EAST CORK LANDFILL
ROSSMORE
CARRIGTOHILL
CO CORK

ENVIRONMENTAL PROTECTION AGENCY

WASTE LICENCE W0022-01

ANNUAL ENVIRONMENTAL REPORT

1st JANUARY - 31st DECEMBER 2009

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1 INTRODUCTION

1.1 Scope and Purpose of the Annual Environmental Report

Cork Council Council holds an E.P.A. Waste Licence W0022-01 to operate waste disposal activities at East Cork Landfill, Rossmore, Carrigtohill. The aim of the Annual Environmental Report is to provide a review of activities at Rossmore within the last twelve months. The Table of Contents is derived from Schedule C of the Waste Licence.

1.2 Background to the Report

The landfill facility has been in operation at Rossmore since 1986 with waste received in the lined cells since 10th January 1995. The Waste Licence was issued to Cork County Council by the E.P.A. on 27th July 2000.

In accordance with Condition 2.8 of Waste Licence 22-1 an Annual Environmental Report will issue from the site to the Agency.

This is the ninth A.E.R. for the landfill and covers the period **1st January to 31st December 2009.**

1.3 Site Location

The facility is located 2½ km south of the N25 at Carrigtohill in the townland of Rossmore.

The site address is:

East Cork Landfill,
Rossmore,
Carrigtohill,
Co.Cork.

Tel. (021) 4533934
Fax. (021) 4533880
e-mail: jerome.obrien@corkcoco.ie

1.4 Environmental Policy

Cork County Council is committed to conducting all activities such that they have a minimal effect on the environment.

The main objectives are:

A commitment to comply with the Conditions of the Waste Licence and all relevant environmental legislation.

To ensure that management and all personnel working on the site are familiar with the Conditions of the Waste Licence, the content of the Environmental Management Plan and the Emergency Response Procedures.

2 SITE DESCRIPTION AND ACTIVITIES

2.1 Description of the Site

East Cork Landfill is sited in the Rossmore Peninsula at the midpoint of the northern estuary of Cork Harbour, 10 km from Midleton, 19 km from Cork City and 5 km from the industrial area of Little Island.

The site is the void left by limestone quarrying formerly owned and worked by Cemex Ltd. The total site occupies an area of 38 acres of land. The mining resources are depleted since December 2001
.
The former waste disposal floor area of the site occupies 16.25 acres.

The peninsula has grazing and tillage farming activities almost completely on the perimeter of the landfill. A former oyster farming business, owned by Atlantic Shellfish Ltd., also shares the southeastern end of the region.

Cork Harbour waters almost fully surround the peninsula and there are extensive mudflats at low tide which provide feeding grounds for aquatic birds. The baseline ecological study indicated a quality of invertebrates, annelids and crustaceans not normally associated with waters adjacent to a landfill.

This region of Cork Harbour is a designated Special Protection Area for wildlife.

There is one groundwater abstraction in the peninsula which is included in the monthly schedule of monitoring. Potable water is supplied to the locality by a Cork County Council main.

The prevailing wind directions over the site are varied but predominantly southwesterly. The change in tides has an effect on wind speed and impacts on site.

The access road from the nearest Local route is in private ownership. It is not possible to place traffic calming, control signage or direction signage along this route as it is ‘not in charge’. The surface is maintained and cleaned by Cork County Council under Condition 4.4.2. Following the construction of an asphalt plant by Irish Asphalt Ltd the road was widened in accordance with planning requirements.

2.2 Reporting Period

The period being reported on is that from 1st January to 31st December 2009.

2.3 Waste Activities now carried out at the Facility

Waste activities at East Cork Landfill are restricted to those outlined in Schedule A of the Waste Licence in accordance with the Waste Management Act: Third Schedule, as outlined below.

2.3 Waste Activities carried out at the Facility (continued)

Class 4: Surface impoundment, including placement of liquid or sludge discards into pits, ponds or lagoons.

Class 7: Physico-chemical treatment not referred to elsewhere in this Schedule (including evaporation, drying, and calcination) which results in final compounds or mixtures which are disposed of by means of any activity referred to in paragraphs 1 to 10 of this Schedule.

Class 11: Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule.

Class 12: Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.

Class 13: Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule other than temporary storage, pending collection, on the premises where the waste concerned is produced.

2.4 Quantity and Composition of Waste Received and Disposed

The quantity and composition of waste received, disposed of, recovered and recycled during the reporting period is outlined in Table 2.1.

Table 2.1 Quantities of MS Waste Received at Civic Amenity and Disposed of at landfill during the Reporting Period

Month	Quantity of Waste/tonnes	Disposal Destination
January 2009	**148.86**	**Youghal Landfill**
February	**136.88**	**Youghal Landfill**
March	**144.89**	**Youghal Landfill**
April	**182.98**	**Youghal Landfill**
May	**162.70**	**Youghal Landfill**
June	**195.72**	**Youghal Landfill**
July	**207.12**	**Youghal Landfill**
August	**190.00**	**Youghal Landfill**
September	**160.66**	**Youghal Landfill**
October	**139.74**	**Youghal Landfill**
November	**161.96**	**Youghal Landfill**
December	**159.62**	**Youghal Landfill**
Total	**1991.13**	

Table 2.2 Quantities of C&D Received and Disposed of during the Reporting Period

Month	Quantity of C&D/tonnes	Disposal Destination
none	none	none

The software associated with the weighing mechanism is maintained by Precia Molen Ltd. Annual weighbridge calibration is performed by Precia Molen Ltd under new metrology regulations and the calibration certificate is held in the site file.

2.5 Tank Testing and Inspection Reports

Integrity testing of water retaining structures to comply with Condition 4.14.5 of the Waste Licence was not required in the year being reported.

3 SUMMARY OF MONITORING AND EMISSIONS

3.1 Landfill Gas

The possible migration of landfill gas is monitored daily by site technical staff in excess of the frequencies indicated in Schedule F, Table F.1 (a) and Condition 9 of the Waste Licence. The movement of landfill gas to the perimeter is detected by monitoring boreholes situated around the perimeter of the site. The natural existence of carbon dioxide in the underlying limestone cannot be discounted. Constant landfill gas monitoring is taken in the accommodation areas including the site office and weighbridge to detect the accumulation of methane and carbon dioxide. Monitoring is performed on the wells located on the capped landfill.

An extensive survey of the landfill gas infrastructure was carried out by Fehily Timoney & Co in 2009, highlighting areas for improvement by surface methods. The system was subjected to some of the most adverse weather conditions experienced in this country in terms of rain and freezing conditions in November and December 2009 and January 2010.

The landfill gas detection device is a LMSx Multigas Analyzer, calibrated and serviced regularly by CEMS Ltd.

FTC Drawing No.2000-004-18-10 Rev ‘E’ is the illustrated layout of the landfill gas monitoring locations agreed with the Agency.

The installation of the landfill gas flare in September 2004 has resulted in constant flaring of emissions. The recorded results were sent to the Agency as part of the monthly monitoring. The average percentage for methane, oxygen and carbon dioxide gas burned on the site is in the region of 30%, 1-2% and 20-25% respectively. Gas field balancing is carried out on site when required. The gas is collected from 51 wells in the lined area of the landfill and 9 wells in the unlined area of the landfill. The gas main was extend to incorporate cells 6 to 8b and transducer risers at cells 8b to 9 and also the pump risers at cells 9 and 10 in a bid to reduce odour nuisances in these areas during landfill operation. Now, a dual system is place which allows varying levels of vacuum on particular areas of the site. The results are relayed to a SCADA pc in the main office building.

Average levels for methane, oxygen and carbon dioxide burned at the flare are 31.3, 2.15 and 23.8% respectively with gas field-balancing being done when required.

3.2 Surface Water

Surface water is monitored at the locations described in Schedule F, Table F4.2, of the Waste Licence and FTC Drawing No.2000-004-18-10 Rev ‘E’ by agreement with the Agency and in accordance with Condition 9. The frequency and composition of analysis is illustrated in Table F4.2 of the Licence. Consultants RPS MCO’S Ltd. sample, analyse and interpret the results of the surface water monitoring on behalf of Cork County Council.

Precipitation falling on the capped landfill is directed by gravity to the surface water lagoon. Some falls to the holding tanks to the rear of Lagoon 2 from where it is pumped to the surface water lagoon at the western end of the site. There, sampling takes place before the inlet and at the outlet for TOC, pH and conductivity.

Installed by Automatic Flare Systems Ltd., the flow is continuously sampled and results compared and trigger levels set. If these levels are exceeded in any of the above an actuated valve closes the outlet pending the dilution of the cause of the exceedence.

3.3 Groundwater

Surface water is monitored at the locations described in Schedule F5 of the Waste Licence and FTC Drawing No.2000-004-18-10 Rev 'E' by agreement with the Agency and in accordance with Condition 9. The frequency and composition of analysis is illustrated in Table F4.2 of the Licence which requires that some parameters are monitored monthly, some quarterly and others annually. Consultants RPS MCO'S Ltd. sample, analyse and interpret the results of Groundwater monitoring on behalf of Cork County Council.

3.4 Leachate

Leachate is monitored at the locations described in Schedule F.6, Table F6.1, of the Waste Licence and FTC Drawing No.2000-004-18-10 Rev 'E' by agreement with the Agency and in accordance with Condition 9. The frequency and composition of analysis is illustrated in Table F4.2 of the Licence.

Leachate levels in the ten waste cells and both lagoons are recorded daily on the instruction of the Agency. pH and temperature readings are recorded daily also as per Table F7.1.

Leachate analysis for ammonia, suspended solids, BOD and COD is conducted weekly at Inniscarra Laboratories on leachate sample from the lagoon from where leachate is removed.

Ammonia levels have shown an overall range is from 440 to 2180mg/l in Lagoon 2 in the monitoring period. pH has shown no major change in comparison to the last reporting period, with ranges from 7.48 to 8.50 in Lagoon 2.

BOD values range from 24 to 330mg/l for Lagoon 2 over the period. COD varies from 465 to 3250mg/l. The ranges vary in relation to the results shown in 2008. While Ammonia, pH and BOD have all shown a reduction a slight increase in COD was evident this year.

3.5 Noise

A noise survey was carried at the landfill in accordance with the requirements of Schedule F.3 and Table F.3, Schedule G1 on the 4th, 25th and 26th of June 2009, the locations illustrated in FTC Drawing No.2000-004-18-10 Rev 'E' and Condition 9.3. All locations were within the limits as set out in the Waste Licence. The results indicate that the maximum equivalent continuous noise measurement was 51dBA at monitoring locations N4 opposite the site entrance gate. The second highest measurement of 45 dBA was recorded at N5 at the western boundary of the landfill. The third highest measurement was 43 dBA at monitoring location GG1. All recordings were lower than the limit of 55dBA as directed by Schedule G2 of the Waste Licence. Results for 2009 are indicative of the decline in activity and are the lowest since records first begun in 2000. The report by the Environment Department, Cork County Council, is contained in Attachment F.

3.6 Dust

Three dust surveys were carried in accordance with the requirements of Schedule F.3 and Table F.3, Schedule G2, the locations illustrated in FTC Drawing No.2000-004-18-10 Rev 'E' and Condition 9.5. The dust was collected in Bergerhoff bottles of aperture size from 88mm diameter.

The dust limit in Schedule G2 of 350mg/m^2/day was exceeded in locations D3 during two monitoring periods. In the case of D3 this may be a result of the proper procedures not been followed such as washing out of the gauges before or during the erecting of the sampling gauges. D3 is situated on the south side of the landfill approximately mid way along the site perimeter.

In the areas where site staff and customers work and visit the levels of dust are well within the allowable margin.

Indeed, there is a case for the removal of D1 and D4 from the monitoring schedule because of low level of population, activity and traffic.

3.7 Dust Survey

Date	Location	Duration	Dust Concentration	Dust Level mg/m^2/day
Aug 09	Atlantic Shellfish D1	30 days	22.9	125.5
	Civic Amenity D2	30 days	14.9	81.7
	South Road (pylon) D3	30 days	114.5	627.5
	Northwestern corner D4	30 days	30.3	166.1

Date	Location	Duration	Dust Concentration	Dust Level mg/m^2/day
Sept 09	Atlantic Shellfish D1	30 days	5.6	30.7
	Civic Amenity D2	30 days	23.3	127.7
	South Road (pylon) D3	30 days	73.8	404.5
	Northwestern corner D4	30 days	5.4	29.6

Date	Location	Duration	Dust Concentration	Dust Level mg/m^2/day
Dec 09	Atlantic Shellfish D1	31 days	3.60	19.09
	Civic Amenity D2	31 days	6.60	35.00
	South Road (pylon) D3	31 days	21.30	112.97
	Northwestern corner D4	31 days	3.90	20.68

Table 3.

3.8 Ecology Parameters

In this licence period, the ecology monitoring of the landfill and surrounds was awarded again to Limosa Environmental for consistency and comparison. Dr Lesley Lewis has conducted an extensive ecology report on this site in accordance with the agreed parameters set out by the Agency in Condition 9.14.

The annual ecology survey is enclosed as Attachment G, and includes as required the following:

- *Brief survey of terrestrial component of site to assess changes in habitats and species of flora and fauna since baseline survey of 1998.*

- *Survey of estuarine sediments and shoreline for macro-invertebrates, macro, algae and Spartina distribution.*

- *Analysis of sediments (collected from same sampling points as for fauna/flora) for total nitrogen, total phosphorus, copper, cadmium chromium, zinc, lead and mercury. Organic content of sediment would also be determined. Results to be compared with 1998 data.*

- *Interpretation of water quality data for North Channel area from water quality programme as carried out by Environmental Protection Agency.*

- *Assessment of usage of intertidal flats by feeding wildfowl and waders in vicinity of Rossmore Peninsula and Brick Island. This would be done by systematic observations during low tide periods. Up to six visits would be made during the winter period.*

- *Assessment of relative importance of the North Channel area within the Cork Harbour SPA. This would be done by analysis of data for Cork Harbour from the I-WeBS scheme.*

- *Summary and interpretation of the significance of results of monitoring of shellfish growing areas in the vicinity of the landfill as undertaken by the Department of the Marine and Natural Resources.*

- *Contact with Duchas re any recent surveys or monitoring that might have been carried out in the SPA and the proposed NHA and also to discuss the possible trends in bird population.*

4. SITE DEVELOPMENT WORKS

4.1 Site Development Works during the Reporting Period

No site development works were conducted during the reporting period.

4.2 Proposed Development Works

Cork County Council proposes the following site development works January-December 2010 pending tendering and appointment of competent contractor/s:

4.3 Site Development Works during the Coming Year

The site development works for the current Waste Licence year will be the collection and discharge within the site perimeter of surface water arising from runoff from the site roads at the bin marshalling area.

4.4 Report on completed development works

There is no development work to report on in the Licence year.

4.5 Slope Stability

Analysis of slope stability in accordance with Condition 9.20 on a selected area of the restored cells was carried out by Fehily Timoney & Co. The analysis was conducted using the *Reslope* software programme on twelve locations. Factors of safety ranging from 1.25 to 2.23 evolved indicating stable conditions. A full and comprehensive report is included in Appendix A.

4.6 Quantity of indirect emissions to Groundwater

There are no indirect emissions from the site to groundwater. The cell leachate level condition is complied with as much as is possible given volumetric constraints at the waste water treatment plant. Monitoring of surface water does not indicate contamination from leachate.

4.7 Water Balance Calculations

The water balance calculations are illustrated in Appendix B. The volume of leachate predicted is 11,172m^3 less than tankered off for that Licence period. The significance of this deficit can be attributed to lesser absorptive properties of the waste than assumed, high levels of moisture retention in sludges and low levels of evapo-transpiration during the year.

5 WASTE RECEIVED BY THE FACILITY

5.1 Waste Acceptance

Only domestic MSW in small quantities are accepted at the facility in ro-ro bins for collection, transport and disposal at Youghal Landfill

The site offers a comprehensive range of vessels for the storage of solid and liquid recyclable materials.

The site generates approximately 5.25 tonnes of WEEE each week

6.1 Incidents

The following is a table of reportable incidents under Condition 3.1 which occurred this Licence period. It also outlines corrective action, if any required, taken by site management to prevent recurrence.

Site Incidents Log

Date	Nature of Incident	Cause	Corrective Action
16/01/09	LFG flare shut down	A relay contact in the electronic programme card was welded shut causing the louvres to obey the close command	The relay was replaced by the UK maintenance contractors following a period of manual louvre operation
26/01/09	Flow of LFG reduced to flare	Compressed air line becomes detached from pneumatic KO pot head causing condensate build-up.	Air line re-attached to drain build-up of condensate.
30/01/09	Flow of LFG reduced to flare	Damage to pneumatic pump sleeve causing failure to drain condensate	Retrieve spare part from redundant pump and replace
20/02/09	Exceedence of gas in perimeter wells	Condensation in the line reduction in flow and pumps 6-10 not operational	Reduce condensation in the pipeline and Endeavour to have pumps 6-10 operational as soon as is safe to do so.
25/03/09	Exceedence of gas in perimeter wells	Condensation in the line reduction in flow and pumps 6-10 not operational	Reduce condensation in the pipeline and Endeavour to have pumps 6-10 operational as soon as is safe to do so.
20/04/09	Exceedence of gas in perimeter wells	Condensation in the line reduction in flow and pumps 6-10 not operational	Reduce condensation in the pipeline and Endeavour to have pumps 6-10 operational as soon as is safe to do so.
15/05/09	LFG flare shut down	Methane depletion causes outage	Site LF gas resources allowed to re-charge overnight
15/05/09	Exceedence of gas in perimeter wells	Condensation in the line reduction in flow and pumps 6-10 not operational	Reduce condensation in the pipeline and Endeavour to have pumps 6-10 operational as soon as is safe to do so.
06/06/09	LFG flare shut down	Methane depletion causes outage	Site LF gas resources allowed to re-charge overnight. Field balanced twice.
08/06/09	LFG flare shut down	Power trip-out at local ESB Sub-Station	Incident beyond the control of CCC
15/06/09	Exceedence of gas in perimeter wells	Condensation in the line reduction in flow and pumps 6-10 not operational	Reduce condensation in the pipeline and endeavour to have pumps 6-10 operational as soon as is safe to do so.

Date	Nature of Incident	Cause	Corrective Action
02/07/09	LFG flare operating at reduced temperature	Heat sensing thermocouple broken	Replace and re-start
15/07/09	Exceedence of gas in perimeter wells	Condensation in the line reduction in flow and pumps 6-10 not operational	Our consultants FTC are undertaking a survey of all gas collection points.
18/08/09	Exceedence of gas in perimeter wells –sampling on a weekly basis	Condensation in the line reduction in flow and pumps 6-10 not operational	Our consultants FTC are undertaking a survey of all gas collection points.
04/09/09	LFG flare shut down	Failure of flare thermocouple	Locate replacement from another facility. Summon electrician to replace thermocouple
04/09/09	Exceedence of gas in perimeter wells	Condensation in the line reduction in flow and pumps 6-10 not operational	Our consultants FTC are undertaking a survey of all gas collection points.
31/08/09	Exceedence of gas in perimeter wells	Condensation in the line reduction in flow and pumps 6-10 not operational	Our consultants FTC are undertaking a survey of all gas collection points.
14/09/09	Exceedence of gas in perimeter wells	Condensation in the line reduction in flow and pumps 6-10 not operational	Our consultants FTC are undertaking a survey of all gas collection points.
31/10/09	LFG flare shut down	Failure of flare thermocouple	Replace thermocouple with spare unit
2/11/09	Exceedence of gas in perimeter wells	Condensation in the line reduction in flow and pumps 6-10 not operational	Our consultants FTC are undertaking a survey of all gas collection points.
22/12/09	LFG flare shut down	Methane depletion due to frost action causes outage	Balance manifolds to shut off poorly performing LFG wells
22/12/09	Leachate level signal failure from solar panel Station 6	Loose fuse housing	Take down solar panel and reset fuses

6.2 Complaints

There were no complaints registered against the site this year.

Site Complaints Log

Date	Complainant	Cause	Corrective Action	CAR Ref Number

Table 6.2

DOCUMENT CONTROL SHEET

Client	Cork County Council					
Project Title	Rossmore Landfill					
Document Title	Annual Environmental Report 2009					
Document No.	MCW0608Rp0002F01					
This Document Comprises	DCS	TOC	Text	List of Tables	List of Figures	No. of Appendices
	1	1	27	0	0	0

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REVIEW OF MONITORING DATA AT ROSSMORE LANDFILL JANUARY TO DECEMBER 2008

1.0 INTRODUCTION

A comparison has been made with the environmental monitoring results for the current monitoring period January to December 2009 and the monitoring data for the previous years 2006, 2007 and 2008 to establish if any changing trends in the composition of the leachate, groundwater or surface water are apparent.

2.0 SURFACE WATER MONITORING

Surface water quality monitoring has been undertaken at three locations (SW1, SW2, SW3) in the vicinity of Rossmore Landfill. Quarterly monitoring of the ammoniacal nitrogen, BOD, COD, chloride, dissolved oxygen, electrical conductivity, pH, total suspended solids and temperature is undertaken. The results of the surface water monitoring at Rossmore Landfill during 2009 have been compared to the results of the previous monitoring undertaken between 2004 and 2008.

During the monitoring period, quarterly monitoring was undertaken in February, May, August and November 2009. A more comprehensive analysis is required by the EPA on an annual basis and this was undertaken on the November 2009 round of sampling. In all of the monitoring undertaken to date the results indicate the surface water composition is most strongly influenced by its estuarine location.

2.1 SURFACE WATER QUARTERLY MONITORING

pH

The pH monitoring data indicates that the pH ranges from 7.68 to 8.07 units during the monitoring period. When compared to the previous three years monitoring data (2006, 2007 & 2008) there has been no significant change in the range of values measured. The pH data is summarised in Table 1.

Table 1: Surface Water – pH (pH units)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
SW1	7.68	8.05	7.86	7.07 -8.23	7.23-8.06	7.49-8.14
SW2	7.82	8.07	7.94	7.35-8.17	7.20-8.33	7.88-8.22
SW3	7.76	8.07	7.89	7.17-7.86	7.01-8.17	7.66-8.12

Electrical Conductivity

The electrical conductivity at the surface water monitoring locations ranged from 26,900 to 45,200 us/cm during 2009. This range is within than the ranges seen in 2006, 2007 and 2008. The electrical conductivity is highly influenced by the estuarine location of the monitoring points which gives rise to a naturally elevated electrical conductivity.

Table 2: Surface Water – Electrical Conductivity (uS/cm)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
SW1	26,900	44,500	35,925	31,100-44,900	26,300-57,900	12,140-50,400
SW2	28,500	45,200	40,550	35,700-46,200	35,500-58,700	13,410-52,500
SW3	31,500	43,100	39,375	33,300-44,300	34,500-58,200	12,620-50,300

Ammoniacal Nitrogen

The 2009 results indicate a range in ammoniacal nitrogen from 0.01 to 8.2 mg/l. The maximum levels during 2009 at SW1 and SW3 are higher than the maximum levels seen during 2008, 2007 and 2006. Similar ranges were seen in 2005 at SW1 (0.1 to 7.0 mg/l), SW2 (0.05 to 6mg/l) and SW3 (0.1 to 5 mg/l).

Table 3: Surface Water – Ammoniacal Nitrogen (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
SW1	0.02	2.5	0.65	0.02-0.25	<0.01-0.32	< 0.01-1.76
SW2	0.01	0.05	0.0275	<0.01-0.04	<0.01-0.07	< 0.01-1.36
SW3	0.02	8.2	2.08	0.02-0.27	<0.01-0.13	< 0.01-1.09

Dissolved Oxygen

The dissolved oxygen levels ranged from 90.3% to 100%. This range is similar to the levels seen in 2008 and an improvement on the range seen in 2006 and 2007.

Table 4: Surface Water – Dissolved Oxygen (% Saturation)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
SW1	96.7	100	98.4	97-100	69.2-93	71.5-87.9
SW2	90.3	100	96.1	97.9-100	61.4-97.5	69-84.2
SW3	90.3	100	97.1	92-100	70.7-92.1	70.7-92.1

Chloride

The results of the chloride monitoring are summarised in Table 5. The concentration ranged from 1,612 to 26,490mg/l in 2009. Lower minimum values were seen at all three monitoring in 2009 compared to the minimum values recorded in 2008, 2007 and 2006. There are normally significant variations in the chloride concentration at this site due to the estuarine nature of the monitoring locations.

Table 5: Surface Water – Chloride (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
SW1	1,678	16,027	5,685	10,143-21,321	13,761-26,683	11,460-19,075
SW2	2,222	4,209	8,516	10,194-24,602	16,770-28,667	12,108-23,381
SW3	1,612	26,490	9,084	17,657-24,762	21,304-26,905	11,511-18,936

Chemical Oxygen Demand

The COD levels at the surface water monitoring locations ranged from 30 to 500 mg/l in 2009. The 2009 COD levels at SW1 and SW3 are lower than the 2008 levels while the levels at SW2 are higher than the 2008 levels. Lower maximum levels were recorded at all locations in 2006 and 2007. The results are summarised in Table 6.

Table 6: Surface Water – Chemical Oxygen Demand (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
SW1	30	300	118	140-340	20-150	10-190
SW2	70	500	237	50-460	120-200	110-180
SW3	80	200	120	192-400	60-230	9-150

Biochemical Oxygen Demand

During 2009 the BOD levels ranged from 5mg/l to 88mg/l. The levels exceed previously detected levels from 2006 to 2008. The results are summarised in Table 7.

Table 7: Surface Water – Biochemical Oxygen Demand (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
SW1	5	88	37	1-74	<1-3	1-11
SW2	5	88	36	1-55	<1-33	1-7
SW3	5	48	29	1-65	<1-3	2-7

Suspended Solids

The concentration of suspended solids ranged from 94 to 513 mg/l during 2009. The maximum level at SW1 has reduced below the 2008, 2007 and 2006 levels. The levels at SW2 and SW3 remain similar to the 2006, 2007 and 2008 levels. The results are summarised in Table 8.

Table 8: Surface Water – Suspended Solids (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
SW1	110	446	308	185.5-915	85.3-915	87.9-2,221
SW2	116.8	513	359	116-316	23.3-638	74.4-638
SW3	94	398	289	183-396	65.5-386	75.5-361

2.2 SURFACE WATER ANNUAL PARAMETERS

The results have been compared to the monitoring results for the period 2004 to 2008 for the site and to the environmental quality standards (EQS) set for surface water by the EPA in the publication “Towards Setting Guideline Values for The protection of Groundwater in Ireland”.

SW1

Analysis of the annual parameters indicates a similar composition to that seen previously. There have been some increases in the concentration of iron, lead, magnesium, manganese, total oxidised nitrogen and nitrate from the 2008 levels but the concentrations remain within the ranges seen previously at the site. Most of the parameters are within the EQS levels set for surface water where specified with the exception of the iron and lead concentration. The iron concentration at 0.696mg/l is above the EQS for surface water of 0.2 mg/l. The iron concentration has increased from the 2008 level but a similar concentration was measured in 2002. The lead concentration at 0.097 mg/l is above the EQS for surface water of 0.01 mg/l. The lead concentration has increased from the 2008 level but a similar concentration was measured in 2005. There has been a reduction in concentration of sulphate from 227.5 mg/l in 2008 to 34.3 mg/l in 2009. The concentration of cadmium, mercury and nitrite were below the detection limits of the analysis methods used.

The estuarine nature of the monitoring location results in natural variations in calcium, magnesium, potassium, sodium and sulphate due to the tidal conditions; this has been seen on all sampling occasions to date.

