PARRY'S QUARRY LANDFILL, ALLTAMI, FLINTSHIRE

Environmental Permit Application

Leachate Management and Design Plan

Prepared for: Mold Investments Limited

Client Ref: 416.07238.00001

SLR Ref: 416.07238.00001
Version No: 1
August 2019

BASIS OF REPORT

CONTENTS

DOCUMENT REFERENCES

TABLES

APPENDIX

DRAWINGS

1.0 Introduction

Mold Investments Ltd (Mold) intend to develop a landfill facility at their Parry's Quarry site located in Mold, Flintshire. As part of the application process the Natural Resources Wales (NRW).

To support an application for an Environmental Permit for Parry's Quarry Landfill and Waste Transfer Station (WTS) under the Environmental Permitting (EP) (England and Wales) Regulations 2016, a leachate management and design plan (LMP) has been produced.

This LMP describes how leachate will be managed across the proposed site during both operational and the post closure periods and includes the following information;

- an outline description of the proposed landfill cells, their leachate collection point numbers and distribution;
- an assessment of the likely volumes of leachate generation, over time, for all currently proposed cells at the Parry's Landfill Site;
- an assessment of the required operational maximum and long-term leachate abstraction rate from each cell and from the site as a whole;
- an assessment and outline specification of the pumping systems required to achieve the abstraction rates required;
- an assessment of the capacity of disposal arrangements available for the site to accommodate the additional leachate generation volumes from the proposed cells; and
- an outline of the management techniques that may be required to minimise the risk posed by leachate contained within the site of exceeding assessment limits or otherwise escaping from containment.

2.0 Leachate Engineering Design Outline Description

There are to be eight landfilled cells at the proposed Parry's Quarry landfill site; Cells 1, 2, 3, 4, 5, 6, 7 and 8. These cells will ultimately occupy a surface area of 9.8ha.

One of these cells, Cell 6, is designated as the cell that will accept biodegradable wastes. It is anticipated that all other cells at the site will essentially accept commercial and industrial wastes that are anticipated as containing significantly lower contraptions of biodegradable material.

Cell numbering, size, layout and shape are proposed to be as per Drawing 'Proposed Landfill Design' submitted as part of the permit application and included here as Drawing 01, unless otherwise subsequently agreed with NRW. Cell surface areas are summarised in Table 2-1.

Table 2-1: Proposed Cell Areas

Cell Number	Surface Area (m^2)
Cell 1	16,648
Cell 2	10,823
Cell 3	10,042
Cell 4	9,821
Cell 5	12,065
Cell 6	11,637
Cell 7	13,340
Cell 8	14,099
Totals	**98,475**

2.1 Leachate Collection Systems

Each new landfill cell will be installed with a basal containment system and basal drainage blanket as specified within the environmental permit application. In accordance with the guidance contained within LFTGN02[1] each new cell will be installed with three leachate wells in continuity with the basal drainage blanket. The well installed at the lowest point in each cell will be designated as the combined leachate monitoring and abstraction well, the other two wells will be designated as monitoring only locations unless otherwise agreed with NRW.

As can be seen from Table 2-1, all cells will have a surface area of less than 50,000m^2, therefore three leachate monitoring points are the minimum number required by LFTGN02[1] (for cells that range in size from 0ha to 5ha).

Each cell floor will be designed to fall to a low point. At this location a main leachate collection and pumping well will be installed. Two further leachate collection points will be installed up-slope from this low point so that leachate levels can be determined at (approximately) the mid-point and the high-point in the cell. These two

[1] LFTGN02: Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water, Section 6.2.2, Table 6.3. Environment Agency 2003.

collection points will be assigned as leachate monitoring only points (no pumping or abstraction) but will be constructed such they can, if required, be installed with a suitable down-well submersible pump.

The leachate monitoring point identification (ID) names are proposed below in Table 2-2, these will be the sample point names used in subsequent drawings and correspondence unless otherwise agreed with NRW.

Table 2-2: Proposed Leachate Monitoring Point ID

Cell Number	Pumping and Monitoring Point	Monitoring Point
Cell 1	LCP01	LMP01.1; LMP01.2
Cell 2	LCP02	LMP02.1; LMP02.2
Cell 3	LCP03	LMP03.1; LMP03.2
Cell 4	LCP04	LMP04.1; LMP04.2
Cell 5	LCP05	LMP05.1; LMP05.2
Cell 6	LCP06	LMP06.1; LMP06.2
Cell 7	LCP07	LMP07.1; LMP07.2
Cell 8	LCP08	LMP08.1; LMP08.2

2.1.1 Leachate Collection Point Design

Leachate collection points will be designed to be sufficiently robust to ensure that they remain serviceable for the proposed active management period for the site. Leachate collection points will be of sufficient diameter to allow for easy access to monitor leachate levels, obtain leachate samples, install and remove leachate pumps and, if necessary, remediate for example by removal of sludge.

Unless otherwise agreed with NRW, leachate collection points will be a mixture of inclined side wall risers (where chambers are located against the foot of the sites external sidewall) and vertical wells. Side wall risers will be formed from polyethylene (PE) pipework, installed in sections from the base of the site to the surface. The basal sections will be perforated to a vertical depth of 3m above the base of the site, and will be of plain, unperforated sections thereafter. Vertical wells will be formed from an inner PE pipe installed in sections from the base of the site to the surface, sections being added progressively as the site is filled. The basal section will be perforated and will be keyed into the cells basal leachate drainage system. All other sections of the inner PE pipe (except for the basal 3m section) will be of plain, non-perforated design. The PE pipe will have a minimum diameter of 250mm.

For vertical wells, the PE pipe will be provided with protection by outer pre-cast concrete rings, each stacked on top of the previous ring with the final concrete ring being installed at just below final cell cap level. Only the PE pipe will penetrate through the final landfill cap so that an effective seal can be formed to help control ingress and egress of gas. Similarly to the PE pipe installation, the basal 3m of the concrete ring stack will be of perforated design and the upper sections will be of plain, non-perorated design. The annulus between the inner PE pipe and the outer concrete ring will be filled with suitably sized, clean drainage stone for at least the basal 4m. Thereafter the annulus may be filled with drainage stone or other suitable materials. The whole structure will be founded on a concrete slab integrated into the design of the basal containment engineering.

During landfilling, whilst the leachate collection points are being actively raised on a regular basis, they may be closed off with temporary gas tight end caps to both prevent gas ingress and egress but also to prevent debris falling down the collection point. Once raised to their final height, or should raising of the chambers not be anticipated to be required for a period of more than 12 months, permanent gas tight headworks complete with leachate and gas monitoring fittings (sample ports, gas taps etc) shall be installed. Permanent well heads will also be installed with fittings to enable the installation and operation of down-well pumps and monitoring equipment.

2.1.2 Leachate Collection Point Headworks Design

Leachate collection points will be fitted with headworks as soon as is practical after waste filling begins. Unless otherwise agreed with NRW, headworks designs will be gas tight including all fittings for pumps, control equipment, monitoring and sampling (including where appropriate gas sampling). Well heads will be:

- pre-fabricated from black HDPE or similar;
- permanently marked with a suitable name tag and ATEX / DSEAR marking (if required);
- blanked off, 'T-Piece' stub ends for connection of suitable landfill gas control valves and leachate pumping pipework, a flanged inlet to allow pump removal / reinstallation, glanded inlets / outlets for electrical cabling and down-well pipework along with a minimum 5cm diameter sampling aperture that can be quickly and easily sealed (with a 'cam-lock' type cover) to enable manual leachate level monitoring and sampling with a bailer; and
- installed with a snap on gas analyser port / Teflon valve.

3.0 Leachate Volume and Quality Assessment

An estimate of the rate of leachate abstraction required from each cell (operational maximum and in closure) has been undertaken to assess the leachate pumping and disposal requirements for the proposed site. Leachate quality estimates have also been made. Together, this information is used to propose an outline specification for the new leachate pumping infrastructure.

An assessment of the estimated leachate generation rate from all existing and proposed cells over the lifetime of the site has been assessed to ensure that leachate can be managed in compliance with the environmental permit's requirements and the operator's Duty of Care. To complete the assessment of how much leachate will be generated per cell at the site a site development, or phasing, plan has been developed.

3.1 Site Phasing Plan

The sequence in which the cells will be filled at the proposed Parry's Landfill site has been estimated based on the following factors:

- the 'biodegradable waste' cell should be located as far as is possible from sensitive receptors (mainly to the east of the site, the A55 'service station'); and
- the cells along the northern and eastern edges of the site should be filled and permanently capped as rapidly as possible to screen the site from sensitive receptors as quickly as is possible.

As such, a phasing plan has been developed that sees Cell 6 designated as the 'biodegradable waste' cell. Cell 1 (in the south east corner of the site) is filled first, with its eastern perimeter being permanently capped as early as possible, with the 'inner' west facing batter provided with temporary capping after the next cell, Cell 2, is opened. This sequence is continued as the site is filled in a counter clockwise direction from Cell 1 in the southeast to Cell 8 in the southwest. AS temporary capped 'inner' cell batters are filled against, temporary capping will be progressively removed.

A graphical representation of the phased filling of the site is presented as Drawing ESID5.

3.2 Leachate Generation Model

Using the phasing plan outlined above (Section 3.1) and the cell surface areas detailed in Table 2-1, a theoretical annual leachate generation model for the site has been constructed that employs the following basic assumptions:

Table 3-1: Leachate Generation Model Assumptions

Parameter	Unit	Value	Notes
Precipitation	m/yr	0.800	ESID MORECS data for square 104 – Long-term average 1971 to 2000 for grass land use with median available water capacity (AWC) soil type
Evaporation Rate	m/yr	25%	HER from reference 1 (above) is 261.8mm/yr, this represents a 67% loss from rainfall. A conservative figure of 25% loss has been used instead.
Rainfall Infiltration Open Cell after evaporation	m/yr	0.600	
Rainfall Infiltration Temp Cap / Slopes	m/yr	0.100	Assumption based on SLR experience
Rainfall Infiltration Hi Q Cap	m/yr	0.031	Based on calculation Q = $(1x10^{-9})$ x $1m^2$ x (1m / 1m) x 86,400 x 365 = 31.5mm per year
Groundwater Infiltration Rate	m/yr	0.000	Not applicable, above groundwater landfill
Absorptive Capacity of Waste (% of t as m^3 capacity)	%	1.0	Conservative assumption based on SLR experience

In addition, it is assumed that each pf the eight phases of landfilling will take one year to complete so that the landfill is filled and capped in year nine after opening. Tonnage inputs are derived from the assumed void usage implied by the phasing plan converted to tonnages at $1.2t/m^3$ of void used. The total tonnage for the site of 2,460,000t (approximately 2,460,161t) is then divided equally into each of the 8 operational years (i.e. 307,500t/yr input). To provide operational flexibility the permit will be set to the acceptance of up to 320,000tpa.

It is noted that the above assumptions are unlikely to be exactly replicated in the actual operation of the Parry's Quarry landfill, this particularly being true in relation to site development plans. In reality, cells may fill faster or slower than the periods allowed in the model and cells may not necessarily develop in the order proposed. Areas of capped and uncapped waste may also vary compared to those contained within the model.

