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KNOCKHARLEY LANDFILL FACILITY
KENTSTOWN,
CO. MEATH

CLOSURE, RESTORATION AND AFTERCARE MANAGEMENT PLAN (CRAMP) REVIEW

January 2017
SLR Ref: 402.06792.00001

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CONTENTS

TABLES

APPENDICES

1.0 INTRODUCTION

1.1 General

A Closure, Restoration and Aftercare Management Plan (CRAMP) for Knockharley Landfill facility was prepared by SLR Consulting Limited in April 2013. The CRAMP was prepared accordance with the requirements of Condition 4 of Waste Licence W0165-02.

The Waste Licence was issued by the Environmental Protection Agency (EPA) in March 2010 to Greenstar Holdings Limited but was transferred to Knockharley Landfill Limited on 4th March 2014. The Waste Licence principally provides for the disposal of waste by landfilling.

The EPA has requested that Knockharley Landfill Limited carry out a review of the 2013 CRAMP, and Knockharley Landfill Limited has appointed SLR Consulting Limited (SLR) to perform that review. This report presents the results of the review.

1.2 The Site

The site is located 1.5km to the north of the village of Kentstown, Co. Meath, approximately 7km south of Slane, and 12.5km east of Navan. The site is accessed off the N2.

1.3 Waste Licence – Condition 4

Condition 4 of the waste licence deals with restoration and aftercare management of the waste facility and states that:

4.1 The licensee shall maintain and implement a Restoration and Aftercare Plan for the facility. The restoration and Aftercare Plan shall have regard to the guidance published in the Agency's Landfill Manual on "Landfill Restoration and Aftercare" or any other relevant guidance as agreed by the Agency. The licensee shall restore the facility on a phased basis. In particular the plan shall include:

a) Potential restoration options;

b) The proposed consultation process in relation to the restoration options for the facility; and

c) Proposals for nature conservation and woodland restoration.

The plan shall be reviewed annually and proposed amendments notified to the Agency for agreement as part of the AER. No amendments may be implemented without the prior agreement of the Agency.

4.2 The final profile/height of the facility shall be a maximum of 74mOD Malin and be domed in shape. The licensee shall submit a map showing the final contour layout within three months of the date of grant of licence.

4.3 Final Capping

4.3.1. Unless otherwise agreed by the Agency, the final capping shall consist of the following:

a) top soil (150 -300mm);

b) subsoils, such that total thickness of top soil and subsoils is at least 1m;

c) drainage layer of 0.5m thickness having a minimum hydraulic conductivity of 1 x 10^{-4} m/s or an equivalent geosynthetic layer;

d) compacted mineral layer of a minimum 0.6m thickness with a permeability of less than 1 x 10^{-9} m/s or a geosynthetic material (e.g. GCL) or similar that provides equivalent protection; and

e) gas collection layer of natural material (minimum 0.3mm) or a geosynthetic layer.

4.4 The licensee shall maintain a stockpile of capping materials at the facility containing the requisite volume of capping materials for a six-month period. If using geosynthetic material. The licensee shall ensure that adequate secure supplies are available.

4.5 No material or object that is incompatible with the proposed restoration of the facility shall be present within one metre of the final soil surface levels.

4.6 Where tree planting is to be carried out above waste-filled areas, a synthetic barrier shall be used to augment the clay cap in accordance with the EPA Manual on Landfill Restoration and Aftercare.

4.7 Soil Storage

4.7.1 All soils shall be stored to preserve the soil structure for future use.

4.8 A final validation report to include a certificate of completion for the Restoration and Aftercare Plan, for all or part of the site as necessary. shall be submitted to the Agency within three months of execution of the plan. The licensee shall carry out such tests, investigations or submit certification, as requested by the Agency, to confirm that there is no continuing risk to the environment.

Restoration is not referred to only in the waste licence condition, the planning permission (An Bord Pleanala Ref. No. PL 17.125891) also covers restoration of the site. In particular, Conditions 12, 16 and 20.

Condition 12, has regard to the restoration of the site in that it conditions:

- the establishment of screening berms
- landscaping
- supplementary planting of hedgerows and tree belts
- the height of proposed planting
- the maintenance of landscaping.