Table 9: SW1 – Annual Results

Parameter	Annual Results (mg/l)						
	Nov'04	Dec'05	Nov'06	Nov'07	Nov'08	Nov'09	EQS
Calcium Ca	379	218.5	478.5	398.9	358.8	301.4	
Cadmium Cd	<0.0035	<0.0035	<0.0035	<0.0035	<0.0035	< 0.0035	0.005
Total Chromium Cr	0.068	< 0.01	<0.01	<0.01	0.014	0.015	0.03
Copper Cu	0.31	< 0.015	0.017	0.013	< 0.015	0.018	0.03
Iron Fe	0.626	0.476	0.254	0.183	0.087	0.696	0.2
Lead Pb	< 0.049	0.098	<0.049	<0.049	0.046	0.097	0.01
Magnesium Mg	565	766.5	1,246	710.6	866.6	1,023.1	
Manganese Mn	0.259	0.026	0.019	0.078	0.017	0.156	0.3
Mercury Hg	< 0.0005	0.0005	<0.0005	<0.0005	<0.0005	< 0.0005	0.001
Potassium K	180	225.9	430	350.1	314.3	286.4	
Sodium Na	1,110	5,772	9,922	5,748	6,288	4,210	
Sulphate SO_4	1,807	1,458.1	1,726	2,344	227.5	34.3	200
Zinc Zn	0.114	< 0.011	<0.011	<0.011	<0.011	0.025	0.1
Total alkalinity (as $CaCO_3$)	117	115	177	149	129	115	
Total oxidised nitrogen TON	< 0.1	0.85	8.82	9.47	0.81	1.23	
Nitrite NO_2	< 0.1	0.18	<0.05	<0.05	<0.05	< 0.05	0.2
Nitrate NO_3	< 0.1	3.52	39.19	42.1	3.6	5.46	50
Total Phosphorous P	< 0.01	0.04	0.05	0.05	0.25	0.08	

SW2

Analysis of the annual parameters indicates increases in the concentration of the following parameters from the 2008 levels: total chromium, copper, iron, lead, magnesium, manganese, sulphate, zinc, TON, nitrate. The concentration of cadmium, total chromium, copper, iron, lead and sulphate are above the EQS for surface water.

The cadmium concentration at 0.007 mg/l is above the EQS for surface water of 0.005 mg/l. A higher cadmium concentration was measured in 2008 (0.009mg/l) while on all previous sampling dates from 2004 to 2007 the concentration was less than the detection limit (< 0.0035 mg/l). The chromium concentration of 0.071 mg/l is above the EQS for surface water of 0.03 mg/l. This concentration is higher than the 2008 level of 0.014 mg/l and slightly higher than the 2004 concentration of 0.069 mg/l. The copper concentration was 0.097 mg/l which is higher than the 2008 concentration of < 0.015 mg/l and higher than the EQS for surface water of 0.03 mg/l. A higher copper concentration was detected in 2004. The iron concentration has increased from < 0.03 mg/l in 2008 to 1.564 mg/l in 2009. The iron concentration is above the EQS for surface water of 0.2mg/l. The 2009 iron concentration is higher than the range seen from 2004 to 2008 (< 0.03 to 1.392mg/l). The lead concentration has increased from 0.035 mg/l in 2008 to 0.355 mg/l both levels being above the EQS for surface water of 0.01 mg/l. The 2009 lead concentration is higher than the 2004 to 2008 range of < 0.049 to 0.035 mg/l.

The concentration of calcium, magnesium, manganese, mercury, potassium, sodium, sulphate, zinc, total alkalinity, nitrite, and nitrate were within the normal range seen previously at the site. The sulphate concentration of 1,614.6 mg/l is above the EQS for surface water of 200mg/l but it within the normal range seen at the site.

The estuarine nature of the monitoring location results in natural variations in calcium, magnesium, potassium, sodium and sulphate due to the tidal conditions; this has been seen on all sampling occasions to date.

Table 10: SW2 – Annual Results

Parameter	Annual Results (mg/l)						
	Nov'04	Dec'05	Nov'06	Nov'07	Nov'08	Nov'09	EQS
Calcium Ca	414	361.4	413.3	346.3	432.3	384.5	
Cadmium Cd	< 0.0035	< 0.0035	<0.0035	<0.0035	0.009	0.007	0.005
Total Chromium Cr	0.069	< 0.01	<0.01	<0.01	0.014	0.071	0.03
Copper Cu	0.385	< 0.015	<0.015	0.016	<0.015	0.097	0.03
Iron Fe	0.62	< 0.03	1.392	0.163	< 0.03	1.564	0.2
Lead Pb	< 0.049	< 0.002	0.006	<0.049	0.035	0.355	0.01
Magnesium Mg	597	1078	1288	935.2	1068	678	
Manganese Mn	0.415	< 0.014	0.058	0.074	< 0.014	0.103	0.3
Mercury Hg	< 0.0005	< 0.0005	0.0008	<0.0005	< 0.0005	< 0.0005	0.001
Potassium K	397	316.5	360.3	292.2	396.9	247.4	
Sodium Na	6,380	8,763	3,648	6,035	9,231	7,841	
Sulphate SO_4	3,576	1,417	1,523	2,527	345.5	1,614.6	200
Zinc Zn	0.265	< 0.011	<0.011	<0.011	<0.011	0.025	0.1
Total alkalinity (as $CaCO_3$)	112	116	121	164	116	100	
Total oxidised nitrogen TON	< 0.1	0.81	1.14	10.1	1.01	1.49	
Nitrite NO_2	< 0.1	0.08	<0.05	<0.05	<0.05	< 0.05	0.2
Nitrate NO_3	< 0.1	3.52	4.56	44.9	4.5	6.62	50
Total Phosphorous P	< 0.01	0.03	0.04	0.2	0.03	0.06	

SW3

Analysis of the annual parameters indicates increases in the concentration of the following parameters: chromium, copper, iron, lead, manganese, sulphate and zinc. The concentration of chromium has increased from 0.017 mg/l in 2008 to 0.031 mg/l in 2009. The 2009 chromium concentration is close to the EQS for surface water of 0.03 mg/l and higher than the 2005 to 2008 range. A higher chromium concentration was seen in 2004. The copper concentration of 0.6 mg/l is higher than the surface water EQS of 0.03 mg/l. The copper concentration is higher than the 2004 to 2008 range at this monitoring location. The iron concentration of 0.467 mg/l is higher than the surface water EQS of 0.2 mg/l. The iron concentration is higher than the 2005 to 2008 range but a higher concentration was seen in 2004. The lead concentration at 0.124 mg/l is above the 0.01 mg/l EQS for surface water. The lead concentration is higher than the levels seen from 2004 to 2008. The manganese concentration has increased from the 2008 level but is less than the EQS.

The sulphate concentration of 1,935.7 mg/l is above the EQS for surface water of 200mg/l but it within the normal range seen at the site. The concentration of zinc has increased from 0.014 mg/l in 2008 to 0.025 mg/l in 2009 which is within the EQS for surface water. The concentration of cadmium, mercury and nitrite were less than the limit of detection. The remainder of the annual parameters were within the normal range seen previously.

The estuarine nature of the monitoring location results in natural variations in calcium, magnesium, potassium, sodium and sulphate due to the tidal conditions; this has been seen on all sampling occasions to date.

Table 11: SW3 – Annual Results

Parameter	Annual Results (mg/l)						
	Nov'04	Dec'05	Nov'06	Nov'07	Nov'08	Nov'09	EQS
Calcium Ca	415	379.6	514.8	314.1	396.8	304.6	
Cadmium Cd	< 0.0035	< 0.0035	<0.0035	<0.0035	<0.0035	< 0.0035	0.005
Total Chromium Cr	0.083	< 0.01	<0.01	0.012	0.017	0.031	0.03
Copper Cu	0.344	< 0.015	<0.015	0.017	<0.015	0.6	0.03
Iron Fe	0.62	< 0.03	0.26	0.287	< 0.03	0.467	0.2
Lead Pb	< 0.049	< 0.002	<0.002	<0.049	0.012	0.124	0.01
Magnesium Mg	587	1,048	1,232	898	1,236	1,008	
Manganese Mn	0.201	< 0.014	0.019	0.084	< 0.014	0.108	0.3
Mercury Hg	< 0.0005	< 0.0005	<0.0005	<0.0005	<0.0005	< 0.0005	0.001
Potassium K	378	332.1	443.2	282.9	365.1	268.4	
Sodium Na	6,090	8525	9875	6171	7093	8048	
Sulphate SO_4	3,568	1,383.1	1421	2909	454.1	1,935.7	200
Zinc Zn	0.096	< 0.011	<0.011	0.014	0.014	0.025	0.1
Total alkalinity (as $CaCO_3$)	103	112	130	131	123	112	
Total oxidised nitrogen TON	2,038	0.81	1.17	10.48	1.2	1.43	
Nitrite NO_2	< 0.1	0.08	<0.05	<0.05	<0.05	< 0.05	0.2
Nitrate NO_3	9,061	3.52	5.21	46.6	5.3	6.38	50
Total Phosphorous P	< 0.01	0.02	0.04	0.89	0.01	0.03	

2.3 SUMMARY OF SURFACE WATER MONITORING

As mentioned previously, the composition of the surface water is strongly influenced by the tidal nature of the estuary due to the location of the site within Cork Harbour. This results in all of the surface water monitoring points having a naturally elevated calcium, magnesium, potassium, sodium, sulphate, electrical conductivity and chloride concentration. It is considered that the landfilling activities are not significantly impacting on the surface water quality in the vicinity of the site. There has been no significant change in the characteristics of the surface water since the monitoring programme commenced at the site.

There have been increases in the concentration of iron, lead, magnesium, manganese, total oxidised nitrogen and nitrate at SW1 from the 2008 levels but the concentrations remain within the ranges seen previously at the site. Most of the parameters are within the EQS levels set for surface water, where specified, with the exception of the iron and lead concentration.

At SW2 analysis of the annual parameters indicates increases in the concentration of the following parameters from the 2008 levels: total chromium, copper, iron, lead, magnesium, manganese, sulphate, zinc, TON and nitrate. Only the iron and lead levels are above the ranges seen previously. The concentration of cadmium, total chromium, copper, iron, lead and sulphate are above the EQS for surface water.

At SW3 the concentration of copper and lead were higher than EQS and above the 2004 to 2008 range.

3.0 GROUNDWATER MONITORING PROGRAMME

Monitoring of the groundwater compositions was undertaken at five locations (BH1, BH2, BH3, BH4, BH6) within and in the vicinity of the landfill site during 2009. In accordance with the Waste Licence for the site, monitoring of the groundwater composition at the site is undertaken on a monthly, quarterly and annual basis. During 2007, revised trigger levels were set for the concentration of ammoniacal nitrogen, electrical conductivity and total organic carbon in groundwater at monitoring locations BH1, BH2 and BH3.

3.1 GROUNDWATER MONTHLY MONITORING

Groundwater Levels

The monitoring of groundwater levels is undertaken on a monthly basis. The lowest groundwater levels were recorded in June at BH1 and BH4. In borehole BH2 the lowest level was recorded in February. The lowest level in borehole BH3 was recorded in April. Borehole BH6 was dry on most sampling dates with water levels only being recorded in July, November and December. The groundwater levels for 2008 are shown in Table 12.

Table 12: Groundwater Levels for 2009

Month	BH1 (m bgl)	BH2 (m bgl)	BH3 (m bgl)	BH4 (m bgl)	BH6 (m bgl)
January	5.84	11.82	3.56	2.41	No access
February	5.52	11.93	2.86	1.98	No access
March	5.90	11.8	3.40	2.30	Dry
April	5.90	11.90	3.68	2.40	Dry
May	5.85	11.70	3.50	2.30	Dry
June	5.96	11.70	3.67	2.50	Dry
July	5.87	11.54	3.57	2.38	Dry
August	5.82	11.80	3.35	2.20	3.62
September	5.78	11.75	3.28	2.17	Dry
October	5.78	11.65	3.57	2.40	Dry
November	5.00	11.40	3.00	1.94	3.25
December	5.00	11.00	2.20	1.51	2.80

Water Temperature

Monitoring of the temperature of the groundwater is undertaken on a monthly basis in the groundwater monitoring boreholes within and in the vicinity of the landfill site. The temperature data is presented in Table 13.

Table 13: Water Temperatures for 2009

Month	BH1 (° C)	BH2 (° C)	BH3 (° C)	BH4 (° C)	BH6 (° C)
January	9.9	10.1	10.1	10.1	No access
February	7.5.8	7.1	7.4	7.1	No access
March	11.3	13.6	10.4	9.4	Dry
April	10.9	13.5	10.8	9.8	Dry
May	11.3	13.9	11.3	10.6	Dry
June	11.2	12.8	11.6	10.6	Dry
July	13.9	15.1	14.1	15.4	Dry
August	12.1	14.3	13.3	13.0	16.2
September	11.8	12.7	12.9	12.7	Dry
October	12.4	13.5	12.5	13.1	Dry
November	12.7	13.3	12.4	11.6	12.8
December	10.4	10.6	10.1	10.4	10.1

pH

Monthly monitoring of the pH is undertaken. A summary of the results is presented in Table 14. The results indicate a pH range from 6.77 to 7.83 during 2009. There is no significant difference between the results for this year's monitoring period and the results from 2006, 2007 and 2008.

Table 14: Groundwater – pH (pH units)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
BH1	6.78	7.30	7.03	6.35-7.56	6.93-7.71	6.93-7.47
BH2	6.89	7.45	7.17	6.30-7.06	6.45-7.29	6.72-7.23
BH3	6.87	7.42	7.12	6.59-7.43	6.76-7.81	6.82-7.69
BH4	6.77	7.27	7.02	6.43-7.96	6.76-7.37	6.7-7.05
BH6	7.19	7.83	7.43	6.94-7.96	6.70-7.64	7.02-7.41

Electrical Conductivity

A summary of the results of the electrical conductivity monitoring is shown in Table 15. Electrical conductivity is measured on a monthly frequency. The electrical conductivity is affected by the proximity of the sampling locations to the estuary and tidal influence.

The trigger levels of 2,000 us/cm at BH1 was exceeded in January, February, March, April, May, June, July, August and October. A similar range for electrical conductivity was measured during 2008. The levels at BH2 and BH3 were within the trigger levels. There has been a reduction in the maximum levels at these two locations during 2009. There has also been a reduction in the electrical conductivity range at BH4 and BH6 during 2009.

Table 15: Groundwater – Electrical Conductivity (us/cm)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006	Trigger Level
BH1	836	7,670	3,963	874-8,840	656-1,904	769-2,080	2,000
BH2	345	18,800	2,153	669-31,700	1,262-37,300	1,904-30,200	33,000
BH3	3,120	4,400	3,526	3,820-44,700	1,142-9,270	1,600-22,00	15,500
BH4	2,061	16,570	10,241	9,040-31,600	8,120-44,800	2,900-27,300	
BH6	367	1,574	1,131	306-3,750	307-34,900	191.4-301	

Ammoniacal Nitrogen

The results of the monthly monitoring of the ammoniacal nitrogen levels are summarised in Table 16. The concentration ranged from < 0.01 to 44.5 mg/l at the site during 2009. Trigger levels are specified for BH1, BH2 and BH3 but these were not exceeded during the reporting period.

During 2009 the lowest ammoniacal nitrogen concentrations were at BH2 and BH4. The maximum values at both these locations were less than the maximum values seen in 2006, 2007 and 2008. The highest concentrations were measured at BH3 however all of the levels in 2009 were less than the trigger level of 115 mg/l. The maximum values at BH3 in 2009 were lower than the maximum values in 2007 and 2008. The results at BH1 were similar to the results during 2006, 2007 and 2008. The maximum values at BH6 were less than the 2008, 2007 and 2006 maximum values.

Table 16: Groundwater – Ammoniacal Nitrogen (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006	Trigger Level
BH1	< 0.01	8.25	2.69	0.51-8.2	<0.01-2.15	<0.01-3.89	4
BH2	< 0.01	1.20	0.21	<0.01-42	0.02-9.4	<0.01-8.38	10
BH3	6.8	44.5	30.58	0.01-165	18-120	<0.01-110.87	115
BH4	< 0.01	2.25	0.25	0.01-160	<0.01-7.9	<0.01-97	
BH6	< 0.01	0.03	0.11	0.01-0.51	<0.01-14.57	2.99-3.42	

3.2 GROUNDWATER QUARTERLY MONITORING

Total Oxidised Nitrogen

The ranges measured in 2009 at all of the monitoring points are different to those measured in 2006, 2007 and 2008. At BH1, BH3, BH4 and BH6 there has been an increase in the maximum concentration compared to the levels of the previous three years. At BH2 the maximum concentration has reduced from the 2008 maximum, but is above the 2006 and 2007 maximum level. Considerable variation in concentrations is seen at the site.

Table 17: Groundwater – Total Oxidised Nitrogen (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
BH1	0.75	222.3	56.9	0.94-6.06	0.56-2.4	0.54-3.05
BH2	1.37	15.82	8.9	1.33-84.15	0.6-9.09	<0.1-3.07
BH3	0.08	131.9	33.3	< 0.1-0.44	<0.1-<0.1	<0.1-1.88
BH4	9.29	180.9	86.9	2.0-3.94	0.16-8.82	<0.1-3.8
BH6	5.72	29.36	17.5	N/A	12.47-12.74	3.8-3.8

Total Organic Carbon

There was no significant change in the range of total organic carbon concentrations monitored at the site during 2009 compared to the 2006, 2007 and 2008 ranges. The trigger levels at BH1, BH2 and BH3 were not exceeded during the reporting period.

Table 18: Groundwater – Total Organic Carbon (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006	Trigger Levels
BH1	5.6	19.8	11.45	10.3-29.6	5.4-9.8	3.3-20	22
BH2	< 0.4	27	9.5	3.0-25.0	14-185	9-36	36
BH3	2.8	50	20.6	20.5-86.0	12.4-50	14.7-79	82
BH4	14.1	79	40.7	19.7-78.0	<0.4-80	6.7-210	
BH6	3.3	20	16.2	N/A	21.1-21.1	1.2-1.2	

Potassium

A summary of the concentration of potassium is shown in Table 19. The ranges measured in 2009 at all of the monitoring points are different to those measured in 2006, 2007 and 2008. The maximum value at BH1 in 2009 is higher than the maximum value in 2006, 2007 and 2008. At BH2, BH3 and BH4 the maximum value is lower than the maximum values previously seen in 2006, 2007 and 2008. At BH6 the maximum value is higher than the previous maximum values from 2006 to 2008. It is not unusual to see a wide variation in the concentration of potassium as the groundwater chemistry is strongly influenced by the proximity of the boreholes to the estuary.

Table 19: Groundwater – Potassium (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
BH1	8.15	24.27	16.7	8.34-16.53	6.54-9.49	11.32-14.95
BH2	3.12	5.71	4.4	6.21-170.1	57.18-420.6	24.94-218.6
BH3	9.5	36.03	26.2	33.34-82.62	47.38-88.79	45.75-52.26
BH4	21.5	86.54	47.6	83.59-174.2	15.6-271.3	82.08-173.8
BH6	14.2	32.1	23.2	3.17-3.17	3.17-3.17	<0.01

Sodium

The results of sodium monitoring are shown in Table 20. The concentration levels in the monitoring boreholes are within ranges detected during 2006, 2007 and 2008 as seen previously there is a wide variation in the concentration of sodium related to the proximity of the boreholes to the estuary. The maximum concentration of sodium is above the maximum range seen between 2006 and 2008.

Table 20: Groundwater – Sodium (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
BH1	21.5	657.9	304	63.1-400.2	19.28-69.01	71.59-196.7
BH2	8.12	17.25	12.1	28.06-936.3	358.1-4,100	443.8-5,284
BH3	24.5	411.5	290	386.2-873.7	117.1-1,336	13.83-216.9
BH4	148.7	1,964	1,008.3	28.51-3,433	352.9-1,526	1,899-4,950
BH6	45.1	211.4	128.3	8.97-8.97	357	<0.8

Chloride

A summary of the results of the chloride monitoring are presented in Table 21. With the exception of BH1, the chloride concentration at all monitoring locations was within ranges seen at the site during 2006, 2007 and 2008. The concentration of BH1 during Quarter 3 exceeded previously detected levels, however the concentration reduced to within 2006 and 2007 ranges during Quarter 4, 2008.

Table 21: Groundwater – Chloride (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
BH1	16.22	4212	1,385.9	132.2-2,224	33.8-269.5	105.7-454
BH2	15.03	70.35	38.5	448.5-1,078	2,745-14,793	226.9-9,634
BH3	75.9	1,004.9	637.1	398.4-1,892	271.7-3,170.5	192.8-6,487.3
BH4	263.2	7,094	2,140.3	326-7,234	3,465-27,857	1,972.7-37,622
BH6	130.5	857.3	493.9	247.9-247.9	5,620	17.73

3.3 GROUNDWATER ANNUAL MONITORING

BH1

The results of the analysis of the annual parameters in 2009 indicate a similar composition to that seen in 2006, 2007 and 2008. The monitoring results have been compared to the Interim Guideline Values (IGV) for groundwater recommended by the EPA in the publication "Towards Setting Guideline Values For The Protection Of Groundwater In Ireland". The majority of the parameters are less than the IGV values for groundwater, as recommended by the EPA, with the exception of phosphorus and coliforms. The concentration of cadmium, chromium, copper, mercury and zinc are below the detection limit of the analysis methods used.

There has been a reduction in the concentration of calcium, magnesium, lead, sulphate, total alkalinity and residue on evaporation from the 2008 concentrations but the concentrations remain within the normal range seen previously at this location. There has been an increase in the concentration of total cyanide, iron and fluoride but these remain within normal range seen previously and below the IGV for groundwater.

Table 22: BH1 – Annual Results

Parameter	Results (mg/l)					
	Annual Dec'05	Annual Nov '06	Annual Nov '07	Annual Nov '08	Annual Nov '09	IGV
Residue on evaporation	655	84	596	1721	462	
Calcium Ca	112.2	134.5	135.1	166.3	145.1	200
Cadmium Cd	< 0.0035	<0.0035	<0.0035	<0.0035	< 0.0035	0.005
Total Chromium Cr	< 0.01	<0.01	<0.01	<0.01	< 0.01	0.03
Copper Cu	< 0.015	<0.015	<0.015	<0.015	< 0.015	0.03
Total Cyanide Cn	0.016	0.006	0.008	0.003	0.006	0.01
Iron Fe	0.07	1.262	<0.03	<0.03	0.161	0.2
Lead Pb	< 0.002	0.003	<0.002	0.01	0.002	0.01
Magnesium Mg	14.13	27.61	14.48	35.6	21.9	50
Manganese Mn	1.018	1.887	0.009	0.048	< 0.014	0.05
Mercury Hg	< 0.0005	<0.0005	<0.0005	<0.0005	< 0.0005	0.001
Sulphate SO_4	27.91	43.8	63.75	152.26	37.8	200
Zinc Zn	< 0.011	0.02	<0.011		< 0.011	0.1
Total alkalinity (as $CaCO_3$)	349	361	365	355	320	
Boron B	0.142	0.357	0.253	0.129	0.12	1.0
Fluoride F	0.14	<0.08	0.51	<0.08	0.16	1.0
Total Phosphorus P	0.01	0.02	0.01	<0.01	0.07	0.03
Faecal coliforms (CFU/100mls)	3	162	1	None Found	22	0
Total coliforms (CFU/100mls)	613	7	272	275	2420	0

BH2

The results of monitoring of the annual parameters in 2009 indicate that the concentration is similar to that seen previously with the majority of the parameters being less than the IGV for groundwater with the exception of iron and coliforms. The concentration of cadmium, chromium, copper, lead, manganese, mercury and zinc are below the detection limit of the analysis methods used.

There has been a reduction in the concentration of calcium, total cyanide, lead, magnesium, sulphate, total alkalinity, boron and residue on evaporation from the 2008 levels. There has been an increase in iron and fluoride from 2008 levels. The iron concentration at 0.293 mg/l is slightly above the IGV for groundwater of 0.2 mg/l. This concentration is above the range seen at the site from 2006 to 2008.

Table 23: BH2 – Annual Results

Parameter	Results (mg/l)					
	Annual Dec'05	Annual Nov '06	Annual Nov '07	Annual Nov '08	Annual Nov '09	IGV
Residue on evaporation	5,850	7,750	10,432	1,280	236	
Calcium Ca	310.7	196.2	269.8	248.9	184.1	200
Cadmium Cd	< 0.0035	<0.0035	<0.0035	<0.0035	< 0.0035	0.005
Total Chromium Cr	< 0.01	0.013	0.01	<0.01	< 0.01	0.03
Copper Cu	< 0.015	<0.015	<0.015	<0.015	< 0.015	0.03
Total Cyanide Cn	0.011	0.016	0.008	0.019	0.005	0.01
Iron Fe	0.041	<0.03	0.087	<0.03	0.293	0.2
Lead Pb	0.007	<0.002	<0.002	0.005	< 0.002	0.01
Magnesium Mg	217.5	187.6	228.1	95.34	64.21	50
Manganese Mn	3.279	3.925	0.805	<0.014	< 0.014	0.05
Mercury Hg	< 0.0005	<0.0005	<0.0005	<0.0005	< 0.0005	0.001
Sulphate SO_4	170.7	439.9	646	373.6	42.2	200
Zinc Zn	0.082	0.014	<0.011	<0.011	< 0.011	0.1
Total alkalinity (as $CaCO_3$)	465	515	455	500	176	
Boron B	0.84	0.838	0.892	0.338	0.218	1.0
Fluoride F	6.8	8.84	7.9	<0.08	0.24	1.0
Total Phosphorus P	0.01	0.01	0.07	<0.01	0.1	0.03
Faecal coliforms (CFU/100mls)	1	4	8	1	2420	0
Total coliforms (CFU/100mls)	290	345	8,150	3,120	8500	0

BH3

Analysis of the annual parameters in 2009 indicated that the majority of the parameters were within the normal levels seen at the site with some minor changes. The majority of the parameters are less that the IGV for groundwater. The concentration of cadmium and mercury are below the detection limit of the analysis methods used.

The concentrations of the following parameters are above the IGV for groundwater: copper, total cyanide, iron, lead, magnesium, manganese and zinc. The copper concentration has increased to 0.1 mg/l during 2009 which is above the IGV of 0.03 mg/l and which is higher than the levels seen between 2005 and 2008. The total cyanide concentration of 0.037 mg/l is above the IGV of 0.01 mg/l but similar concentrations have been seen previously. The iron concentration has increased to 19.77 mg/l which is above the IGV of 0.2 mg/l however a higher concentration was seen in 2005. The concentration of lead at 0.013 mg/l is slightly above the IGV of 0.01 mg/l. The magnesium concentration of 55.4 mg/l is lower than the 2005 to 2008 levels but is above the IGV of 50 mg/l. The manganese concentration of 0.814 mg/l is above the IGV but similar levels have been seen previously. The zinc concentration of 0.281 mg/l is above the IGV of 0.1 mg/l.

There has been a reduction in the concentration of calcium, total cyanide, lead, magnesium, sulphate and residue on evaporation from the 2008 levels. There has been an increase in the concentration of chromium, copper, iron, manganese, zinc, total alkalinity, boron, fluoride, total phosphorus from the 2008 levels.

Table 24: BH3 – Annual Results

Parameter	**Results (mg/l)**					
	Annual Dec'05	**Annual Nov '06**	**Annual Nov '07**	**Annual Nov '08**	**Annual Nov '09**	**IGV**
Residue on evaporation	3,096		Dry	2,643	1,766	
Calcium Ca	112.1	56.52		129.8	111.4	200
Cadmium Cd	< 0.0035	<0.0035		<0.0035	< 0.0035	0.005
Total Chromium Cr	0.089	<0.01		<0.01	0.029	0.03
Copper Cu	0.048	0.022		0.023	0.1	0.03
Total Cyanide Cn	0.001	0.014		0.055	0.037	0.01
Iron Fe	2242	0.721		0.404	19.771	0.2
Lead Pb	0.004	<0.002		0.024	0.013	0.01
Magnesium Mg	100.6	129.5		64.5	55.4	50
Manganese Mn	5.08	0.832		0.101	0.814	0.05
Mercury Hg	< 0.0005	<0.0005		<0.0005	< 0.0005	0.001
Sulphate SO_4	32.35	298.7		229.9	6.2	200
Zinc Zn	0.03	0.021		<0.011	0.281	0.1
Total alkalinity (as $CaCO_3$)	600	490		211	240	
Boron B	0.705	0.804		0.445	0.548	1.0
Fluoride F	2.25	2.19		<0.08	0.19	1.0
Total Phosphorus P	0.01	0.05		<0.01	0.15	0.03
Faecal coliforms (CFU/100mls)	600	16		None Found	5	0
Total coliforms (CFU/100mls)	3096	3200		119	2850	0

BH4

Analysis of the annual parameters in 2009 indicated the majority of parameters are within the normal range seen previously at the site. There have been decreases in the concentrations of calcium, cadmium, copper, magnesium, sulphate, total alkalinity, boron and residue on evaporation. There have been increases in the concentration of total cyanide, iron, manganese and fluoride.

