is located along the southern edge of the Site, but it is noted to be consistently dry. Given the well-drained nature of superficial deposits within the area of the Site, there are no other significant drainage features within the immediate vicinity of the Site.

The Balrinnet stream and upper River Glash to the north-east of the Site were attributed WFD 'Poor' status by the EPA for both the 2010-2012 and 2010-2015 periods. Downstream areas of the River Glash and in the area where it joins the River Boyne both show an improvement to 'Moderate' rating, with the River Boyne being classified as "Good" further downstream, near Boleykeogh.

Biological surface water quality data available from the EPA for their station at Clonuff Bridge (downstream of the Site, where the Balrinnet stream discharges into the River Glash, see Figure 6.1) reported a quality value (Q) rating of 2-3 in 2015, which represents 'moderately polluted' water. Historically, the water has typically been reported with a quality rating 3, both prior to and during extraction activities, showing little to no impact by the Site on stream quality. Downstream Q values at Ashfield Bridge (following the confluence of River Glash with River Boyne) show an improvement to a 3-4 rating in 2015, indicating 'slight pollution'. It should be noted that Moyvalley Meats and Clonuff residences are licenced to discharge waste water to the River Glash and is likely to contribute to the makeup of the waters assessed when producing the Q ratings discussed above.

It should also be noted that Carbury Bog is a designated Natural Heritage Area (NHA) wet peatland located within 2 km to the south of the Site. The Bog is raised above ground level and is rainwater fed; it is not in hydraulic connectivity with the Site due to a surface water runoff flow divide located north of Carbury Bog and South of the Site.



Figure 6.1: Surface water drainage features and EPA biological (Q value) survey locations

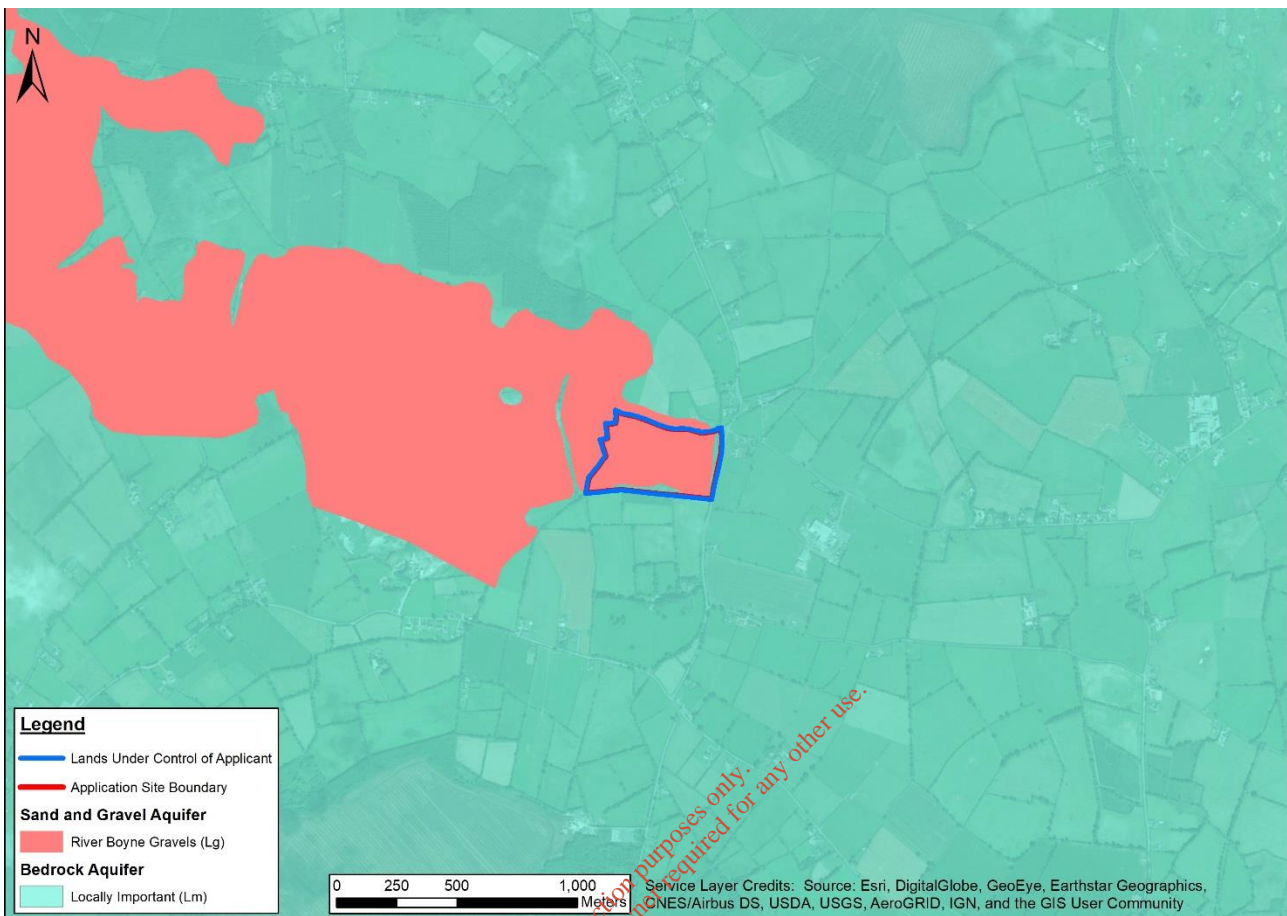


Figure 6.2: Groundwater aquifer map (Ownership boundary in blue)