Condition 16 of the planning permission requires that the planning authority shall, two years after the final capping of the last phase of the landfill, require the licensee to implement any final landscaping restoration measures that it (the planning authority) may require.

Condition 20 of the planning permission requires the licensee to lodge a cash deposit to secure the final landscaping restoration measures.

This April 2013 document comprises a submission to the Agency in compliance with Condition 4.1 of the licence, with due regard to the above referenced planning conditions.

This document comprises a review of the April 2013 document to reflect the passage of time.

1.4 Scope of CRAMP

The objective of the CRAMP is to ensure that on completion / cessation of waste disposal activities at Knockharley, the site is restored in accordance with the waste licence and planning permission as outlined above.

The CRAMP was prepared in 2013. The scope of the CRAMP review comprises:

- a review of the Site Evaluation, which presents details of its planning / waste licensing history and an inventory of existing mobile plant and fixed infrastructure;
- a review of the Closure Considerations and Criteria for successful closure;
- a review of the outline Closure Plan costings and measures proposed in respect of its ongoing update, review and implementation and final validation;
- a review of the Facility Restoration and Aftercare proposals, including a review of the outline costings, originally prepared in 2013.

2.0 SITE EVALUATION

2.1 Site Description

Knockharley Landfill facility accepts residual, nonhazardous, household, commercial and industrial waste arising in the north-east counties of Ireland. Under the waste licence, the waste intake is limited to 200,000 tonnes of waste per annum and the facility has an operating life of approximately 14 years. Under the planning permission, however, the waste input is limited to 88,000 tonnes per annum, over the same14 year lifespan.

The facility covers a total area of 135 hectares and consists of the landfill, an administration building, leachate lagoon, surface water pond, weighbridges, wheelwash and a landfill gas collection and flaring system. There are no direct discharges of effluent to surface water or groundwater. Leachate is tankered off-site to a waste water treatment plant.

The landfill, which is positioned in the centre of the site, covers an area of approximately 25 hectares. At present, approximately 13 hectares of the landfill has been developed in preparation for waste deposit, with approximately 7 hectares having been restored.

At present, 14 cells have been developed at the site. Cells 1 to 8 have been capped. Filling is complete to Cell 10. Filling is currently underway in Cells 13 and 14.

At present, the site has full planning permission to continue operating until 2021. Prior to this date, a planning application may be submitted to further extend this period having regard to remaining site capacity as well as the role of the site in meeting the future residual waste infrastructure needs in the region.

2.2 Planning and Licensing History

Prior to grant of planning permission for waste deposit, the land within the site was greenfield land, under arable crops and pasture. Planning permission was granted by Meath County Council in 2001 (Ref 01/5006) but following appeal of the planning permission both by the applicant, and a number of interested parties, revised planning permission was granted by An Bord Pleanala in 2002 (Ref 17.125891).

A Waste Licence (Reg No W0146-01) was issued by the EPA for the site in March 2003. That licence was amended by the EPA in October 2005 under section 76(4) of the Waste Management Acts 1996 to 2003. In accordance with Article 34 of the Waste Management (Licensing) Regulations, the Agency issued a revised Waste Licence (Reg No W0146-02) in March 2010. This licence was amended by the EPA on 15th January 2013 under Section 42B(1)(c) of the Waste Management Acts, 1996 to 2011.This licence was further amended on 20 December 2013 under Section 76A(11) of the Waste Management Act 1996 as amended, and again on 15th November 2016 under Section 96(1)(c) of the Environmental Protection Agency Act, as amended.

2.3 Site Inventory / Infrastructure

The established site facilities, mobile plant and fixed infrastructure at the licensed site at Knockharley remain unchanged since the 2013 CRAMP and are listed below. The principal site facilities and infrastructure will remain in place until such a time as they are no longer required for the management of the site. The site facilities include

- Buildings: Administration Offices; Weighbridge Office; Maintenance Shed.
- Fixed Infrastructure: Paved / unpaved internal road network; paved parking area; weighbridge; wheelwash; hardstanding area (for quarantine and storage of

unacceptable wastes prior to disposal elsewhere); fuel storage tank; leachate storage lagoon; surface water lagoon; Landfill Gas Utilisation Plant (currently 4 Engines) and backup flares; Leachate and Landfill Gas extraction and monitoring wells; Leachate and Landfill gas pipework; Groundwater monitoring wells.