A number of parameters are above the IGV for groundwater. The copper concentration at 0.041 mg/l has reduced from the 2007 and 2008 concentrations but is above the IGV of 0.03 mg/l. The concentration of total cyanide at 0.028 mg/l is above the IGV of 0.01 mg/l and is higher than the levels seen between 2005 and 2008. The iron concentration at 1.019 mg/l is above the IGV of 0.2 mg/l. The iron concentration has increased from the 2008 level but is lower than the 2007 level. The lead concentration, while similar to levels seen previously, is above the IGV of 0.01 mg/l. The magnesium concentration has reduced from the 2008 level and is above the IGV of 50 mg/l but is within the normal range seen previously at the site. The manganese concentration is above the IGV of 0.05 mg/l but is within the normal range seen previously at the site. The phosphorus concentration is above the IGV of 0.03 mg/l but is within the normal range seen previously at the site.

Table 24: BH4 – Annual Results

Parameter	Results (mg/l)					
	Annual Dec'05	Annual Nov '06	Annual Nov '07	Annual Nov '08	Annual Nov '09	IGV
Residue on evaporation	10,426	10,094	4,103	11,010	2,214	
Calcium Ca	135.7	132.4	455.8	133.5	103.4	200
Cadmium Cd	< 0.0035	<0.0035	0.028	0.007	0.004	0.005
Total Chromium Cr	< 0.01	<0.01	0.09	<0.01	0.01	0.03
Copper Cu	0.019	<0.015	4.314	0.057	0.041	0.03
Total Cyanide Cn	0.001	0.004	0.007	0.001	0.028	0.01
Iron Fe	0.21	0.196	1.614	0.039	1.019	0.2
Lead Pb	0.003	<0.002	0.406	0.109	0.111	0.01
Magnesium Mg	332	312.5	123.3	263.4	185.4	50
Manganese Mn	0.097	0.062	1.451	<0.014	0.067	0.05
Mercury Hg	< 0.0005	<0.0005	<0.0005	<0.0005	< 0.0005	0.001
Sulphate SO_4	620.3	1005.2	3,022	457	181.1	200
Zinc Zn	< 0.011		0.015	<0.011	< 0.011	0.1
Total alkalinity (as $CaCO_3$)	234		176	306	245	
Boron B	1.633	0.952	2.802	0.752	0.502	1.0
Fluoride F	13.98	11.43	64.4	<0.08	0.29	1.0
Total Phosphorus P	0.14	0.12	0.17	0.31	0.32	0.03
Faecal coliforms (CFU/100mls)	9	22	2850	225	194	0
Total coliforms (CFU/100mls)	2419	3200	0	4280	5,880	0

BH6

The results have been compared to 2005, 2006 and 2008 results as the borehole was dry in 2007. The results of the annual monitoring in 2009 indicated most of the parameters were within the normal ranges seen previously. The concentration of iron and total coliforms are above the IGV for groundwater. The concentration of iron increased to 0.698 mg/l in 2009 which is above the IGV and higher than the values seen from 2005 to 2008.

There have been decreases in the concentrations of calcium, lead, magnesium, sulphate, boron and phosphorus. There have been increases in the concentration of residue on evaporation, iron, manganese, total alkalinity and fluoride.

Table 25: BH6– Annual Results

Parameter	Results (mg/l)					
	Annual Dec'05	Annual Nov '06	Annual Nov '07	Annual Nov '08	Annual Nov '09	IGV
Residue on evaporation	343		Dry	417	824	
Calcium Ca	54.34	22.59		21.76	19.54	200
Cadmium Cd	< 0.0035	<0.0035		<0.0035	< 0.0035	0.005
Total Chromium Cr	< 0.01	<0.01		<0.01	< 0.01	0.03
Copper Cu	0.043	<0.015		<0.015	< 0.015	0.03
Total Cyanide Cn	0.001	0.009		<0.001	< 0.001	0.01
Iron Fe	0.043	0.187		<0.03	0.698	0.2
Lead Pb	0.002	0.002		0.009	0.008	0.01
Magnesium Mg	9.8	8.52		4.7	3.4	50
Manganese Mn	0.057	<0.014		<0.014	0.034	0.05
Mercury Hg	< 0.0005	<0.0005		<0.0005	< 0.0005	0.001
Sulphate SO_4	18.32	17.8		189.3	107.9	200
Zinc Zn	0.012			<0.011	< 0.011	0.1
Total alkalinity (as $CaCO_3$)	103	50		66	213	
Boron B	0.234	0.199		0.055	0.023	1.0
Fluoride F	1.52	1.53		0.39	0.55	1.0
Total Phosphorus P	0.02	0.02		0.62	0.14	0.03
Faecal coliforms (CFU/100mls)	29	980		1553	66	0
Total coliforms (CFU/100mls)	> 2419	14		6580	3,140	0

3.3 SUMMARY OF GROUNDWATER MONITORING

Analysis of the annual parameters was undertaken during November, 2009. The groundwater chemistry is strongly influenced by the proximity of the boreholes to the estuary. This results in a naturally elevated chloride, electrical conductivity, sodium, potassium, magnesium and sulphate concentration.

The quarterly monitoring indicates a reduction in the maximum ammoniacal nitrogen levels at BH2, BH4 and BH6. There were variations in the electrical conductivity, chloride, potassium and sodium levels however variations in these are likely to be affected by the proximity of the monitoring locations to the estuary. The annual monitoring indicates the concentration of iron at BH2 has increased above the IGV, the copper concentration at BH3 has increased above the IGV and the total cyanide concentration at BH4 has increased above the IGV. The concentration of ammoniacal nitrogen remains high at groundwater monitoring location BH3, but is within the normal range seen previously at the site and has remained below the trigger level during the reporting period.

4.0 LEACHATE MONITORING

Monitoring of the leachate composition is undertaken at the leachate lagoon and from three monitoring points within the former unlined portion of the site (C1, C2 and C3). Monitoring of leachate composition is undertaken on a quarterly basis with analysis of a wider range of parameters on an annual basis. Leachate level monitoring is undertaken by Cork County Council.

4.1 LEACHATE QUARTERLY MONITORING

pH

The results of monitoring are summarised in Table 26. The overall pH in the leachate lagoon has ranged from 7.95 to 8.74 pH units during 2009 compared to a range of 7.18 to 8.77 pH units in 2008, 7.95 to 8.25 pH units in 2007 and 7.86 to 7.98 in 2006.

The range in the unlined and capped portion of the site has ranged overall from 7.05 to 7.99 pH units during 2009 compared to 6.53 to 8.51 pH units during 2008 and 6.73 to 7.93 pH units in 2007 and 6.3 to 8.21 pH units in 2006. There has been no significant change during the reporting period.

Table 26: Leachate – pH (pH units)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
Lagoon	7.95	8.74	8.20	7.18-8.77	7.95-8.25	7.86-7.98
C1	7.58	7.62	7.61	7.41-7.96	6.78-7.58	6.64-7.88
C2	7.05	7.77	7.24	6.53-7.45	6.73-7.12	6.3-6.94
C3	7.84	7.99	7.91	7.31-8.51	7.58-7.93	7.98-8.21

Electrical Conductivity

The results of the monitoring of the electrical conductivity for the 2009 are summarised in Table 27. As seen previously at the site considerable variation is seen in the electrical conductivity at all of the monitoring locations. All of the levels at C1, C2 and C3 are within ranges seen previously at the site. The minimum value for the leachate lagoon in 2009 is the lowest level measured since 2006 but there has been no significant change in the maximum concentration.

Table 27: Leachate – Electrical Conductivity (us/cm)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
Lagoon	136.9	17,740	7,372	701-8,900	9,040-17,680	6,710-21,500
C1	13,720	18,670	16,228	18,600-31,650	3,910-15,990	2,220-23,250
C2	6,020	7,760	6,513	5,140-8,080	5,330-6,520	2,300-6,420
C3	15,290	24,700	20,248	29,900-41,350	17,600-43,600	9,750-38,700

Ammoniacal Nitrogen

A summary of the results of the monitoring is presented in Table 28. Monitoring in the unlined capped portion of the site indicates ammoniacal nitrogen concentrations within the levels seen from 2006 to 2008 with the exception of the minimum value of 57.2 mg/l measured at C2 during 2009. Both the minimum value (< 0.01 mg/l) and maximum value (1,530 mg/l) at the leachate lagoon are outside of the ranges observed from 2006 to 2008.

Table 28: Leachate – Ammoniacal Nitrogen (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
Lagoon	< 0.01	1,530	436	3.2-551	485-970	861-1,149
C1	680	1,680	1,140	1,770-2,660	237.5-576	26.4-1,587
C2	57.2	800	310	400-800	313-440	233-510
C3	286	2,600	1,406	2,000-5,900	294-4,600	880-3,140

Biochemical Oxygen Demand

The results for the biochemical oxygen demand are summarised in Table 29. As seen previously there is considerable variation in the results for all the monitoring locations. There has been a reduction in the BOD range in 2009 compared to the 2006 to 2008 levels. At C1 and C2 there has been an increase in the maximum concentration compared to the 2006 to 2008 results however higher maximum values were seen in 2005 when C1 ranged from 91 to 331 mg/l and C2 ranged from 63 to 533 mg/l.

Table 29: Leachate – Biochemical Oxygen Demand (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
Lagoon	1	201	129	27-1,276	167-308	49-440
C1	123	252	158	48-231	22-105	11-108
C2	20	221	96	23-140	21-53	23-150
C3	61	430	339	476-1,439	1,500-8,424	373-1386

Chemical Oxygen Demand

The COD levels in the leachate lagoon ranged from 5 to 1,900 mg/l in 2009. The minimum level is lower than the levels seen from 2005 to 2008 while the maximum level is within the range seen previously. There has been a reduction in the range seen at C3 with both a reduction in the minimum and maximum levels. There has been an increase in the maximum level at C1 and C2 compared to the 2006 to 2008 levels. There has been a reduction in the minimum levels at all locations compared to the 2008 minimum levels.

Table 30: Leachate – Chemical Oxygen Demand (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
Lagoon	5	1,900	1,040	150-2,200	600-7,200	1,080-1,440
C1	260	1,800	818	500-1,060	190-790	170-1,090
C2	86	500	247	180-400	80-300	180-380
C3	300	4,600	1,840	1,600-8,150	6,200-59,200	2,740-9,900

Chloride

The chloride results are shown in Table 31. A considerable variation in the chloride concentration is seen at all of the monitoring points. During 2009 the chloride concentration ranged from 35.8 to 1,760 mg/l in the leachate lagoon. This is a reduction in both the maximum and minimum concentrations from the 2008 levels. The maximum concentration at C1 at 7,320 mg/l is higher than the maximum levels seen from 2006 to 2008 but is within the range seen in 2005 (3,595 to 11,980 mg/l). The maximum concentration at C2 at 2,513 mg/l is above the maximum level seen between 2006 and 2008 but is within the 2005 range (217.1 to 4,894 mg/l).

Table 31: Leachate – Chloride (mg/l)

Monitoring Location	Minimum 2009	Maximum 2009	Average 2009	Range 2008	Range 2007	Range 2006
Lagoon	35.8	1,760	856	529-12,821	1,065-2,404	1,304-5,633
C1	1,288	7,320	3,565	4,650-4,800	624-4,024	654.5-3,568
C2	610.1	2,513	1,815	258-1,323	641-943	134.2-611.7
C3	673	3,348.3	1,924	2,914-3,100	251-3,924	1,075-2,261

4.2 LEACHATE ANNUAL MONITORING

Analysis of the annual parameters was undertaken during November 2009. The composition of the leachate monitored at the site during the current monitoring period is similar to that seen previously at the site. A wide variation is seen in most of the parameters monitored.

LEACHATE LAGOON

Results from the 2009 annual monitoring have been compared to the results for the period 2004 to 2008 to determine if there are any apparent trends. During 2009 many of the parameters were within the limits set for drinking water i.e. calcium, chromium, copper, mercury, sulphate, zinc, boron, total cyanide, fluoride, nitrite and nitrate. There were slight increases from the 2008 concentrations in cadmium, total chromium, iron, sulphate, zinc, total oxidised nitrogen and nitrate however all of the concentrations were within the ranges seen previously.

Table 32: Leachate Lagoon– Annual Results

Parameter	Results (mg/l)					
	Annual Nov'04	Annual Dec'05	Annual Nov'06	Annual Nov'07	Annual Nov'08	Annual Nov'09
Calcium Ca	28.3	38.2	125.5	Dry	191.2	145.4
Cadmium Cd	< 0.0035	< 0.0035	<0.0035		0.021	0.026
Total Chromium Cr	0.067	0.098	0.112		0.01	0.023
Copper Cu	< 0.015	0.026	0.046		<0.015	< 0.015
Iron Fe	5.04	7.215	16.44		2.499	2.789
Lead Pb	< 0.049	0.015	<0.049		0.012	0.012
Magnesium Mg	19.6	40.5	134.3		86.76	78.41
Manganese Mn	3.3	0.414	1.045		0.978	0.176
Mercury Hg	< 0.0005	< 0.0005	0.0008		< 0.0005	< 0.0005
Potassium K	130	313.7	792.6		328.3	257.4
Sulphate SO_4	4.22	8.08	147.4		13.82	16.84
Zinc Zn	0.283	0.018	0.099		<0.011	0.047
Total alkalinity (as $CaCO_3$)	549	1980	1670		2760	690
Total oxidised nitrogen (as N)	0.57	0.9	1.26		0.53	0.55
Total Phosphorous	0.36	3	4.75		0.4	0.4
Boron B	4.43	5.838	3.494		1.662	0.42
Total Cyanide	0.005	0.01	0.006		0.115	0.015
Nitrite NO_2	< 0.1	< 0.1	<0.1		<0.1	< 0.1
Nitrate	2.56	3.98	5.8		0.53	2.44
Fluoride F	1.39	3.86	13.6		13.31	0.22
Faecal Coliforms	209	100	165		212	37
Total Coliforms	> 24,190	7701	5250		6520	41

C1 Leachate Borehole

The results of the annual monitoring indicate a similar composition to that seen previously, with some exceptions outlined below. During 2009 there have been increase in the concentration of the following annual parameters: total chromium, iron, lead, manganese, zinc, total alkalinity, total phosphorus, nitrate and fluoride from the 2008 concentrations. The concentrations have remained within the range seen previously.

The calcium concentration of 145.8 mg/l is higher than the range of 0.34 to 121.1 mg/l observed for period 2004 to 2008. The sulphate concentration of 1,269.5 mg/l is above the range of 38.7 to 761.7 mg/l observed from 2004 to 2008. The following parameters are less than the drinking water limits during 2009: calcium, total chromium, copper, mercury, zinc, nitrite, nitrate, fluoride and faecal coliforms.

Table 33: C1– Annual Results

Parameter	Results (mg/l)					
	Annual Nov'04	Annual Dec'05	Annual Nov'06	Annual Nov'07	Annual Nov'08	Annual Nov'09
Calcium Ca	117	80.3	0.34	121.1	115.2	145.8
Cadmium Cd	< 0.0035	< 0.0035	<0.0035	0.0035	0.033	0.016
Total Chromium Cr	0.133	0.102	0.022	0.027	<0.01	0.033
Copper Cu	0.41	0.016	<0.015	0.237	0.327	0.061
Iron Fe	74.1	204.4	0.466	2.544	0.299	1.612
Lead Pb	< 0.049	0.08	<0.049	0.28	0.016	0.052
Magnesium Mg	212	186.8	<0.01	125.6	229.8	184.7
Manganese Mn	0.962	0.304	4.054	<0.014	<0.014	0.188
Mercury Hg	< 0.0005	< 0.0005	<0.0005	<0.0005	<0.0005	< 0.0005
Potassium K	1,510	1,339	<0.1	125.4	1,313	1,215
Sulphate SO_4	171.3	761.7	38.7	179.2	105.3	1,269.5
Zinc Zn	1.09	0.02	0.016	0.012	<0.011	0.017
Total alkalinity (as $CaCO_3$)	5,400	5,130	579	5,000	4,590	3,500
Total oxidised nitrogen (as N)	29.12	< 0.1	1.26	3.89	2.93	4.31
Total Phosphorous	3	3	0.05	2	0.18	1.2
Boron B	7.68	5.356	0.325	3.207	2.594	1.028
Total Cyanide	0.078	< 0.001	0.014	0.01	0.355	0.091
Nitrite NO_2	< 0.1	< 0.1	<0.1	<0.1	< 0.1	< 0.1
Nitrate	129.4	< 0.1	5.6	17.3	13.05	19.16
Fluoride F	353.3	9.55	0.96	4.6	0.92	0.22
Faecal Coliforms	10	None found	31	0	None Found	None Found
Total Coliforms	> 24,190	2755	2800	25000	3000	187

C2 - Leachate Borehole

The results of the annual monitoring indicate a similar composition to that seen previously, with some exceptions outlined below. During 2009 there have been increase in the concentration of the following annual parameters from the 2008 concentrations: calcium, iron, manganese, sulphate, total alkalinity, total oxidised nitrogen, boron, total cyanide, nitrate, fluoride, total coliforms. The concentrations have remained within the range seen previously with the exception of total oxidised nitrogen, total cyanide and nitrate. The concentration of total oxidised nitrogen at 1.58 mg/l is above the range of < 0.1 to 1.13 mg/l recorded from 2004 to 2008. The concentration of total cyanide at 0.266 mg/l is above the range of 0.029 to 0.148 mg/l recorded from 2004 to 2008. There has been an increase in the nitrate concentration from < 0.1 to 5 mg/l for period 2004 to 2008 to a concentration of 7.06 mg/l which is still less than t he drinking water limit of 50 mg/l. The following parameters are less than the drinking water limits during 2009: calcium, chromium, copper, lead, magnesium, mercury, sulphate, zinc, boron, nitrite, nitrate and fluoride. The results of the annual monitoring indicate no significant change in the leachate composition the majority of the parameters are within the normal range seen at the site.

Table 34: C2– Annual Results

Parameter	Results (mg/l)					
	Annual Nov'04	Annual Dec'05	Annual Nov'06	Annual Nov'07	Annual Nov'08	Annual Nov'09
Calcium Ca	185	228.3	224.5	122	6.18	21.54
Cadmium Cd	< 0.0035	< 0.0035	<0.0035	<0.0035	0.019	0.019
Total Chromium Cr	0.053	0.01	<0.01	<0.01	<0.01	< 0.01
Copper Cu	0.147	0.017	<0.015	<0.015	<0.015	< 0.015
Iron Fe	13	314.1	43.03	0.386	0.213	0.456
Lead Pb	< 0.049	0.008	<0.049	0.052	0.008	< 0.002
Magnesium Mg	126	138	180.2	130.2	21.72	19.51
Manganese Mn	4.34	1.116	0.922	0.03	0.014	0.07
Mercury Hg	< 0.0005	< 0.0005	<0.0005	<0.0005	<0.0005	< 0.0005
Potassium K	164	211.8	305.1	110.2	138.9	101.7
Sulphate SO_4	6.56	80.35	3.2	21.9	20	31.2
Zinc Zn	0.05	0.031	0.029	<0.011	<0.011	< 0.011
Total alkalinity (as $CaCO_3$)	1,900	1,615	2,120	1,820	1,070	1,950
Total oxidised nitrogen (as N)	0.71	< 0.1	0.26	1.13	0.1	1.58
Total Phosphorous	1.5	0.5	0.25	0.75	1.8	0.8
Boron B	9.41	1.754	1.712	1.911	0.718	0.414
Total Cyanide	0.148	0.029	0.032	0.03	0.034	0.266
Nitrite NO_2	< 0.1	< 0.1	<0.1	<0.1	<0.1	< 0.1
Nitrate	3.15	< 0.1	1.03	5	0.42	7.06
Fluoride F	5.19	1.02	6.11	13.29	<0.08	0.16
Faecal Coliforms	None found	None found	53	0	None Found	4
Total Coliforms	> 24,190	> 24190	3500	9208	153	980

C3 - Leachate Borehole

The results of the annual monitoring indicate a similar composition to that seen previously, with some exceptions as outlined below. During 2009 there have been increase in the concentration of the following annual parameters from the 2008 concentrations: cadmium, total chromium, copper, iron, lead, manganese, sulphate, total alkalinity, total cyanide. The concentrations have remained within the range seen previously with the exception of cadmium and manganese. The 2009 cadmium concentration of 0.028 mg/l has increased above the 2004 to 2008 range of < 0.0035 to 0.008 mg/l. The manganese concentration of 1.132 mg/l is above the 2004 to 2009 range of 0.028 to 0.384 mg/l. The following parameters are less than the drinking water limits during 2009: calcium, copper, mercury, sulphate, zinc, nitrite, nitrate and fluoride. The results of the annual monitoring indicate no significant change in the leachate composition the majority of the parameters are within the normal range seen at the site.

Table 35: C3– Annual Results

Parameter	Results (mg/l)					
	Annual Nov'04	Annual Dec'05	Annual Nov'06	Annual Nov'07	Annual Nov'08	Annual Nov'09
Calcium Ca	24.3	64.37	7.56	292.8	232.1	180.4
Cadmium Cd	< 0.0035	< 0.0035	<0.0035	0.005	0.008	0.028
Total Chromium Cr	0.292	0.038	0.026	0.141	0.01	0.116
Copper Cu	0.264	< 0.015	<0.015	0.415	<0.015	0.021
Iron Fe	35.9	456.9	0.783	5.907	0.429	0.891
Lead Pb	< 0.049	0.016	<0.049	0.602	0.048	0.062
Magnesium Mg	420	234.9	67.41	389.4	417.3	274.8
Manganese Mn	0.365	0.384	0.028	0.115	0.068	1.132
Mercury Hg	< 0.0005	< 0.0005	<0.0005	<0.0005	<0.0005	< 0.0005
Potassium K	1,900	661.7	310.6	165.2	1,347	1,048
Sulphate SO_4	36.54	1.31	16.8	9.8	13.06	21.12
Zinc Zn	1.82	0.10	0.107	<0.011	0.016	0.084
Total alkalinity (as $CaCO_3$)	18,400	6,300	3,670	8,010	9,920	10,730
Total oxidised nitrogen (as N)	99.24	2.18	0.55	15.97	0.77	0.67
Total Phosphorous	4	1.5	1.25	5	2.2	1.8
Boron B	3.01	9.475	0.694	4.05	3.864	2.02
Total Cyanide	0.487	0.06	0.342	0.043	0.13	0.165
Nitrite NO_2	< 0.1	< 0.1	<0.1	<0.1	<0.1	< 0.1
Nitrate	441.1	9.7	2.45	71	3.44	2.96
Fluoride F	389.6	41.77	3.12	33.5	1.37	0.33
Faecal Coliforms	None found	None found	3000	0	None Found	None Found
Total Coliforms	> 24,190	> 24190	11500	341	1355	579

4.3 SUMMARY OF LEACHATE MONITORING

Monitoring of the composition of leachate in the unlined portion of the site and in the lagoon indicated no significant change in the composition of the leachate at the landfill during the reporting period. A wide variation is typically seen in most parameters monitored to date.

5.0 CONCLUSIONS

There have been no significant changes in the composition of the leachate and the surface water or groundwater in the vicinity of the landfill site. All of the parameters monitored were within the normal range seen previously at the site.

8 ENVIRONMENTAL EMISSIONS

8.1 Volume of Leachate Produced & Transported

The volume of leachate produced is the volume of leachate pumped to the lagoons and transported to the waste water treatment plants at the end of the period 1st January to 31st December 2009.

The total measure is 12,655.51 tonnes or 2,790,062 gallons.

This represents a reduction on 2008 of 131 tonnes.

Month	Leachate tonnes
January	997.65
February	1,147.46
March	1,687.52
April	801.80
May	806.88
June	468.42
July	831.09
August	1,186.55
September	1,429.45
October	627.18
November	1,245.51
December	1,426.00

Total leachate	**12,655.51 tonnes**

8.2 Effectiveness of Environmental Nuisance Emission Control

Noise

The degree of noise emissions from the landfill wis proportional to the number of plant machinery items operating at any one time. Since closure this has declined to a point where only the vacuum tanker, 360° excavator and customer vehicles are contributory. From observations little airborne sound is evident offsite.

All pumps are electrically or pneumatically powered.

Dust

Dust problems on site were attributed to dry weather, fine waste, fine imported soil for development, screening, waste covering, winds, landfill development traffic and works. Other potential sources of wind-blown dust exist in the near locality.

Because the site roads are constructed of hardcore they generate dust on drying and have to be treated to water spraying by vacuum tanker daily and/or mechanical sweeping as required to comply with the Operational Plan and good work practice.

Odours
Since landfill activity has ceased odours have been completely eliminated.

Landfill Gas
Fehily Timoney & Co completed two landfill gas assessments in the Licence year. The findings and recommendations are being acted on with repair work to some failed extrusion welds through which groundwater in being pulled by the gas field blower/vacuum. The Estimation of Cumulative and Annual Landfill Gas Emissions is contained in Appendix C.

The installation of the landfill gas flare coincided with the restoration of the landfill to final contour levels. The flare burns landfill gas continuously. Regular field balancing of the well connections to the manifolds yields methane of combustible quality with the elimination of oxygen to minimum quantities. Typically, the field produces about 450m^3 per hour, depending on atmospherics and prime operating conditions.

Leachate
The main environmental protection system against emissions from leachate is the HDPE liner. Failure of this system will cause environmental pollution. The liner is safeguarded in the sense that it is largely located underground with the exception of the lagoons which are fenced off. It is intrinsically safe from damage and the possibility of leakage is removed.

Litter
Litter no longer presents a nuisance either on or offsite.

Vermin
A contract was in place with a pest control firm, PestGuard Ltd., who visit the site fortnightly. Bait is set at six-week intervals by site staff. Experience has shown that less or more frequent baiting is ineffective and not in accordance with bait manufacturers' recommendations. This year we introduced effective baiting boxes with tipping floor technology by Ekomille Ltd. The device contains a unit counter which gives a service requirement indication.

Birds
Birds no longer present a nuisance on the site. The site has an abundance of pheasants and linnets.

8.3 Meteorological Report

Weather
The Vaisala 101 weather station was installed with the commencement of the Waste Licence on the capped landfill and connected to the pc in the landfill manager's office.

The datalogger on the weather station can store up to sixty day's weather information at a time. The read-out is a comprehensive recording of all relevant daily and hourly weather parameters.

Complete daily weather records for the landfill are enclosed in Appendix D. Maxima and minima are highlighted in red text.

The total rainfall for 2009 at the landfill was recorded at 1473.7.4mm, an increase of 430mm on 2008. The peak month for rainfall was November with a nine-year high of 240.1mm since records commenced at East Cork Landfill. The next highest month was July with 230.6mm, still well in excess of the previous high of 198.8mm in September 2006. The driest month was February with 16.2mm. The maximum rainfall for any one day was 50.2mm on Thursday 19th November.

The warmest day was Tuesday 11th August with 25.7°C and the coldest day recorded was Christmas Day with -4.6°C.
The highest relative humidity was 99.7% on Wednesday 28th January and the lowest was on Saturday 28th March with 33.0%.