However, it is believed that the model is sufficiently robust to be useful in proposing site leachate management techniques and outline specifications.

The annual landfill leachate generation model is summarised as Table 3-2, detailed models are presented in Appendix 01.

Table 3-2: Leachate Generation Model Summary

Year	Cell 1*	Cell 2*	Cell 3*	Cell 4*	Cell 5*	Cell 6*	Cell 7*	Cell 8*	Total*	Total**
Area (m^2)	16,648	10,823	10,042	9,821	12,065	11,637	13,340	14,099	98,475	98,475
1	**9,985**	-	-	-	-	-	-	-	**9,985**	**6,910**
2	1,090	**6,491**	-	-	-	-	-	-	**7,582**	**4,507**
3	1,090	833	**6,023**	-	-	-	-	-	**7,947**	**4,872**

Year	Cell 1*	Cell 2*	Cell 3*	Cell 4*	Cell 5*	Cell 6*	Cell 7*	Cell 8*	Total*	Total**
4	1,090	833	773	**5,890**	-	-	-	-	**8,587**	**5,512**
5	1,090	833	773	474	**7,236**	-	-	-	**10,407**	**7,332**
6	1,090	833	485	*304*	*374*	**6,980**	-	-	**10,066**	**6,991**
7	1,090	522	*311*	*304*	*374*	*361*	**8,001**	-	**10,964**	**7,889**
8	1,090	522	*311*	*304*	*374*	*361*	1,150	**8,456**	**12,569**	**9,494**
Aftercare	*516*	*336*	*311*	*304*	*374*	*361*	*414*	*437*	*3,053*	*3,053*

	-	Zero leachate generation (cell not filled)
	bold	Cell active (uncapped cell areas)
Notes	*italic*	Cell fully capped
	*	Total leachate generation (before losses to adsorption)
	**	Leachate disposal volume (after losses to adsorption)

This work indicates that leachate pumping, and disposal systems will need to be designed to accommodate the following information:

- during the active phase of landfilling the maximum leachate generation rate in any one cell is likely to be 9,985m^3/yr (equivalent to circa. 28m^3/day);
- during the active phase of landfilling the maximum leachate generation for the whole site is likely to be 9,494m^3/yr (26m^3/day) to 12,569m^3/yr (35m^3/day), the variance being due to whether the effect of adsorption of incident rainfall into fresh waste is zero or at 1.0% of the incoming waste tonnage;
- during the post-closure phase of site management, the maximum leachate generation rate in any one cell is likely to be 516m^3/yr (1.5m^3/day); and
- during the post closure phase of site management, the maximum leachate generation rate for the whole site is likely to be 3,053m^3/hr (8.5m^3/day).

3.3 Leachate Quality Model

To assist in the assessment of risk posed by the Parry's Quarry landfill an estimate of the leachate quality likely to be generated by the site has been made.

Leachate quality data from an existing site accepting similar waste streams as those anticipated as being placed in all Cells with the exception of Cell 6 at the proposed parry's Quarry landfill. This data has been used as a 'proxy' for the leachate quality expected from Cells 1 to 5 and 7 and 8 (see Table 3-3).

For Cell 6, an amalgamation of leachate qualities from landfill sites accepting putrescible wastes (Municipal Solid Waste landfills) has been used to approximate the leachate quality anticipated as being generated from Cell 6 (see Table 3-3).

For each leachate 'type' concentrations of zinc, benzene, phenol and naphthalene have been estimated to assist in the Hydrogeological Risk Assessment of the site in addition to more 'usual' leachate components such as ammonia, BOD, COD, chloride and metals etc.

Table 3-3: 'Proxy' Leachate Quality for Cell 6 and Cells 1-5 and 7-8

Analyte	Unit	Cell 6	Cell 1-5 and 7-8
Alkalinity as $CaCO_3$	mg/l	7,569	2,543

Analyte	Unit	Cell 6	Cell 1-5 and 7-8
Ammoniacal Nitrogen as N	mg/l	1,460	41
Arsenic, Total as As	mg/l	0.18	0.05
BOD + ATU (5 day)	mg/l	310	500
Cadmium, Total as Cd	mg/l	0.001	0.001
Calcium, Total as Ca	mg/l	161	78
Chloride as Cl	mg/l	1,793	4,035
Chromium, Total as Cr	mg/l	0.32	0.02
COD	mg/l	3,116	1,000
Conductivity Electrical 20°C	µS/cm	16,300	35,386
Copper, Total as Cu	mg/l	0.17	0.03
Iron, Total as Fe	mg/l	12.2	2.3
Lead, Total as Pb	mg/l	0.007	0.058
Magnesium, Total as Mg	mg/l	128	107
Manganese, Total as Mn	mg/l	1.3	0.258
Nickel, Total as Ni	mg/l	0.148	0.079
pH	pH units	8.1	8.686
Potassium, Total as K	mg/l	575	764
Sodium, Total as Na	mg/l	1,207	2,615
Sulphate as SO_4	mg/l	129	160
TOC (Filtered)	mg/l	1,185	268
Total Suspended Solids	mg/l	92	100
Zinc, Total as Zn	mg/l	0.1	0.3
Benzene	mg/l	0.003	0.02
Phenol	mg/l	0.19	0.22
Naphthalene	mg/l	0.002	0.001

These leachate qualities have been combined with the leachate generation volumes from each cell reported in Table 3-2 to generate an anticipated 'blend' leachate quality for the whole site using mass balance calculations relating to the analyte concentrations and cell leachate yield volumes for each individual cell and the total volume of leachate and total mass of analyte converted to a n instantaneous milligram per litre concentration.

This calculation has been performed on a year by year basis with a summary produced showing the minimum, average and maximum concentrations for the whole site during the active filling phase and as an average concentration for the whole site during the post closure phase in Table 3-4. The full details of the calculation are presented in Appendix 02.

Table 3-4: Leachate Quality Estimates for Parry's Quarry Landfill

Analyte	Unit	Active Years		Aftercare	
		Maximum	Average	Maximum	Blend
Volume	m^3/yr	12,570	9,764	3,053	3,053
Alkalinity as $CaCO_3$	mg/l	6,028	3,017	6,845	3,137
Ammoniacal Nitrogen as N	mg/l	1,025	175	110	209
Arsenic, Total as As	mg/l	0.14	0.06	0.13	0.07
BOD + ATU (5 day)	mg/l	500	482	1,346	478
Cadmium, Total as Cd	mg/l	0.001	0.001	0.002	0.001
Calcium, Total as Ca	mg/l	136	86	210	88
Chloride as Cl	mg/l	4,035	3,823	10,861	3,770
Chromium, Total as Cr	mg/l	0.23	0.05	0.04	0.05
COD	mg/l	2,467	1,200	2,692	1,250
Conductivity Electrical 20°C	µS/cm	35,386	33,585	95,258	33,129
Copper, Total as Cu	mg/l	0.13	0.04	0.08	0.05
Iron, Total as Fe	mg/l	9.1	3.2	6.1	3.4
Lead, Total as Pb	mg/l	0.058	0.053	0.156	0.052
Magnesium, Total as Mg	mg/l	121	109	287	109
Manganese, Total as Mn	mg/l	0.98	0.36	0.69	0.38
Nickel, Total as Ni	mg/l	0.13	0.09	0.21	0.09
pH	pH units	8.7	8.6	23.4	8.6
Potassium, Total as K	mg/l	764	746	2,056	742
Sodium, Total as Na	mg/l	2,615	2,482	7,040	2,449
Sulphate as SO_4	mg/l	160	157	431	156
TOC (Filtered)	mg/l	904	355	721	376
Total Suspended Solids	mg/l	100	99	269	99
Zinc, Total as Zn	mg/l	1	1	3	1
Benzene	mg/l	0.30	0.28	0.80	0.28
Phenol	mg/l	0.020	0.018	0.054	0.018
Naphthalene	mg/l	0.22	0.22	0.60	0.22

4.0 Outline Leachate Pumping System Specification

Unless otherwise agreed with NRW, each vertical collection sump installed to each new cell will be fitted with electrical submersible pump(s) complete with down well pipework, level control and low-level shutoff (for example pressure transducer, float switch or similar), electrical supply and suitable headworks. Leachate discharge legs from each well head will be fitted with an electro-magnetic or similar flowmeter capable of recording instantaneous flow and / or cumulative volumes.

Each sump location will be connected to a carrier main located via a short connection leg from the well head to the main. Pipework layout and locations will be justified prior to installation via a suitable risk assessment to ensure that pipework is afforded as much protection from damage as possible whilst at the same time minimising resource use.

Leachate collected from the cells in the site will discharge into storage tanks located to the north of the site, off-waste, adjacent to the current parking areas for ease of access by road-going tanker. From these storage tanks leachate will be disposed from site in a tanker or treated on-site in suitable leachate treatment plant (LTP) for discharge to sewer or controlled waters if this is deemed the most appropriate method of leachate disposal (see Section 5.0).

Electrical supply will be provided from a mains distribution board to each of the new pump locations. Each pump location will be provided with a self-supported, weather proof, lockable kiosk to house control and power distribution equipment. Electrical supply to pumps will be connected at the local distribution panel by simple 'plug-and-play' type connections. All electrical cabling from the local distribution panel down the well will be in single, unjointed lengths.

4.1 Pumps

Unless otherwise agreed with NRW, installation of electrical submersible borehole pumps is preferred. Pumps selected will have the following characteristics;

- simple installation and removal, preferably by lone worker with no need for additional lifting equipment;
- low maintenance requirements;
- capable of variable flow rate operation;
- capable of running dry with no impairment;
- able to handle fines and sludges associated with leachate;
- generally, meet the requirements of WIMES[2] 1.05 Submersible Borehole Pump Units, or its subsequent updates;
- easy servicing with field rewindable motor and/or interchangeable motor;
- non-clogging, lightweight, progressive cavity type pump;
- stable pump head-flow curve with the tangent at any point directed downward in the direction of increasing flow rate. The pump shall avoid run out conditions with the wet well at maximum water level;

[2] Water Industry Mechanical and Electrical Specifications (UK)

- capable of continuous operation over its full operating range, either partially or fully submerged. Cooling of the motor shall be an integral part of the pump design and shall not rely on a separately supplied or driven cooling supply;
- designed for both continuous and intermittent operation capable of a minimum of 15 starts per hour;
- capable of withstanding the effects of short-term reverse rotation following pump stop;
- capable of operating at zero flow rate (closed valve) for a period not less than 2 minutes;
- capable of running dry for short periods during maintenance and inspection;
- integral voltage or clixon (temperature overload) cut-out;
- direction of rotation clearly and permanently marked on the pump housing; and
- motor enclosures rated to IP68 with a continuous submergence depth rating of 20m.