6.3.3.1 Groundwater Vulnerability

'The vulnerability of groundwater depends on: (i) the time of travel of infiltrating water (and contaminants); (ii) the relative quantity of contaminants that can reach the groundwater; and (iii) the contaminant attenuation capacity of the geological materials through which the water and contaminants infiltrate. As all groundwater is hydrologically connected to the land surface, it is the effectiveness of this connection that determines the relative vulnerability to contamination. Groundwater that readily and quickly receives water (and contaminants) from the land surface is considered to be more vulnerable than groundwater that receives water (and contaminants) more slowly and in lower quantities. The travel time, attenuation capacity and quantity of contaminants are a function of the following natural geological and hydrogeological attributes of any area:

- i) The sub-soils that overlie the groundwater;
- ii) The type of recharge - whether point or diffuse; and
- iii) The thickness of the unsaturated zone through which the contaminant moves.

In summary, the entire land surface is divided into four vulnerability categories Table 6.1: extreme (E), high (H), moderate (M) and low (L) - based on the geological and hydrogeological factors described above. This subdivision is shown on a groundwater vulnerability map. The map shows the vulnerability of the first groundwater encountered (in either sand/gravel aquifers or in bedrock) to contaminants released at depths of 1-2 m below the ground surface. Where contaminants are released at significantly different depths, there will be a need to determine groundwater vulnerability using site-specific data. The characteristics of individual contaminants are not taken into account.' GSI 1999.



Table 6.1: Extract from ‘Groundwater Protection Schemes’, Department of the Environment and Local Government, Environmental Protection Agency, Geological Survey of Ireland, 1999

Vulnerability Rating	Hydrogeological Characteristics				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High Permeability (Sand/Gravel)	Moderate Permeability (Sandy subsoil)	Low Permeability (Clayey Till, Clay, Peat)	(Sand/gravel aquifers only)	(<30 m radius)
Extreme (E)	0 – 3.0 m	0 – 3.0 m	0 – 3.0 m	0 – 3.0 m	-
High (H)	> 3.0 m	3.0 – 10.0 m	3.0 – 5.0 m	> 3.0 m	N/A
Moderate (M)	N/A	> 10.0 m	5.0 – 10.0 m	N/A	N/A
Low (L)	N/A	N/A	> 10.0 m	N/A	N/A

Notes: i) N/A = not applicable
 ii) Precise permeability values cannot be given at present.
 iii) Release point of contaminants is assumed to be 1-2 m below ground surface.

Groundwater vulnerability at the Site has been defined as predominantly ‘High’ by GSI (Figure 6.3), but should be considered ‘Extreme’ in areas where the unsaturated thickness of the sand and gravel deposits is less than 3 m, or in areas where the aquifer is directly exposed i.e. Ponds B and C.