The highest atmospheric pressure was recorded at 1037.4 on both Thursday 10th and Friday 11th September and the lowest was 965.6 on Sunday January 25th.

The strongest winds were experienced on Saturday 17th January with 29.42m/s or 105.92mph.

Complete hourly weather records for the landfill are held on the office pc for reference.

Monthly Rainfall Statistics

Month	Rainfall mm
January	176.8
February	16.2
March	33.8
April	161.4
May	69.6
June	91.6
July	230.6
August	152.4
September	52.2
October	77.2
November	240.1
December	171.8

Total rainfall	**1473.7mm**

Schedule of Environmental Objectives and Targets

In accordance with Condition 2.2 of the facilities Waste Licence, specific objectives and targets have been identified, along with a programme for their implementation.

The schedule of objectives and targets for 2010 are outlined in Table 1:

Table 1: Schedule of Objectives & Targets

Objective No.	Objective	Target
1	To monitor and control landfill gas emissions at the facility	Continue efficient control of landfill gas at the facility
2	To promote sustainable energy options and increase the energy efficiency of the facility	Identity at least one feasible sustainable option by December 2010
3	To improve the efficiency of operation and monitoring of the leachate and stormwater management system	Ensure compliance with Condition 4.18 of the waste licence with reference to leachate management
4	To identify possibilities for the after-use of the landfill area following restoration	Identify an after-use plan for the landfill by the end of 2010
5	To maximise the efficiency and continuously improve operations at the civic amenity facility.	To increase the efficiency of the civic amenity and reduce security breaches.
6	Review closure modifications of the Waste Licence following the closure of the landfill facility	Reduce the monitoring requirements and schedules following closure of the landfill
7	Review staffing levels across the organisation to enable a continual service to the public	Ensure minimum staff levels on site to prevent facility closure

Environmental Management Programme

An Environmental Management Programme (EMP) is a programme for achieving the Schedule of Objectives and Targets. This programme defines the principal tasks to be undertaken to achieve the objectives and targets. It identifies those responsible for the carrying out the tasks and the scheduled timeframe for the tasks to be completed.

East Cork Landfill's Environmental Management Programme (EMP) is available in Table 2 below:

Table 2: Environmental Management Programme

Objective No.	Objective	Target	Tasks	Person Responsible	Estimated Completion Date
1	To monitor and control landfill gas emissions at the facility	Continue the efficient control of landfill gas at the facility	Ensure the correct abstraction of landfill gas and operation of the landfill gas flare at the facility.	Jerome O'Brien	January 2010-onwards
			Balance the landfill gas collection system monthly and maintain records	Lisa Collins	Ongoing
			Ensure the correct operation of the remote monitoring and alarm system to control the operation of the flare especially at night-time, at weekends and Bank Holidays.	Jerome O'Brien	January 2009
			Following completion of the capping of the landfill facility conduct a survey to ensure no landfill gas leakage is detected.	Jerome O'Brien	March 2010
			Request expressions of interest from interested parties to establishing a contract to design, build, operate and finance the complete gas collection, utilisation and flaring system at the landfill.	Jerome O'Brien	March 2010
			Explore the market options for utilising the grass growing at the landfill to generate biogas for use as an energy source	Jerome O'Brien	September 2010
2	To promote sustainable energy options and increase the energy efficiency of the facility	Identity at least one feasible sustainable energy option by December 2010	Maintenance and calibration of the stormwater pond control equipment to ensure correct operation of the equipment	Jerome O'Brien	Bi-annual Ongoing
			Carry out a study on the upper and lower limits used to control the actuated valve on the stormwater pond, to ensure correct operation.	Jerome O'Brien	July 2010

Objective No.	Objective	Target	Tasks	Person Responsible	Estimated Completion Date
3	To improve the efficiency of operation and monitoring of the leachate and stormwater management system	Ensure compliance with Condition 4.18 of the waste licence with reference to leachate management	Set up a training manual to contain maintenance, sampling and monitoring procedures for the stormwater pond and ensure all personnel are trained on its operation.	Lisa Collins	April 2010 Training Ongoing
			Test and commission the SCADA control of the leachate recirculation installed. Ensure leachate levels are in compliance with the facilities waste licence	Jerome O'Brien	Ongoing
			Carry out a feasibility study into the possibilities for after use of the landfill area following restoration	Jerome O'Brien	December 2010
			Investigate the possibility of revising the traffic flow layout of the civic amenity facility	Jerome O'Brien	November 2010
			Continue to monitor and control the site security of the facility through the CCTV system.	Jerome O'Brien	Ongoing
4	To identify possibilities for the afteruse of the landfill area following restoration	Identify an after-use plan for the landfill by the end of 2009	Introduce handheld devices to log and record customers using the Civic Amenity Facility and types and tonnages of quantities to be disposed/recycled.	Jerome O'Brien	March 2010
5	To maximise the efficiency and continuously improve operations at the civic amenity facility.	To increase the efficiency of the civic amenity	Install traffic control barriers at the entrance and exit of the facility.	Jerome O'Brien	Ongoing

Objective No.	Objective	Target	Tasks	Person Responsible	Estimated Completion Date
6	Review closure modifications of the Waste Licence following the closure of the landfill facility	Reduce the monitoring requirements following closure of the landfill	Conduct discussions with Agency in relation to monitoring relevance, frequencies etc	Jerome O'Brien	Ongoing
7	Review staffing levels across the organisation to enable a continual service to the public	Ensure minimum staff levels on site to prevent facility closure		Jerome O'Brien	Ongoing

It is a reality that the realisation of each and every one of the above objectives is conditional on the current economic climate and on Cork County Council's ability to provide a budget for payment of the supply of services, materials, maintenance and consultation in view of a 30% reduction in operating revenue for 2010. In light of the County Manager's directive to staff of 28th January 2009 regarding the provision of service, strict guidelines have been laid out to supervisory staff in regard to economics, budgets and expenditure.

Cork County Council will attempt to uphold its statutory and regulatory responsibility in as far as it relates to any historic and conventional areas of compliance but cannot give assurance on the resolution of any unforeseen or any circumstances requiring unbudgeted expenditure.

10 RESOURCE CONSUMPTION

10.1 Energy and Resource Consumption

During the reporting period the following were the recorded energy and resources consumption for the landfill. The totals include those of the plant hire firm as well as Cork County Council usage for plant, offices, weighbridge, night lighting, leachate pumps, compressor and landfill gas flare.

The reliance on fossil fuels continued the downward trend in 2009 over 2008 by 47,110 litres of gas oil for plant machinery due to the completion of the last capping contract. There was an increase in usage of 30,833 kWh of electricity possibly attributable to the continuous operation of the compressor supplying compressed air to the pneumatic pumps.

Company	Diesel	Electricity
Ted Motherway AgriPlant Ltd	**9,300 litres**	**0 kWh**
Cork County Council	**2,400 litres**	
Cork County Council		**Day 82,858 kWh**
Cork County Council		**Night 51,117 kWh**
Totals	**11,700 litres**	**133,975 kWh**

2009

Table 10.1

11 SUMMARY OF PROCEDURES DEVELOPED

The summary of procedures developed during this period of the Waste Licence, is illustrated as follows:

Operational Health & Safety Plan

Environmental Liabilities Risk Assessment

Landfill Gas Collection System Balancing   Interim Report

11.1 Operational Health & Safety Plan

The Operational Health and Safety Plan has been revised to take account of recent changes in legislation, primarily the Safety Health and Welfare at Work Act, Construction Regulations 2006.

11.2 Environmental Liabilities Risk Assessment

The Environmental Liabilities Risk Assessment first submitted by this facility in October 2004 has been re-assessed for submission to the Agency by the third anniversary of the closure of the landfill, 26th February 2010.

This will signal the emergence of the landfill into the aftercare phase on completion of all elements of the landfill restoration as designed and constructed.

REPORTS ON FINANCIAL PROVISION

12.1 Financial Provision under the Licence

Cork County Council has made the necessary provision to ensure that there is adequate funding for the management of East Cork Landfill and Civic Amenity Site.

12.2 Management Structure

Details of Operator

Operator Name:	Cork County Council
Operator Address:	County Hall, Carrigrohane Rd., Cork. (021) 4276891
Site Name:	East Cork Landfill,
Site Address:	Rossmore, Carrigtohill, Co.Cork. (021) 4533934

Management Structure

Cork County Council has overall responsibility for the management and operation of East Cork Landfill and Civic Amenity Site. The Senior Engineer, Environment, South Division is responsible for the management of municipal waste and waste facilities in the Southern Division. The site manager with responsibility for day to day site operations is a Senior Executive Engineer, who is supported by an Environmental Technician in her roles as deputy manager.

Cork County Council continues to contract Fehily Timoney & Company to provide technical and site engineering support and RPS Group Ltd for scheduled environmental monitoring in accordance with the Waste Licence.

Fehily Timoney & Company have been authorised to assist Cork County Council with the following site related activities,
Provision of site engineering assistance and support
Leachate assessment and management
Landfill gas assessment and management
Environmental Liabilities Risk Assessment for the entire landfill
Site management procedures, to incorporate the development of an environmental management system (EMS) and preparation of an annual environmental report (AER); engineering design and document preparation.

RPS Group Ltd are authorised by Cork County Council to assist in environmental monitoring of surface water, groundwater and leachate and interpretation of results.

12.3 PUBLIC CONSULTATION

The programme for public consultation has been outlined on pages 40-42 in the six-month report, dated January 2001. The Public File is located in the Waste Management Section on Floor 4, County Hall, Cork. The Site File is maintained at Rossmore in the event of a request for consultation.

12.4 MANAGEMENT & STAFFING STRUCTURE

	Contact Telephone No.
Senior Engineer: Mr Liam Singleton	(021) 4276891
Landfill & CA Site Manager & *Senior Executive Engineer:* Mr Jerome O'Brien	(021) 4533934
Deputy Landfill Manager & *Executive Engineer:* Mr John Paul O'Neill	(024) 93834
Deputy Landfill Manager & CA Site & *Environmental Technician:* Ms Lisa Collins	(021) 4533934
Deputy CA Site Manager & *Weighbridge Operator* Mr Brian Duggan	(021) 4883936

EAST CORK LANDFILL WASTE INTAKE RECORDS **2009**

Waste Type	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Cum. Total
Domestic waste to Youghal L/F	148.86	136.88	144.89	182.98	162.70	195.72	207.12	190.00	160.66	139.74	161.96	159.62	1,991.13
Bring Sites Cleaning- waste in										0.34	1.18	1.34	2.86
												TOTAL	1,993.99
RECYCLING	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Cum. Total
Bottle Banks and can recycling	7.58	2.72	3.55	3.70	4.06	3.58	3.72	3.50	3.12	2.84	3.38	3.52	45.27
Metals	12.93	4.80	17.92	12.24	9.55	17.42	17.58	3.82	22.90	14.26	11.04	9.52	153.98
Timber	18.83	24.42	23.65	28.74	23.18	28.38	29.34	25.34	43.45	25.94	23.24	20.32	314.83
Cardboard	9.08	9.32	6.42	7.87	7.59	5.92	6.70	10.70	6.31	6.46	2.1	6.2	84.67
Newspapers & card	14.06	8.50	6.74	7.75	11.88	7.78	10.62	8.93	8.21	11.79	9.67	10.98	116.91
Batteries lead		2.27			0.43		0.64			0.545	0.556		4.44
Batteries alkaline		0.40		0.32	0.01						0.198		0.93
Fluorescent tubes/ lamps											0.12		0.12
Glass					8.62						7.88		16.50
Plastics	2.35	1.61	2.30	1.95	1.98	1.51	3.58	1.66	1.76	1.3	3.64	1.54	25.18
WEEE (all goods)	16.12	26.56	27.41	24.20	11.30	14.54	25.38	27.60	23.41	22.84	28.66	24.3	272.32
Cooking Oil						0.86							0.86
Engine Oil	1.50	1.88	0.72	0.70	0.62	1.00	0.46		1.22	0.82	0.66	0.66	10.24
Farm Plastics													-
Textiles and cloths		1.14	0.84	0.76	0.60	0.50	0.82	0.66	0.52	0.84	0.62	0.4	7.70
Paints		1.06	0.44	0.48		0.80			1.04	0.94			4.76
Total Recycled	82.45	84.68	89.99	88.71	79.82	82.29	98.84	82.21	111.94	88.575	91.764	77.44	1,058.71

TOTAL Recycling	1,103.98

Appendix A

Slope Stability Report

2008 SLOPE STABILITY REPORT

EAST CORK LANDFILL, ROSSMORE, CARRIGTOHILL

WASTE LICENCE REGISTER W0022-01

Prepared for:

Cork County Council
Rossmore
Carrigtohill
County Cork

Prepared by:

Fehily Timoney & Company
Core House
Pouladuff Road
Cork

January 2009

2008 SLOPE STABILITY REPORT

EAST CORK LANDFILL, ROSSMORE CARRIGTOHILL

WASTE LICENCE REGISTER W0022-01

User is Responsible for Checking the Revision Status of This Document

Rev. Nr.	Description of Changes	Prepared by:	Checked by:	Approved by:	Date:
0	Issue to Client	GS	JM	PR	05/01/09

Client: Cork County Council

Keywords: Landfill, capping, slope stability

Abstract: Cork County Council requested FTC to carry out a slope stability analysis of the Rossmore Landfill site side slopes to comply with Condition 9.20 of the Waste Licence.

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APPENDICES

1. INTRODUCTION

1.1. Purpose

This report presents the results of a slope stability assessment carried out for East Cork Landfill at Rossmore, Carrigtwohill, Co. Cork. This is in accordance with Condition 9.20 of the EPA waste licence issued to the site (reference: W0022-01). Section 9 of the licence relates to Environmental Monitoring.

1.2. Site Description

The landfill site is located at Rossmore, Carrigtohill, Co. Cork, adjacent to Rossmore Bay. The site is a former limestone quarry surrounded by agricultural land and intertidal mud flats.

The southern part of the landfill site consists of lined cells numbered 01-10. The eastern side of the landfill (Cells 1-4) is capped and covered by vegetation. Cells 5-10, located to the west of the site, are lined and recently capped. Waste slopes have been raised in a domed profile above the perimeter access road level (approximately 8 to 9 m AOD), to a maximum height of around 22 m AOD.

1.3. Slope Stability Analysis Method

SLOPE/W software of GEO-SLOPE International Ltd. was used to assess the stability of Rossmore Landfill Facility's waste embankments. SLOPE/W is a general software tool for the slope stability analysis of earth structures. It uses the limit equilibrium method of analysis by using the idea of dissecting a potential sliding mass into vertical slices. It assesses the factor of safety for both, moment and force equilibrium based on various methods, including Bishops, Janbu and Morgenstern-Price.

Using this software, it is possible to model complex stratigraphy, highly irregular pore-water pressure conditions, a variety of linear and nonlinear shear strength models, virtually any kind of slip surface shape, concentrated loads and pressure lines. Limit equilibrium formulations based on the method of slices are also applied increasingly to stability analysis of structures such as tieback walls, nail or fabric reinforced slopes, and even the sliding stability of structures subjected to high horizontal loading arising, for example, from ice flows.

Traditionally, the factor of safety is defined as that factor by which the shear strength of the soil must be reduced in order to bring the mass of soil into a state of limiting equilibrium along a selected slip surface. The results of the analysis show the overall stability of the embankment expressed as a factor of safety.

The definition of factor of safety used within SLOPE/W is:

$$F = \frac{\text{Available restoring moment (or forces)}}{\text{Total disturbing moment (or forces)}}$$

1.4. Limitations of Slope Stability Analyses

Updated shear strength parameters for landfill waste have been estimated based on parameters used by Kolsch (1995) and Thomas *et al* (1999).

Leachate in landfills may occur in irregular perched bodies as opposed to interconnected liquid bodies. For the purposes of this analysis a waste body leachate level only has been considered.

1.5. Factors Controlling the Stability of Landfill Slopes

The factors controlling the stability of landfill slopes are:

1. Slope geometry
2. Geology
3. Properties of the landfill wastes
4. Properties of the supporting soil
5. Leachate levels within the waste
6. Groundwater levels in the supporting soil
7. Surcharge.

2. DESIGN CRITERIA

2.1. Slope Geometry

Using the most recent available topographical survey by Focus Surveys Ltd. presented on Drawing No. 00-023_1 Rev ZI, dated June 2008, typical cross-sections through the waste slopes of the site were taken at the locations shown on Drawings 2005-004-02-010 and 011. The three slopes analysed namely, 1 - 1, 2 – 2 & 3 – 3 were identified as the steepest slope locations and are representative of the recently capped slopes located at the western side of the landfill. Slope 4 - 4 was analysed as being representative of the already capped slope along the eastern side of the landfill site.

Slope 1 - 1 is approximately 11 m high, 45 m long and has a maximum slope of 1:3.0 (vertical : horizontal).

Slope 2 - 2 is approximately 12 m high, 45 m long, with a maximum slope of 1:3.0.

Slope 3 - 3 is approximately 12 m high, 50 m long, with a maximum slope of 1:3.3.

Slope 4 - 4 is approximately 12 m high, 45 m long and has a maximum slope of 1:2.4.

Sections through the slopes 1 – 1, 2 – 2, 3 - 3 and 4 – 4 are presented in Figures 3.1 to 3.4.

2.2. Geology

The site is underlain by carboniferous deposits of Waulsortian Limestone and Cork Red Marble. The Waulsortian Limestone comprises calcareous mudstone, wackestones and packstones, many of which contain original cavities filled with internal sediments and cements.

The subsoils in the area have been described as Quaternary sandy clays and minor sand and gravel deposits. They range in thickness from 1 m to 3 m in the central part of the peninsula on which the site is located and up to 24 m towards the east of the site. It is understood that the subsoils have been removed from the central part of the site during quarry excavation.

2.3. Waste Parameters

Table 2.1 below shows the parameters used for the landfill waste materials.

Table 2.1: Shear Strength Parameters for Waste Materials

Material	Waste (Old)	Waste (Fresh)
Cohesion (c')	10 kN/m^2	10 kN/m^2
Effective friction angle (ϕ')	22°	15°
Unit weight γ	11 kN/m^3	9.5 kN/m^3

The Slope 4 – 4 for already capped cells located at the eastern side is considered as consisting of old waste. Slopes 1 – 1, 2 – 2 & 3 – 3 for recently capped cells located at the western side are considered as consisting of fresh waste. These parameters are the typical range of values from published papers on the properties of waste.

2.4. Properties of the supporting materials and capping layer

Table 2.2 below shows typical parameters used for the capping, clay liner and bedrock.

Table 2.2: Shear Strength Parameters for Typical Supporting Materials

Material	Clay Capping	Clay Liner	Bedrock
Cohesion, c', kN/m^2	4	5	Impenetrable
Effective Friction angle, ϕ', °	27	25	
Bulk unit weight, γ, kN/m^3	18	19	

2.5. Leachate levels within the waste material

In practice, the leachate level in the lined cells is maintained at 1 m above the clay liner through pumping from a series of cell pumps. To assess the effects of leachate levels within the waste, analyses was carried out for models simulating the leachate level maintained at 1 m below the toe of the slope as elevation of the clay liner may vary from one section to another.

The leachate levels modelled were as follows:

Slope	Modelled Leachate Level (mAOD)
1 – 1	9.50
2 – 2	9.00
3 – 3	9.00
4 - 4	5.25

2.6. Surcharge

No surcharge loads were used in the analyses of all the Slopes as the landfill is now closed and surcharging above that imposed by grass cutting and other maintenance is not envisaged. Surcharge due to grass cutting machinery etc is not expected to significantly impact on overall stability.

3. RESULTS

3.1. Slope Stability Analyses

Eight models were run at four representative locations to assess the slope stability of the landfill waste embankments. The results of these analyses are summarised in Table 3.1 with factors of safety calculated for Bishop, Janbu and Morgenstern-Price methods. Table 3.1 also gives the slip location of each slope, the waste parameters applied, the leachate level simulated, and the length of the relevant slip.

A typical analysis carried out for each of the slopes is presented in Figures 3.1 - 3.4.

3.2. Factors of Safety

Factors of safety for potential slope failures (Table 3.1) ranged from 1.41 to 2.20. A factor of safety of 1.0 indicates the slope is in equilibrium and on the point of failure. Factors of safety greater than 1.0 indicate a margin of safety against failure. A factor of safety of 1.3 or greater is appropriate for landfill interim side slopes, with this value increasing to 1.5 for final side slopes after capping is complete.

Table 3.1: Slope Analyses Results

Slope name	Waste parameters (C, γ & φ)	Leachate Level (mAOD)	Bishop FoS	Janbu FoS	Morgenstern-Price FoS	Slip Length (m)	Slip location
1 - 1	10, 9.5, 15	9.5	1.73	1.53	1.73	44	Deep slip through waste materials
1 - 1	10, 9.5, 15	9.5	2.20	2.09	2.20	23	Surficial translational slip in middle section in waste material
2 - 2	10, 9.5, 15	9.0	1.62	1.41	1.62	50	Deep slip through waste materials
2 - 2	10, 9.5, 15	9.0	2.00	1.89	2.00	24	Surficial translational slip in middle section in waste material
3 - 3	10, 9.5, 15	9.0	1.77	1.54	1.77	46	Deep slip through waste materials
3 - 3	10, 9.5, 15	9.0	2.06	1.92	2.06	30	Surficial translational slip in lower section in waste material
4 - 4	10, 11, 22	5.25	1.89	1.71	1.89	38	Deep slip through waste materials
4 - 4	10, 11, 22	5.25	2.02	1.89	2.02	28	Surficial translational slip in middle section in waste material

Figure 3.1: Typical plane slope failure for Section 1 – 1 Leachate Level 9.5 mAOD (Morgenstern-Price method)

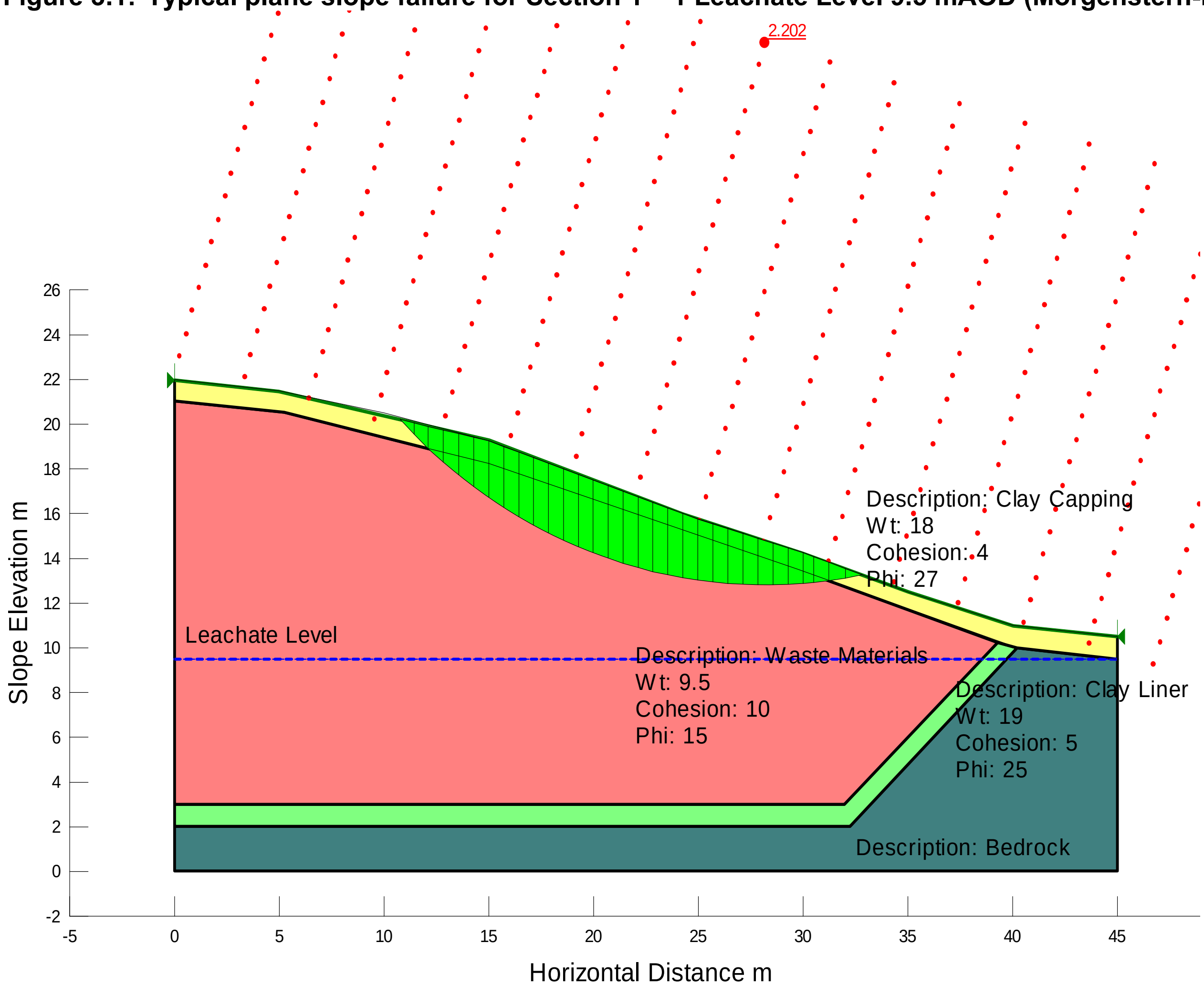


Figure 3.2: Typical deep slope failure for Section 2 – 2 Leachate Level 9 mAOD (Bishop Method)

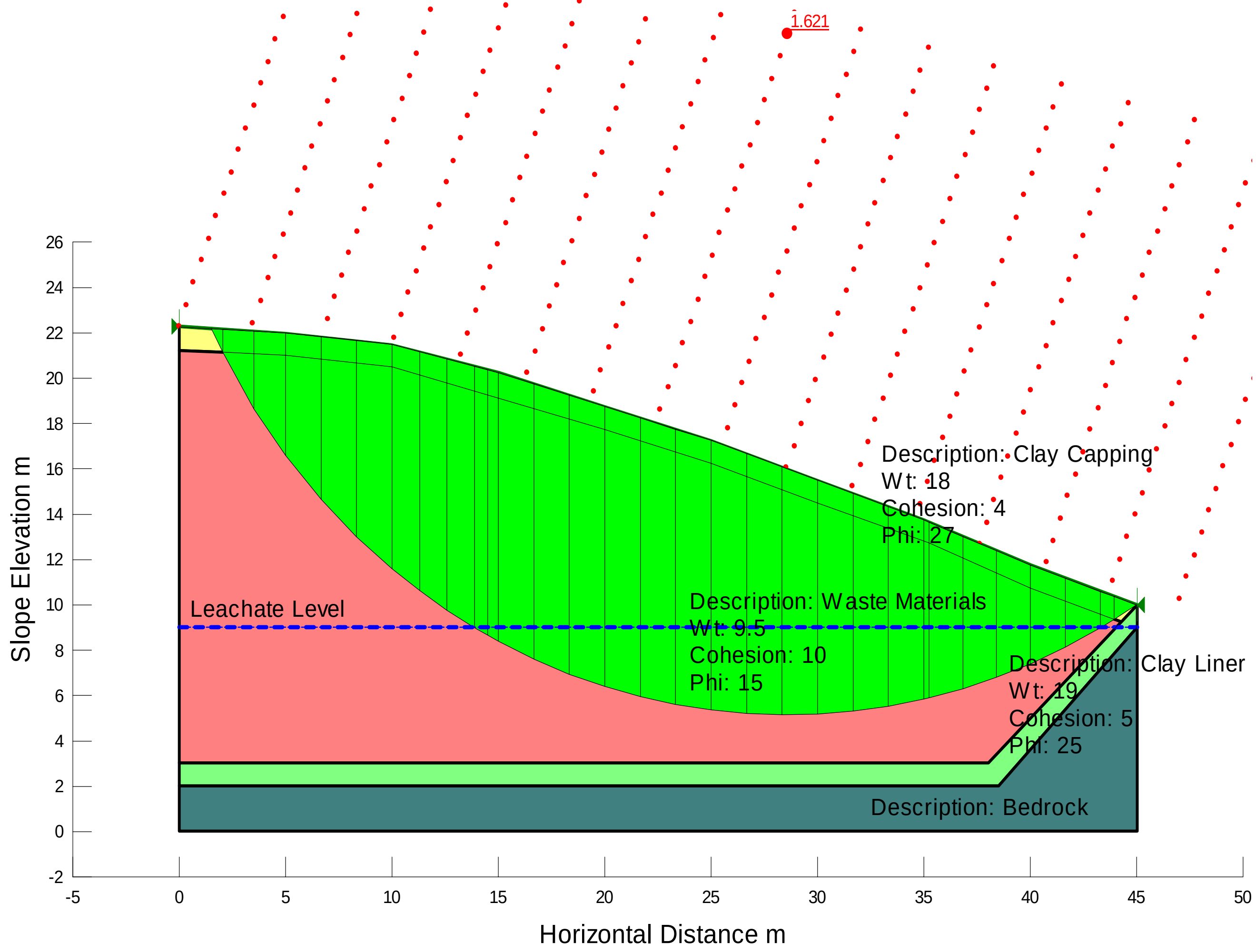


Figure 3.3: Typical deep slope failure for Section 3 – 3 Leachate Level 9 mAOD (Bishop Method).