4.1.1 Local Control Panels

Unless otherwise agreed with NRW, local control panels (LCP's) will be in accordance with British Standards and relevant WIMES[2], incorporating equipment as detailed on the LCP WIMES data sheets. The LCPs will be freestanding, bottom cable entry, front cable access. The LCP's will consist of the following;

- lockable anti-vandal / tampering cover / door;
- suitable all-weather kiosk / housing;
- electrical isolator switch;
- emergency stop button;
- 'On', 'Off' and 'Hand' control switches and indicator lamps;
- CEE industrial plug type plug connection for power supply cable; and
- local digital readout for pressure transducer.

4.2 Pipework

Unless otherwise agreed with NRW, all pipework will be welded pipework comprised of HDPE smooth bore PE80 SDR 11, rated to 10 bar and made to DIN8074/75 specification.

Carrier mains are to be buried and provided with marker tape once sufficient areas of permanent landfill cap have been placed in the required locations.

Signal and power cabling will run alongside pipework where pipework routes are temporary (e.g.: where on-waste) and within a common trench where buried (e.g.: the carrier main).

Pipework will be sized such that the total system head and pump type chosen allow a flow rate at the well head as specified above in Section 4.5.1 or 4.5.2.

Typically, carrier mains will be of 90mm diameter, stepping down progressively to 63mm and 25mm for down-well pipework.

4.3 Control Systems

4.3.1 Level sensors

Unless otherwise agreed with NRW, each down well pump will be installed with a level sensor to provide on/off signals to the local pump. Pump 'off' level will be set to ensure that the pump remains submerged below the liquid level. Pump 'on' level will be set above the 'off' level but below the trigger level for the well in the site's environmental permit.

Unless otherwise agreed with NRW, each leachate tank that is capable of independent filling with leachate from automated pumping systems will be installed with level sensor(s) to provide control of pumping into the tank from the down well leachate pumps to prevent overtopping. One switch should provide normal operational full control (sending a signal to de-energise the mains supply to the pumps when the tank is full and to re-energise when the tank has spare capacity).

A second, fully independent level sensor (including separate signal wiring back to the mains power supply) should be installed at a slightly higher level in the tank system to act as a back-up, fail-safe system to ensure pumps cannot overtop the tank should the first level sensor system fail to operate.

4.3.2 Flow-metering

Unless otherwise agreed with NRW, each outlet from the headworks of the new pumped leachate sumps will be fitted with a suitable flow meter (suitably sized to fit on the riser pipe or the connection spurs) that can display instantaneous flow (in l/s) and / or records and displays totalised flow (in m^3).

4.4 Leachate Storage

Unless otherwise agreed with NRW a leachate storage tank or tanks will be provided to collect leachate pumped from the landfill. The tank(s) will be located off the landfill near the site offices / weighbridge and access road to the public highway so that it can be accessible to road going articulated tankers. Any tank installed will conform with relevant best practice, currently contained within the CIRIA C736[3] Guide and the Industry Code of Practice[4]. The tank and tankering facility will consist of the following:

- roofed / enclosed tank (or tanks) constructed from suitable plastics (for example HDPE), glass reinforced plastic, mild steel or concrete;
- level control device to prevent overfilling of tank
- inlet automated valve to isolate tank and prevent from over filling due to effects such as siphoning
- inlet and outlet apertures for leachate in and leachate out plus suitably sized air vent, roof mounted (so that inlet and outlet of tank is 'up-and-over' design rather than tank wall penetration);
- manway in roof to allow internal inspection and sludge removal (if necessary);
- secondary containment bund at 110% capacity of largest tank contained (or 25% of total volume of contained tanks, whichever is the largest) including bund water detection device (level sensor) and bund water pump

[3] Containment systems for the prevention of pollution: Secondary, tertiary and other measures for industrial and commercial premises'. CIRIA C736, 2014.
[4] 'UK Landfill Industry Code of Practice: The Establishment of Appropriate Standards for Leachate Storage Infrastructure'. Published by ESA, 2017.

- suitable access arrangements (ladder or access steps to top of tank); and
- tanker loading bay to consist of the following;
  - hardstanding, impervious surface loading bay of sufficient size to accommodate an articulated tanker;
  - loading bay to fall to a low point beneath which is installed a sump to collect any spills or drips;
  - pump with automated start / stop triggered by presence of liquid to empty sump back to tank.
  - tanker connection point with locking Bauer connection.

4.4.1 Minimum Leachate Storage Capacities

The leachate storage tanks should have enough capacity to enable buffering and blending of flow and leachate quality.

The main leachate storage tank, as described above, should have a minimum storage capacity of 30m^3 so that a single articulated tanker load can be removed in one collection.

Additional leachate storage capacity may also be provided in the form of 'intermediate' tanks located on the waste mass or within the footprint of the landfill site as a means of enabling leachate pumping during active waste deposit. In these circumstances the exact nature of the tank and its set up will vary from that described above. However, all tanks located outside of containment (including on-waste but above final capping) will be required to have secondary containment provided.

On-site total leachate storage capacity should also have capacity to hold at least 3 days of maximum leachate production so that leachate pumping can continue even if off-site disposal outlets are closed. Most off-site disposal outlets accept leachate on weekdays and on Saturdays but are generally closed on Sundays and Bank Holidays. Therefore, in most circumstances 3 days of on-site storage is enough to enable 24/7 pumping of leachate from the waste mass if required (i.e. Christmas shutdown falling around a Sunday). Bearing in mind the need for a minimum of 30m^3 storage capacity described above to enable economic removal of leachate from the site, the following storage capacity reequipments are estimated for the site;

- minimum leachate storage capacity = 30m^3;
- maximum leachate storage capacity = 105m^3 (last year of filling); and
- post closure leachate storage capacity = 30m^3 (actual is 8.5m^3 but default to 30m^3 minimum for economic tankering).

Note that the above capacities are defined using the pre-adsorption leachate generation volumes. Operational experience indicates that these capacities can be reduced if leachate is found to be readily adsorbed into freshly deposited wastes. Calculations from Table 3-2 indicate that the maximum leachate storage capacity could fall to 78m^3 in the last year of filling.

4.5 System Design Parameters

Elements of the leachate pumping and storage infrastructure should be designed around the following parameters.

4.5.1 Open Site Leachate Pump System Design Parameters

Leachate Quality

All infrastructure that is to come into contact with leachate should be constructed from materials that will not be adversely affected by liquids with qualities similar to those described in Table 3-4.

When selecting materials for use in leachate management infrastructure it should also be considered that equipment is likely to be repeatedly flooded and then exposed to air. In addition, scaling is likely to form in infrastructure conveying or storing leachate (usually from precipitation of calcium bicarbonate).

Finally, leachates generated from putrescible wastes may also contain significant concentrations of dissolved methane. As such at Parry's Quarry landfill, infrastructure should be assessed for the presence of hazardous atmospheres in accordance with the relevant Industry Code of Practice [5] that essentially defines the following zones:

- below leachate liquid surface; non-hazardous;
- above liquid surface but below cover / roof / lid (for example, in a leachate well or tank headspace; zone 1; and
- around vent points from a leachate well head or tank roof; zone 2 (radii vary generally from around 1m to 2.2m).

Leachate Quantity

The following maximum leachate generation rates are anticipated during the operational phase of the landfills life;

- single cell: 9,985m^3/yr (Cell 1 when uncapped) or 28m^3/day; and
- whole site: 12,569m^3/yr (final operational year) or 35m^3/day.

During the operational phase of the landfill, pump systems installed to each new cell will be designed to be capable of removing at least 150% of the maximum anticipated single cell annual generation rate so that some redundancy is built into the leachate pumping system to allow for contingencies such as, for example, 'catch-up' pumping should down-time be experienced for any reason or 'run-in' from adjacent filling areas.

This equates to an annual pumping rate of 9,985m^3/yr x 1.5 or 14,978m^3/yr.

This means that pump and pipework systems will be designed and selected to achieve a minimum theoretical yield of 0.47l/s at each well head.

Leachate carrier mains, disposal infrastructure and outlets will have capacity to deal with the maximum anticipated rate of leachate generation, up to 12,569m^3/yr, this figure already having redundancy built into it as it assumes that no adsorption will take place in freshly deposited waste.

Employing one pump per cell results in a combined theoretical flow rate of 3.79l/s, this being equivalent to nearly 120,000m^3/yr, far more than the required 12,569m^3/yr. In addition, a well head flow rate per pump of 0.47l/s is well within the performance specification of commonly used electrical submersible leachate pumps. Therefore, a single pump per cell that can yield at least 0.47l/s is enough to provide adequate pumping capacity in each cell and for the site as a whole.

[5] 'UK Landfill Industry Code of Practice: Area Classification for Leachate extraction, Treatment & Disposal, ESA ICoP 03'. Published by ESA, 2006.

4.5.2 Closed Site Leachate Pump System Design Parameters

Once landfill cells are filled and permanently capped, the leachate system design parameters could be relaxed as leachate generation rates will fall considerably due to the very low permeability of the presence of the low permeability cap. For the post-closure period the maximum anticipated leachate generation rates are;

- Single cell: 516m^3/yr; and
- Whole site: 3,053m^3/yr.

During the aftercare phase of the landfill, pump systems installed to each cell may be re-designed to be capable of removing at least 150% of the maximum anticipated single cell annual generation rate so that some redundancy is built into the leachate pumping system to allow for contingencies such as, for example, 'catch-up' pumping should down-time be experienced for any reason or 'run-in' from adjacent filling areas.

This equates to an annual pumping rate of 516m^3/yr x 1.5 or 774m^3/yr.

This means that pump and pipework systems will be designed and selected to achieve a minimum theoretical yield of 0.025l/s at each well head.

Leachate carrier mains, disposal infrastructure and outlets will have capacity to deal with the maximum anticipated rate of leachate generation, up to 3,053m^3/yr, this figure already having redundancy built into it as it assumes that no adsorption will take place in freshly deposited waste.

Employing one pump per cell results in a combined theoretical flow rate of 0.2l/s, this being equivalent to nearly 6,307m^3/yr, more than the required 3,053m^3/yr. In addition, a well head flow rate per pump of 0.025l/s is well within the performance specification of commonly used electrical submersible leachate pumps. Therefore, a single pump per cell that can yield at least 0.025l/s is enough to provide adequate pumping capacity in each cell and for the site as a whole.

5.0 Assessment of Disposal Options

Leachate is estimated to be generated from the Parry's Quarry landfill at a rate of between 3,053m^3/yr and 12,569m^3/yr with a more likely maximum rate for disposal of circa. 9,494m^3/yr.

This suggests that during active filling leachate disposal requirements will equate to between 26m^3/day – 35m^3/day. However, this period of maximum production is likely to be relatively short lived, even if the total time to complete waste deposit at the landfill is closer to 20 years than the currently modelled 8 years.

If an aftercare period of 60 years is presumed, the total volume of leachate generated at the site will be 227,513m^3 (53,508m^3 over the 8 operational years and 183,164m^3 over 60 aftercare years). This is an average of just less than 10m^3/day for the entire period.

Even if the operational period is doubled (and so the volume of leachate generated is doubled for this period) the total leachate generation is only increased to 290,180m^3 (107,016m^3 over the 16 operational years and 183,164m^3 over 60 aftercare years). This is an average of just over 10m^3/day for the entire period.