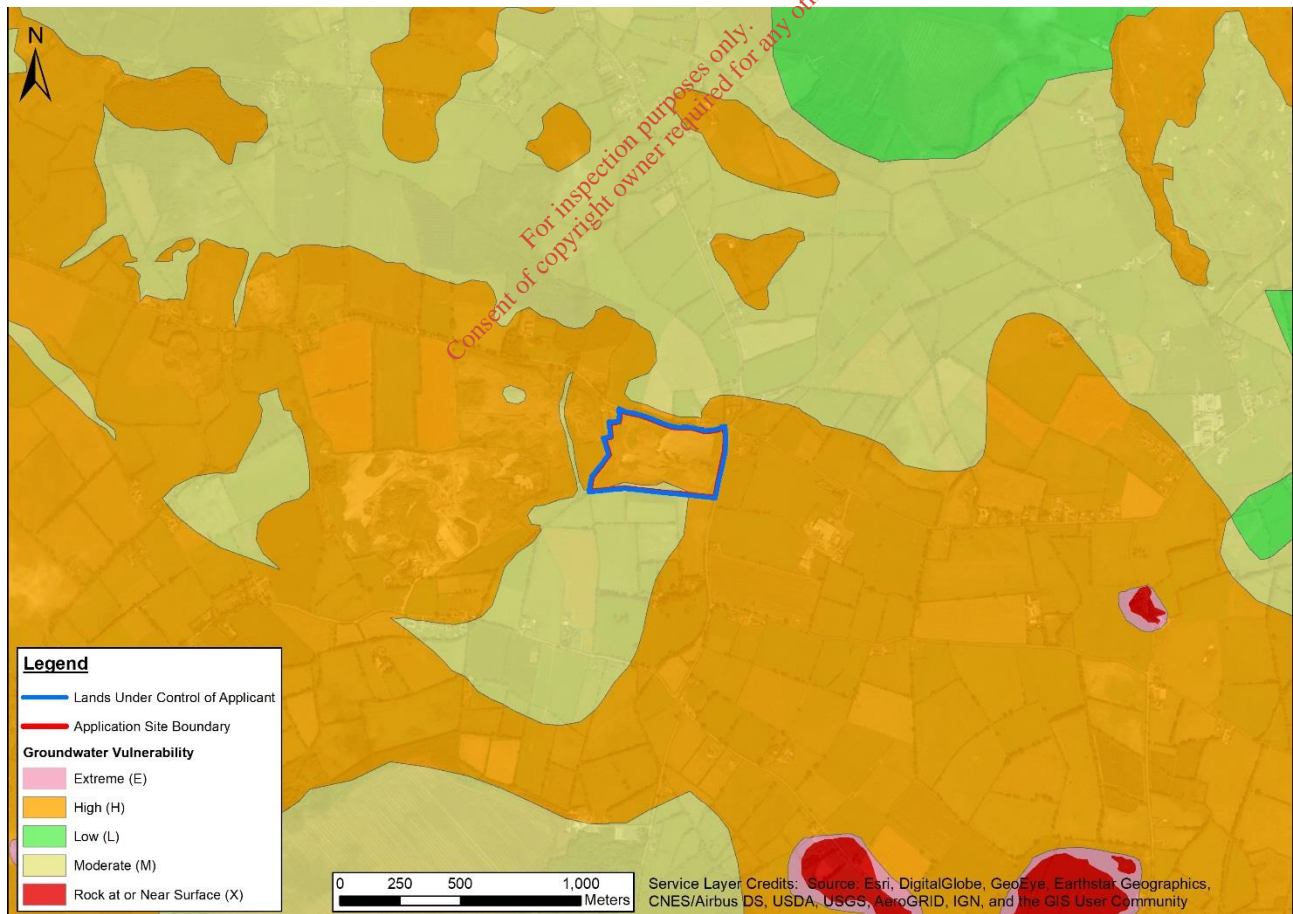


Figure 6.3 Groundwater vulnerability map (Ownership boundary in blue)



6.3.3.2 Source Protection Zones

There are no source protection zones within the Site boundary, with the nearest source protection areas located approximately 8 km to the south-east and south-west of the Site, at Johnstown and Edenderry respectively. However, there are two private supplies located along the immediate boundary of the Site, to the north-west and north-east, and a public supply well for 14 homes located in Clonuff to the north-east, which should be considered.

6.3.4 Water Quality

Four groundwater monitoring boreholes were drilled at the Site during 2017 and 2018 in order to establish the pre-restoration 'baseline' groundwater quality information. Four groundwater samples were collected from the boreholes on 27 March 2018 (GWM1, GWM2, GWM3 and GWM4). Pond B and two points along the Site adjacent River Glash (SW2 and SW3, upgradient and downgradient) were also sampled on 09 May 2018. Sampling locations are presented on Figures 6.4 and 6.5.

At least three volumes of water were abstracted from each of the boreholes prior to sampling to ensure that water sampled was representative of the surrounding groundwater aquifer. Field parameters of pH, electrical conductivity (EC), oxidation-reduction potential (ORP) and temperature were recorded during sampling and are displayed in Table 6.2.

Table 6.2: Summary of Field Parameters for Groundwater, 27/03/2018

Table with 5 columns: Location, pH (pH Units), Conductivity (EC, µS/cm), Temp (°C), and ORP (mV). Rows include GWM1, GWM2, GWM3, and GWM4.

Each sample was then tested at UKAS accredited Exova Jones Laboratory for the following parameters:

- Dissolved Metals: Aluminium, Arsenic, Cadmium, Calcium, Chromium, Copper, Iron, Lead, Magnesium Manganese, Mercury, Nickel, Potassium, Selenium, Sodium and Zinc;
■ Total Dissolved Hardness (as CaCO3);
■ Extractable Petroleum hydrocarbons (C8-C40);
■ MTBE, Benzene, Toluene, Ethylbenzene, m/p-Xylene, o-Xylene;
■ Sulphate;
■ Chloride;
■ Nitrate as NO3;
■ Nitrite as NO2;
■ Orthophosphate as PO4;
■ Total Oxidised Nitrogen
■ Ammoniacal Nitrogen as NH4;
■ Total Alkalinity as CaCO3;
■ Total Organic Carbon;
■ Total Dissolved Solids;
■ Dissolved Oxygen;
■ Electrical Conductivity; and
■ pH.