- Services: septic tank (domestic only), utilities electricity, water, telephone.

- Plant and Machinery: mobile plant necessary for landfill operation (Landfill Compactor, tractors, site vehicles, etc)

2.4 Requirement for this Plan

The waste disposal facility at Knockharley will result in substantial landform, and ground composition changes which, if not properly managed, could introduce some potential risks to the long-term environment.

In 2013, an initial screening and operational risk assessment was undertaken in respect of the landfill facility at Knockharley in accordance with an assessment methodology prescribed by the EPA in its publication *Guidance on Environmental Liability Risk Assessment, Residuals, Management Plans and Financial Provision (2006)*.

This screening exercise indicated that the waste disposal facility at Knockharley can be classified as a Category 2 Risk Facility. Due to the nature of the operation, a process of extensive restoration and aftercare will be required. This assessment remains valid.

3.0 FACILITY CLOSURE

3.1 Closure Considerations

The 2013 closure plan envisaged that the licensed waste disposal and recovery facility will achieve a non-clean closure, such that, on cessation of waste disposal activities, and decommissioning / removal of plant and infrastructure from the facility, there will be remaining environmental liabilities which will require a restoration and aftercare management plan. Given the non-clean closure of the site, there will be a period of time between closure and completion of restoration; for clarity, we refer to interim restoration and final restoration, whereas the former refers to any level of restoration prior to the final restoration. In preparing the original CRAMP, and this review, we have assumed a planned closure after filling of the site until the void has been fully consumed.

Condition 4 of the waste licence for Knockharley requires that the site is restored on a phased basis. In preparing the original CRAMP, and this review we have assumed that the landfill is restored on a phased basis during the operational life of the landfill, and that the finances for this are covered in the operational budgets for the site. On completion of the final phase of landfilling, much of the work required to achieve interim restoration and closure of the waste facility will already have been completed. We have assumed that at this stage of the lifecycle of the landfill an area of 4 hectares will require capping and interim restoration, and we have assumed that the costs for this will fall into the facility closure costs presented in this CRAMP review.

It is expected that full interim restoration of the landfill area will be completed within 1 to 2 years, and we have allowed a 2 year period within the closure costings. Aftercare and management, leading to Final Restoration, may span some years following closure of the landfill. Details of the aftercare and management works are outlined in some detail in Chapter 4 of this CRAMP review.

3.2 Capping and Interim Restoration

On completion of the deposit of waste at the facility, final capping shall be restored over the waste mass in accordance with Condition 4.3 of the Waste Licence. At this time, an interim restoration scheme will also be put in place at the site. Restoration proposals are described in Section 3.3, 3.4 and 3.5 of this report. Through the aftercare management of the site, the final restoration will be delivered.

3.3 Restoration Options

Prior to development, the site comprised 135.2 ha of high quality agricultural land used both for tilling and grazing purposes. Just 25 ha (less than 20%) of the site is being developed as landfill. Hence reversion to grazing and tillage would appear the most appropriate after-use and restoration option.

Compliance with other conditions of the licence and planning permission however, influences the restoration options in that a large proportion of the land not being used for the landfill and ancillary infrastructure has been planted with mixed species trees. The extent of existing and proposed planting is shown on Figure 4.10.4 of the EIS that was submitted to the Agency in support of the waste licence application.

Notwithstanding the amount of planting undertaken by the licensee, a significant area of land remains that could revert to pasture or tillage usage, the former would be a more attractive option for all lands to the west of the CR384 with both options being suitable to the east.

The final gradients and extent of any buried infrastructure (leachate and landfill gas infrastructure) would limit the agricultural use of the land over the “landfill footprint” to rough grazing.