For on-site treatment of leachate to a standard typically required for disposal to the public sewer or controlled waters an average daily flow of nearer to 50m^3/day is usually needed for a period of greater than 15 years for construction and operation of a suitable leachate treatment plant to be economically viable versus the cost of tankering to 3rd party outlet.

It is therefore most likely that tankering of leachate from site to suitably licensed 3rd party disposal sites is the most likely option for Parry's Quarry landfill.

5.1 3rd Party Tanker Disposal

Leachate from the Parry's Quarry landfill site is most likely to be disposed of via road tanker to suitably permitted off-site facilities.

The leachate quality (see Table 3-4) and volumes (see Table 3-2) predicted for the site are well within the ranges of acceptable criteria for local 3rd party disposal outlets that operate within the region. Most leachates produced from sites within northeast Wales and the northwest of England (Cheshire, Lancashire and Manchester areas) typically are disposed of to one of the United Utilities Sewage Works that are licensed to accept such input via road tanker. There are also several smaller companies that provide similar services within economic tankering from the Parry's Quarry site.

The following 3rd Party disposal outlets (along with their approximate distance by road) are known to exist within 50 miles of Parry's Landfill. They are known to have accepted, within the last 5 years, leachate of similar quality to those anticipated as being derived from Parry's Quarry landfill. They are also known to have between them accepted more than 100,000m^3/yr of landfill leachate from a single customer whilst also accepting similar quantities from other landfill operators at the same time;

- United Utilities Ltd at Ellesmere Port WwTW (Merseyside) – 12 miles;
- Avanti Environmental (now Tradebe) at Knowsley (Liverpool) – 36 miles;
- CSG at Cadishead (Manchester) – 36 miles;
- Future Industrial Services Ltd at Knowsley (Liverpool) – 43 miles;
- Caste Environmental Ltd at Longport (Stoke-on-Trent) – 44 miles; and
- United Utilities Ltd at Daveyhulme WwTW (Manchester) – 47 miles.

It is therefore considered that there is enough capacity in the regional market for acceptance and disposal of landfill leachate should leachate generated at Parry's Wood landfill be disposed of via this route for the duration of its operational and aftercare phases.

5.2 On-Site Leachate Treatment

As discussed above, tankering of leachate from site for disposal at a 3rd Party is the most likely leachate disposal option. However, should on-site treatment of leachate be considered necessary it would first be required to find a suitable outlet for treated leachate effluent.

In the first instance access to a suitable public sewer would be required. It is known that the near-by Brookhill Landfill Site operated by AD Waste constructed a 100m^3/day capacity Sequencing Batch Reactor type leachate treatment plant that discharges to the local sewer network. This site is approximately 1.2km to the southeast of the Parry's Quarry site and so it may be possible that access to the sewer network could be possible.

Without access to the sewer network, a discharge to controlled surface waters would be required. The nearest surface water feature to the Parry's Quarry site is the Alltami Brook, approximately 350m to the northwest of the site.

In both cases a discharge consent would need to be agreed with NSW, this would almost certainly require completion of both a qualitative and quantitative H1 Risk Assessment. For a discharge to the public sewer, there would also be a need for a Trade Effluent agreement with the local sewer operator, United Utilities.

To assess whether on-site leachate treatment is technically feasible at the Parry's Quarry site, the anticipated leachate quality (maximum value for the operational phase) will be used to assess the likely treated leachate quality that would be produced from a 'standard' Sequence Batch Reactor (SBR) type LTP should one be constructed for the landfill. This will then be compared to 'typical' consent values for discharges to the public sewer and to controlled surface waters for critical substances, bearing in mind that the site is in the Dee Water Protection Zone but that the Alltami Brook and the Wepre Brook that it flows into, and the Dee downstream from the confluence with the Wepre Brook is not in a designated Nitrate Vulnerable Zone (so reduction in total nitrogen may not be required).

Table 5-1: Review of Potential Treated leachate Quality and Discharge Consent Value

Analyte	Unit	Raw Leachate	Anticipated Reduction % in an SBR	Estimated Treated Effluent	Indicative Discharge Consent Value Ranges	
					Sewer	Surface Water
Ammoniacal Nitrogen as N	mg/l	1,025	100%	5	50 – 250	5 – 10
Arsenic, Total as As	mg/l	0.14	0%	0.14	0.5 – 1.0	0.01 – 0.5
BOD + ATU (5 day)	mg/l	500	100%	3	100 – 500	10 - 50
Cadmium, Total as Cd	mg/l	0.0009	20%	0.0007	0.5 – 1.0	0.001 – 0.01
Chloride as Cl	mg/l	4,035	0%	4,035	1,000 – 5,000	250 – 5,000
Chromium, Total as Cr	mg/l	0.23	47%	0.12	1.0 – 3.0	0.1 – 0.3
COD	mg/l	2,467	80%	493	1,000 – 3,000	500 – 1,500
Copper, Total as Cu	mg/l	0.13	0%	0.13	3.0 – 5.0	0.5 - 1
Iron, Total as Fe	mg/l	9	55%	4	15 – 50	2.5 - 10

Analyte	Unit	Raw Leachate	Anticipated Reduction % in an SBR	Estimated Treated Effluent	Indicative Discharge Consent Value Ranges	
					Sewer	Surface Water
Lead, Total as Pb	mg/l	0.06	20%	0.05	3.0 – 5.0	0.1 – 0.05
Nickel, Total as Ni	mg/l	0.13	0%	0.13	2.0 – 5.0	0.1 – 1.0
pH	pH unit	9	-	7.5	5 - 11	6 - 9
Sulphate as SO_4	mg/l	160	0%	160	1,000 – 1,500	500 – 1,000
Total Suspended Solids	mg/l	100	83%	17	1,000 – 3,000	20 - 100
Zinc, Total as Zn	mg/l	1	60%	0.4	3.0 – 5.0	0.2 – 3.0

This review is summarised in Table 5-1 and indicates that on-site treatment in an SBR could produce an effluent that may be acceptable for discharge to the public sewer. However, production of an effluent that is likely to be acceptable for discharge to surface water is less likely with ammonia, COD, chloride and a range of metals potentially being at higher concentrations than may be acceptable. Improved effluent quality could be achieved employing alterative or additional treatment process such a membrane filtration or effluent polishing in constructed wetlands, but this would be costly and could potentially require a large area of land.

Clearly this assessment is indicative only and, should on-site treatment of leachate be considered in future, a full assessment of both the availability of local sewer access and any discharge consent limits to either a sewer or surface water will need to be completed in detail. It does however indicate that on-site treatment and discharge to sewer in particular is, technically, a viable option for the site if a sewer is available. Options to construct and operate such a system should remain open albeit that tankering from the site is the most likely leachate disposal route.

6.0 Leachate Management Techniques

Management of leachate at the site will be undertaken with the aim of maintaining leachate levels below the limits proposed within the HRA, this being 1.5m above lowest point at base of cell during operational filling and up to 3.5m in the post-closure management period of the site. This will be achieved by abstracting enough leachate, assumed to be equivalent to the leachate generation rates calculated in Section 3.2, so that a stable leachate level is maintained below the compliance limits.

Other techniques that will be incorporated into the site's management practices to assist with the control of leachate include management of the open (uncapped) area of waste, maintenance of a freeboard in the leachate storage tanks and the design risk assessment of pipework installations.

6.1 Uncapped Waste Areas

So that the rate of leachate generation is limited to manageable volumes, unless otherwise agreed with NRW, areas of uncapped waste will be controlled to the maximum uncapped areas modelled as part of the leachate generation assessment detailed in Appendix 01.

This equates to an uncapped area of 16,648m^2 (calculated for year 1of the site development model where Cell 1 is open).

An open area of this size would be likely to generate a maximum of 9,985m^3/yr of leachate. This volume, which equates to an instantaneous flow rate of 0.32l/s, is within the maximum performance of widely available electrical submersible borehole pumps commonly employed on landfill sites that would also conform with the outline specification laid out in Section 4.1. This flow rate is below the minimum single cell flow rate capacity calculated in Section 4.5.1 of 0.47l/s. Therefore, it is considered that the current site phasing plan and leachate infrastructure proposals are adequate to control leachate to proposed levels.

Should a larger open area be required at the site, a reassessment of the likely leachate generation volumes and the adequacy of pumping and disposal arrangements will be submitted to NRW for agreement, demonstrating that suitable arrangements for leachate pumping and disposal are still in place at the site.

6.2 Surface Water Management

The site will be engineered and operated to ensure that, as far as is possible, clean surface water is diverted away from exposed areas of waste and drained away from the landfilled areas of site to be dealt with as clean surface water drainage. This will reduce the volume of liquid entering the landfill and so help to control the generation of leachate.

This will be accomplished by various methods including the following;

- temporary segregation of landfill cell basal drainage before the cell floor is fully covered with waste;
- provision of temporary capping to areas of waste that will not be permanently capped or landfilled for prolonged period of time;
- early installation of permanent cap wherever possible and practical;
- formation of a 'domed' final landfill profile to encourage run-off from capped areas away from active landfilling; and
- Provision of drainage ditches, contour drains etc to prevent ponding of surface water on the landfill surface and cap

Surface water will be protected wherever possible from the risk of contamination from leachate by various method including the following;

- Locating leachate management infrastructure such as pipework and storage facilities as far from surface water management features as possible and practicable;
- Proving secondary containment where risk assessment shows it to be required, in particular this will include the installation of secondary containment (bunding) to leachate storage tanks; and
- Maintaining enough 'free-board' between the leading toe of any waste batter and any external retaining bund to reduce the risk of leachate seepages running directly off uncapped waste flanks into surface water features or uncontained areas.

6.3 Leachate Re-circulation

Leachate re-circulation was not explicitly included within the models used for the sites original HRA. However, this does not rule out future leachate re-circulation occurring at the site for the following reasons;

- within the HRA risk assessment modelling, leachate heads were fixed within certain assumed ranges. As long as these ranges are maintained while re-circulation is occurring, then it is considered that this provides a sufficient appreciation of the risks; and
- the inclusion of leachate re-circulation within the models could potentially decrease the longevity of the source term, which, in turn, could potentially reduce the risks associated with the development.

If leachate re-circulation is introduced at the site within the waste mass, it is noted that no revision of the site's HRA would be required prior to its commencement, as long as leachate heads were maintained within the relevant compliance limits. As such, a key factor in determining if leachate re-circulation can take place in any given location is whether the cell into which leachate will be recirculated is in compliance with leachate level limits. Leachate should not be re-circulated into cells where leachate is present at above compliant levels.

Leachate re-circulation will not be introduced at the site without having first agreed a method of re-circulation with NRW. Any such method is likely to be informed by information contained within document 'A technical assessment of leachate recirculation'[6].

It is also likely that as part of the works to install final capping and restoration of the finished landfill surface that a sub-cap engineered leachate re-circulation will be installed so that the option to re-circulate leachate within the site in a controlled and safe manner is maintained for the aftercare period.