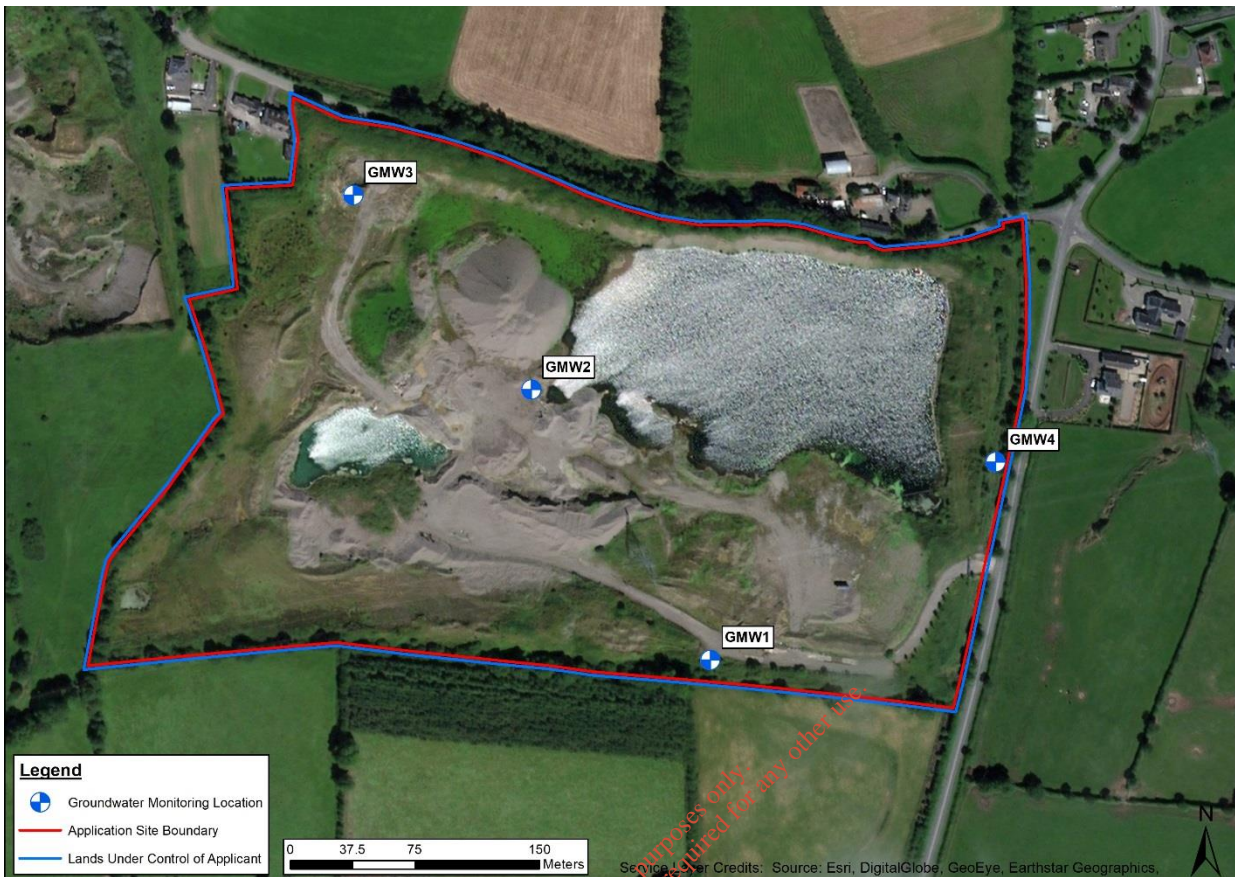


Figure 6.4: Plan showing location of groundwater monitoring points.



Figure 6.5: Plan showing location of surface water monitoring points.



The results of the groundwater and surface water quality analysis at the Site are presented below and compared with S.I. No.9 (2010), the European Communities Environmental Objectives (Groundwater) Regulations regarding groundwater status; where a screening value does not exist, the EPA Interim Guideline Values for Groundwater Protection were applied. Full screening results are presented as Appendix 6.1 and a summary of detected determinands are presented in Table 6.3. The laboratory certificates for the results are included in Appendix 6.2.

The groundwater analyses indicate that elevated results were recorded for Ammoniacal Nitrogen as NH_4 , Total Dissolved Iron, Dissolved Manganese and Total Hardness Dissolved (as CaCO_3). Surface water analyses also indicate elevated results for Hardness, Ammoniacal Nitrogen as NH_4 and additionally Nitrite as NO_2 .

As there was no blasting carried out at the Site, elevated levels of Ammoniacal Nitrogen and Nitrite are likely attributable to the local arable land use or discharge from the Moyvalley Meats facility, whilst elevated Iron, Manganese and Hardness are all characteristic of the local groundwater due to the presence of limestone bedrock underlying the Site (Kildare County Council, 2006). Therefore, the results indicate that there has been no perceivable impact upon groundwater or surface water by the Site previously. Results also reflect the likely baseline loading of the surface water courses with groundwater.