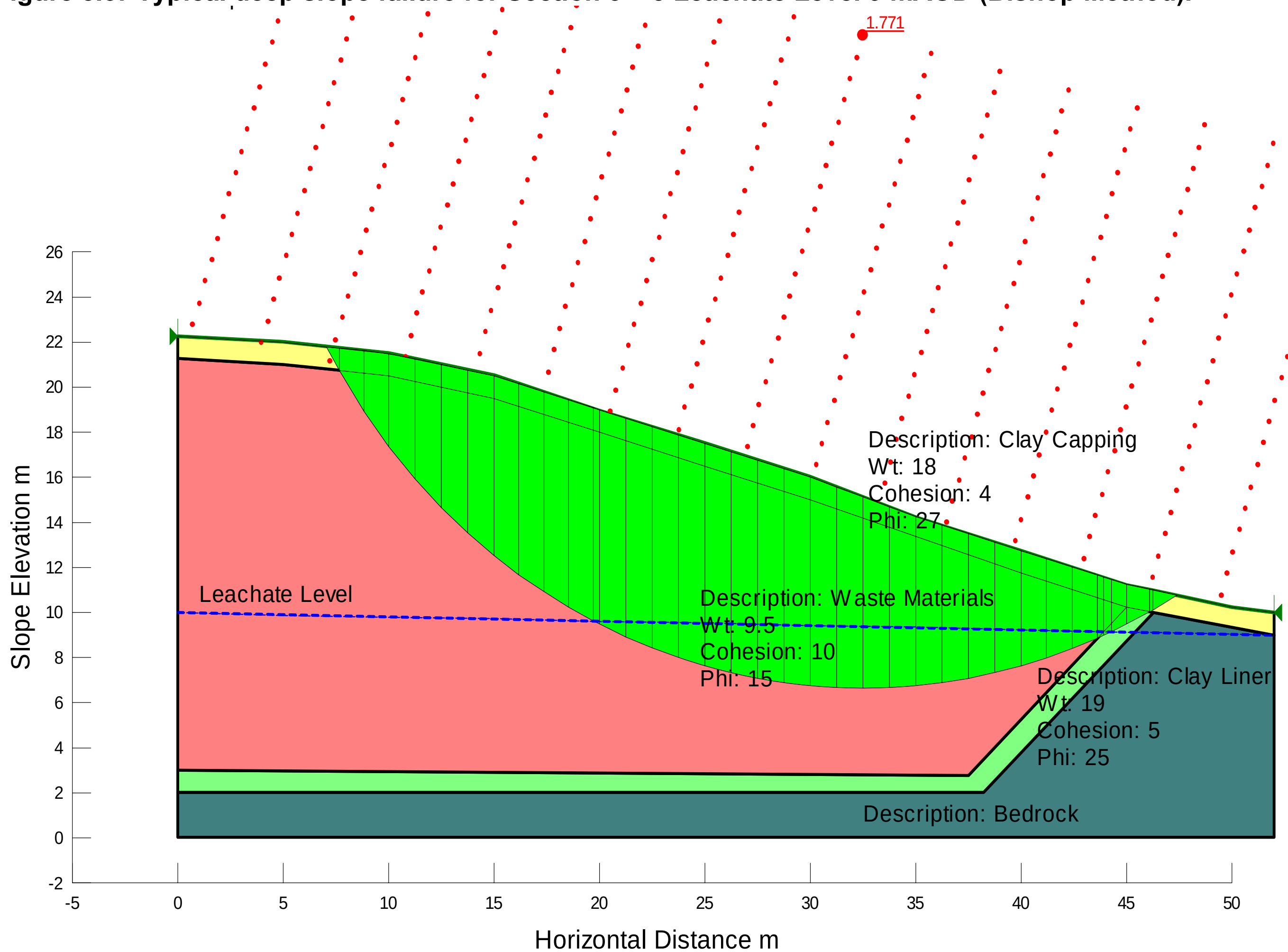
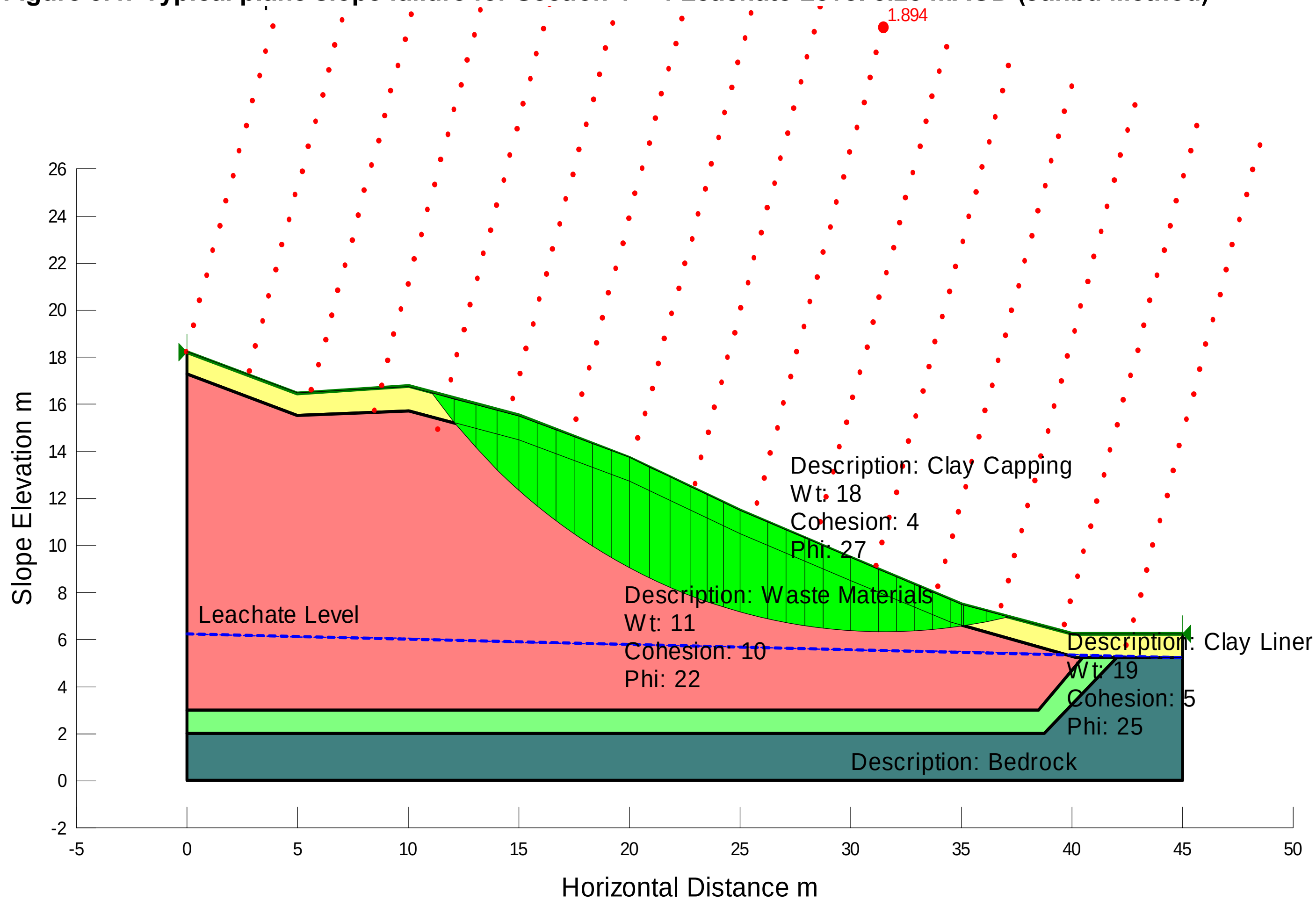


Figure 3.4: Typical plane slope failure for Section 4 – 4 Leachate Level 5.25 mAOD (Janbu Method)



4. DISCUSSIONS AND CONCLUSIONS

Factors of safety for potential slope failures for the four typical slope locations ranged from 1.41 to 2.20. Out of the total 24 factor of safety values calculated for eight case scenarios, all of the factors of safety greater than 1.5 except one that is 1.41.

Factors of safety values against deep-seated failure of the landfill embankment within the waste material ranged from 1.41 to 1.89. The lengths of the potential deep-seated failures are in the range of 38 to 50 m.

Factors of safety for deep-seated failure through both the capping and waste material were obtained along recently capped Slopes 1-1, 2-2 and 3-3 investigated and based on the analyses presented, the landfill side slopes are considered stable. Factors of safety for Slope 4 – 4, taken as a typical example of slopes in Cells 01-04, ranged from 1.71 – 2.02 and is hence considered stable.

To maintain a factor of safety 1.5 or greater, leachate and groundwater levels must be regularly monitored and pumped down to prevent a build up within the waste body and cause potential instability of the landfill slopes.

It will be possible to better control leachate level in Cells 01-10 as the entire area is now permanently capped. Leachate cell pumps have also recently been upgraded and the leachate recirculation system has been extended over Cells 05-10.

5. REFERENCES

1. Kusch (1995) Material values for some mechanical properties of domestic waste, Proceedings 5th Sardinia International Landfill Symposium, Vol 2, pp 711-729.

2. S Thomas, A Aboura, J P Gourc, P Gotteland, H Billard, T Delineau, T Gisbert, J F Ouvry and M Vuillemin, (1999), An in-situ waste mechanical experimentation on a French Landfill, Vol 3, Sardinia Landfill Symposium, pp 445-452.

3. Slope Stability Report (2007). East Cork Landfill, Rossmore, County Cork.

4. Survey Drawing No. 00-023_1 Rev ZI provided by Focus Surveys Ltd., Rossmore Landfill Site, dated 13 June 2008.

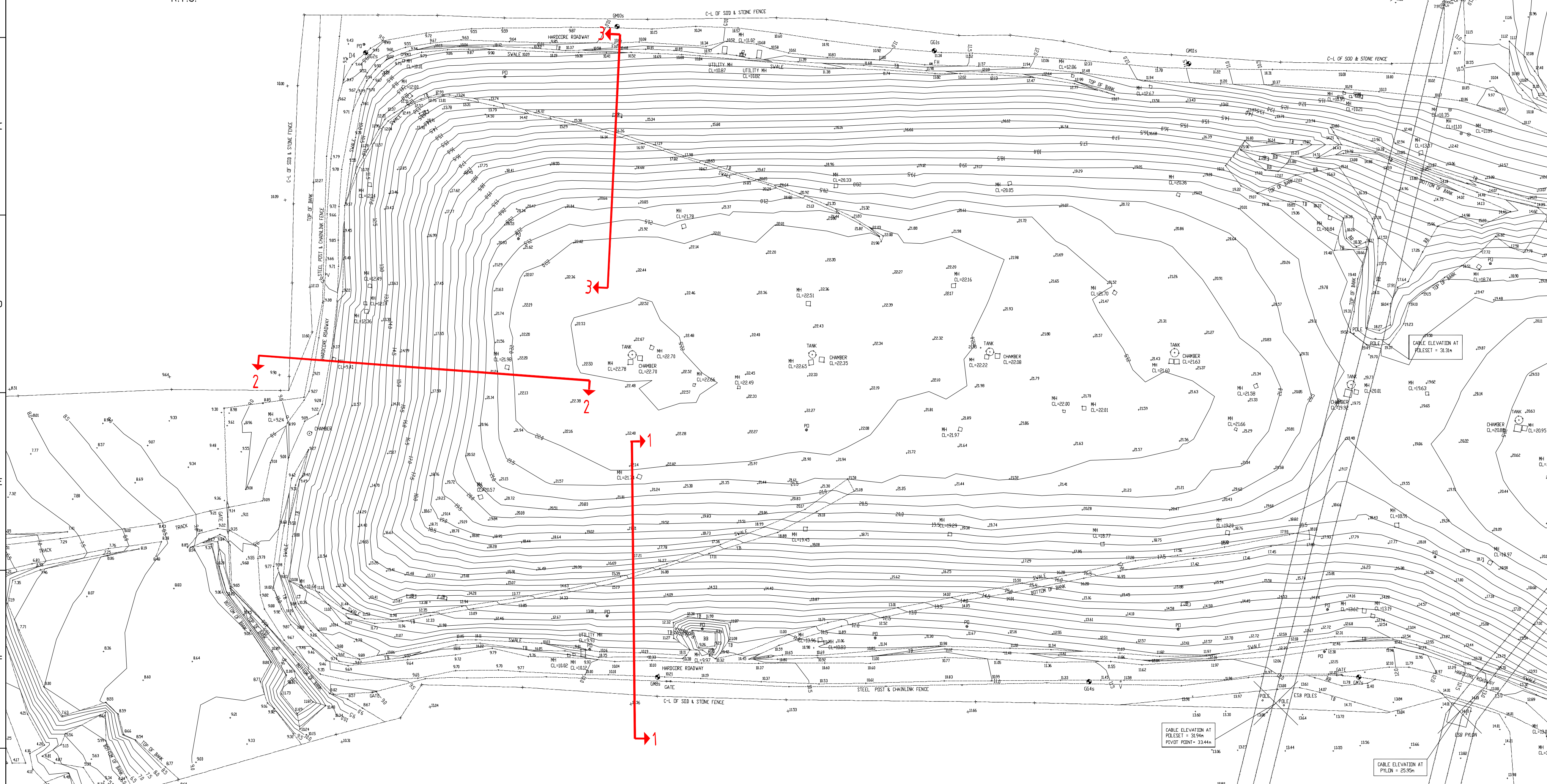
Appendix A – Drawings

DRAWINGS 2005-004-02-010 & 2005-004-02-011 Rev A

Topographic Survey showing
Section lines for Slope Stability Analysis

SITE LOCATION MAP

N.T.S.



SECTIONS LOCATION PLAN

Scale 1:1000

Scale 1:1000

Notes:

1. Based On Topographic Site Survey Drawing No. 00-23-01 Rev ZI (25-06-08) Received from Focus Surveys Ltd.
2. Refer to report CCC-RLC_Rpt009-0 2008 Slope Stability for Figures relating to sections;
 Section 1-1 : Figure 3.1
 Section 2-2 : Figure 3.2
 Section 3-3 : Figure 3.3

Rev.	Drawn	Chk'd	App'd	Rev Origin / Date	Description
A	MM	JM	PC	Cork 05.01.09	ISSUE TO CLIENT

Revision History A

Name of Client

CORK COUNTY COUNCIL

Name of Job

ROSSMORE LICENCE COMPLIANCE

Title of Drawing

2008 SLOPE STABILITY ANALYSIS FOR CAPPED WESTERN SLOPES

Scales Used: 1:1000

This Drawing was printed to A3

Dwg. No.: 2005-004-02-010 | Rev.: A

O:\ACAD\2005\004\02\CCC-RLC_010-011.dwg

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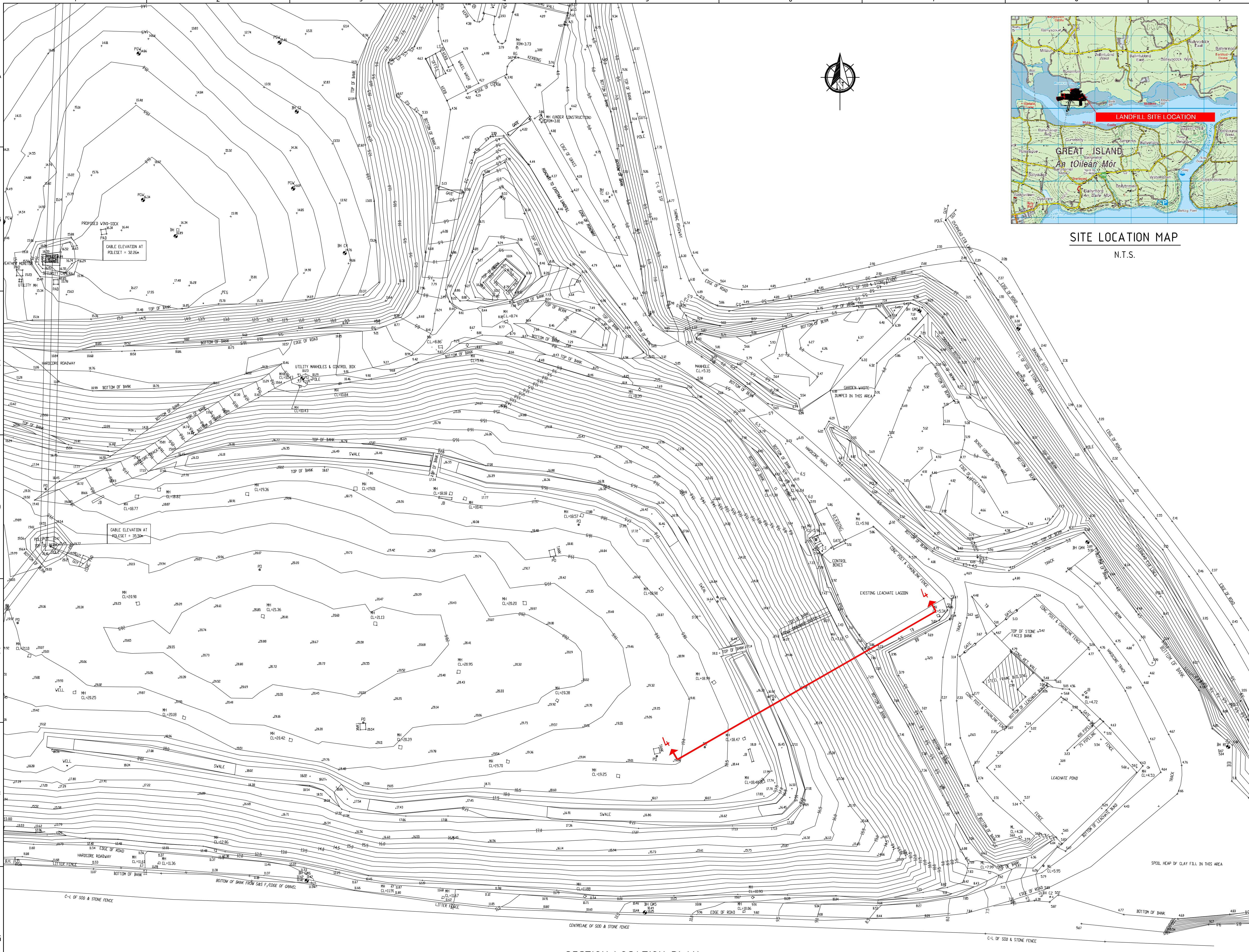
Sheet FTC-A1-2006 rev. C (template filed in O:\Acad\Templates\Autocad) (May 2007) - template externally referenced



SECTION LOCATION PLAN

Scale 1:1000

Scale 1:1000

SITE LOCATION MAP

N.T.S.

Notes:

1. Based On Topographic Site Survey Drawing No. 00-23-01 Rev Z1 (25-06-08) Received from Focus Surveys Ltd.
2. Refer to report CCC-RLC_Rpt009-0 2008 Slope Stability for Figures relating to sections; Section 4-4 : Figure 3.4

Rev.	Drawn	Chk'd	App'd	Rev Origin / Date	Description
A	MM	JM	PC	Cork 05.01.09	ISSUE TO CLIENT

Revision History A

Name of Client

CORK COUNTY COUNCIL

Name of Job

ROSSMORE LICENCE COMPLIANCE

Title of Drawing

2008 SLOPE STABILITY ANALYSIS
CAPPED EASTERN SLOPES

Scales Used: 1:1000

This Drawing was printed to A3

Dwg. No.: 2005-004-02-011

Rev.: A

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ORIGINAL DRAWING SIZE A1 - (841 x 594)

NATURAL SCALE

Appendix B

Water Balance Calculations for East Cork Landfill

1st January – 31st December 2009

Water Balance Calculation for East Cork Landfill

Month	Rainfall	Potential Evapotran-spiration (P.E.)	Effective Rainfall	Waste Input	Active Cells	Temporarily Capped Cells	Permanently Restored Cells	Active Area	Temporarily Capped Cells	Permanently Restored Cells	Infiltration		
											Active	Temp Capped Cells	Permanently Restored Cells
	(mm)	(mm)	(mm)	(tonnes)				(m^2)	(m^2)	(m^2)	(m^3)	(m^3)	(m^3)
Jan-09	176.80	28.6	148.2	0	-			0	0	66,735	0	0	5
Feb-09	16.20	21.8	0.0	0	-			0	0	66,735	0	0	0
Mar-09	33.80	40.9	0.0	0	-			0	0	66,735	0	0	0
Apr-09	161.40	39.5	121.9	0	-			0	0	66,735	0	0	4
May-09	69.60	64.4	5.2	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	0
Jun-09	91.60	72.0	19.6	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	1
Jul-09	230.60	69.5	161.1	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	5
Aug-09	152.40	57.1	95.3	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	3
Sep-09	52.20	52.8	0.0	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	0
Oct-09	77.20	34.4	42.8	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	1
Nov-09	240.10	32.3	207.8	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	7
Dec-09	171.80	19.6	152.2	0	-	-	1,2,3,4,5,6,7,8,9,10	0	0	66,735	0	0	5
Total	**1,474**	**533**	**954**	**0**							**0**	**0**	**32**

Infiltration rates (%)	
Active Area	0%
Temp. Covered Area	0%
Permanently Capped Area	5%

† Absorptive Capacity (m^3/tonne) 0.07

Area of leachate lagoons = 1,135 m^2

Month	Liquid Waste	Lagoon Contribution	Absorptive Capacity† of the waste	Leachate			Total Predicted Leachate	Cumulative Predicted Leachate	Leachate Tankered Off-Site		Deficit
				Active Cells	Temporarily Capped Cells	Permanently Restored Cells					
	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(t)	(m^3)	(m^3)
Jan-09	0	168	0	0	0	5	173	173	998	969	-795
Feb-09	0	0	0	0	0	0	0	173	1,147	1,114	-1,114
Mar-09	0	0	0	0	0	0	0	173	1,688	1,638	-1,638
Apr-09	0	138	0	0	0	4	142	316	802	778	-636
May-09	0	6	0	0	0	0	6	322	807	783	-777
Jun-09	0	22	0	0	0	1	23	345	468	455	-432
Jul-09	0	183	0	0	0	5	188	533	831	807	-619
Aug-09	0	108	0	0	0	3	111	644	1,187	1,152	-1,041
Sep-09	0	0	0	0	0	0	0	644	1,429	1,388	-1,388
Oct-09	0	49	0	0	0	1	50	694	627	609	-559
Nov-09	0	236	0	0	0	7	243	937	1,246	1,209	-966
Dec-09	0	173	0	0	0	5	178	1,115	1,426	1,384	-1,207
Total	**0**	**1,083**	**0**	**0**	**0**	**32**	**1,115**		**12,656**	**12,287**	**-11,172**

Appendix C

Estimation of Cumulative and Annual Landfill Gas Emissions

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DESIGNED:	AR	**CHECKED:**	JM
DATE:	20/01/09	**REVISION:**	1
JOB NUMBER:		**2005-004-02**	
CALC NUMBER:			
FILE	\\ftc05dr\RCP\2005\004\02\Calculations\Rossmore Gas Mo		
SHEET	Calc cover		

PROJECT: **Regulatory Compliance - Rossmore Landfill**

DESCRIPTION: **GasSim Gas Production Model for Rossmore Landfill**

Page 1 of 11

Rev	Date	Purpose and Description	Prepared	Checked	Reviewed	Approved
0	09-Dec-08	The purpose of this calculation is to present two gas production model for East Cork (Rossmore) Landfill, prepared using GasSim Lite version 1.5 from Golder Associates (UK) Ltd. and LandGEM from the US EPA. This calculation and its results will be submitted with the 2008 AER for the site in accordance with the requirements of the waste licence, WL0022 01.	AR			
1	20-Jan-09	Revision of model to use inventory defaults for LandGEM model	AR	JM		

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FEHILY TIMONEY & COMPANY	DESIGNED:	AR	CHECKED:	JM
	DATE:	20/01/09	REVISION:	
	JOB NUMBER:		2005-004-02	
CONSULTANTS IN ENGINEERING & ENVIRONMENTAL SCIENCES	CALC NUMBER:			0
Cork : Tel 021-4964133 Fax 021-4964464	FILE	\\ftc05dr\RCP\2005\004\02\Calculations\Rossmore Gas Models\2008 Gas Model\CCC-RLC_Landfill Gas Models		
	SHEET	Check Sheet		

PROJECT: **Regulatory Compliance - Rossmore Landfill**

DESCRIPTION: **GasSim Gas Production Model for Rossmore Landfill**

Description of Calculations

1.0 GENERAL – Review See note 1

A constructability review has been carried out

Functionality issues have been addressed

Health and Safety issues have been reviewed

Planning, Waste License and fire safety issues have been addressed

2.0 DRAWINGS, REPORTS

All drawings & reports have been signed, checked and approved

Drawings & reports have been cross-checked against design information / calculations

3.0 ELECTRONIC CALCULATIONS ONLY

The software used is on the list of approved software

The printout is identified with the software title and version

Is the input information selected suitable

Has required output information been suitably assessed

The output data files are held in the appropriate storage area HARD COPY

4.0 CALCULATIONS

Assumptions are realistic

Calculations comply with the inputs, appropriate codes and standards

Standards, codes and other regulatory documents are appropriately referenced in the calculations

Sources of information are referenced and attached where appropriate

The range of pages in question are identified and marked with the date

Calculations comply with the project brief/inputs

The lead page is signed and dated by the designer.

All tasks associated with this calculation signed off (see Task Manager)

Calculation review by peer

All electronic calculations have path, file name on each hard copy sheet

5.0 OPPORTUNITIES FOR IMPROVEMENT

The checker must sign here to confirm that any learning points or useful feedback have been entered in the task management database as a “KNOWLEDGE” item.