The need to connect to and operate any re-circulation infrastructure at Parry's Quarry landfill will be periodically reviewed by the site management team and will not be undertaken without first having informed NRW of the intention to do so.

6.4 Monitoring

Monitoring of the site to assist with leachate management will include leachate level and quality monitoring as per the proposals in the HRA. To ensure that leachate collection points are functioning correctly this will also include a 6-monthly plumb to the base of chambers and a comparison to as-built basal foundation levels. If the base of chambers are found to be inaccessible through siltation or other obstructions (allowing for some degree

[6] 'Evidence: A Technical Assessment of Leachate Recirculation'. Published by the EA, 2009.

of error in the plumb to base reading) further investigations and possible remedial action will be taken. Actions may include the following:

1. Re-survey of location and checking of as-built information;
2. If required after 1., closed circuit television survey of location to determine details of issues;
3. Depending on the outcome of 2., consideration of the following additional actions;
    - De-silt of the well using sludge pumps, air lift or suction tanker (or other appropriate methods) as appropriate; and/or
    - Removal of debris using 'down well' grabs etc; and/or
    - Re-sleeve of well; or
    - Retro-drill of replacement well.

Records of leachate production volumes as flow (at each well head) and total tonnage removed from site will be recorded on a monthly basis.

The proposed leachate monitoring regime also includes for analysis of leachate quality from both individual wells and from storage tank(s) to ensure that the site remains within the range of conditions assessed in the HRA but also to assist with planning and management of leachate disposal activities (and so includes parameters that would enable a suitable treatment process to be designed in the future and would also allow a suitable dataset to be collected for completion of H1 assessment). The following leachate monitoring regime is proposed for the operational phase of landfilling (see Table 6-1).

Once landfilling ceases and the site enters its closure period, this leachate monitoring regime should be re-assessed, and any proposed changes agreed with NRW.

6.5 Leachate Level Action Plan

Compliance limits have been proposed for the parry's Quarry landfill in the HRA. In the event that leachate levels, reported as per the monitoring regime proposed in Section 6.4, rise to within 0.2m of the compliance limit, removal of leachate will commence via the installed leachate pumping system as described in Section 4.0. Leachate will then be disposed of or re-circulated as described in Section 6.3 and 5.0 respectively.

Should leachate level compliance limits be breached, a contingency action plan is presented below:

- advise landfill site management within 24 hours;
- confirm by repeat measurement;
- advise NRW within 48 hours;
- review existing monitoring information;
- check and confirm efficiency and operation of the leachate extraction system within 2 weeks;
- review site management and operations, and implement actions to prevent future breach of compliance limit e.g. increased abstraction or the installation of additional leachate wells; and
- if levels cannot be reduced to below compliant limits;
    - review the assumptions incorporated into the site conceptual model;
    - review existing hydrogeological risk assessment;

- if risks are unacceptable, set in place procedures for implementing corrective measures in consultation with or as required by the NRW.

6.6 System Maintenance and Inspection

All leachate management equipment and infrastructure will be maintained in good working order and in accordance with the supplier or manufacturer's recommendations. Leachate management equipment and infrastructure will be routinely inspected by the site or aftercare management team as appropriate. Inspections will be undertaken at least annually and will be recorded within the site log. Any defects will be reported to the responsible manager and will be rectified as soon as practical.

All leachate system maintenance schedules will incorporate an annual service of moving parts, together with checks and cleaning of flow meters and level indicator equipment. This process is will be completed by suitably trained operators or specialist contractor as appropriate.

Any MCERTS flow meters will be checked and calibrated on an annual basis by an accredited specialist contractor or as otherwise agreed with NRW. Records of calibrations will be retained as part of the sites Business Management Systems.

Records of service, maintenance, and calibration will also be retained as part of the sites Business Management System.

Surface water drainage ditches and sumps are to be inspected by the site management team as appropriate at a minimum annual frequency and recorded within the site log. Any blockages or sediment build-up will be cleared as soon as is practical.

If the inspection and review process identify potential shortfalls in the provision of the existing leachate management facilities at the installation, action will be taken as soon as practical to enhance system capability. This action may include the following:

- increase in capacity of leachate pumping facilities;
- installation of additional leachate re-circulation infrastructure; and
- installation of additional leachate storage and/or disposal infrastructure.

Table 6-1: Parry's Quarry Landfill Proposed Leachate Monitoring Schedule

Interval	Monitoring Type	Sample Points	Monitoring Determinands	Sampling Determinands
Monthly	Leachate	All Combined Pumping and Monitoring Wells	Field Log[1], leachate level[2], pump status[3], pump volume[4]	-
		All Monitoring Only Wells	Field Log[1], leachate level[2]	-
	Leachate Storage	Leachate Tank(s)	Field Log[1], Disposal volume[5]	-
	Leachate Re-Circulation	Re-circulation points(s)	Field Log[1], Re-circulation volume[6]	-
Quarterly	Leachate	All Combined Pumping and Monitoring Wells	Field Log[1], leachate level[2], pump status[3], pump volume[4]	Ammoniacal Nitrogen, Arsenic, BOD, COD, Cadmium, Chloride, Chromium, Copper, EC, Iron, Lead, Nickel, Oil and Grease, pH, Sulphate, Total Dissolved Solids, Total Suspended Solids, Temperature, Zinc
		All Monitoring Only Wells	Field Log[1], leachate level[2]	-
	Leachate Storage	Leachate Tank(s)	Field Log[1], Re-circulation volume[5]	Ammoniacal Nitrogen, Arsenic, BOD, COD, Cadmium, Chloride, Chromium, Copper, EC, Iron, Lead, Nickel, Oil and Grease, pH, Sulphate, Total Dissolved Solids, Total Suspended Solids, Temperature, Zinc
	Leachate Re-Circulation	Re-circulation points(s)	Field Log[1], Re-circulation volume[6]	-
6 Monthly	Leachate Levels	All Combined Pumping and Monitoring Wells	Field Log[1], leachate level, base of sump level[2], pump status[3], pump volume[4]	Ammoniacal Nitrogen, Arsenic, Alkalinity, BOD, COD, Cadmium, Calcium, Chloride, Chromium, Copper, EC, Iron, Lead, Magnesium, Manganese, Nickel, Oil and

				Grease, pH, Potassium, Sodium, Sulphate, Total Alkalinity, Total Dissolved Solids, Total Suspended Solids, Temperature, Zinc
		All Monitoring Only Wells	Field Log[1], leachate level, base of sump level[2]	-
	Leachate Storage	Leachate Tank(s)	Field Log[1], Re-circulation volume[5]	Ammoniacal Nitrogen, Arsenic, Alkalinity, BOD, COD, Cadmium, Calcium, Chloride, Chromium, Copper, EC, Iron, Lead, Magnesium, Manganese, Nickel, Oil and Grease, pH, Potassium, Sodium, Sulphate, Total Alkalinity, Total Dissolved Solids, Total Suspended Solids, Temperature, Zinc
	Leachate Re-Circulation	Re-circulation points(s)	Field Log[1], Re-circulation volume[6]	-
Annually	Leachate Levels	All Combined Pumping and Monitoring Wells	Field Log[1], leachate level[2], pump status[3], pump volume[4]	Ammoniacal Nitrogen, Arsenic, Alkalinity, BOD, COD, Cadmium, Calcium, Chloride, Chromium, Copper, EC, Iron, Lead, Magnesium, Manganese, Nickel, Oil and Grease, pH, Potassium, Sodium, Sulphate, Total Alkalinity, Total Dissolved Solids, Total Suspended Solids, Temperature, Zinc, Benzene, Phenol, Naphthalene
		All Monitoring Only Wells	Field Log[1], leachate level[2]	-
	Leachate Storage	Leachate Tanks(s)	Field Log[1], Re-circulation volume[5]	Ammoniacal Nitrogen, Arsenic, Alkalinity, BOD, COD, Cadmium, Calcium, Chloride, Chromium, Copper, EC, Iron, Lead, Magnesium, Manganese, Nickel, Oil and Grease, pH, Potassium, Sodium, Sulphate, Total Alkalinity, Total Dissolved Solids, Total Suspended Solids, Temperature, Zinc, Benzene, Phenol,

				Naphthalene plus remaining Priority & 'Other' Substances List (see Appendix 03)
	Leachate Re-Circulation	Re-circulation points(s)	Field Log[1], Re-circulation volume[6]	-

Notes

1 For each sample point visited: site name, sample point name, date, time, monitoring technician name, monitoring equipment used, calibration details of equipment used, weather at time of monitoring, any relevant comments.

2 If a pressure transducer installed, liquid head above base of well, converted to level relative to ordnance datum. If a vertical well using a dip tape, dip to liquid converted to liquid level relative to ordnance datum. If a side slope riser using a dip tape, use Pythagorean theorem to convert dip to leachate to leachate level relative to ordnance datum

3 Record current status of pump (on/off at time of monitoring) and time since pump last active (if known)

4 Record volume pumped since last visit

5 Record volume disposed of from site since last visit to each destination

6 Record volume re-circulated to each location since last visit

APPENDIX 01

Leachate Generation Models

Parrys Quarry: Leachate Management Yr 1

Parameter	(m/yr)	Notes
Precipitation	0.800	1 - ESIDX MORECS data for square 104 – Long-term average 1971 to 2000 for grass land use with median available water capacity (AWC) soil type
Evaporation Rate	25%	2 - HER from reference 1 (above) is 261.8mm/yr, this represents a 67% loss from rainfall. A conservative figure of 25% loss has been used instead.
Rainfall Infiltration Open Cell after evaporation	0.600	
Rainfall Infiltration Temp Cap / Slopes	0.100	3 - Assumption based on SLR experience
Rainfall Infiltration Hi Q Cap	0.031	4 - Based on calcuation Q = $(1x10^{-9})$ x $1m^2$ x (1m / 1m) x 86400 x 365 = 31.5mm per year
Groundwater Infiltration Rate	0.000	5 - Not applicable, above groundwater landfill

Phase	Total Area (m²)	Permanent Hi Q Cap Area (m²)	Temp/Sloping Area (m²)	Open Cell Area (m²)	Basal Area Subject to Groundwater Infiltration (m²)	Leachate Production (m³/yr)
Cell 1	16,648	0	0	16,648	0	**9,985**
Cell 2	10,823	0	0	0	0	**0**
Cell 3	10,042	0	0	0	0	**0**
Cell 4	9,821	0	0	0	0	**0**
Cell 5	12,065	0	0	0	0	**0**
Cell 6	11,637	0	0	0	0	**0**
Cell 7	13,340	0	0	0	0	**0**
Cell 8	14,099	0	0	0	0	**0**
Totals	**98,475**	**0**	**0**	**16,648**	**0**	**9,985**

Implied tonnage/annum	307,500
Absorptive Capacity (t/m3)	1.0%
Modelled Leachate Volume (m³/yr)	**6,910**

	m3/day
Av daily volume (m3/day) >>	**19**
Variance: Hi vol	**28**
Variance: Lo vol	**13**