A second restoration option for the residual land (i.e. the non-forested land outside of the landfill footprint) would be to establish intensive horticulture under cover. This option could utilise both the heat generated within the waste mass and possibly heat recovered from the combustion of the landfill gas as an energy source.

A third restoration option would be as a nature conservation area and parkland. In this regard, the landscaping and its screening infrastructure proposed in the application and required by the licence and planning permission is appropriate. In addition, both the stormwater lagoon and downstream wetland will prove an appropriate habitat for nature conservation and the establishment of biodiversity.

Any after-use of the site that would involve access to the site either by the public or by third party users would require considerable infrastructural modifications to secure the permanent works, including:

- the construction of secure and lockable chambers on the landfill gas and leachate control points
- security fencing of items such as the lagoons and flare
- fencing to delineate after-use zones.

A possible after-use for the lands close to the CR384 would be the establishment of playing fields in that the land is relatively flat. In that instance, security fencing of the standard currently employed on the site would be used to isolate the playing fields from the formal landfill area.

It is already established that part of the site will form nature reserve and mixed species woodland. The licensee will continue to liaise with the National Parks and Wildlife Service with respect to the maintenance and enhancement of the woodland. It is noted that the woodland has been part-financed by the Forestry Service and, on a long-term basis, part of the woodland might be felled for commercial reasons. However, put in context, any tree felling would occur 20 to 30 years after landfilling has ceased and, from a screening point of view, the trees will have outlived their original purpose.

3.4 Proposed Consultation Process

In Section 4.10 of the EIS, the licensee has declared its intention with respect to restoration. Notwithstanding that, the licensee will, when appropriate, enter discussions with the Community Liaison Committee established under Condition 5 of the planning permission to advise the local community of the restoration proposals.

Apart from liaison with local residents and other members of the committee, the licensee will, when appropriate, and as required by the planning permission, consult with Meath County Council on the subject of restoration and after-use.

3.5 Proposals for Nature Conservation and Woodland Restoration

As stated in previous sections, a significant area of mixed species woodland has been established where none existed prior to the development. The woodland is subject to a formal management plan. The use of mixed species is intended to widen the biodiversity (flora and fauna) within the woodland.

In addition, with the consent of the Agency, the stormwater retention pond has been broken into two zones comprising a stormwater retention pond and an associated wetland. The licensee has been advised that, given the existence of poorly drained soil to the west and north-west of the pond, the likelihood is that the wetland will become naturally colonised with species from the poorly drained lands. If this is not evident after two growing seasons, then the wetland will be artificially colonised with appropriate species. In this regard, reference will be made to Appendix A 5.5 of the Agency's manual on Landfill Restoration and Aftercare. It is suggested that the established wetland is in accordance with that described in Figure A1 of the manual and it will encourage the establishment of aquatic, marginal/emergent, fringing and carr plant types. It is assumed that both aquatic and terrestrial animals will follow.

3.6 Plant Removal and Decommissioning

Following completion of the final capping and establishment of interim restoration of the site, all structures, plant and equipment that are not required for restoration purposes will be decontaminated by appropriately licensed contractors in accordance with recognised standard procedures and regulatory requirements and removed from the site.

3.7 Criteria for Successful Closure

The principal criteria against which successful closure will be gauged are as follows:

a) The landfill void has been filled with the wastes under the licence to the required surcharge levels to produce the contours agreed by the Agency.
b) Waste acceptance has ceased.
c) All structures, plant and equipment that are not required for restoration purposes have been safely decontaminated by appropriately licensed contractors in accordance with recognised standard procedures and regulatory requirements and removed from the site
d) All records of waste transfer, disposal and recovery are held on file.
e) Adequate landfill gas collection infrastructure has been installed in the waste body to the agreement of the Agency.
f) Adequate leachate management infrastructure including recirculation trenches and treatment systems has been installed at the site to the agreement of the agency.
g) The foot print perimeter has been landscaped with shrubs and trees and greened wherever possible.

3.8 Closure Plan Costing

The expected costs (present-day values), associated with the future closure of the landfill facility at Knockharley, are outlined in Table 3-1 below; a full breakdown of the costs in Table 3-1, together with underlying assumptions is presented in Appendix 1. The cost inputs are considered to be conservative, so no additional contingency sums have been included in the closure costs.