The checker must sign here to confirm that, If applicable, the above information has been emailed to the Senior CAD Technician or other relevant personnel to ensure that standard design

Checked By JM Date: 27-01-2009

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DESIGNED:	AR	**CHECKED:**	JM
DATE:	20.1.09	**REVISION:**	1
JOB NUMBER:	2005-004-02		
CALC NUMBER:	0		
FILE	\\ftc05dr\RCP\2005\004\02\Calculations\Rossmore Gas Models\2008 Gas Model\CCC-RLC_Landfill Gas Models 2008 rev 1 9-12-08.xls		
	SHEET	Calc Sheet	

PROJECT: **Regulatory Compliance - Rossmore Landfill**

DESCRIPTION: **GasSim Gas Production Model for Rossmore Landfill**

Ref. Output

i References

1 GasSim Lite version 1.5
2 FTC Calculation: CCC-RLC Rossmore Water Balance 2007 (see *Q:\2005\004\02\Calculations\Rossmore Gas Models\2007 Gas Model)*
3 Waste Tonnages January to December 2007 *(see Q:\2005-004-02\Incoming\07 - Jan-Dec'07 Waste Data.xls*
4 Waste Tonnages January to December 2006 *(see Q:\2005-004-02\Calculations\Water Balance\Incoming\Rossmore Waste Deposited Jan 06 - Dec 06.xls)*
5 Waste Tonnages January to December 2005 (see *Q:\2005-004-02\Calculations\Water Balance\Water Balance info from CCC\CCC-RLC_waste tonnages January to December 2005.xls)*

6 2006 Gas Model *(see Q:\2005\004\02\Calculations\Rossmore Gas Models\2006 Gas Model\CCC-RLC gas model rev2.xls)*
7 Gas utilisation report *(see Q:\2006\004\01\Reports\CCC-LGU_Rpt 001_C.doc)*
8 Gas utilisation model calculation *(see Q:\2006\004\01\Calculations\CCC-LGU_Gas Model rev 3.xls)*
9 2007 Gas Model (*see Q:\2005\004\02\Calculations\Rossmore Gas Models\2007 Gas Model_)*
10 LandGEM-v302-guide by US EPA

ii List of FTC Drawings

iii List of Appendices

App A - GasSim Outputs (graphically)
App B - GasSim Outputs (tabular summary)
App C - LandGem Outputs, Inventory
Chart 1 - LandGem Outputs, Inventory
Chart 2 - Comparison of Results (CH4)
Chart 3 - Comparison of Results (LFG)

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Contents

1.0 Introduction & Purpose

The purpose of this Calc Set is to present previously prepared Landfill Gas Prediction Models for Rossmore Landfill for inclusion in the 2008 AER. As no waste was deposited at Rossmore since the 2007 model, the inputs and outputs from that model will not change. The models prepared in 2007 were developed using both the Golder Associates software package, GasSim Lite 1.5, and the US EPA package, LandGEM v3.02.

2.0 Input Data

Opening Year: 1995
Closure Year: Feb-07

2.1 Waste input data:

2,3,4,5 The waste input data for the site is as shown below. These figures come from communications with Cork County Council, and from previous calculations carried out by FTC.

Year	Input Units (t/year)
1995	28,000
1996	29,801
1997	20,476
1998	37,837
1999	34,763
2000	52,000
2001	63,303
2002	82,679
2003	71,708
2004	55,715
2005	31,527
2006	43,115
2007	4,265

Ref 01 **2.2 GasSim Model Details**

Ref 01 **2.2.1 Background**

GasSim is a UK based software package for investigating the gas production from landfills.

Ref 01 **2.2.2 Assumptions**

GasSim makes the following general assumptions (among others):
- the model operates at steady state with a minimum time period of 1 year;
- migration of gas is not modelled in the saturated zone;
- the model does not determine the pressure generated by the landfill and to simplify the model pressure has been excluded from all modules;

2.2.3 Comments on model

This model uses rainfall data for the UK and while Irish rainfall data may be broadly similar it is not a true reflection of the situation. This is a possible source of error in this model which will need to be taken into account in considering inaccuracies.

This calculation set focuses on the Total Landfill Gas emissions from the landfill site and does not consider what proportion of these gases has been captured by the gas collection network and burnt at the flare

2.2.4 Input justification

The following is a summary of justifications for parameters inputted to the GasSim model.

Infiltration	Default Value of 50mm/yr with a standard deviation of 5mm
Waste Input - tonnages	Based on communication with Landfill maager
Waste Breakdown	90% domestic, 5% civic amenity, 5% sewage sludge
Waste Composition	1980-2010 waste stream from software
% Waste in Place Capped	Area of Cell 1,2,3,4 (28402m2) divided by the total area of the landfill (66735m2)
C02%	Default Value
CH4%	Default Value
Cellulose Decay Rates	Default Value
Moisture Content	Not Justified
Waste Density	Default Value
Leachate Head	Default Value
Hydraulic Conductivity	Default Value
Trace Gas Concentration	Default Value
Trace Gas Molecular Ratios	Default Value
Trace Gas Cap Half-Life	Default Value
Landfill Geometry	Based on drawing no. 2006-004-01-008 total area (66735m2)
Biological Methane Oxidation	Default Value
Cap Thickness	Based on construction detail drawings
Cap Hydraulic Conductivity	Based on details in spec
Liner Thickness	Based on construction detail drawings
Liner Hydraulic Conductivity	Based on details in spec

10 **2.3 LandGEM Model Parameters**

10 **2.3.1 Methane Generation Rate (k)**

The Methane Generation Rate, k, determines the rate of methane generation for the mass of waste in the landfill. The higher the value of k, the faster the methane generation rate increases and then decays over time. The value of k is primarily a function of four factors:

- Moisture content of the waste mass,
- Availability of the nutrients for micro organisms that break down the waste to form methane and carbon dioxide
- pH of the waste mass, and
- Temperature of the waste mass.

The k value as it is used in the first-order decomposition rate equation, is in units of 1/year, or year$^{-1.}$ There are 5 k values given as options in LandGEM. The default k value is the CAA k value for conventional landfills.

10 **2.3.2 Potential Methane Generation Capacity (Lo)**

The Potential Methane Generation Capacity, Lo, depends only on the type and composition of waste placed in the landfill. The higher the cellulose content of the waste, the higher the value of Lo. The default Lo values used by LandGEM are representative of MSW. The Lo value, as it is used in the first-order decomposition rate equation, is measured in metric units of cubic metres per megagram to be consistent with the CAA.
The default Lo value is the CAA Lo value for conventional landfills.

10 **2.3.3 Non-methane Organic Compound Concentration**

The NMOC Concentration in landfill gas is a function of the types of waste in the landfill and the extent of the reaction that produce various compounds from the anaerobic decomposition of waste. NMOC concentration is measured in units of parts per million by volume (ppmv) and is used by LandGEM only when NMOC emissions are being estimated. The NMOC concentration for the CAA default is 4,000 ppmv as hexane. The NMOC Concentration for the Inventory default is 600 ppmv where co-disposal of hazardous waste has either not occurred or is unknown and 2,400 ppmv where co-disposal of hazardous waste has occurred. The default NMOC concentration is the CAA value. If you use a site-specific value for NMOC concentration, then you must correct for air infiltration.

10 **2.3.4 Methane Content**

For LandGEM, landfill gas is assumed to be 50 percent methane and 50 percent carbon dioxide, with additional, trace constituents of NMOC's and other air pollutants. When using LandGEM for complying with the CAA, methane content must remain fixed at 50 percent by volume (the model default value).

You may choose other methane amounts for the methane content using the User-specified selection if data exist to support using another concentration. However, using LandGEM at landfills that have methane content outside the range 40 to 60 percent is not recommended. The first-order decomposition rate equation used by LandGEM to determine emissions may not be valid outside this range.

The production of methane is determined using the first-order decomposition rate equation and is not affected by the concentration of methane. However, the concentration of methane affects the calculated production of carbon dioxide. The production of carbon dioxide (Q_{CO2}) is calculated from the production of methane (Q_{CH4} and the methane content percentage (P_{CH4}) using the equation:

$$Q_{CO2} = Q_{CH4} \times \{[1/(P_{CH4}/100)] - 1\}$$

This equation is derived as follows:

$$Q_{total} = Q_{CH4} + Q_{CO2}$$
$$Q_{CH4} = Q_{total} \times (P_{CH4}/100)$$
$$Q_{CO2} = Q_{total} - Q_{CH4} = [Q_{CH4}/(P_{CH4}/100)] - Q_{CH4}$$
$$Q_{CO2} = Q_{CH4} \times \{[1/(P_{CH4}/100)] - 1\}$$

where Q_{total} is the total production of landfill gas.

2.3.5 CAA & Inventory Parameters

LandGEM contains two sets of default parameters:

CAA Defaults—The CAA defaults are based on requirements for MSW landfills laid out by the US Clean Air Act (CAA), including the NSPS/EG and NESHAP. This set of default parameters yields conservative emission estimates and can be used for determining whether a landfill is subject to the control requirements of the NSPS/EG or NESHAP.

Inventory Defaults—With the exception of wet landfill defaults, the inventory defaults are based on emission factors in the U.S. Environmental Protection Agency's (EPA) Compilation of Air Pollutant Emission Factors (AP-42). This set of defaults yields average emissions and can be used to generate emission estimates for use in emission inventories and air permits in the absence of site-specific test data.

2.3.6 Site Specific Parameters

Where site specific data is available for the actual quantities of gas produced, the model can be calibrated by varying the parameters to match the predicted volumes to the actual volumes as closely as possible.

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JOB NUMBER: 2005-004-02
CALC NUMBER: 0
FILE \\ftc05dr\RCP\2005\004\02\Calculations\Rossmore Gas Models\2008 Gas Model\CCC-RLC_Landfill Gas Models 2008 rev 1 9-12-08.xls
SHEET Calc Sheet

PROJECT: **Regulatory Compliance - Rossmore Landfill**

DESCRIPTION: **GasSim Gas Production Model for Rossmore Landfill**

Ref.		Output

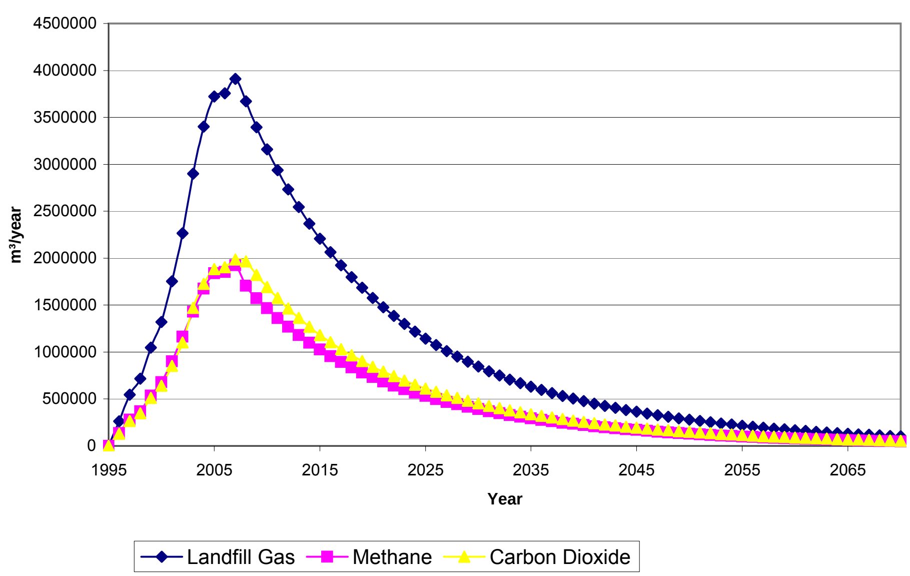
3.0 GasSim Calculations

A simulation using the GasSIM model was carried out to predict the volumes of gas arising from the landfill. The modelled outputs from the simulation are outlined below

App A **3.1 "CCC-RLC 2007 GasSim Lite 1.5"**

6,7 MODEL PARAMETERS (See Section 2.4 above)

Predicted Gas Volumes using GasSim Lite 1.5



Peak Production Year: 2007

Peak Volumes during Peak Production Year:	3,910,548 m^3 landfill gas	446 m^3/hr
	1,925,700 m^3 methane	220 m^3/hr
	1,984,848 m^3 carbon dioxide	227 m^3/hr

For 2008 these volumes become:
419 m^3/hr landfill gas
195 m^3/hr methane

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JOB NUMBER:	2005-004-02		
CALC NUMBER:	0		
FILE	\\ftc05dr\RCP\2005\004\02\Calculations\Rossmore Gas Models\2008 Gas Model\CCC-RLC_Landfill Gas Models 2008 rev 1 9-12-08.xls		
	SHEET	Calc Sheet	

PROJECT: **Regulatory Compliance - Rossmore Landfill**

DESCRIPTION: **GasSim Gas Production Model for Rossmore Landfill**

Ref. | Output

4.0 LandGEM Calculations

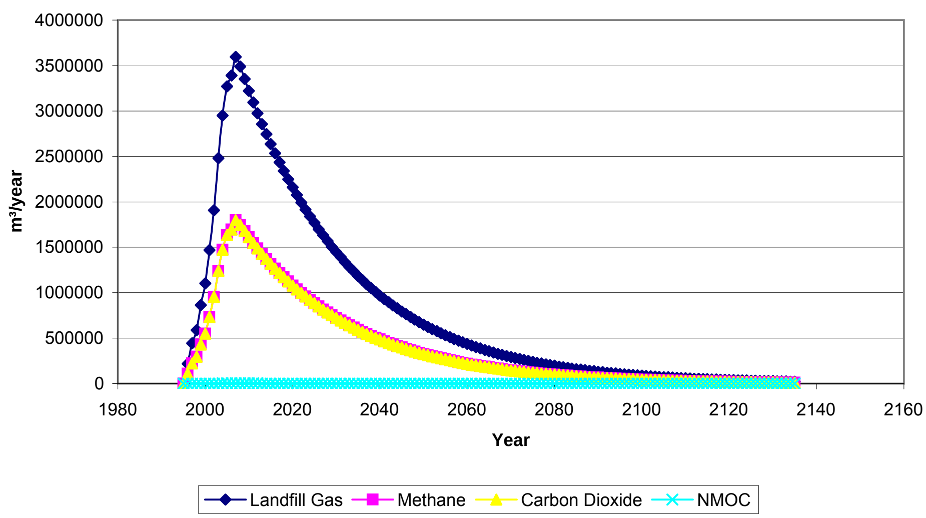
The calculation carried out in LandGEM uses Inventory specific parameters as explained previously.

4.1 "CCC-RLC 2007 Inventory Defaults LandGEM-v302"

MODEL PARAMETERS

Methane Generation Rate, k	0.04	$year^{-1}$
Potential Methane Generation Capacity, Lo	100	m^3/Mg
NMOC Concentration	600	ppmv as hexane
Methane Content	50	% by volume

App D



Peak Production Year: **2007**

Peak Volumes:	3,596,260 m^3 landfill gas	411	m^3/hr
	1,798,130 m^3 methane	205	m^3/hr
	1,798,130 m^3 carbon dioxide		
	2,158 m^3 NMOC		

These figures give an indication of the volumes of gas likely to be produced based on average production values.

For 2008 these figures become: 398 m^3/hr landfill gas
199 m^3/hr methane

Fehily Timoney Co.,
Core House,
Pouladuff Rd.,
Cork
Tel 021 4964133

5.0 Discussion

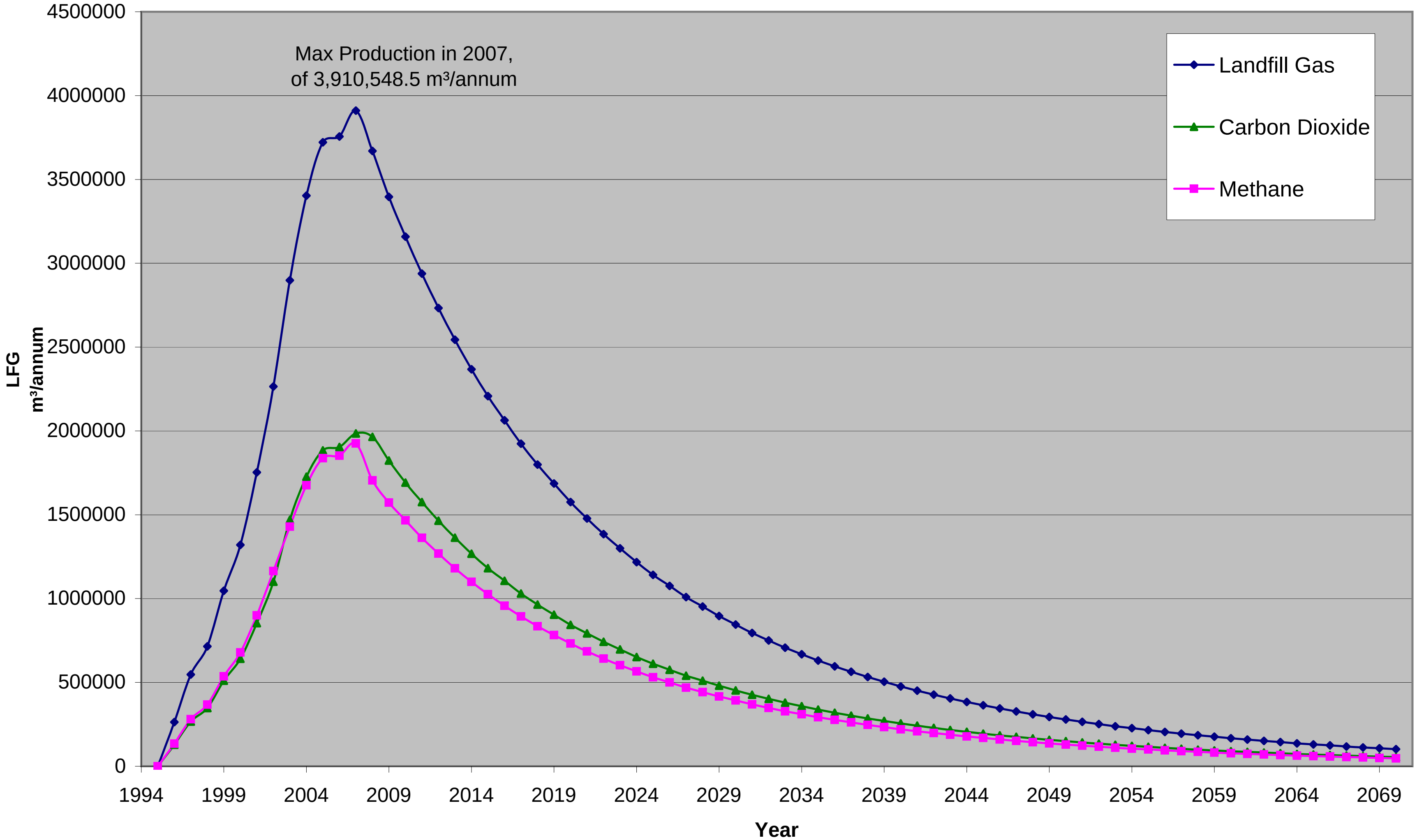
The maximum predicted hourly production volume of landfill gas using the GasSim model is 446 m³/hr, occuring in 2007, which equates to 3,910,548 m³ for the year of 2007. For 2008, this falls to 3,669,846 m³ (i.e. 418 m³/hr). These values reflect the theoretical gas volume available for utilisation at Rossmore.

Using the Inventory default parameters for the LandGem model, outputs a similar production level of landfill gas, with a peak in annual production 2007 of just under 3.6 million m^3 of gas (411 m^3/hr, of which 205 m^3/hr is methane). For 2008, this falls to 398 m³/hr (3,486,480 m³ for the entire year).

These predictions correspond relatively well with the reported flaring rates on site of approximately 425 m³/hr, or approximately 3,723,000 m³/year for 2008.

However, it should be noted that it is likely that the actual gas production from the landfill site is somewhat higher than these levels, as collection efficiencies and methane concentrations are not fully taken account of in these calculations.

Appendix A - Rossmore Landfill, GasSim Model Outputs



Appendix B - GasSim Model Outputs

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Carbon Dioxide - 'chemical'	0	254	527	688	1,010.00	1,270.00	1,690.00	2,180.00	2,910.00	3,420.00	3,730.00	3,770.00	3,930.00	3,890.00	3,610.00
Carbon Dioxide (m^3/hr)	0	128282.828	266161.616	347474.747	510101.0101	641414.1414	853535.3535	1101010.101	1469696.97	1727272.727	1883838.384	1904040.404	1984848.485	1964646.46	1823232.32
Methane (t)	0	91.9	191	250	365	462	612	792	972	1,140.00	1,250.00	1,260.00	1,310.00	1,160.00	1,070.00
Methane (m^3)	0	135093	280770	367500	536550	679140	899640	1164240	1428840	1675800	1837500	1852200	1925700	1705200	1572900
Methane (m^3/hr)	0	15.4215753	32.0513699	41.9520548	61.25	77.52739726	102.6986301	132.9041096	163.109589	191.3013699	209.760274	211.4383562	219.8287671	194.657534	179.554795
CO_2 & Methane (LFG - m^3)	0	263375.8	546931.6	714974.7	1046651	1320554.1	1753175.4	2265250.1	2898537	3403072.7	3721338.4	3756240.4	3910548.5	3669846	3396132
CO_2 & Methane (LFG - m^3/hr)	0	30.06573	62.43512	81.61812	119.48071	150.74819	200.13417	258.59019	330.88322	388.47862	424.81032	428.79457	446.40964	418.9322	387.6863

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Carbon Dioxide - 'chemical'	3350	3120	2900	2700	2510	2340	2190	2040	1910	1790	1670	1570	1470	1380	1290
Carbon Dioxide (m^3/hr)	1691919	1575758	1464646	1363636	1267676.8	1181818.2	1106060.6	1030303	964646.46	904040.4	843434.34	792929.29	742424.24	696969.7	651515.2
Methane (t)	998	927	863	803	748	698	651	608	568	532	498	466	437	410	385
Methane (m^3)	1467060	1362690	1268610	1180410	1099560	1026060	956970	893760	834960	782040	732060	685020	642390	602700	565950
Methane (m^3/hr)	167.472603	155.558219	144.818493	134.75	125.5205479	117.130137	109.2431507	102.0273973	95.31506849	89.2739726	83.56849315	78.19863014	73.33219178	68.8013699	64.6061644
CO_2 & Methane (LFG - m^3)	3158979	2938448	2733256	2544046	2367236.8	2207878.2	2063030.6	1924063	1799606.5	1686080.4	1575494.3	1477949.3	1384814.2	1299670	1217465
CO_2 & Methane (LFG - m^3/hr)	360.6141	335.4392	312.0156	290.4163	270.23251	252.04089	235.50578	219.6419	205.43453	192.47493	179.85095	168.71567	158.08382	148.3641	138.98

	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Carbon Dioxide - 'chemical'	1210	1140	1070	1010	951	896	844	796	751	709	669	632	598	565	535
Carbon Dioxide (m^3/hr)	611111.1	575757.6	540404	510101	480303.0303	452525.2525	426262.6263	402020.202	379292.9293	358080.8081	337878.7879	319191.9192	302020.202	285353.535	270202.02
Methane (t)	361	340	319	301	283	267	251	237	223	211	199	188	178	168	159
Methane (m^3)	530670	499800	468930	442470	416010	392490	368970	348390	327810	310170	292530	276360	261660	246960	233730
Methane (m^3/hr)	60.5787671	57.0547945	53.5308219	50.510274	47.48972603	44.80479452	42.11986301	39.77054795	37.42123288	35.40753425	33.39383562	31.54794521	29.86986301	28.1917808	26.6815068
CO_2 & Methane (LFG - m^3)	1141781	1075558	1009334	952571	896313.03	845015.25	795232.63	750410.2	707102.93	668250.81	630408.79	595551.92	563680.2	532313.5	503932
CO_2 & Methane (LFG - m^3/hr)	130.3403	122.7805	115.2208	108.741	102.31884	96.462928	90.77998	85.663265	80.719512	76.284339	71.964474	67.985379	64.347055	60.76639	57.52649

	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Carbon Dioxide - 'chemical'	506	479	453	429	407	385	365	347	329	312	296	281	267	253	241
Carbon Dioxide (m^3/hr)	255555.556	241919.192	228787.879	216666.667	205555.5556	194444.4444	184343.4343	175252.5253	166161.6162	157575.7576	149494.9495	141919.1919	134848.4848	127777.778	121717.172
Methane (t)	150	142	135	128	121	115	109	103	97.8	92.8	88.1	83.6	79.4	75.4	71.6
Methane (m^3)	220500	208740	198450	188160	177870	169050	160230	151410	143766	136416	129507	122892	116718	110838	105252
Methane (m^3/hr)	25.1712329	23.8287671	22.6541096	21.4794521	20.30479452	19.29794521	18.29109589	17.28424658	16.41164384	15.57260274	14.78390411	14.02876712	13.3239726	12.6527397	12.0150685
CO_2 & Methane (LFG - m^3)	476055.6	450659.2	427237.9	404826.7	383425.56	363494.44	344573.43	326662.53	309927.62	293991.76	279001.95	264811.19	251566.48	238615.8	226969.2
CO_2 & Methane (LFG - m^3/hr)	54.34424	51.44511	48.77145	46.21309	43.770041	41.4948	39.334867	37.290243	35.379865	33.560703	31.849538	30.229588	28.717635	27.23924	25.90972

	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Carbon Dioxide - 'chemical'	229	217	206	196	187	177	169	161	153	145	138	132	125	119	114
Carbon Dioxide (m^3/hr)	115656.566	109595.96	104040.404	98989.899	94444.44444	89393.93939	85353.53535	81313.13131	77272.72727	73232.32323	69696.9697	66666.66667	63131.31313	60101.0101	57575.7576
Methane (t)	68	64.6	61.4	58.4	55.5	52.8	50.2	47.8	45.4	43.2	41.1	39.2	37.3	35.5	33.8
Methane (m^3)	99960	94962	90258	85848	81585	77616	73794	70266	66738	63504	60417	57624	54831	52185	49686
Methane (m^3/hr)	11.4109589	10.840411	10.3034247	9.8	9.313356164	8.860273973	8.423972603	8.021232877	7.618493151	7.249315068	6.896917808	6.578082192	6.259246575	5.95719178	5.67191781
CO_2 & Methane (LFG - m^3)	215616.6	204558	194298.4	184837.9	176029.44	167009.94	159147.54	151579.13	144010.73	136736.32	130113.97	124290.67	117962.31	112286	107261.8
CO_2 & Methane (LFG - m^3/hr)	24.61376	23.35137	22.18018	21.10022	20.094685	19.065062	18.167527	17.303554	16.439581	15.609169	14.853193	14.188432	13.466017	12.81804	12.24449