Parrys Quarry: Leachate Management Yr 2

Parameter	(m/yr)	Notes
Precipitation	0.800	1 - ESIDX MORECS data for square 104 – Long-term average 1971 to 2000 for grass land use with median available water capacity (AWC) soil type
Evaporation Rate	25%	2 - HER from reference 1 (above) is 261.8mm/yr, this represents a 67% loss from rainfall. A conservative figure of 25% loss has been used instead.
Rainfall Infiltration Open Cell after evaporation	0.600	
Rainfall Infiltration Temp Cap / Slopes	0.100	3 - Assumption based on SLR experience
Rainfall Infiltration Hi Q Cap	0.031	4 - Based on calcuation Q = $(1x10^{-9})$ x $1m^2$ x (1m / 1m) x 86400 x 365 = 31.5mm per year
Groundwater Infiltration Rate	0.000	5 - Not applicable, above groundwater landfill

Phase	Total Area (m^2)	Permanent Hi Q Cap Area (m^2)	Temp/Sloping Area (m^2)	Open Cell Area (m^2)	Basal Area Subject to Groundwater Infiltration (m^2)	Leachate Production (m^3/yr)
Cell 1	16,648	8,324	8,324	0	0	**1,090**
Cell 2	10,823	0	0	10,823	0	**6,491**
Cell 3	10,042	0	0	0	0	**0**
Cell 4	9,821	0	0	0	0	**0**
Cell 5	12,065	0	0	0	0	**0**
Cell 6	11,637	0	0	0	0	**0**
Cell 7	13,340	0	0	0	0	**0**
Cell 8	14,099	0	0	0	0	**0**
Totals	**98,475**	**8,324**	**8,324**	**10,823**	**0**	**7,582**

Implied tonnage/annum	307,500
Absorptive Capacity (t/m3)	1.0%
Modelled Leachate Volume (m^3/yr)	**4,507**

	m3/day
Av daily volume (m3/day) >>	**12**
Variance: Hi vol	**19**
Variance: Lo vol	**8**

Parrys Quarry: Leachate Management Yr 3

Parameter	(m/yr)	Notes
Precipitation	0.800	1 - ESIDX MORECS data for square 104 – Long-term average 1971 to 2000 for grass land use with median available water capacity (AWC) soil type
Evaporation Rate	25%	2 - HER from reference 1 (above) is 261.8mm/yr, this represents a 67% loss from rainfall. A conservative figure of 25% loss has been used instead.
Rainfall Infiltration Open Cell after evaporation	0.600	
Rainfall Infiltration Temp Cap / Slopes	0.100	3 - Assumption based on SLR experience
Rainfall Infiltration Hi Q Cap	0.031	4 - Based on calcuation Q = $(1x10^{-9})$ x $1m^2$ x (1m / 1m) x 86400 x 365 = 31.5mm per year
Groundwater Infiltration Rate	0.000	5 - Not applicable, above groundwater landfill

Phase	Total Area (m^2)	Permanent Hi Q Cap Area (m^2)	Temp/Sloping Area (m^2)	Open Cell Area (m^2)	Basal Area Subject to Groundwater Infiltration (m^2)	Leachate Production (m^3/yr)
Cell 1	16,648	8,324	8,324	0	0	**1,090**
Cell 2	10,823	3,608	7,215	0	0	**833**
Cell 3	10,042	0	0	10,042	0	**6,023**
Cell 4	9,821	0	0	0	0	**0**
Cell 5	12,065	0	0	0	0	**0**
Cell 6	11,637	0	0	0	0	**0**
Cell 7	13,340	0	0	0	0	**0**
Cell 8	14,099	0	0	0	0	**0**
Totals	**98,475**	**11,932**	**15,539**	**10,042**	**0**	**7,947**

Implied tonnage/annum	307,500
Absorptive Capacity (t/m3)	1.0%
Modelled Leachate Volume (m^3/yr)	**4,872**

	m3/day
Av daily volume (m3/day) >>	**13**
Variance: Hi vol	**20**
Variance: Lo vol	**9**

Parrys Quarry: Leachate Management Yr 4

Parameter	(m/yr)	Notes
Precipitation	0.800	1 - ESIDX MORECS data for square 104 – Long-term average 1971 to 2000 for grass land use with median available water capacity (AWC) soil type
Evaporation Rate	25%	2 - HER from reference 1 (above) is 261.8mm/yr, this represents a 67% loss from rainfall. A conservative figure of 25% loss has been used instead.
Rainfall Infiltration Open Cell after evaporation	0.600	
Rainfall Infiltration Temp Cap / Slopes	0.100	3 - Assumption based on SLR experience
Rainfall Infiltration Hi Q Cap	0.031	4 - Based on calcuation Q = $(1x10^{-9})$ x $1m^2$ x (1m / 1m) x 86400 x 365 = 31.5mm per year
Groundwater Infiltration Rate	0.000	5 - Not applicable, above groundwater landfill

Phase	Total Area (m^2)	Permanent Hi Q Cap Area (m^2)	Temp/Sloping Area (m^2)	Open Cell Area (m^2)	Basal Area Subject to Groundwater Infiltration (m^2)	Leachate Production (m^3/yr)
Cell 1	16,648	8,324	8,324	0	0	**1,090**
Cell 2	10,823	3,608	7,215	0	0	**833**
Cell 3	10,042	3,347	6,695	0	0	**773**
Cell 4	9,821	0	0	9,821	0	**5,890**
Cell 5	12,065	0	0	0	0	**0**
Cell 6	11,637	0	0	0	0	**0**
Cell 7	13,340	0	0	0	0	**0**
Cell 8	14,099	0	0	0	0	**0**
Totals	**98,475**	**15,279**	**22,234**	**9,821**	**0**	**8,587**

Implied tonnage/annum	307,500
Absorptive Capacity (t/m3)	1.0%
Modelled Leachate Volume (m^3/yr)	**5,512**

	m3/day
Av daily volume (m3/day) >>	**15**
Variance: Hi vol	**23**
Variance: Lo vol	**10**

Parrys Quarry: Leachate Management Yr 5

Parameter	(m/yr)	Notes
Precipitation	0.800	1 - ESIDX MORECS data for square 104 – Long-term average 1971 to 2000 for grass land use with median available water capacity (AWC) soil type
Evaporation Rate	25%	2 - HER from reference 1 (above) is 261.8mm/yr, this represents a 67% loss from rainfall. A conservative figure of 25% loss has been used instead.
Rainfall Infiltration Open Cell after evaporation	0.600	
Rainfall Infiltration Temp Cap / Slopes	0.100	3 - Assumption based on SLR experience
Rainfall Infiltration Hi Q Cap	0.031	4 - Based on calcuation Q = $(1x10^{-9})$ x $1m^2$ x (1m / 1m) x 86400 x 365 = 31.5mm per year
Groundwater Infiltration Rate	0.000	5 - Not applicable, above groundwater landfill

Phase	Total Area (m^2)	Permanent Hi Q Cap Area (m^2)	Temp/Sloping Area (m^2)	Open Cell Area (m^2)	Basal Area Subject to Groundwater Infiltration (m^2)	Leachate Production (m^3/yr)
Cell 1	16,648	8,324	8,324	0	0	**1,090**
Cell 2	10,823	3,608	7,215	0	0	**833**
Cell 3	10,042	3,347	6,695	0	0	**773**
Cell 4	9,821	7,366	2,455	0	0	**474**
Cell 5	12,065	0	0	12,065	0	**7,236**
Cell 6	11,637	0	0	0	0	**0**
Cell 7	13,340	0	0	0	0	**0**
Cell 8	14,099	0	0	0	0	**0**
Totals	**98,475**	**22,645**	**24,689**	**12,065**	**0**	**10,407**

Implied tonnage/annum	307,500
Absorptive Capacity (t/m3)	1.0%
Modelled Leachate Volume (m^3/yr)	**7,332**

	m3/day
Av daily volume (m3/day) >>	**20**
Variance: Hi vol	**30**
Variance: Lo vol	**13**

Parrys Quarry: Leachate Management Yr 6

Parameter	(m/yr)	Notes
Precipitation	0.800	1 - ESIDX MORECS data for square 104 – Long-term average 1971 to 2000 for grass land use with median available water capacity (AWC) soil type
Evaporation Rate	25%	2 - HER from reference 1 (above) is 261.8mm/yr, this represents a 67% loss from rainfall. A conservative figure of 25% loss has been used instead.
Rainfall Infiltration Open Cell after evaporation	0.600	
Rainfall Infiltration Temp Cap / Slopes	0.100	3 - Assumption based on SLR experience
Rainfall Infiltration Hi Q Cap	0.031	4 - Based on calcuation Q = $(1x10^{-9})$ x $1m^2$ x (1m / 1m) x 86400 x 365 = 31.5mm per year
Groundwater Infiltration Rate	0.000	5 - Not applicable, above groundwater landfill

Phase	Total Area (m^2)	Permanent Hi Q Cap Area (m^2)	Temp/Sloping Area (m^2)	Open Cell Area (m^2)	Basal Area Subject to Groundwater Infiltration (m^2)	Leachate Production (m^3/yr)
Cell 1	16,648	8,324	8,324	0	0	**1,090**
Cell 2	10,823	3,608	7,215	0	0	**833**
Cell 3	10,042	7,532	2,511	0	0	**485**
Cell 4	9,821	9,821	0	0	0	**304**
Cell 5	12,065	12,065	0	0	0	**374**
Cell 6	11,637	0	0	11,637	0	**6,980**
Cell 7	13,340	0	0	0	0	**0**
Cell 8	14,099	0	0	0	0	**0**
Totals	**98,475**	**41,349**	**18,050**	**11,637**	**0**	**10,066**

Implied tonnage/annum	307,500
Absorptive Capacity (t/m3)	1.0%
Modelled Leachate Volume (m^3/yr)	**6,991**

	m3/day
Av daily volume (m3/day) >>	**19**
Variance: Hi vol	**29**
Variance: Lo vol	**13**

Parrys Quarry: Leachate Management Yr 7

Parameter	(m/yr)	Notes
Precipitation	0.800	1 - ESIDX MORECS data for square 104 – Long-term average 1971 to 2000 for grass land use with median available water capacity (AWC) soil type
Evaporation Rate	25%	2 - HER from reference 1 (above) is 261.8mm/yr, this represents a 67% loss from rainfall. A conservative figure of 25% loss has been used instead.
Rainfall Infiltration Open Cell after evaporation	0.600	
Rainfall Infiltration Temp Cap / Slopes	0.100	3 - Assumption based on SLR experience
Rainfall Infiltration Hi Q Cap	0.031	4 - Based on calcuation Q = $(1x10^{-9})$ x $1m^2$ x (1m / 1m) x 86400 x 365 = 31.5mm per year
Groundwater Infiltration Rate	0.000	5 - Not applicable, above groundwater landfill