Table 3-1
Facility Closure Costs

ITEM	COST €
Closure Period Monitoring, Maintenance and Management	246,000
Capping and Restoration Costs	1,120,000
Leachate Management Costs	822,000
Landfill Gas	44,000
Total Site Closure Cost (excl. VAT)	**€2,232,000**

3.9 Closure Plan Update and Review

As required by the waste licence conditions, this Closure Plan will be reviewed and updated annually as part of the Annual Environmental Report (AER) submission to the EPA. The updated and reviewed Closure Plan will take account of any site or process changes, technology changes and costing changes.

3.10 Closure Plan Implementation

At present, the site is expected to remain operational until 2021, when the planning permission expires. Prior to this date, a planning application may be submitted to further extend this period having regard to remaining site capacity as well as the role of the site in meeting the future residual waste infrastructure needs in the region.

The EPA will be given 1 month's notice of any proposed temporary closure and 6 months notice of the intended final closure date of this facility. Notice will be provided in accordance with prevailing guidance and it is anticipated that there will also be ongoing discussions with the EPA in respect of its required closure procedures.

3.11 Closure Plan Validation

As required by Condition 4.8 of the Waste Licence, a final validation report (including a Certificate of Completion for the Restoration and Aftercare Plan) in respect of the licensed waste facility will be submitted to the Agency within 3 months of completion of the works outlined herein.

The validation audit will be undertaken by an independent, external environmental Consultant. The final validation report will include:

- an assessment of how the objectives of the Closure Plan have been achieved;
- final 'as-restored' drawings and photographs of the site;
- a Certificate of Completion for the Restoration and Aftercare Plan.

4.0 AFTERCARE MANAGEMENT PLAN

4.1 Restoration Proposals

Restoration proposals are outlined in Chapter 3 of this report. It is expected that full interim restoration of the landfill area will be completed within a relatively short period of time of cessation of waste deposit at the site. Aftercare management, leading to Final Restoration, may span some years following closure of the landfill.

4.2 Aftercare Management

Final capping of the landfill (in accordance with Condition 4.3 of the licence), and closure plan validation (in accordance with Section 3.11 of this report) will trigger the commencement of aftercare. A waste licence review application will be made in or around the time that the aftercare is identified and commenced. The review application will have regard to:

- the management structure at the facility
- the removal of redundant facility infrastructure
- changes to the monitoring regime
- modification to the annual charge paid under Condition 12 of the licence.

Aftercare will include the management of:

- landfill gas
- leachate
- environmental monitoring
- ongoing inspection and maintenance

4.2.1 Landfill Gas Management

Landfill gas will continue to be produced in the landfill many years after closure. Landfill Gas utilisation is active at the site, there are currently 4 Landfill Gas engines, generating approximately 2MW of electricity for export to the national grid. Back-up flaring is carried out as necessary in response to outages of the engines, or in support of the engines should gas exceed the capacity of the engines, to reduce the potential for the nuisance effect of the landfill gas.

It is likely that the gas utilisation operation will continue for some years after landfilling ceases. The management and maintenance of the landfill gas utilisation plant will be on the basis of a specialist contract with an approved service provider, with additional engines or flaring capacity being provided as necessary in response to any increased gas generation.

Gas utilisation would continue until the quantity of combustible gas decreases, with engines and flares being decommissioned and removed from site as they are no longer required. When gas levels have declined to the extent that landfill gas utilisation is no longer appropriate, gas would be flared until such time that the gas no longer poses a risk to the environment.

As landfill gas infrastructure is decommissioned, all buried pipework and cables will be grubbed up and removed from site.

4.2.2 Leachate Management

Leachate extraction and management will continue in the aftercare phase, notwithstanding the fact that the landfill will be capped. Despite the low permeability cap over the waste, a small portion of the rainfall incident on the landfill will percolate into the waste mass, for example through penetrations (gas wells, etc.) through the cap.