	2070
Carbon Dioxide - 'chemical'	108
Carbon Dioxide (m^3/hr)	54545.4545
Methane (t)	32.2
Methane (m^3)	47334

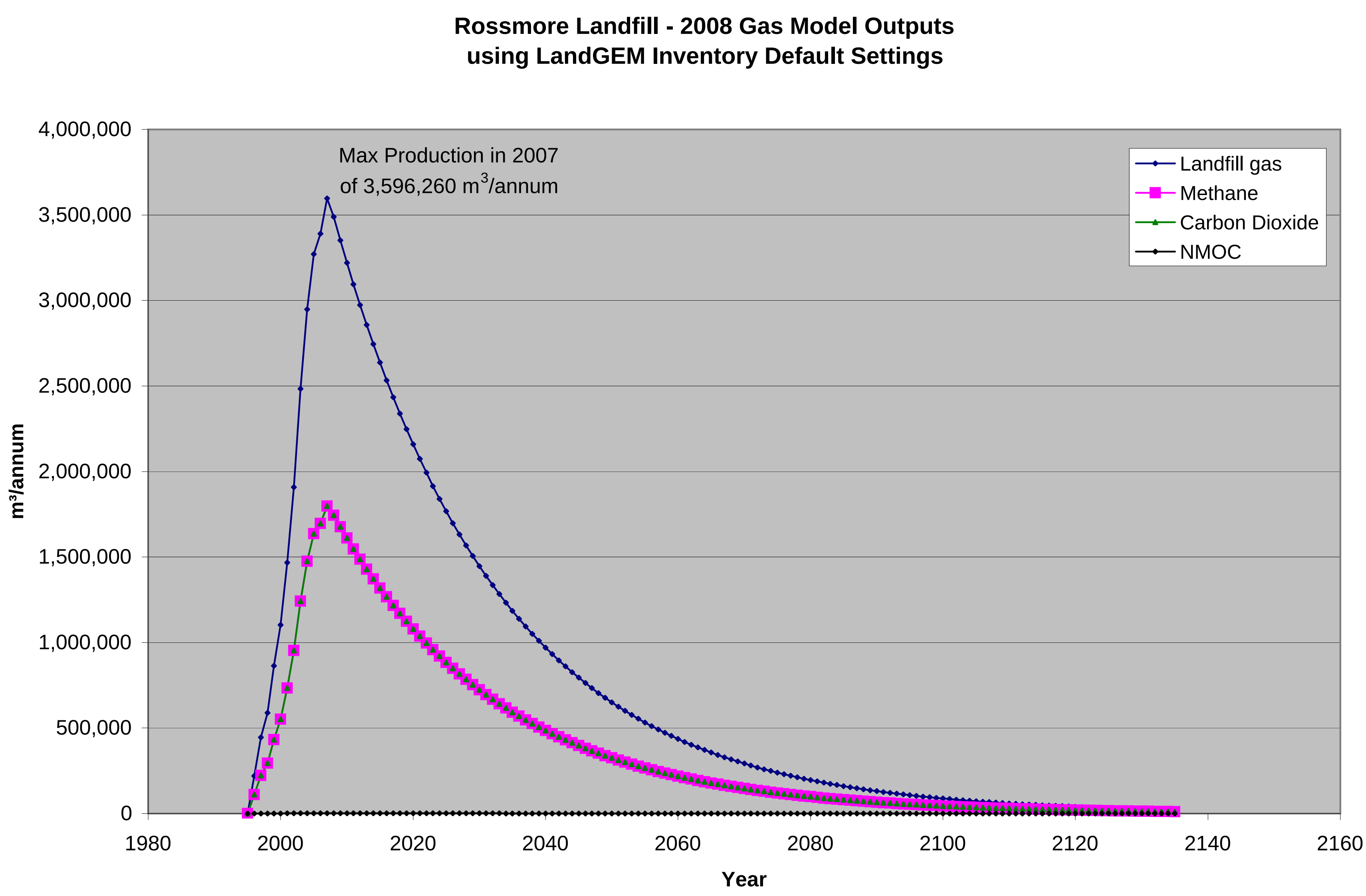
Methane (m^3/hr)	5.40342466
CO2 & Methane (LFG - m^3)	101879.5
CO2 & Methane (LFG - m^3/hr)	11.63007

Appendix C - Gas Generation Model Outputs using LandGEM Inventory Default Settings

Year	Landfill Gas	Methane	Carbon Dioxide	NMOC	Landfill Gas	Methane	Waste Placed
	(m^3/year)	(m^3/year)	(m^3/year)	(m^3/year)	(m^3/hr)	(m^3/hr)	tonnes
1995	0	0	0	0	0	0	0
1996	220,019	110,009	110,009	132	25	13	28,000
1997	445,562	222,781	222,781	267	51	25	57,801
1998	588,988	294,494	294,494	353	67	34	78,277
1999	863,209	431,605	431,605	518	99	49	116,114
2000	1,102,523	551,262	551,262	662	126	63	150,877
2001	1,467,898	733,949	733,949	881	168	84	202,877
2002	1,907,764	953,882	953,882	1,145	218	109	266,180
2003	2,482,635	1,241,318	1,241,318	1,490	283	142	348,859
2004	2,948,757	1,474,379	1,474,379	1,769	337	168	420,567
2005	3,270,933	1,635,466	1,635,466	1,963	373	187	476,282
2006	3,390,411	1,695,205	1,695,205	2,034	387	194	507,809
2007	3,596,260	1,798,130	1,798,130	2,158	411	205	550,924
2008	3,488,766	1,744,383	1,744,383	2,093	398	199	555,189
2009	3,351,970	1,675,985	1,675,985	2,011	383	191	555,189
2010	3,220,537	1,610,268	1,610,268	1,932	368	184	555,189
2011	3,094,258	1,547,129	1,547,129	1,857	353	177	555,189
2012	2,972,930	1,486,465	1,486,465	1,784	339	170	555,189
2013	2,856,360	1,428,180	1,428,180	1,714	326	163	555,189
2014	2,744,361	1,372,180	1,372,180	1,647	313	157	555,189
2015	2,636,753	1,318,376	1,318,376	1,582	301	150	555,189
2016	2,533,364	1,266,682	1,266,682	1,520	289	145	555,189
2017	2,434,029	1,217,015	1,217,015	1,460	278	139	555,189
2018	2,338,590	1,169,295	1,169,295	1,403	267	133	555,189
2019	2,246,892	1,123,446	1,123,446	1,348	256	128	555,189
2020	2,158,790	1,079,395	1,079,395	1,295	246	123	555,189
2021	2,074,143	1,037,072	1,037,072	1,244	237	118	555,189
2022	1,992,815	996,407	996,407	1,196	227	114	555,189
2023	1,914,675	957,338	957,338	1,149	219	109	555,189
2024	1,839,600	919,800	919,800	1,104	210	105	555,189
2025	1,767,468	883,734	883,734	1,060	202	101	555,189
2026	1,698,165	849,082	849,082	1,019	194	97	555,189
2027	1,631,579	815,789	815,789	979	186	93	555,189
2028	1,567,604	783,802	783,802	941	179	89	555,189
2029	1,506,137	753,069	753,069	904	172	86	555,189
2030	1,447,081	723,540	723,540	868	165	83	555,189
2031	1,390,340	695,170	695,170	834	159	79	555,189
2032	1,335,824	667,912	667,912	801	152	76	555,189
2033	1,283,445	641,723	641,723	770	147	73	555,189
2034	1,233,121	616,560	616,560	740	141	70	555,189
2035	1,184,769	592,385	592,385	711	135	68	555,189
2036	1,138,314	569,157	569,157	683	130	65	555,189
2037	1,093,680	546,840	546,840	656	125	62	555,189
2038	1,050,796	525,398	525,398	630	120	60	555,189
2039	1,009,594	504,797	504,797	606	115	58	555,189
2040	970,007	485,004	485,004	582	111	55	555,189
2041	931,973	465,986	465,986	559	106	53	555,189
2042	895,429	447,715	447,715	537	102	51	555,189
2043	860,319	430,160	430,160	516	98	49	555,189
2044	826,586	413,293	413,293	496	94	47	555,189
2045	794,175	397,087	397,087	477	91	45	555,189
2046	763,035	381,517	381,517	458	87	44	555,189
2047	733,116	366,558	366,558	440	84	42	555,189
2048	704,370	352,185	352,185	423	80	40	555,189
2049	676,751	338,375	338,375	406	77	39	555,189
2050	650,215	325,108	325,108	390	74	37	555,189
2051	624,720	312,360	312,360	375	71	36	555,189
2052	600,224	300,112	300,112	360	69	34	555,189
2053	576,689	288,345	288,345	346	66	33	555,189
2054	554,077	277,038	277,038	332	63	32	555,189
2055	532,351	266,176	266,176	319	61	30	555,189
2056	511,477	255,739	255,739	307	58	29	555,189
2057	491,422	245,711	245,711	295	56	28	555,189
2058	472,153	236,077	236,077	283	54	27	555,189

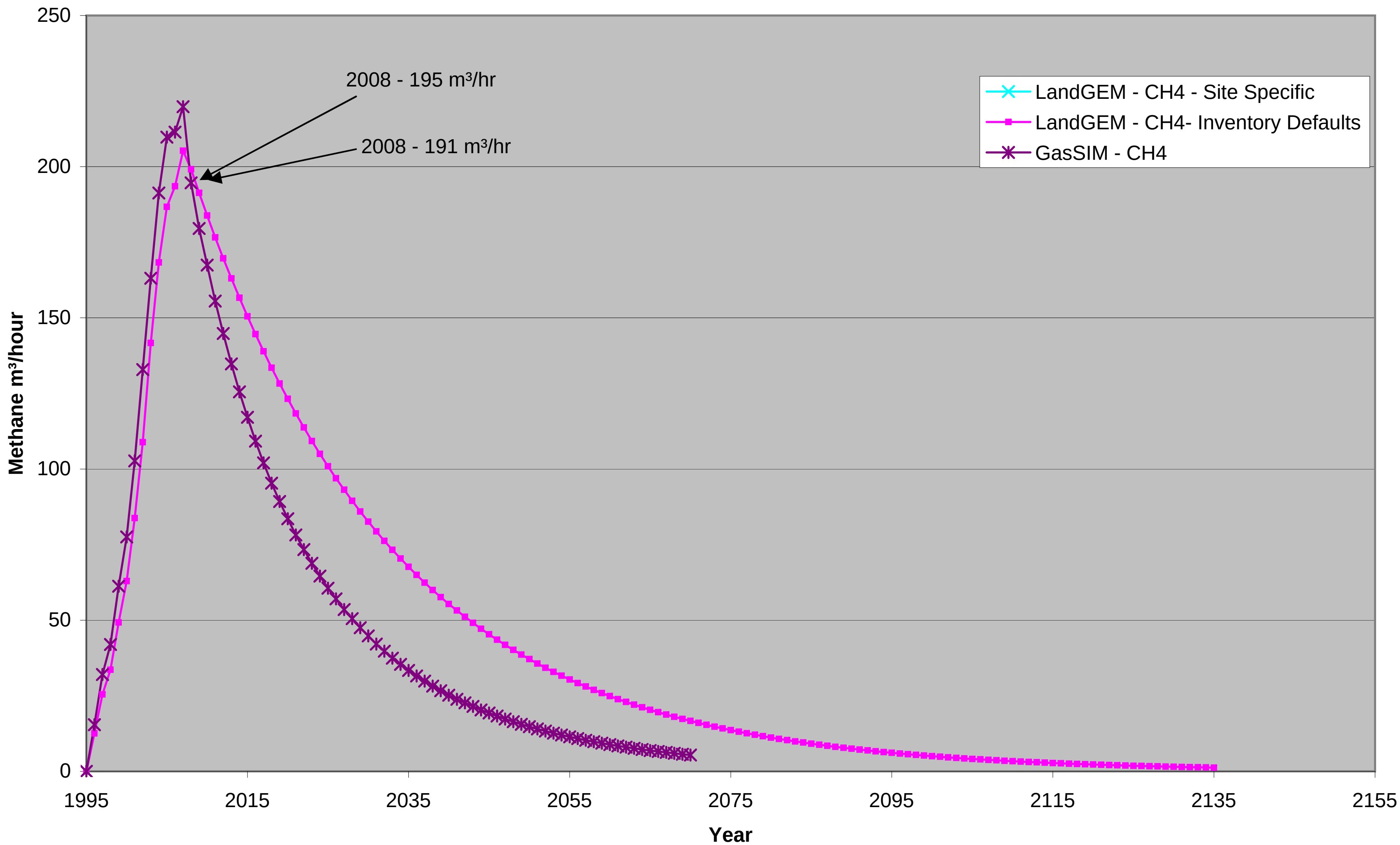
Year	Landfill Gas	Methane	Carbon Dioxide	NMOC	Landfill Gas	Methane	Waste Placed
	(m^3/year)	***(m^3/year)***	***(m^3/year)***	***(m^3/year)***	***(m^3/hr)***	***(m^3/hr)***	***tonnes***
2059	453,640	226,820	226,820	272	52	26	555,189
2060	435,852	217,926	217,926	262	50	25	555,189
2061	418,762	209,381	209,381	251	48	24	555,189
2062	402,342	201,171	201,171	241	46	23	555,189
2063	386,566	193,283	193,283	232	44	22	555,189
2064	371,409	185,704	185,704	223	42	21	555,189
2065	356,846	178,423	178,423	214	41	20	555,189
2066	342,854	171,427	171,427	206	39	20	555,189
2067	329,410	164,705	164,705	198	38	19	555,189
2068	316,494	158,247	158,247	190	36	18	555,189
2069	304,084	152,042	152,042	182	35	17	555,189
2070	292,161	146,080	146,080	175	33	17	555,189
2071	280,705	140,352	140,352	168	32	16	555,189
2072	269,698	134,849	134,849	162	31	15	555,189
2073	259,123	129,562	129,562	155	30	15	555,189
2074	248,963	124,481	124,481	149	28	14	555,189
2075	239,201	119,600	119,600	144	27	14	555,189
2076	229,822	114,911	114,911	138	26	13	555,189
2077	220,810	110,405	110,405	132	25	13	555,189
2078	212,152	106,076	106,076	127	24	12	555,189
2079	203,833	101,917	101,917	122	23	12	555,189
2080	195,841	97,921	97,921	118	22	11	555,189
2081	188,162	94,081	94,081	113	21	11	555,189
2082	180,784	90,392	90,392	108	21	10	555,189
2083	173,695	86,848	86,848	104	20	10	555,189
2084	166,885	83,442	83,442	100	19	10	555,189
2085	160,341	80,171	80,171	96	18	9	555,189
2086	154,054	77,027	77,027	92	18	9	555,189
2087	148,013	74,007	74,007	89	17	8	555,189
2088	142,210	71,105	71,105	85	16	8	555,189
2089	136,634	68,317	68,317	82	16	8	555,189
2090	131,276	65,638	65,638	79	15	7	555,189
2091	126,129	63,064	63,064	76	14	7	555,189
2092	121,183	60,592	60,592	73	14	7	555,189
2093	116,432	58,216	58,216	70	13	7	555,189
2094	111,866	55,933	55,933	67	13	6	555,189
2095	107,480	53,740	53,740	64	12	6	555,189
2096	103,266	51,633	51,633	62	12	6	555,189
2097	99,216	49,608	49,608	60	11	6	555,189
2098	95,326	47,663	47,663	57	11	5	555,189
2099	91,588	45,794	45,794	55	10	5	555,189
2100	87,997	43,999	43,999	53	10	5	555,189
2101	84,547	42,273	42,273	51	10	5	555,189
2102	81,232	40,616	40,616	49	9	5	555,189
2103	78,046	39,023	39,023	47	9	4	555,189
2104	74,986	37,493	37,493	45	9	4	555,189
2105	72,046	36,023	36,023	43	8	4	555,189
2106	69,221	34,610	34,610	42	8	4	555,189
2107	66,507	33,253	33,253	40	8	4	555,189
2108	63,899	31,949	31,949	38	7	4	555,189
2109	61,393	30,697	30,697	37	7	4	555,189
2110	58,986	29,493	29,493	35	7	3	555,189
2111	56,673	28,337	28,337	34	6	3	555,189
2112	54,451	27,226	27,226	33	6	3	555,189
2113	52,316	26,158	26,158	31	6	3	555,189
2114	50,265	25,132	25,132	30	6	3	555,189
2115	48,294	24,147	24,147	29	6	3	555,189
2116	46,400	23,200	23,200	28	5	3	555,189
2117	44,581	22,290	22,290	27	5	3	555,189
2118	42,833	21,416	21,416	26	5	2	555,189
2119	41,153	20,577	20,577	25	5	2	555,189
2120	39,540	19,770	19,770	24	5	2	555,189
2121	37,989	18,995	18,995	23	4	2	555,189
2122	36,500	18,250	18,250	22	4	2	555,189
2123	35,069	17,534	17,534	21	4	2	555,189
2124	33,693	16,847	16,847	20	4	2	555,189
2125	32,372	16,186	16,186	19	4	2	555,189

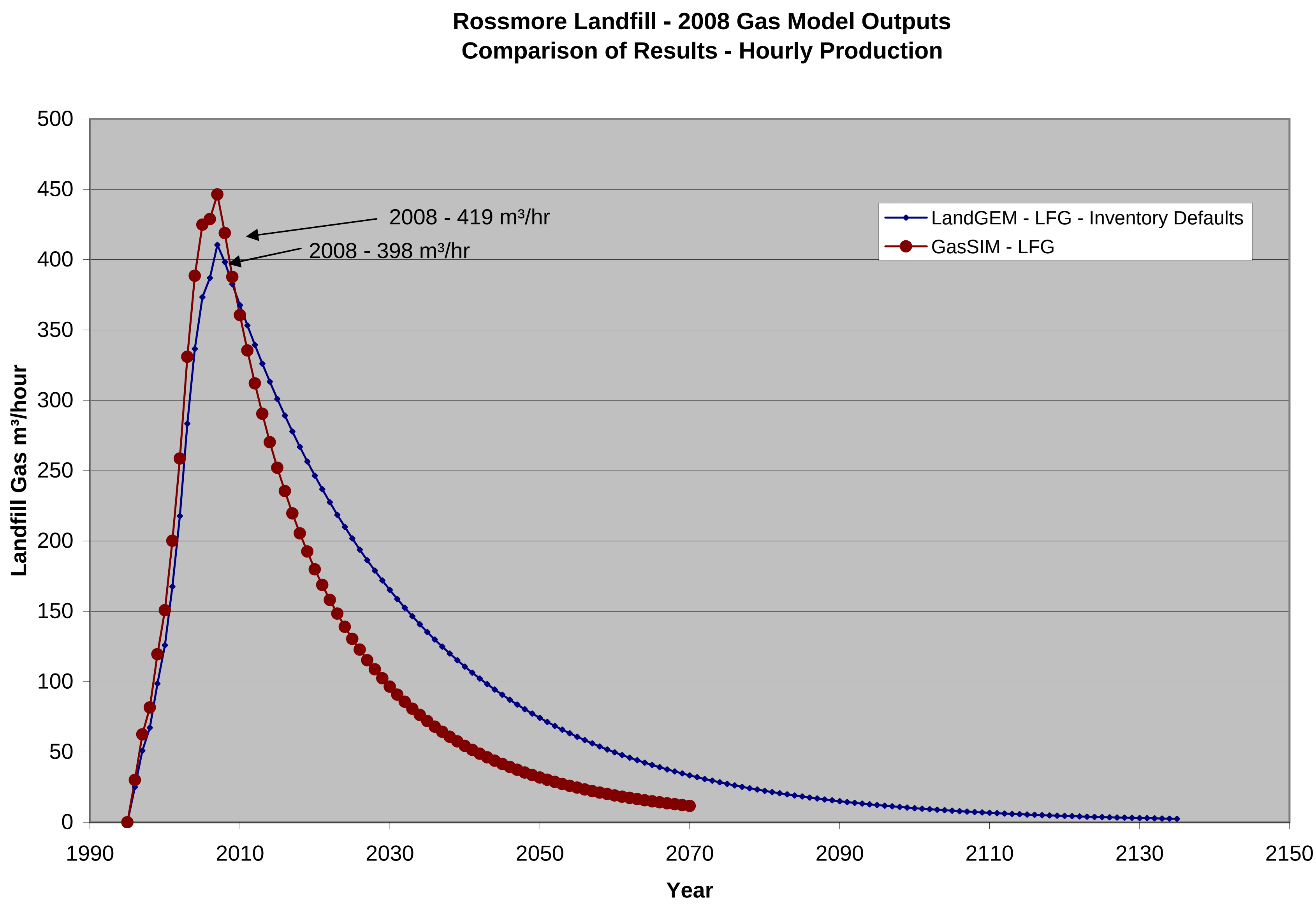
Year	Landfill Gas	Methane	Carbon Dioxide	NMOC	Landfill Gas	Methane	Waste Placed
	(m^3/year)	***(m^3/year)***	***(m^3/year)***	***(m^3/year)***	***(m^3/hr)***	***(m^3/hr)***	***tonnes***
2126	31,103	15,551	15,551	19	4	2	555,189
2127	29,883	14,942	14,942	18	3	2	555,189
2128	28,712	14,356	14,356	17	3	2	555,189
2129	27,586	13,793	13,793	17	3	2	555,189
2130	26,504	13,252	13,252	16	3	2	555,189
2131	25,465	12,732	12,732	15	3	1	555,189
2132	24,466	12,233	12,233	15	3	1	555,189
2133	23,507	11,754	11,754	14	3	1	555,189
2134	22,585	11,293	11,293	14	3	1	555,189
2135	21,700	10,850	10,850	13	2	1	555,189



Rossmore Landfill - 2008 Gas Model Outputs
using LandGEM Inventory Default Settings
Max Production in 2007
of 3,596,260 m³/annum
Landfill gas
Methane
Carbon Dioxide
NMOC
m³/annum
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1980
2000
2020
2040
2060
2080
2100
2120
2140
2160
Year

Rossmore Landfill - 2008 Gas Model Outputs
Comparison of Results - Hourly Production





Rossmore Landfill - 2008 Gas Model Outputs
Comparison of Results - Hourly Production
2008 - 419 m³/hr
2008 - 398 m³/hr
LandGEM - LFG - Inventory Defaults
GasSIM - LFG
Landfill Gas m³/hour
Year
500
450
400
350
300
250
200
150
100
50
0
1990
2010
2030
2050
2070
2090
2110
2130
2150

Appendix D

Meteorological Records for East Cork Landfill

1st January – 31st December 2009

Date/time	EvapCalcDaily evap	PR_Sum24h PR_Sum24h	TA_24h Avg	TA_24h Max	TA_24h Min	RH_24h Avg	RH_24h Max	RH_24h Min	PA_24h Avg	PA_24h Max	PA_24h Min	WD_24h Avg	WD_24h Max	WD_24h Min	WS_24h Avg	WS_24h Max	WS_24h Min
Thu Jan 01 23:59:08 2009	1.4	0	6.4	7.5	4.8	83.6	89.1	77.4	1024.1	1025.3	1023.0	276	336	156	4	10	1
Fri Jan 02 23:59:07 2009	0.9	0	5.9	6.6	5.0	76.2	87.2	67.6	1026.0	1027.1	1024.5	280	343	160	5	12	1
Sat Jan 03 23:59:07 2009	1.2	0	4.7	6.1	3.0	76.7	86.0	65.9	1026.6	1027.7	1025.8	270	342	131	2	9	0
Sun Jan 04 23:59:07 2009	0.8	0.8	4.2	7.4	2.7	88.5	95.3	76.5	1022.1	1025.8	1019.5	125	360	1	1	3	0
Mon Jan 05 23:59:07 2009	0.3	0.8	3.7	7.6	0.2	88.3	96.5	77.5	1021.8	1025.7	1019.0	254	355	14	1	8	0
Tue Jan 06 23:59:07 2009	0.4	0	0.0	4.5	-2.8	78.8	89.4	4.0	1026.3	1027.7	1025.6	281	360	179	1	5	0
Wed Jan 07 23:59:07 2009	0.9	0	0.0	5.1	-3.2	90.1	97.3	76.9	1025.9	1027.3	1024.9	149	360	1	1	3	0
Thu Jan 08 23:59:08 2009	0.2	0	1.9	6.9	-2.9	86.0	98.9	4.0	1025.7	1027.3	1023.8	184	360	1	1	7	0
Fri Jan 09 23:59:08 2009	1.1	0	6.3	7.5	4.6	74.0	92.1	4.0	1022.6	1023.8	1020.2	289	360	1	3	12	0
Sat Jan 10 23:59:08 2009	2.5	0.6	8.9	9.7	6.8	76.6	90.9	67.3	1016.0	1020.5	1012.5	104	360	1	6	15	1
Sun Jan 11 23:59:08 2009	1.4	22.2	10.4	11.6	9.2	93.6	94.8	90.9	1006.8	1012.5	1000.7	68	360	1	8	22	1
Mon Jan 12 23:59:08 2009	0.6	1	8.7	10.2	5.0	91.7	94.3	86.7	1002.0	1003.1	1001.0	64	360	1	2	9	0
Tue Jan 13 23:59:08 2009	0.4	0.4	4.0	7.3	0.1	91.1	97.0	77.0	1007.6	1010.6	1003.1	110	360	1	1	10	0
Wed Jan 14 23:59:07 2009	0.3	19.4	7.9	10.6	-0.8	93.0	98.5	82.4	1000.8	1010.3	992.8	293	360	1	7	20	0
Thu Jan 15 23:59:07 2009	0.7	5.8	9.4	10.6	6.1	90.3	95.2	84.4	997.5	1004.1	992.8	144	360	1	4	19	0
Fri Jan 16 23:59:07 2009	0.6	7.2	8.3	10.5	5.2	86.3	93.8	72.6	1000.8	1004.3	996.9	91	360	1	4	17	0
Sat Jan 17 23:59:07 2009	1.0	11.8	6.6	10.2	3.6	82.9	94.8	68.3	993.0	1002.3	984.3	98	360	1	6	**29.42**	0
Sun Jan 18 23:59:07 2009	1.3	10.2	4.8	8.2	1.8	83.2	92.7	68.0	989.3	992.8	981.8	87	360	1	5	21	0
Mon Jan 19 23:59:07 2009	1.1	12.4	3.4	7.3	1.3	88.2	95.2	72.7	977.4	982.0	974.2	76	360	1	4	15	0
Tue Jan 20 23:59:07 2009	0.8	3.2	2.8	6.2	0.9	84.6	94.0	74.7	987.8	996.2	981.7	77	210	6	3	11	0
Wed Jan 21 23:59:08 2009	0.6	6.2	6.0	10.9	-0.3	93.1	97.6	40.8	989.2	997.1	975.9	150	360	1	4	16	0
Thu Jan 22 23:59:08 2009	1.9	3.4	7.0	11.2	4.0	82.9	96.6	63.3	978.9	983.8	972.8	103	360	1	3	15	0
Fri Jan 23 23:59:08 2009	1.2	2.4	4.1	8.0	0.9	85.9	96.8	67.1	979.8	983.1	972.6	102	360	1	3	14	0
Sat Jan 24 23:59:08 2009	0.9	2.4	5.2	9.3	1.3	87.9	95.9	70.8	982.3	989.8	968.2	136	360	1	4	22	0
Sun Jan 25 23:59:08 2009	1.0	13.8	5.1	8.0	3.3	86.2	93.2	75.5	971.8	986.0	**965.6**	141	360	1	6	19	1
Mon Jan 26 23:59:07 2009	0.9	2.2	7.5	9.7	5.4	81.2	96.6	66.1	999.0	1004.0	986.1	140	360	1	3	13	0
Tue Jan 27 23:59:07 2009	1.0	0.2	8.4	10.0	4.6	94.6	96.8	91.2	1006.0	1009.3	1002.8	120	360	1	1	9	0
Wed Jan 28 23:59:07 2009	0.1	0.2	5.0	10.1	0.2	96.2	**99.7**	82.2	1010.3	1012.0	1007.6	213	360	1	2	8	0
Thu Jan 29 23:59:07 2009	0.4	2.8	9.2	11.0	7.6	92.7	97.4	84.7	1000.7	1007.5	996.2	316	360	1	7	19	2
Fri Jan 30 23:59:07 2009	0.7	38.8	8.6	10.8	6.6	96.1	96.9	94.6	997.7	999.9	994.6	233	360	1	3	16	0
Sat Jan 31 23:59:07 2009	0.2	8.6	7.0	9.5	5.0	93.7	96.9	82.0	1000.2	1002.7	998.3	223	360	1	2	11	0
	26.8	**176.8**															