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Table 6.3: Summary of Detected Substances in Groundwater and Surface Water, March & May 2018

Determinand	Units	Screening Values*	LOD	MW01	MW02	MW03	MW04	SW1	SW2	SW3
				27/03/2018	27/03/2018	27/03/2018	27/03/2018	09/05/2018	09/05/2018	09/05/2018
Dissolved Calcium	mg/l	200*	<0.2	127.1	102.7	117.9	158	69.5	118.3	123.7
Total Dissolved Iron	µg/l	1000*	<20	547	1623	242	50	<20	185	97
Dissolved Magnesium	mg/l	50*	<0.1	13.7	16.7	14.7	12.5	5.8	6.9	8.1
Dissolved Manganese	µg/l	50*	<2	480	751	479	57	4	22	35
Dissolved Nickel	µg/l	15	<2	6	3	3	3	<2	3	2
Dissolved Potassium	mg/l	5*	<0.1	0.8	0.9	1.3	2.5	1.2	1	4.7
Dissolved Sodium	mg/l	150*	<0.1	8.2	12.2	9.1	21.4	8.6	8.3	23.7
Dissolved Zinc	µg/l	100*	<3	<3	<3	4	3	<3	3	<3
Hardness (as CaCO ₃)	mg/l	200*	<1	375	327	356	448	198	325	343
Sulphate as SO ₄	mg/l	200*	<0.5	18.9	17.9	23.8	23.7	18.4	12	16
Chloride	mg/l	187.5	<0.3	12.9	20.7	14.2	25.7	16.6	14.4	36.8
Nitrate as NO ₃	mg/l	37.5	<0.2	3.3	<0.2	<0.2	16.9	5.6	8.7	12.1
Nitrite as NO ₂	mg/l	0.1*	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.13
Total Oxidised Nitrogen as N	mg/l	NAC*	<0.2	0.7	<0.2	<0.2	3.8	1.3	2	2.8
Ammoniacal Nitrogen as NH ₄	mg/l	0.065	<0.03	0.09	0.09	0.08	0.04	0.08	0.04	0.08
Alkalinity as CaCO ₃	mg/l	NAC*	<1	384	446	332	430	188	306	316
Dissolved Oxygen	mg/l	-	<1	10	8	8	10	11	10	10
Electrical Conductivity	µS/cm	1875	<2	607	517	586	708	422	637	777
pH	pH Units	6.5 - 9.5*	<0.01	7.12	7.18	7.18	6.94	8.07	7.91	7.64
Total Organic Carbon	mg/l	NAC*	<2	<2	<2	2	<2	4	13	5
Total Dissolved Solids	mg/l	1000*	<35	417	388	415	550	242	348	412

*Screening values marked with an * indicate where the EPA Interim Guideline Values for Groundwater Protection were applied in the absence of EU S.I. No.9 (2010) values.
 NB: Values in **bold** indicate where a determinand has been detected. Values in **red shading** indicate an exceedance of the groundwater screening value. "NAC" = no abnormal change.



6.3.5 Groundwater Flow Direction

Historically, pre-development groundwater was noted to generally flow in a south-easterly direction (Declan Brassil, 2002), likely dominated by the presence of, and groundwater discharge to, the River Boyne (which forms the eastern boundary of the Site). Groundwater was reported to be present at elevations between approximately 84 and 75 m above ordnance datum (m AOD).

Table 6.4 includes the surveyed water level of Ponds B and C on 08 March 2018. These ponds are located where the gravel extraction exceeds the depth of the groundwater table and are thought to be representative of rest groundwater elevation. A comparison of the two water levels indicates a general easterly flow direction, broadly consistent with the pre-development groundwater flow regime.

The four monitoring boreholes were dipped with regards to groundwater elevation on 27 March 2018; the results are also presented in Table 6.4. Whilst some areas of groundwater flow appears to be broadly consistent with the pre-development easterly flow direction, GWM3 displays evidence of some drawdown, causing a flow divide towards the north-west and north-east of the Site. This flow divide could be caused by the drawdown cone generated from the private supply well located adjacent the north-west corner of the Site boundary, local effects of other sand and gravel extractions to the west and north-west, or by the regional effects of groundwater drainage into the River Boyne.

It is acknowledged that it is difficult to assess a dynamic groundwater flow regime, such as that at Ballinderry, using one monitoring event only, and the groundwater flow direction should be reassessed when further monitoring data becomes available.

Table 6.4: Groundwater elevations (m AOD), March 2018

Location	Date Monitored	Surface Elevation (m AOD)	Depth to Groundwater (m bGL)	Groundwater Elevation (m AOD)
Pond B	08/03/2018	-	-	77.94
Pond C	08/03/2018	-	-	77.49
GMW1	27/03/2018	79.72	2.45	77.55
GMW2	27/03/2018	77.98	0.83	77.18
GMW3	27/03/2018	86.35	9.35	76.66
GMW4	27/03/2018	78*	1.66	76.34*

*Borehole has not been surveyed; surface elevation estimated from topographical survey.