In addition, it is considered desirable to recirculate leachate back into the waste mass so as to accelerate the biodegradation of waste matter. Two benefits accrue:

- the aftercare phase is shortened because the waste stabilises, (i.e. approaches an inert state) more speedily
- the quantity and quality of landfill gas being produced can be managed and manipulated, thus making recovery options more attractive.

The initiation of leachate recirculation would be by agreement with the Agency and subject to a specified engineering works report.

Throughout the aftercare period, leachate within the landfill would be maintained at or below the levels required by the licence. To achieve this, Leachate would continue to be pumped to the leachate lagoon before being treated in an on-site treatment plant prior to being tankered off site for disposal. It has been assumed that on site leachate treatment, will commence during the operational life of the site, and that the capital investment in any leachate plant will be funded from operational revenues. Leachate Management would continue until such time that the leachate no longer poses a risk to the environment, at which point, the leachate management infrastructure would be decommissioned.

As leachate management infrastructure is decommissioned, all buried pipework and cables will be grubbed up and removed from site.

4.2.3 Environmental Monitoring

The current licence prescribes a monitoring regime that will continue during waste placement. Following validation of closure as per Section 3.11 of this report, the licensee will apply to the Agency for a modified schedule and frequency of monitoring under the headings:

- landfill gas
- leachate
- dust
- odours

- surface water
- groundwater
- landfill settlement
- landfill stability
- flora and fauna

The results of the environmental monitoring will be used to assess the progress of the waste mass towards stabilisation.

4.2.4 Ongoing Inspection and Maintenance

Regular maintenance of all relevant infrastructure will continue in the aftercare phase including the maintenance of drainage ditches, internal roads, fencing, CCTV, gates, etc.

4.3 Waste Licence Surrender

At some point in the future, when the licensee considers that the waste mass has become effectively “stable”, a further licence review application will be made and, ultimately, it is envisioned that, by agreement with the EPA, the landfill will be regarded as having no potential impact on the environment and the waste licence will be surrendered and aftercare activities will cease.

4.4 Final Restoration and Aftercare Management Costs

The expected cost, associated with the site restoration and aftercare management, are outlined in Table 4-1 below; a full breakdown of the costs in Table 4-1, together with underlying assumptions is presented in Appendix 2. The cost inputs are considered to be conservative, so no additional contingency sums have been included in the aftercare management costs.

Table 4-1
Estimated Restoration Cost (Based on a 30 Year Aftercare Period)

ITEM	COST €
Closure Period Monitoring, Maintenance and Management	1,965,000
Leachate Management Costs	5,500,000
Landfill Gas	932,500
Decommission and Decontaminate Residual Site Plant and Infrastructure	125,000
Total Site Closure Cost (excl. VAT)	**€8,522,500**

5.0 REPORT CLOSURE

This report has been prepared by SLR Consulting Limited with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the Client. Information reported herein is based on the interpretation of data collected and supplied by Knockharley Landfill Limited and their environmental consultants. This has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of Knockharley Landfill Limited. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