Phase	Total Area (m^2)	Permanent Hi Q Cap Area (m^2)	Temp/Sloping Area (m^2)	Open Cell Area (m^2)	Basal Area Subject to Groundwater Infiltration (m^2)	Leachate Production (m^3/yr)
Cell 1	16,648	8,324	8,324	0	0	**1,090**
Cell 2	10,823	8,117	2,706	0	0	**522**
Cell 3	10,042	10,042	0	0	0	**311**
Cell 4	9,821	9,821	0	0	0	**304**
Cell 5	12,065	12,065	0	0	0	**374**
Cell 6	11,637	11,637	0	0	0	**361**
Cell 7	13,340	0	0	13,340	0	**8,001**
Cell 8	14,099	0	0	0	0	**0**
Totals	**98,475**	**60,006**	**11,030**	**13,340**	**0**	**10,964**

Implied tonnage/annum	307,500
Absorptive Capacity (t/m3)	1.0%
Modelled Leachate Volume (m^3/yr)	**7,889**

	m3/day
Av daily volume (m3/day) >>	**22**
Variance: Hi vol	**32**
Variance: Lo vol	**14**

Parrys Quarry: Leachate Management Yr 8

Parameter	(m/yr)	Notes
Precipitation	0.800	1 - ESIDX MORECS data for square 104 – Long-term average 1971 to 2000 for grass land use with median available water capacity (AWC) soil type
Evaporation Rate	25%	2 - HER from reference 1 (above) is 261.8mm/yr, this represents a 67% loss from rainfall. A conservative figure of 25% loss has been used instead.
Rainfall Infiltration Open Cell after evaporation	0.600	
Rainfall Infiltration Temp Cap / Slopes	0.100	3 - Assumption based on SLR experience
Rainfall Infiltration Hi Q Cap	0.031	4 - Based on calcuation Q = $(1x10^{-9})$ x $1m^2$ x (1m / 1m) x 86400 x 365 = 31.5mm per year
Groundwater Infiltration Rate	0.000	5 - Not applicable, above groundwater landfill

Phase	Total Area (m²)	Permanent Hi Q Cap Area (m²)	Temp/Sloping Area (m²)	Open Cell Area (m²)	Basal Area Subject to Groundwater Infiltration (m²)	Leachate Production (m³/yr)
Cell 1	16,648	8,324	8,324	0	0	**1,090**
Cell 2	10,823	8,117	2,706	0	0	**522**
Cell 3	10,042	10,042	0	0	0	**311**
Cell 4	9,821	9,821	0	0	0	**304**
Cell 5	12,065	12,065	0	0	0	**374**
Cell 6	11,637	11,637	0	0	0	**361**
Cell 7	13,340	2,668	10,672	0	0	**1,150**
Cell 8	14,099	0	0	14,099	0	**8,456**
Totals	**98,475**	**62,674**	**21,702**	**14,099**	**0**	**12,569**

Implied tonnage/annum	307,500
Absorptive Capacity (t/m3)	1.0%
Modelled Leachate Volume (m³/yr)	**9,494**

	m3/day
Av daily volume (m3/day) >>	**26**
Variance: Hi vol	**39**
Variance: Lo vol	**17**

Parrys Quarry: Leachate Management Aftercare Years

Parameter	(m/yr)	Notes
Precipitation	0.800	1 - ESIDX MORECS data for square 104 – Long-term average 1971 to 2000 for grass land use with median available water capacity (AWC) soil type
Evaporation Rate	25%	2 - HER from reference 1 (above) is 261.8mm/yr, this represents a 67% loss from rainfall. A conservative figure of 25% loss has been used instead.
Rainfall Infiltration Open Cell after evaporation	0.600	
Rainfall Infiltration Temp Cap / Slopes	0.100	3 - Assumption based on SLR experience
Rainfall Infiltration Hi Q Cap	0.031	4 - Based on calcuation $Q = (1x10^{-9}) \times 1m^2 \times (1m / 1m) \times 86400 \times 365$ = 31.5mm per year
Groundwater Infiltration Rate	0.000	5 - Not applicable, above groundwater landfill

Phase	Total Area (m^2)	Permanent Hi Q Cap Area (m^2)	Temp/Sloping Area (m^2)	Open Cell Area (m^2)	Basal Area Subject to Groundwater Infiltration (m^2)	Leachate Production (m^3/yr)
Cell 1	16,648	16,648	0	0	0	**516**
Cell 2	10,823	10,823	0	0	0	**336**
Cell 3	10,042	10,042	0	0	0	**311**
Cell 4	9,821	9,821	0	0	0	**304**
Cell 5	12,065	12,065	0	0	0	**374**
Cell 6	11,637	11,637	0	0	0	**361**
Cell 7	13,340	13,340	0	0	0	**414**
Cell 8	14,099	14,099	0	0	0	**437**
Totals	**98,475**	**98,475**	**0**	**0**	**0**	**3,053**

Implied tonnage/annum	0
Absorptive Capacity (t/m3)	2.5%
Modelled Leachate Volume (m^3/yr)	**3,053**

	m3/day
Av daily volume (m3/day) >>	**8**
Variance: Hi vol	**13**
Variance: Lo vol	**6**

APPENDIX 02

Leachate Quality Model

Analyte	Unit	Cell 6	Cell 1-5 and 7-8	Year 1			Year 2			Year 3		
				Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend
Volume	m^3/yr				9,985	**9,985**	0	7,582	**7,582**	0	7,947	**7,947**
Alkalinity as CaCO3	mg/l	7,569	2,543	0	25,389	**2,543**	0	19,279	**2,543**	0	20,207	**2,543**
Ammoniacal Nitrogen as N	mg/l	1,460	41	0	408	**41**	0	310	**41**	0	324	**41**
Arsenic, Total as As	mg/l	0.18	0.05	0.00	0.50	**0.05**	0.00	0.38	**0.05**	0.00	0.40	**0.05**
BOD + ATU (5 day)	mg/l	310	500	0	4,993	**500**	0	3,791	**500**	0	3,974	**500**
Cadmium, Total as Cd	mg/l	0.001	0.001	0.000	0.008	**0.001**	0.000	0.006	**0.001**	0.000	0.006	**0.001**
Calcium, Total as Ca	mg/l	161	78	0	780	**78**	0	592	**78**	0	621	**78**
Chloride as Cl	mg/l	1,793	4,035	0	40,286	**4,035**	0	30,591	**4,035**	0	32,063	**4,035**
Chromium, Total as Cr	mg/l	0.32	0.02	0.00	0.17	**0.02**	0.00	0.13	**0.02**	0.00	0.13	**0.02**
COD	mg/l	3,116	1,000	0	9,985	**1,000**	0	7,582	**1,000**	0	7,947	**1,000**
Conductivity Electrical 20°C	uS/cm	16,300	35,386	0	353,326	**35,386**	0	268,294	**35,386**	0	281,210	**35,386**
Copper, Total as Cu	mg/l	0.17	0.03	0.00	0.29	**0.03**	0.00	0.22	**0.03**	0.00	0.23	**0.03**
Iron, Total as Fe	mg/l	12.2	2.3	0.0	22.7	**2.3**	0.0	17.3	**2.3**	0.0	18.1	**2.3**
Lead, Total as Pb	mg/l	0.007	0.058	0.000	0.580	**0.058**	0.000	0.440	**0.058**	0.000	0.461	**0.058**
Magnesium, Total as Mg	mg/l	128	107	0	1,064	**107**	0	808	**107**	0	847	**107**
Manganese, Total as Mn	mg/l	1.300	0.258	0.00	2.58	**0.26**	0.00	1.96	**0.26**	0.00	2.05	**0.26**
Nickel, Total as Ni	mg/l	0.148	0.079	0.00	0.79	**0.08**	0.00	0.60	**0.08**	0.00	0.63	**0.08**
pH	pH unit	8.100	8.686	0.0	86.7	**8.7**	0.0	65.9	**8.7**	0.0	69.0	**8.7**
Potassium, Total as K	mg/l	575	764	0	7,627	**764**	0	5,792	**764**	0	6,070	**764**

Analyte	Unit	Cell 6	Cell 1-5 and 7-8	Year 1			Year 2			Year 3		
				Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend
Sodium, Total as Na	mg/l	1,207	2,615	0	26,114	**2,615**	0	19,829	**2,615**	0	20,784	**2,615**
Sulphate as SO_4	mg/l	129	160	0	1,598	**160**	0	1,213	**160**	0	1,272	**160**
TOC (Filtered)	mg/l	1,185	268	0	2,676	**268**	0	2,032	**268**	0	2,130	**268**
Total Suspended Solids	mg/l	92	100	0	999	**100**	0	758	**100**	0	795	**100**
Zinc, Total as Zn	mg/l	0.10	0.30	0	10	**1.00**	0	8	**1**	0	8	**1**
Benzene	mg/l	0.003	0.020	0.00	2.98	**0.30**	0.00	2.26	**0.30**	0.00	2.37	**0.30**
Phenol	mg/l	0.19	0.22	0.000	0.200	**0.020**	0.000	0.152	**0.020**	0.000	0.159	**0.020**
Napthalene	mg/l	0.002	0.001	0.00	2.24	**0.22**	0.00	1.70	**0.22**	0.00	1.79	**0.22**

Analyte	Unit	Year 4			Year 5			Year 6			Year 7		
		Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend
Volume	m^3/yr	0	8,587	**8,587**	0	10,407	**10,407**	6,980	3,087	**10,067**	361	10,603	**10,964**
Alkalinity as CaCO3	mg/l	0	21,834	**2,543**	0	26,462	**2,543**	52,832	7,849	**6,028**	2,732	26,960	**2,708**
Ammoniacal Nitrogen as N	mg/l	0	351	**41**	0	425	**41**	10,191	126	**1,025**	527	433	**88**
Arsenic, Total as As	mg/l	0.00	0.43	**0.05**	0.00	0.52	**0.05**	1.26	0.15	**0.14**	0.06	0.53	**0.05**
BOD + ATU (5 day)	mg/l	0	4,294	**500**	0	5,204	**500**	2,164	1,544	**368**	112	5,302	**494**
Cadmium, Total as Cd	mg/l	0.000	0.007	**0.001**	0.000	0.008	**0.001**	0.007	0.002	**0.001**	0.000	0.008	**0.001**
Calcium, Total as Ca	mg/l	0	671	**78**	0	813	**78**	1,124	241	**136**	58	829	**81**