6.4 Potential Impacts of the Proposed Development

The main activities which will be conducted when restoration commences, and may cause an impact upon surface water or groundwater, are as follows:

- Phased backfilling of on-site Ponds B and C; and
- Phased backfilling and restoration of quarried void to an elevation which is in keeping with the surrounding topography, as presented on Drawing 4.

The main potential for impacts to surface water and ground water derives from the nature of the backfill materials used and condition of the plant used during the restoration activities. Therefore, the restoration works have the potential to cause the following impacts with regards to water:

- Leaching of contaminants from backfill materials to both surface water and groundwater;
- Hydrocarbon contamination of surface water or groundwater caused by the unmanaged spillage of fuels or lubricants from Site plant used during restoration activities;
- Pollution of groundwater from waste generated by toilet facilities;
- Pollution of private water supplies via the contamination of groundwater;



- Reduced infiltration of rainfall and subsequently an increased surface-water run-off to watercourses; and
- Sediment loading of surface waters.

However, the following should be considered when assessing the potential impacts upon water:

- The direct pathway to groundwater via the site ponds will be removed;
- The majority of backfill will be occurring above the water table in the unsaturated zone;
- There will be no active dewatering of the Site following the backfilling of the Ponds;
- There will be no active discharges from the Site;
- There will be no sewage / waste water pipework at the Site as portable toilet facilities are to be used;
- The wheel washing facility is a wet-grate design, located upon concrete hardstanding, with no discharges of waste water to permeable ground, and therefore acts as a self-contained facility;
- The Site is not located within a Source Protection Area of a public water supply scheme; and
- Surface water run-off from the Site is expected to percolate into the backfill materials.

6.5 Mitigation Measures

It is proposed that the following mitigation measures will be put in place at the Site to ensure that no adverse environmental impacts will occur to surface waterbodies or the underlying groundwater aquifers as a result of the proposed restoration activities:

- Adoption of a proven Environmental Management System (EMS), as outlined in Chapter 2;
- Ponds B and C, and therefore the direct pathway to exposed groundwater, are backfilled with uncontaminated, low permeability material, as outlined in Chapter 2;
- Ponds B and C will be backfilled in a phased approach (refer to Chapter 2), allowing each phase to be bunded then dewatered into the next phase, the final phase will be dewatered to the quarry floor, where it will naturally infiltrate to ground. This allows discharge (and sediment loading) to surface waters to be avoided;
- Backfill and topsoil materials used in restoration of the unsaturated zone will comprise uncontaminated material, comparable to that of virgin ground;
- Importation of backfill material and restoration of topsoil will be carried out on a phased basis to reduce the vulnerability of the underlying aquifers to possible contamination;
- Although it is thought the backfill materials will be of mixed grain size and well graded (and therefore allow adequate infiltration of rain water); if required, a toe-drain / surface water ditch will be installed at the lowest topographical point to manage potential runoff and sediment loading of surface waters;
- Where required, de-siltation of the drain will occur in order to manage any reduction in drainage capacity;
- Mobile plant will use a dedicated concrete hardstanding apron for refuelling. Static plant or tracked excavators will refuel over a drip tray with an absorbent mat. In addition, spill kits will be maintained on site to deal with all spills and leaks, and spill training will be provided to relevant staff members;
- Any mobile plant or vehicles on the Site shall be regularly maintained. Where plant is damaged or leaking it will be fixed or replaced immediately, as part of the ongoing operational management of the restoration works to reduce the risk of leaks;
- Hydrocarbons will be stored in double skinned bunded tanks on an impermeable hardstanding surface;
- Wheel washing is to be carried out in alignment with the methodology employed during mineral extraction, where wash water was recycled and no perceivable impacts were noted upon water quality (see Section 6.3.4);



- Portable toilet facilities will be located upon concrete hardstanding in order to allow any spillages to be managed. Any emptying of toilet facilities should be carried out upon the concrete hardstanding also;
- 6 monthly quality monitoring of both groundwater and surface water shall be undertaken to ensure that no pollution of groundwater or surface water is occurring, this will include measurements of groundwater and surface water levels.

Following the plan for restoration works, and continuing good housekeeping during backfilling operations by adhering to best practice within the work area, will mitigate against potential impacts on the surrounding environment.

6.6 Residual/Likely Significant Effects

If restoration is carried out in line with the mitigation measures and criteria outlined in Section 6.5, Chapter 2 and Chapter 5, no residual and deleterious effects on surrounding water bodies or underlying groundwater aquifers are envisaged.

6.7 Cumulative Impacts

As there are no residual and deleterious effects on surrounding water bodies or underlying groundwater aquifers envisaged, there is no potential for cumulative impacts on surface water or groundwater to occur.