APPENDICES

Appendix 1

Knockharley Closure Expenditure

		Total (€)	Year 1	Year 2
Closure Period Monitoring, Maintenence and Management				
Environmental Monitoring (3rd party) - see note 2		60,000	30,000	30,000
VOC Surveys - see note 2		6,000	3,000	3,000
Surface Water Monitroing - see note 2		5,000	2,500	2,500
AT4 Analysis - see note 2		4,000	2,000	2,000
Leachate Analysis (disposal) - see note 2		4,000	2,000	2,000
Stack Emmissions Monitoring - see note 2		10,000	5,000	5,000
Slope Stability Analysis - see note 2		4,000	2,000	2,000
Annual Topographic Survey - see note 2		3,000	1,500	1,500
Annual Environmental Report - see note 1		10,000	5,000	5,000
Closure Validaton Report - see note 1		5,000		5,000
EPA Waste Licence Contribution - see note 2		40,000	20,000	20,000
Management of monitoring & misc consultancy - see note 1		10,000	5,000	5,000
Insurances - see note 1		5,000	2,500	2,500
General Maintenance - see note 2		10,000	5,000	5,000
Security - see note 2		60,000	30,000	30,000
General Power - see note 2		10,000	5,000	5,000
Sub Total	**€**	**246,000**	**€ 120,500**	**€ 125,500**
Cappping and Restoration Costs - see note 3				
Assumes 4ha to be capped		40,000		
Preparation for capping €1/m2		1	20,000	20,000
Low Permeability Capping €5/m2		5	100,000	100,000
Drainage Layer €5/m2		5	100,000	100,000
Restoration Soil Placement €4/m2		4	80,000	80,000
Top Soil Placement €2/m2		2	40,000	40,000
Seeding €2/m2		2	40,000	40,000
Landfill Gas and Leachate Recirculation Infrastructure €4/m3		4	80,000	80,000
Consulting Engineer and CQA - see note 1			100,000	100,000
Sub Total	**€**	**1,120,000**	**€ 560,000**	**€ 560,000**
Leachate Management Costs				
Leachate Disposal				
Effluent Disposal Volumes - see note 4	*annual volume m3*		*34,500*	*23,500*
			-	
Leachate Treatment				
Operating Cost €/m3 - see note 5		6.00	207,000	141,000
Disposal Cost €/m3 (tanker to WWTP) - see note 2		3.00	103,500	70,500
Disposal Cost €/m3 (WWTP Gate Fee) - see note 6		5.00	172,500	117,500
Caretaker - see note 1			5,000	5,000
Sub Total	**€**	**822,000**	**€ 488,000**	**€ 334,000**
Landfill Gas				
Management of gas field - see note 1		20,000	10,000	10,000
Flare maintenance - see note 1		20,000	10,000	10,000
Flare Power - see note 1		4,000	2,000	2,000
Sub Total	**€**	**44,000**	**€ 22,000**	**€ 22,000**
Total	**€**	**2,232,000**	**€ 1,190,500**	**€ 1,041,500**

Notes

1. Cost based on reasonable assumption.

2. Based on current costs, information provided by Knockharley Landfill Limited

3. Capping costs are on the basis of rates, currently and historically paid to contractors.
Equates to €28 per square metre.

4. Assumes 21Ha capped with 50mm/yr infiltration and 4Ha uncapped with 600mm/yr effective infiltration in year 1, and 23Ha capped with 50mm/yr infiltration and 2Ha uncapped with 600mm/yr effective infiltration in year 2.