Analyte	Unit	Year 4			Year 5			Year 6			Year 7		
		Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend
Chloride as Cl	mg/l	0	34,646	**4,035**	0	41,989	**4,035**	12,515	12,455	**2,480**	647	42,780	**3,961**
Chromium, Total as Cr	mg/l	0.00	0.14	**0.02**	0.00	0.17	**0.02**	2.25	0.05	**0.23**	0.12	0.18	**0.03**
COD	mg/l	0	8,587	**1,000**	0	10,407	**1,000**	21,750	3,087	**2,467**	1,125	10,603	**1,070**
Conductivity Electrical 20°C	uS/cm	0	303,857	**35,386**	0	368,259	**35,386**	113,774	109,236	**22,153**	5,884	375,195	**34,757**
Copper, Total as Cu	mg/l	0.00	0.25	**0.03**	0.00	0.30	**0.03**	1.18	0.09	**0.13**	0.06	0.30	**0.03**
Iron, Total as Fe	mg/l	0.0	19.5	**2.3**	0.0	23.7	**2.3**	84.9	7.0	**9.1**	4.4	24.1	**2.6**
Lead, Total as Pb	mg/l	0.000	0.498	**0.058**	0.000	0.604	**0.058**	0.050	0.179	**0.023**	0.003	0.615	**0.056**
Magnesium, Total as Mg	mg/l	0	915	**107**	0	1,109	**107**	893	329	**121**	46	1,130	**107**
Manganese, Total as Mn	mg/l	0.00	2.22	**0.26**	0.00	2.69	**0.26**	9.07	0.80	**0.98**	0.47	2.74	**0.29**
Nickel, Total as Ni	mg/l	0.00	0.68	**0.08**	0.00	0.83	**0.08**	1.03	0.24	**0.13**	0.05	0.84	**0.08**
pH	pH unit	0.0	74.6	**8.7**	0.0	90.4	**8.7**	56.5	26.8	**8.3**	2.9	92.1	**8.7**
Potassium, Total as K	mg/l	0	6,559	**764**	0	7,949	**764**	4,014	2,358	**633**	208	8,099	**758**
Sodium, Total as Na	mg/l	0	22,457	**2,615**	0	27,217	**2,615**	8,425	8,073	**1,639**	436	27,730	**2,569**
Sulphate as SO_4	mg/l	0	1,374	**160**	0	1,665	**160**	900	494	**139**	47	1,696	**159**
TOC (Filtered)	mg/l	0	2,301	**268**	0	2,789	**268**	8,271	827	**904**	428	2,842	**298**
Total Suspended Solids	mg/l	0	859	**100**	0	1,041	**100**	642	309	**94**	33	1,060	**100**
Zinc, Total as Zn	mg/l	0	9	**1**	0	10	**1**	7	3	**1**	0	11	**1**
Benzene	mg/l	0.00	2.57	**0.30**	0.00	3.11	**0.30**	0.70	0.92	**0.16**	0.04	3.17	**0.29**
Phenol	mg/l	0.000	0.172	**0.020**	0.000	0.208	**0.020**	0.024	0.062	**0.008**	0.001	0.212	**0.019**

Analyte	Unit	Year 4			Year 5			Year 6			Year 7		
		Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend	Cell 6	Cell 1-5 and 7-8	Blend
Napthalene	mg/l	0.00	1.93	**0.22**	0.00	2.34	**0.22**	1.33	0.69	**0.20**	0.07	2.38	**0.22**

Analyte	Unit	Year 8			Active Years			Aftercare		
		Cell 6	Cell 1-5 and 7-8	Blend	Minimum	Average	Maximum	Cell 6	Cell 1-5 and 7-8	Blend
Volume	m^3/yr	361	12,209	**12,570**	7,582	9,764	12,570	361	2,692	**3,053**
Alkalinity as $CaCO_3$	mg/l	2,732	31,044	**2,687**	2,543	3,017	6,028	2,732	6,845	**3,137**
Ammoniacal Nitrogen as N	mg/l	527	498	**82**	41	175	1,025	527	110	**209**
Arsenic, Total as As	mg/l	0.06	0.61	**0.05**	0.05	0.06	0.14	0.06	0.13	**0.07**
BOD + ATU (5 day)	mg/l	112	6,105	**495**	368	482	500	112	1,346	**478**
Cadmium, Total as Cd	mg/l	0.000	0.009	**0.001**	0.001	0.001	0.001	0.000	0.002	**0.001**
Calcium, Total as Ca	mg/l	58	954	**81**	78	86	136	58	210	**88**
Chloride as Cl	mg/l	647	49,259	**3,970**	2,480	3,823	4,035	647	10,861	**3,770**
Chromium, Total as Cr	mg/l	0.12	0.20	**0.03**	0.02	0.05	0.23	0.12	0.04	**0.05**
COD	mg/l	1,125	12,209	**1,061**	1,000	1,200	2,467	1,125	2,692	**1,250**
Conductivity Electrical 20°C	uS/cm	5,884	432,024	**34,838**	22,153	33,585	35,386	5,884	95,258	**33,129**
Copper, Total as Cu	mg/l	0.06	0.35	**0.03**	0.03	0.04	0.13	0.06	0.08	**0.05**
Iron, Total as Fe	mg/l	4.4	27.8	**2.6**	2.3	3.2	9.1	4.4	6.1	**3.4**
Lead, Total as Pb	mg/l	0.003	0.709	**0.057**	0.023	0.053	0.058	0.003	0.156	**0.052**

Magnesium, Total as Mg	mg/l	46	1,301	**107**	107	109	121	46	287	**109**
Manganese, Total as Mn	mg/l	0.47	3.15	**0.29**	0.26	0.36	0.98	0.47	0.69	**0.38**
Nickel, Total as Ni	mg/l	0.05	0.97	**0.08**	0.08	0.09	0.13	0.05	0.21	**0.09**
pH	pH unit	2.9	106.0	**8.7**	8.3	8.6	8.7	2.9	23.4	**8.6**
Potassium, Total as K	mg/l	208	9,326	**758**	633	746	764	208	2,056	**742**
Sodium, Total as Na	mg/l	436	31,930	**2,575**	1,639	2,482	2,615	436	7,040	**2,449**
Sulphate as SO_4	mg/l	47	1,953	**159**	139	157	160	47	431	**156**
TOC (Filtered)	mg/l	428	3,272	**294**	268	355	904	428	721	**376**
Total Suspended Solids	mg/l	33	1,221	**100**	94	99	100	33	269	**99**
Zinc, Total as Zn	mg/l	0	12	**1**	1	1	1	0	3	**1**
Benzene	mg/l	0.04	3.65	**0.29**	0.16	0.28	0.30	0.04	0.80	**0.28**
Phenol	mg/l	0.001	0.244	**0.020**	0.008	0.018	0.020	0.001	0.054	**0.018**
Napthalene	mg/l	0.07	2.74	**0.22**	0.20	0.22	0.22	0.07	0.60	**0.22**

APPENDIX 03

Priority & 'Other' Substances List

Abamectin	Ioxynil
Alachlor	Isoproturon
Ammonia (un-ionised)	Ivermectin
Anthracene	Linuron
Atrazine	Malachite green
Azinphos-methyl - dissolved	Malathion
Bentazone	Mancozeb
Benzo(a)-pyrene (BaP)	Maneb
Benzo(b)-fluor-anthene	MCPA
Benzo(g,h,i)-perylene	Mecoprop
Benzo(k)-fluor-anthene	Mercury and its compounds - dissolved
Benzyl butyl phthalate	Methiocarb
Biphenyl	Mevinphos
Boron	Nitrilotriacetic acid (NTA)
Brominated diphenylether - total PBDE (or congener) numbers 28, 47, 99, 100, 153 and 154	Nonylphenol (4-nonylphenol)
Bromine - total residual oxidant	Octylphenol (4-(1,1',3,3'-tetramethyl-butyl)-phenol)
Bromoxynil	Omethoate
C10-13 chloroalkanes	Ortho Phosphate
Carbendazim	Para-para-DDT
Carbon tetrachloride	PCSDs
2-chlorophenol	Pendimethalin
3-chlorophenol - total or individual monochlorophenols	Pentachloro-benzene
4-chloro-3-methylphenol	Pentachloro-phenol
4-chlorophenol - total or individual monochlorophenols	Permethrin
Chlorfenvinphos	Pirimicarb
Chlorine - total residual oxidant	Pirimiphos-methyl
Chloronitro toluenes	Polyaromatic hydrocarbons (PAH)
Chlorothalonil	Prochloraz
Chlorotoluron	Propetamphos
Chlorpropham	Propyzamide
Chlorpyrifos (chlorpyrifos-ethyl)	Silver - dissolved
Chromium (III) - dissolved	Simazine
Chromium (VI) - dissolved	Styrene
Cobalt - dissolved	Sulcofuron
Coumaphos	Tecnazene - total
Cyanide	Temperature
Cyclodiene pesticides - total aldrin, dieldrin, endrin and isodrin	Tetrachloroethane
Cyfluthrin	Tetrachloro-ethylene
Cypermethrin	Thiabendazole
DDT total	Tin (inorganic) - total

Demetons	Toluene
Di(2-ethylhexyl)-phthalate (DEHP)	Total anions
Diazinon (sheep dip)	Triallate
Dibutyl phthalate	Triazaphos
3,4-dichloroaniline	Tributyl phosphate
Dichlorobenzene - total dichlorobenzene isomers	Tributyltin compounds (tributyltin-cation)
1,2-dichloro-ethane	Trichloro-benzenes
2,4-dichlorophenol	1,1,1-trichloroethane
2,4-dichlorophenoxyacetic acid (2,4-D)	1,1,2-trichloroethane
Dichloro-methane	Trichloro-ethylene
Dichlorvos	Tricholoro-methane (chloroform)
Diethyl phthalate	Triclosan
Diflubenzuron	Trifluralin
Dimethoate	Triphenyltin and derivatives
Dimethyl phthalate	Vanadium
Dioctyl phthalate	Xylene
Dissolved Oxygen	
Diuron	
Doramectin	
EDTA	
Endosulphan	
Fenchlorphos	
Fenitrothion	
Flucofuron	
Fluoranthene	
Fluoride - dissolved	
Formaldehyde	
Glyphosate	
Hexachloro-benzene	
Hexachloro-butadiene	
Hexachloro-cyclohexane	
Hydrogen sulphide	
Indeno(1,2,3-cd)-pyrene	
Inorganic Nitrogen	

EUROPEAN OFFICES

United Kingdom

AYLESBURY
T: +44 (0)1844 337380

BELFAST
T: +44 (0)28 9073 2493

BRADFORD-ON-AVON
T: +44 (0)1225 309400

BRISTOL
T: +44 (0)117 906 4280

CAMBRIDGE
T: + 44 (0)1223 813805

CARDIFF
T: +44 (0)29 2049 1010

CHELMSFORD
T: +44 (0)1245 392170

EDINBURGH
T: +44 (0)131 335 6830

EXETER
T: + 44 (0)1392 490152

GLASGOW
T: +44 (0)141 353 5037

GUILDFORD
T: +44 (0)1483 889800

LEEDS
T: +44 (0)113 258 0650

LONDON
T: +44 (0)203 691 5810

MAIDSTONE
T: +44 (0)1622 609242

MANCHESTER
T: +44 (0)161 872 7564

NEWCASTLE UPON TYNE
T: +44 (0)191 261 1966

NOTTINGHAM
T: +44 (0)115 964 7280

SHEFFIELD
T: +44 (0)114 245 5153

SHREWSBURY
T: +44 (0)1743 23 9250

STAFFORD
T: +44 (0)1785 241755

STIRLING
T: +44 (0)1786 239900

WORCESTER
T: +44 (0)1905 751310

Ireland

DUBLIN
T: + 353 (0)1 296 4667

France

GRENOBLE
T: +33 (0)4 76 70 93 41