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6.8 References

- Kildare County Council Waste Management Plan, 2005-2010, Volume 2 of 4, 2006.
- Kildare County Development Plan 2017-2023.
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- Institute of Geologists of Ireland (2013). Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements.
- Draft - Revised Guidelines on the Information to be contained in Environmental Impact Statements. EPA 2015.
- Working Group on Groundwater (2004) Guidance document GW8: Methodology for risk characterisation of Ireland's groundwater.
- www.epa.ie Environmental Protection Agency - online water quality mapping
- www.gsi.ie Geological Survey of Ireland - online aquifer classification & vulnerability.



APPENDICES

6.1 – Full Screening of Water Quality Results

6.2 – Water Quality Laboratory Certificates

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Test	Units	Screening Values		LOD	Groundwater				Surface Water		
		2010 Groundwater Regs	EPA Interim GW Values		MW01	MW02	MW03	MW04	SW1	SW2	SW3
					27/03/2018	27/03/2018	27/03/2018	27/03/2018	09/05/2018	09/05/2018	09/05/2018
Dissolved Aluminium	ug/l	150	-	<20	<20	<20	<20	<20	<20	<20	<20
Dissolved Arsenic	ug/l	7.5	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Dissolved Boron	ug/l	750	-	<12	N/A	N/A	N/A	N/A	<12	<12	<12
Dissolved Cadmium	ug/l	3.75	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dissolved Calcium	mg/l	-	200	<0.2	127.1	102.7	117.9	158	69.5	118.3	123.7
Total Dissolved Chromium	ug/l	37.5	-	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Dissolved Copper	ug/l	1500	-	<7	<7	<7	<7	<7	<7	<7	<7
Total Dissolved Iron	ug/l	-	1000	<20	547	1623	242	50	<20	185	97
Dissolved Lead	ug/l	18.75	-	<5	<5	<5	<5	<5	<5	<5	<5
Dissolved Magnesium	mg/l	-	50	<0.1	13.7	16.7	14.7	12.5	5.8	6.9	8.1
Dissolved Manganese	ug/l	-	50	<2	480	751	479	57	4	22	35
Dissolved Mercury	ug/l	0.75	-	<1	<1	<1	<1	<1	<1	<1	<1
Dissolved Nickel	ug/l	15	-	<2	6	3	3	3	<2	3	2
Dissolved Potassium	mg/l	-	5	<0.1	0.8	0.9	1.3	2.5	1.2	1	4.7
Dissolved Selenium	ug/l	-	-	<3	<3	<3	<3	<3	<3	<3	<3
Dissolved Sodium	mg/l	-	150	<0.1	8.2	12.2	9	21.4	8.6	8.3	23.7
Dissolved Zinc	ug/l	-	100	<3	<3	<3	4	3	<3	3	<3
Total Hardness Dissolved (as CaCO3)	mg/l	-	200	<1	375	327	356	448	198	325	343
EPH (C8-C40)	ug/l	-	10	<10	<10	<10	<10	<10	<10	<10	<10
C8-C40 Mineral Oil (Calculation)	ug/l	-	10	<10	<10	<10	<10	<10	<10	<10	<10
GRO (>C4-C8)	ug/l	-	10	<10	<10	<10	<10	<10	<10	<10	<10
GRO (>C8-C12)	ug/l	-	10	<10	<10	<10	<10	<10	<10	<10	<10
GRO (>C4-C12)	ug/l	-	10	<10	<10	<10	<10	<10	<10	<10	<10
MTBE	ug/l	-	30	<5	<5	<5	<5	<5	<5	<5	<5
Benzene	ug/l	-	1	<5	<5	<5	<5	<5	<5	<5	<5
Toluene	ug/l	-	10	<5	<5	<5	<5	<5	<5	<5	<5
Ethylbenzene	ug/l	-	10	<5	<5	<5	<5	<5	<5	<5	<5
m/p-Xylene	ug/l	-	10	<5	<5	<5	<5	<5	<5	<5	<5
o-Xylene	ug/l	-	10	<5	<5	<5	<5	<5	<5	<5	<5
Sulphate as SO4	mg/l	-	200	<0.5	18.9	17.9	23.8	23.7	18.4	12	16
Chloride	mg/l	187.5	-	<0.3	12.9	20.7	14.2	25.7	16.6	14.4	36.8
Nitrate as NO3	mg/l	37.5	-	<0.2	3.3	<0.2	<0.2	16.9	5.6	8.7	12.1
Nitrite as NO2	mg/l	-	0.1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.13
Ortho Phosphate as PO4	mg/l	0.035	-	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Total Oxidised Nitrogen as N	mg/l	-	NAC*	<0.2	0.7	<0.2	<0.2	3.8	1.3	2	2.8
Ammoniacal Nitrogen as NH4	mg/l	0.065	-	<0.03	0.09	0.09	0.08	0.04	0.08	0.04	0.08
Total Alkalinity as CaCO3	mg/l	-	NAC*	<1	384	446	332	430	188	306	316
Dissolved Oxygen	mg/l	-	-	<1	10	8	8	10	11	10	10
Electrical Conductivity @25C	uS/cm	1875	-	<2	607	517	586	708	422	637	777
pH	pH units	-	6.5 - 9.5	<0.01	7.12	7.18	7.18	6.94	8.07	7.91	7.64
Total Organic Carbon	mg/l	-	NAC*	<2	<2	<2	2	<2	4	13	5
Total Dissolved Solids	mg/l	-	1000	<35	417	388	415	550	242	348	412