5. Cost based on experience of operation the KTK Plant.

6. Assumed cost for a RO treated effluent.

Appendix 2

Knockharley Aftercare Expenditure

		Total (€)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Closure Period Monitoring, Maintenence and Management																																
Environmental Monitoring (3rd party) - see note 2		600,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Surface Water Monitroing - see note 2		25,000	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500																				
Leachate Analysis (disposal) - see note 2		60,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Stack Emmissions Monitoring - see note 2		100,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Annual Topographic Survey - see note 2		45,000	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Annual Environmental Report - see note 1		150,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Closure Validaton Report - see note 1		20,000																														20,000
EPA Waste Licence Contribution - see note 2		355,000	20,000	20,000	20,000	20,000	15,000	15,000	15,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Management of monitoring & misc consultancy - see note 1		150,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Insurances - see note 1		150,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
General Maintenance - see note 2		90,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Security - see note 2		100,000	15,000	15,000	15,000	10,000	10,000	10,000	10,000	5,000	5,000	5,000																				
General Power - see note 2		120,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Sub Total	**€**	**1,965,000**	**98,000**	**98,000**	**98,000**	**93,000**	**88,000**	**88,000**	**88,000**	**78,000**	**78,000**	**78,000**	**58,000**	**58,000**	**58,000**	**58,000**	**58,000**	**58,000**	**58,000**	**58,000**	**58,000**	**58,000**	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**	**68,000**
Leachate Management Costs																																
Leachate Disposal																																
Effluent Disposal Volumes - see note 3		*volume m3*	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500
Leachate Treatment																																
Operating Cost €/m3 - see note 4		6.00	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Disposal Cost €/m3 (tanker to WWTP) - see note 2		3.00	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500
Disposal Cost €/m3 (WWTP Gate Fee) - see note 5		5.00	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500	62,500
Overhaul - see note 1,6												50,000										50,000										
Caretaker - see note 1			5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Sub Total	**€**	**5,500,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**230,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**230,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**	**180,000**
Landfill Gas																																
Management of gas field - see note 7		210,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Flare maintenance - see note 7		200,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Replace Flare - see note 8		100,000															100,000															
Flare Power - see note 9, 10		237,500	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	7,250	7,250	7,250	7,250	7,250	7,250	7,250	7,250	7,250	7,250
Redrilling of damaged wells - see note 11		30,000					5,000			5,000			5,000				5,000															
Decommissioning Landfill Gas Utilisation Plant (removal of engines (crane), transformers, oils, fencing, reinstatement of ground) - see note 9		25,000					5,000			5,000		15,000																				
Decommission Gas Flares and Gas extraction system - see note 12		130,000						10,000			10,000			10,000			10,000			10,000			10,000			10,000			10,000			50,000
Sub Total - see note 13	**€**	**932,500**	**22,000**	**22,000**	**22,000**	**22,000**	**32,000**	**32,000**	**27,000**	**27,000**	**37,000**	**37,000**	**32,500**	**37,500**	**32,500**	**27,500**	**142,500**	**27,500**	**27,500**	**37,500**	**27,500**	**27,500**	**25,250**	**15,250**	**15,250**	**25,250**	**15,250**	**15,250**	**25,250**	**15,250**	**15,250**	**65,250**
Decommission and Decontaminate Residual Site Plant and Infrastructure																																
Landscaping (post-settlement) (including road removal & disposal, fence removal/replacement)		50,000					10,000					10,000					10,000					10,000				10,000						
Decommission Leachate Management Infrastructure (removal of treatment plant, tanks, pipework, cabling, tanker loading area, sludges, consumable media)		25,000																														25,000
Decommission/dismantle Power Supplies (removal of transformers, substation building and disposal of materials, sealing of ducts)		25,000																														25,000
Decommission/dismantle offices/cabinets/ducts		25,000																														25,000
Sub Total	**€**	**125,000**	**0**	**0**	**0**	**0**	**10,000**	**0**	**0**	**0**	**0**	**10,000**	**0**	**0**	**0**	**0**	**10,000**	**0**	**0**	**0**	**0**	**10,000**	**0**	**0**	**0**	**0**	**10,000**	**0**	**0**	**0**	**0**	**75,000**
Total	**€**	**8,522,500**	**300,000**	**300,000**	**300,000**	**295,000**	**310,000**	**300,000**	**295,000**	**285,000**	**295,000**	**355,000**	**270,500**	**275,500**	**270,500**	**265,500**	**390,500**	**265,500**	**265,500**	**275,500**	**265,500**	**325,500**	**253,250**	**243,250**	**243,250**	**253,250**	**253,250**	**243,250**	**253,250**	**243,250**	**243,250**	**388,250**

Notes
1. Cost based on reasonable assumption.
2. Based on current costs, declining over time as appropriate, information provided by Knockharley Landfill Limited
3. Assumes 25Ha capped with 50mm/yr infiltration.
4. Cost based on Greenstar's experience of operation the KTK Plant.
5. Assumed cost for a RO treated effluent.
6. Assummes full overhall carried out prior to start of aftercare period (opex), then at years 10 and 20 of aftercare.
7. Assumes management of full gas field for first 10 years of aftercare, then 30% decline per 10 years thereafter.
8. Assummes full overhall carried out prior to start of aftercare period (opex), then full replacement at year 15 of aftercare.
9. Assumes landfill gas utilisation plant operates for 10 years of aftercare period.
10. Nominal sum for first 10 years as power provided by utilisation plant, increased demand betweem years 10 and 20 to account for import of power for flares, declines by 50% after year 20 to relflect decreased in gas yield.
11. Assumes rolling replacement of approximately 10 wells every other year between years 5 and 15 of aftercare period.
12. Assumes rolling decommissioning after year 5.
13. It is assumed that costs of "landfill gas" are attribited to operational revenue of the LGUP for the first 14 years, so not included in total.

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