= Result exceeds screen value
 = LoD exceeds screen value
 *NAC = No abnormal change
 "N/A" = Not Analysed



Exova Jones Environmental

Registered Address : Exova (UK) Ltd, Lochend Industrial Estate, Newbridge, Midlothian, EH28 8PL

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Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

Attention : Ruth Treacy
Date : 6th April, 2018
Your reference : 1894029
Our reference : Test Report 18/4731 Batch 1
Location : GCHL - Ballinderry
Date samples received : 29th March, 2018
Status : Final report
Issue : 1

Four samples were received for analysis on 29th March, 2018 of which four were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

**Paul Boden BSc
Project Manager**

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 18/4731

SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overestimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.

Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Please include all sections of this report if it is reproduced

All solid results are expressed on a dry weight basis unless stated otherwise.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

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JE Job No: 18/4731

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM5	Modified USEPA 8015B method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) with carbon banding within the range C8-C40 GC-FID.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.				
TM20	Modified BS 1377-3: 1990/USEPA 160.3 Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.				
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	PM14	Analysis of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for dissolved metals and acidified if required.				
TM31	Modified USEPA 8015B. Determination of Methyltertbutylether, Benzene, Toluene, Ethylbenzene and Xylene by headspace GC-FID.	PM12	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.				
TM36	Modified US EPA method 8015B. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID.	PM12	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.				
TM38	Soluble Ion analysis using the Thermo Aquakem Photometric Automatic Analyser. Modified US EPA methods 325.2, 375.4, 365.2, 353.1, 354.1	PM0	No preparation is required.				
TM59	Determination of Dissolved Oxygen using the Hach HQ30D Oxygen Meter	PM0	No preparation is required.				
TM60	Modified USEPA 9060. Determination of TOC by calculation from Total Carbon and Inorganic Carbon using a TOC analyser, the carbon in the sample is converted to CO2 and then passed through a non-dispersive infrared gas analyser (NDIR).	PM0	No preparation is required.				
TM73	Modified US EPA methods 150.1 and 9045D and BS1377:1990. Determination of pH by Metrohm automated probe analyser.	PM0	No preparation is required.				
TM75	Modified US EPA method 310.1. Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.				

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Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM76	Modified US EPA method 120.1. Determination of Specific Conductance by Metrohm automated probe analyser.	PM0	No preparation is required.				

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Exova Jones Environmental

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Fax: +44 (0) 1244 833781



Attention : Ruth Treacy
Date : 18th May, 2018
Your reference : 1894029
Our reference : Test Report 18/7176 Batch 1
Location :
Date samples received : 11th May, 2018
Status : Final report
Issue : 1

Three samples were received for analysis on 11th May, 2018 of which three were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Paul Boden BSc
Project Manager

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 18/7176

SOILS

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Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

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REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Please include all sections of this report if it is reproduced

ABBREVIATIONS and ACRONYMS USED

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SS	Calibrated against a single substance
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W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to an Exova Jones Environmental approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
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JE Job No: 18/7176

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TM20	Modified BS 1377-3: 1990/USEPA 160.3 Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.	Yes			
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	PM14	Analysis of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for dissolved metals and acidified if required.				
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	PM14	Analysis of waters and leachates for metals by ICP OES/ICP MS. Samples are filtered for dissolved metals and acidified if required.	Yes			
TM31	Modified USEPA 8015B. Determination of Methylterbutylether, Benzene, Toluene, Ethylbenzene and Xylene by headspace GC-FID.	PM12	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.	Yes			
TM36	Modified US EPA method 8015B. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID.	PM12	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.	Yes			
TM38	Soluble Ion analysis using the Thermo Aquakem Photometric Automatic Analyser. Modified US EPA methods 325.2, 375.4, 365.2, 353.1, 354.1	PM0	No preparation is required.	Yes			
TM59	Determination of Dissolved Oxygen using the Hach HQ30D Oxygen Meter	PM0	No preparation is required.				
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JE Job No: 18/7176

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM73	Modified US EPA methods 150.1 and 9045D and BS1377:1990. Determination of pH by Metrohm automated probe analyser.	PM0	No preparation is required.	Yes			
TM75	Modified US EPA method 310.1. Determination of Alkalinity by Metrohm automated titration analyser.	PM0	No preparation is required.	Yes			
TM76	Modified US EPA method 120.1. Determination of Specific Conductance by Metrohm automated probe analyser.	PM0	No preparation is required.	Yes			

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