Date/time	EvapCalcDaily evap	PR_Sum24h PR_Sum24h	TA_24h Avg	TA_24h Max	TA_24h Min	RH_24h Avg	RH_24h Max	RH_24h Min	PA_24h Avg	PA_24h Max	PA_24h Min	WD_24h Avg	WD_24h Max	WD_24h Min	WS_24h Avg	WS_24h Max	WS_24h Min
Sun Feb 01 23:59:08 2009	0.5	1.2	4.2	7.4	2.3	82.9	96.8	68.5	1006.3	1008.7	1002.7	254	336	142	5	13	1
Mon Feb 02 23:59:08 2009	1.0	0	0.9	3.1	-1.2	77.2	85.2	64.7	1003.5	1008.6	995.5	175	317	73	4	11	1
Tue Feb 03 23:59:08 2009	0.9	1.4	0.9	2.6	-1.4	91.0	96.7	83.2	986.8	995.4	983.7	125	360	3	3	9	0
Wed Feb 04 23:59:08 2009	0.3	4.2	2.2	6.4	-1.8	93.4	98.6	84.9	986.2	989.2	983.7	224	360	2	3	12	0
Thu Feb 05 23:59:08 2009	0.3	0	2.4	4.0	0.9	80.9	90.6	70.0	992.0	995.9	989.2	164	252	97	4	13	1
Fri Feb 06 23:59:08 2009	0.9	0	2.6	6.3	0.6	77.6	88.0	59.5	997.4	1001.3	995.6	141	243	56	5	12	0
Sat Feb 07 23:59:07 2009	1.3	0	2.4	6.3	0.0	75.9	88.2	52.9	1003.2	1005.1	1000.7	136	352	9	3	10	0
Sun Feb 08 23:59:07 2009	1.2	5.4	5.1	9.0	0.0	84.3	96.7	55.4	998.4	1003.0	996.0	155	360	1	3	14	0
Mon Feb 09 23:59:07 2009	1.2	0	3.0	5.6	0.9	88.5	97.7	74.8	992.8	998.4	987.9	191	360	1	2	11	0
Tue Feb 10 23:59:07 2009	0.5	0	4.3	8.7	1.3	82.2	92.2	65.7	1007.6	1014.2	996.6	100	360	1	3	12	0
Wed Feb 11 23:59:07 2009	1.0	0	5.9	9.2	2.9	86.8	95.9	74.2	1018.5	1024.3	1014.1	141	360	1	1	3	0
Thu Feb 12 23:59:07 2009	0.3	0.4	7.4	11.8	4.4	89.3	96.1	71.8	1024.5	1025.2	1023.8	143	360	1	1	4	0
Fri Feb 13 23:59:08 2009	0.6	0	7.7	11.3	4.4	87.0	95.0	71.2	1023.9	1024.6	1023.5	191	360	1	1	4	0
Sat Feb 14 23:59:08 2009	0.5	0	7.6	10.6	5.4	86.0	95.0	65.2	1025.4	1027.2	1023.9	154	360	1	1	5	0
Sun Feb 15 23:59:08 2009	0.6	0	7.5	11.5	3.9	86.8	97.2	68.4	1027.2	1028.0	1026.5	79	360	1	1	5	0
Mon Feb 16 23:59:08 2009	0.6	0	6.8	10.0	3.3	91.4	97.5	77.4	1027.4	1028.5	1026.7	96	307	2	1	5	0
Tue Feb 17 23:59:08 2009	0.4	0	7.4	9.3	6.1	88.2	92.7	78.5	1028.9	1029.7	1027.9	76	360	1	1	3	0
Wed Feb 18 23:59:08 2009	0.3	0.2	7.2	8.4	6.1	86.5	95.0	72.3	1026.0	1028.4	1024.7	272	360	1	1	6	0
Thu Feb 19 23:59:07 2009	0.4	0.6	7.5	11.1	4.5	90.3	96.6	76.6	1027.7	1030.5	1025.4	166	360	1	1	6	0
Fri Feb 20 23:59:07 2009	0.4	0	5.0	10.1	0.8	91.4	98.3	76.0	1031.4	1033.2	1030.2	97	360	1	1	6	0
Sat Feb 21 23:59:07 2009	0.5	0.2	6.0	26.9	0.8	87.3	101.1	62.4	1033.2	1034.4	1032.4	84	199	13	2	6	0
Sun Feb 22 23:59:07 2009	2.3	0	9.9	13.4	7.4	80.3	90.3	63.5	1031.1	1032.8	1029.9	106	360	1	3	12	0
Mon Feb 23 23:59:07 2009	1.6	0	9.8	13.3	7.8	85.6	91.8	72.2	1027.8	1029.9	1026.5	121	218	3	2	8	0
Tue Feb 24 23:59:07 2009	1.1	0	8.8	10.4	7.8	85.6	91.0	73.6	1026.9	1027.7	1026.2	132	360	1	1	4	0
Wed Feb 25 23:59:07 2009	0.5	0	8.2	12.1	4.2	81.6	90.6	66.3	1027.4	1028.3	1026.2	103	360	1	2	8	0
Thu Feb 26 23:59:08 2009	0.9	0	7.4	11.9	2.5	84.8	95.0	70.9	1024.4	1027.4	1021.7	82	162	1	2	9	0
Fri Feb 27 23:59:08 2009	0.9	0.2	8.6	10.4	7.8	87.4	93.3	78.0	1018.1	1022.0	1013.4	52	360	1	3	9	0
Sat Feb 28 23:59:08 2009	0.8	2.4	8.8	9.6	6.1	90.0	94.7	85.8	1007.9	1013.4	1004.7	135	360	1	3	10	0
	21.8	**16.2**															

Date/time	EvapCalcDaily	PR_Sum24h	TA_24h	TA_24h	TA_24h	RH_24h	RH_24h	RH_24h	PA_24h	PA_24h	PA_24h	WD_24h	WD_24h	WD_24h	WS_24h	WS_24h	WS_24h
	evap	PR_Sum24h	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Sun Mar 01 23:59:08 2009	0.5	0	6.2	10.8	2.1	84.3	98.9	56.3	1009.3	1015.6	1004.8	99	360	7	3	14	0
Mon Mar 02 23:59:08 2009	1.3	1.6	6.8	11.9	2.2	88.2	96.9	68.6	1014.6	1016.3	1011.7	85	360	1	2	8	0
Tue Mar 03 23:59:07 2009	0.9	8.2	5.5	8.2	1.0	84.6	94.5	71.8	993.8	1011.7	982.7	84	360	1	4	16	0
Wed Mar 04 23:59:07 2009	0.9	6.2	2.6	5.8	0.6	90.2	97.4	72.2	981.2	984.1	978.4	99	197	29	4	14	0
Thu Mar 05 23:59:07 2009	0.8	0	4.8	10.5	1.4	77.2	90.6	41.2	996.7	1004.4	984.0	123	360	1	4	14	0
Fri Mar 06 23:59:07 2009	2.1	2.2	7.1	11.5	2.7	85.4	96.9	67.1	1004.2	1009.5	1002.0	171	360	1	2	11	0
Sat Nar 07 23:59:07 2009	1.0	1	9.6	13.6	5.8	85.6	94.8	71.6	1004.8	1009.8	999.4	78	360	1	5	17	0
Sun Mar 08 23:59:08 2009	1.4	4.4	4.8	7.6	3.1	78.1	91.9	58.0	1003.2	1009.1	999.7	85	350	9	6	19	2
Mon Mar 09 23:59:08 2009	1.5	4	7.1	10.4	3.3	81.9	94.0	67.0	1009.7	1012.9	1003.8	68	360	1	5	15	1
Tue Mar 10 23:59:08 2009	1.3	0	9.9	12.3	8.1	76.4	89.2	64.8	1011.3	1018.1	1003.7	95	360	1	3	12	0
Wed Mar 11 23:59:08 2009	1.4	0.2	11.0	13.5	9.2	89.0	96.3	75.2	1018.4	1019.5	1017.7	80	360	1	3	11	0
Thu Mar 12 23:59:08 2009	1.0	0	11.0	13.5	9.3	87.3	94.7	69.9	1018.7	1019.7	1017.4	62	360	1	3	11	0
Fri Mar 13 23:59:08 2009	1.2	2.4	9.3	10.3	8.7	89.8	95.2	79.9	1011.5	1018.6	1005.7	177	360	1	4	14	0
Sat Mar 14 23:59:07 2009	0.8	0.2	8.9	12.7	5.1	73.3	89.3	54.8	1019.0	1027.0	1008.3	99	360	1	3	13	0
Sun Mar 15 23:59:07 2009	1.9	0	7.2	12.6	2.0	83.5	97.4	59.1	1029.5	1030.7	1027.0	150	360	1	2	9	0
Mon Mar 16 23:59:07 2009	1.2	0	7.6	12.3	4.0	87.3	97.1	65.4	1029.7	1030.6	1028.8	243	360	1	1	6	0
Tue Mar 17 23:59:07 2009	0.8	0.2	8.0	12.8	3.4	89.9	97.7	66.8	1030.5	1031.4	1030.0	276	351	185	3	9	0
Wed Mar 18 23:59:07 2009	1.2	0.2	7.0	10.0	4.0	94.8	98.2	88.1	1028.0	1030.2	1026.2	278	351	2	2	8	0
Thu Mar 19 23:59:07 2009	0.4	0	7.9	12.5	5.6	89.4	96.9	71.5	1024.8	1026.2	1024.0	270	340	167	3	10	0
Fri Mar 20 23:59:08 2009	1.1	0.2	8.2	11.2	4.9	89.6	96.4	81.6	1026.0	1028.6	1024.4	288	360	1	3	9	0
Sat Mar 21 23:59:08 2009	0.7	0	8.2	13.3	3.1	85.4	98.8	70.2	1032.7	1036.7	1028.7	172	360	1	2	8	0
Sun Mar 22 23:59:08 2009	0.9	0	9.3	15.1	4.4	76.9	93.6	52.3	1034.8	1036.8	1031.0	115	360	4	3	9	0
Mon Mar 23 23:59:08 2009	2.0	0	9.7	13.6	6.9	75.7	86.6	61.2	1024.8	1031.0	1021.2	110	195	23	5	18	0
Tue Mar 24 23:59:08 2009	2.1	0.2	8.7	13.1	4.3	79.7	92.0	64.1	1019.9	1024.7	1011.1	97	360	1	3	14	0
Wed Mar 25 23:59:08 2009	1.4	0	9.8	12.4	8.0	69.6	86.6	52.9	1011.0	1012.6	1008.4	105	360	1	5	18	1
Thu Mar 26 23:59:07 2009	2.5	1.2	9.0	11.3	5.2	73.9	91.1	50.2	1003.6	1008.4	1001.4	95	181	4	6	17	2
Fri Mar 27 23:59:07 2009	2.3	0.8	6.3	9.6	4.6	77.0	88.0	57.4	999.2	1004.4	996.3	111	211	25	5	21	1
Sat Mar 28 23:59:07 2009	1.8	0	6.2	9.6	3.5	60.7	82.9	**33.0**	1008.8	1013.7	999.6	142	243	49	6	20	0
Sun Mar 29 23:59:07 2009	3.0	0.6	6.3	8.7	2.2	88.1	96.3	71.0	1010.1	1013.6	1007.5	125	360	1	2	10	0
Mon Mar 30 23:59:07 2009	0.7	0	9.3	12.6	6.8	87.9	96.2	71.8	1016.9	1020.5	1011.8	138	360	1	1	5	0
Tue Mar 31 23:59:07 2009	0.7	0	9.5	12.0	7.9	88.6	96.3	75.8	1020.7	1021.3	1019.9	282	360	1	2	8	0
	40.9	**33.8**															

Date/time	EvapCalcDaily evap	PR_Sum24h PR_Sum24h	TA_24h Avg	TA_24h Max	TA_24h Min	RH_24h Avg	RH_24h Max	RH_24h Min	PA_24h Avg	PA_24h Max	PA_24h Min	WD_24h Avg	WD_24h Max	WD_24h Min	WS_24h Avg	WS_24h Max	WS_24h Min
Wed Apr 01 23:59:07 2009	0.8	0	9.4	13.7	5.7	76.6	92.7	50.9	1021.2	1022.1	1020.1	274	360	1	2	7	0
Thu Apr 02 23:59:08 2009	1.7	0	8.8	15.0	2.3	84.8	97.4	59.4	1018.7	1021.5	1016.3	218	360	1	2	5	0
Fri Apr 03 23:59:08 2009	1.4	14.2	8.8	11.3	5.5	94.1	97.5	84.6	1012.1	1016.3	1008.8	213	360	1	3	12	0
Sat Apr 04 23:59:08 2009	0.5	0	8.6	13.2	4.6	71.5	95.1	34.6	1017.9	1022.3	1012.0	98	360	2	3	11	0
Sun Apr 05 23:59:08 2009	2.3	0	8.0	11.3	2.5	82.8	95.3	70.6	1016.7	1022.0	1008.0	255	360	1	4	12	0
Mon Apr 06 23:59:08 2009	1.2	13.4	9.1	12.9	5.5	81.1	93.5	63.8	1000.3	1008.0	998.2	154	360	1	5	17	0
Tue Apr 07 23:59:07 2009	1.7	9.6	8.2	11.3	5.0	84.8	95.0	70.1	996.9	1000.8	988.4	91	360	1	5	16	0
Wed Apr 08 23:59:07 2009	1.3	8.2	9.3	13.9	5.0	79.4	96.2	57.1	1001.1	1004.1	995.1	154	360	1	4	12	0
Thu Apr 09 23:59:07 2009	1.9	26	9.7	12.2	5.7	92.2	96.2	85.4	993.0	997.6	990.4	213	360	1	6	17	1
Fri Apr 10 23:59:07 2009	0.8	2	7.0	12.0	3.8	80.4	92.6	52.4	999.1	1003.8	994.5	86	360	1	2	10	0
Sat Apr 11 23:59:07 2009	1.4	0	7.4	12.5	1.5	84.9	97.7	61.0	1007.2	1011.4	1003.7	223	360	1	2	9	0
Sun Apr 12 23:59:07 2009	1.3	0	9.3	12.5	6.2	87.0	95.7	74.3	1011.1	1012.8	1006.8	237	360	1	3	10	0
Mon Apr 13 23:59:08 2009	1.2	16.8	10.3	13.2	8.8	89.3	95.5	76.7	1002.5	1006.8	1001.1	265	360	1	4	13	0
Tue Apr 14 23:59:08 2009	1.2	2	10.2	12.1	8.6	89.4	94.1	79.5	1002.9	1006.4	1000.6	304	360	1	5	12	1
Wed Apr 15 23:59:08 2009	1.1	15.8	9.9	11.1	8.2	91.8	94.1	88.4	1004.1	1006.5	1001.1	211	359	1	2	7	0
Thu Apr 16 23:59:08 2009	0.4	0	11.7	14.6	9.3	84.5	93.0	69.8	1003.3	1006.5	1000.5	254	349	153	4	12	1
Fri Apr 17 23:59:08 2009	1.6	0	10.2	14.5	5.4	86.5	96.6	66.8	1009.2	1013.0	1006.4	268	348	162	3	11	0
Sat Apr 18 23:59:08 2009	1.6	0	9.5	14.5	5.8	83.0	95.5	61.8	1017.0	1021.4	1012.9	272	357	156	2	9	0
Sun Apr 19 23:59:07 2009	1.6	0	9.4	14.4	4.7	85.9	96.5	68.1	1023.0	1025.8	1021.0	205	360	1	2	6	0
Mon Apr 20 23:59:07 2009	1.1	0	10.8	14.3	7.8	84.2	94.3	68.9	1026.3	1027.2	1025.4	153	360	1	2	8	0
Tue Apr 21 23:59:07 2009	1.3	0	13.3	19.1	9.5	79.4	93.9	47.9	1025.6	1026.4	1024.9	103	360	1	2	6	0
Wed Apr 22 23:59:07 2009	2.5	0.8	11.0	12.8	8.7	89.2	94.7	79.0	1021.1	1025.7	1016.9	163	360	1	4	12	0
Thu Apr 23 23:59:07 2009	1.0	4.8	10.8	13.0	9.8	91.9	95.4	82.4	1014.8	1017.1	1010.1	197	360	1	2	8	0
Fri Apr 24 23:59:07 2009	0.6	7	10.0	12.3	8.3	84.8	95.4	63.6	1007.3	1010.7	1004.1	137	360	1	3	8	0
Sat Apr 25 23:59:07 2009	1.3	23	8.8	12.9	5.5	83.3	92.0	64.7	1000.8	1006.3	997.6	156	263	60	5	17	0
Sun Apr 26 23:59:07 2009	1.8	0	9.8	11.9	6.3	82.1	92.4	60.3	1004.3	1007.0	996.8	99	360	1	3	11	0
Mon Apr 27 23:59:08 2009	1.6	6	8.6	12.8	6.2	77.4	90.4	62.6	994.6	997.0	992.9	108	232	8	4	17	1
Tue Apr 28 23:59:08 2009	1.8	3.6	8.8	13.9	5.1	88.4	94.3	72.9	1001.8	1004.4	996.5	147	360	1	2	7	0
Wed Apr 29 23:59:08 2009	0.9	8.2	10.1	11.9	8.0	92.6	96.4	81.6	1001.6	1004.3	999.3	196	360	1	3	11	0
Thu Apr 30 23:59:08 2009	0.7	0	11.4	17.0	8.2	77.1	95.6	43.4	1009.8	1017.4	1000.0	92	360	1	3	9	0
	39.5	**161.4**															

Date/time	EvapCalcDaily	PR_Sum24h	TA_24h	TA_24h	TA_24h	RH_24h	RH_24h	RH_24h	PA_24h	PA_24h	PA_24h	WD_24h	WD_24h	WD_24h	WS_24h	WS_24h	WS_24h
	evap	PR_Sum24h	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Fri May 01 23:59:08 2009	2.6	3.4	12.1	16.6	8.4	73.1	94.1	46.5	1018.1	1024.6	1014.2	84	360	1	4	12	0
Sat May 02 23:59:07 2009	3.0	0.4	10.4	14.5	6.4	79.5	92.0	60.8	1026.2	1027.6	1024.6	120	360	1	3	11	0
Sun May 03 23:59:07 2009	1.8	0.0	9.6	14.3	5.1	70.6	88.3	44.3	1029.6	1031.1	1026.7	110	208	24	3	11	0
Mon May 04 23:59:07 2009	2.6	0.0	11.6	15.5	7.7	80.5	87.6	70.6	1025.7	1030.2	1023.6	83	359	1	4	13	1
Tue May 05 23:59:07 2009	1.8	0.0	13.5	16.8	10.8	74.5	89.6	56.2	1021.1	1024.3	1018.2	78	360	2	5	15	1
Wed May 06 23:59:07 2009	2.9	1.2	12.4	15.4	8.9	84.3	93.1	73.4	1014.2	1018.5	1009.7	59	360	1	5	16	0
Thu May 07 23:59:07 2009	1.6	0.8	9.4	13.4	6.3	78.0	89.9	58.4	1007.1	1011.1	1001.4	53	360	1	5	17	0
Fri May 08 23:59:07 2009	2.2	0.0	9.9	14.5	6.3	68.1	83.4	39.5	1006.8	1012.2	1001.8	71	360	1	6	18	1
Sat May 09 23:59:08 2009	3.5	1.2	10.2	13.8	8.0	74.7	89.2	47.2	1011.0	1014.4	1008.6	59	360	1	3	10	0
Sun May 10 23:59:08 2009	2.5	0.0	10.5	14.2	7.7	78.0	90.4	61.6	1017.0	1019.3	1014.4	241	360	1	3	10	0
Mon May 11 23:59:08 2009	1.8	0.0	12.3	16.6	7.3	63.8	82.3	44.7	1018.9	1019.7	1018.2	255	353	139	4	13	0
Tue May 12 23:59:08 2009	3.4	0.0	10.7	14.9	6.7	68.6	83.2	46.1	1018.9	1020.1	1016.5	269	360	149	4	13	0
Wed May 13 23:59:08 2009	3.0	1.2	9.4	10.4	6.7	89.8	95.0	80.2	1011.2	1016.5	1007.5	270	356	145	3	11	0
Thu May 14 23:59:07 2009	0.7	6.6	10.8	13.3	9.0	93.9	96.5	89.0	1006.4	1007.6	1004.7	192	360	1	2	11	0
Fri May 15 23:59:07 2009	0.4	5.0	10.2	13.5	8.2	79.2	94.3	56.8	999.7	1004.8	990.8	122	360	1	4	11	1
Sat May 16 23:59:07 2009	2.0	11.8	9.9	12.3	7.5	81.9	95.4	66.6	989.6	995.8	979.0	123	360	1	6	18	1
Sun May 17 23:59:07 2009	1.7	13.0	10.0	12.8	7.3	85.5	92.8	71.4	993.7	996.1	991.9	192	360	1	4	11	0
Mon May 18 23:59:07 2009	1.4	3.2	11.4	14.2	9.5	82.4	92.4	66.2	1002.0	1006.8	996.0	53	360	1	5	14	1
Tue May 19 23:59:08 2009	1.9	0.6	11.6	15.0	9.1	83.6	92.3	66.2	1008.7	1012.3	1006.7	96	360	1	3	11	0
Wed May 20 23:59:08 2009	1.8	11.2	11.4	14.6	9.4	87.6	92.3	73.9	1012.9	1013.7	1012.3	104	360	1	3	10	0
Thu May 21 23:59:08 2009	1.4	1.0	11.1	15.8	6.4	80.0	95.7	54.8	1013.6	1014.2	1012.8	83	360	1	3	11	0
Fri May 22 23:59:08 2009	2.0	1.0	13.1	18.1	10.4	88.6	95.1	74.2	1012.2	1013.9	1011.0	66	360	1	3	12	0
Sat May 23 23:59:08 2009	1.6	1.6	12.5	16.5	8.4	77.5	95.9	44.8	1014.0	1018.3	1010.6	132	360	1	3	10	0
Sun May 24 23:59:08 2009	2.7	0.0	11.8	16.6	6.3	81.2	94.2	54.6	1018.3	1018.7	1017.6	127	360	1	3	11	0
Mon May 25 23:59:08 2009	2.2	2.2	12.0	16.0	8.2	86.5	95.3	67.7	1014.7	1018.1	1012.7	119	360	1	2	10	0
Tue May 26 23:59:07 2009	1.3	0.0	10.9	15.5	4.9	71.7	92.7	48.6	1017.5	1020.4	1015.1	89	360	1	4	14	0
Wed May 27 23:59:07 2009	2.7	4.2	14.6	18.9	9.5	84.4	93.9	71.7	1017.9	1025.0	1012.8	74	360	1	5	19	1
Thu May 28 23:59:07 2009	2.0	0.0	14.8	18.0	12.9	82.2	89.4	71.5	1028.1	1029.9	1024.9	70	360	1	3	7	0
Fri May 29 23:59:07 2009	1.7	0.0	13.7	17.4	11.3	86.1	93.2	74.6	1025.4	1028.9	1021.9	291	360	1	4	12	0
Sat May 30 23:59:07 2009	1.7	0.0	14.8	19.1	10.6	80.9	95.3	59.1	1021.8	1024.1	1020.0	284	360	1	3	7	0
Sun May 31 23:59:07 2009	2.4	0.0	15.0	21.3	8.5	75.0	94.7	50.5	1024.7	1025.6	1023.9	249	360	1	2	9	0
	64.4	**69.6**															

Date/time	EvapCalcDaily	PR_Sum24h	TA_24h	TA_24h	TA_24h	RH_24h	RH_24h	RH_24h	PA_24h	PA_24h	PA_24h	WD_24h	WD_24h	WD_24h	WS_24h	WS_24h	WS_24h
	evap	PR_Sum24h	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Mon Jun 01 23:59:07 2009	2.8	0.0	16.2	23.0	8.8	74.5	93.4	54.3	1025.3	1025.8	1024.6	214	360	1	2	7	0
Tue Jun 02 23:59:08 2009	2.9	0.0	17.9	24.3	11.3	66.8	91.1	41.4	1025.2	1026.1	1023.9	191	360	1	1	6	0
Wed Jun 03 23:59:08 2009	3.4	0.0	17.3	23.5	12.4	74.6	89.4	54.8	1021.1	1023.9	1019.4	223	360	1	2	7	0
Thu Jun 04 23:59:08 2009	3.1	0.0	14.5	18.8	9.9	80.8	92.2	66.2	1016.6	1019.4	1013.9	267	359	116	2	9	0
Fri Jun 05 23:59:08 2009	1.9	0.4	13.2	18.2	9.1	85.4	95.9	68.2	1008.6	1013.9	1005.2	217	360	1	1	9	0
Sat Jun 06 23:59:07 2009	1.3	6.6	9.4	15.0	6.0	77.3	91.6	41.3	1002.3	1006.3	998.4	167	349	14	4	13	0
Sun Jun 07 23:59:07 2009	2.8	0.4	11.2	16.4	7.8	79.3	92.6	54.7	1002.3	1003.9	999.6	166	360	1	2	11	0
Mon Jun 08 23:59:07 2009	1.9	0.0	12.2	16.4	8.5	77.3	89.6	58.0	1003.3	1004.9	1002.8	246	360	1	3	12	0
Tue Jun 09 23:59:07 2009	2.2	8.8	11.5	14.8	9.6	86.6	93.5	75.1	1007.7	1010.5	1004.9	237	360	1	2	6	0
Wed Jun 10 23:59:07 2009	0.8	4.8	12.9	18.1	9.5	76.7	92.8	50.9	1010.1	1013.8	1008.8	199	360	1	2	6	0
Thu Jun 11 23:59:08 2009	2.0	0.2	12.0	17.3	6.9	71.8	90.7	46.5	1017.3	1018.9	1013.8	187	360	1	2	7	0
Fri Jun 12 23:59:08 2009	2.6	6.4	15.1	18.5	11.9	84.4	96.1	68.1	1015.5	1017.5	1014.6	217	360	1	3	9	0
Sat Jun 13 23:59:08 2009	2.1	1.0	15.1	17.9	12.8	85.3	92.8	73.6	1015.0	1015.8	1014.4	167	360	1	3	11	0
Sun Jun 14 23:59:08 2009	1.9	0.0	15.0	17.8	11.7	83.2	94.3	66.7	1015.2	1015.9	1014.4	165	360	1	3	9	0
Mon Jun 15 23:59:08 2009	2.0	9.4	15.2	19.2	12.5	83.5	93.9	62.9	1013.9	1016.7	1012.9	179	360	1	2	10	0
Tue Jun 16 23:59:08 2009	2.0	0.0	14.9	19.5	10.1	81.7	94.8	63.4	1018.3	1019.7	1015.1	152	360	1	3	10	0
Wed Jun 17 23:59:08 2009	2.2	29.6	14.7	18.8	11.2	77.3	95.4	44.9	1011.3	1015.9	1007.2	116	360	1	5	14	1
Sat Jul 18 23:59:08 2009	4.0	6.6	14.4	17.8	11.6	82.6	94.6	68.3	1011.1	1015.4	1008.5	88	360	1	2	9	0
Fri Jun 19 23:59:07 2009	2.8	0.0	13.7	18.1	9.5	70.6	88.7	49.3	1023.1	1026.2	1018.7	99	360	2	4	13	0
Sat Jun 20 23:59:07 2009	3.2	0.0	15.5	20.8	11.1	71.6	84.6	52.7	1026.1	1027.8	1025.1	117	350	12	4	12	0
Sun Jun 21 23:59:07 2009	3.6	0.0	17.3	23.2	12.0	76.7	86.6	64.8	1025.9	1027.7	1025.1	113	360	1	3	9	0
Mon Jun 22 23:59:07 2009	2.7	0.0	18.9	23.0	14.9	80.2	92.4	63.9	1026.7	1027.3	1025.9	232	360	1	2	7	0
Tue Jun 23 23:59:07 2009	2.1	0.0	17.8	23.8	12.8	83.4	95.7	62.3	1025.2	1027.1	1022.3	287	360	1	2	7	0
Wed Jun 24 23:59:07 2009	2.4	0.0	16.5	20.4	12.3	79.5	94.4	63.2	1018.3	1022.3	1014.9	281	360	127	3	11	0
Thu Jun 25 23:59:07 2009	2.6	0.0	16.3	20.5	12.0	78.2	89.2	62.9	1011.5	1014.9	1009.3	252	359	4	2	10	0
Fri Jun 26 23:59:08 2009	2.6	0.0	17.1	21.4	14.3	82.6	93.4	60.8	1009.9	1012.2	1008.2	276	360	1	2	6	0
Sat Jun 27 23:59:08 2009	2.4	0.4	17.7	21.4	15.2	82.8	94.5	65.7	1012.6	1013.3	1012.0	305	360	1	3	8	0
Sun Jun 28 23:59:08 2009	2.5	9.6	16.2	19.2	14.0	89.5	95.1	75.9	1010.6	1012.3	1008.8	273	360	1	4	12	0
Mon Jun 29 23:59:08 2009	1.5	0.0	15.8	20.4	10.9	84.5	96.1	66.4	1014.1	1015.6	1012.0	239	360	1	2	6	0
Tue Jun 30 23:59:07 2009	1.9	7.4	17.2	19.5	15.7	90.8	95.9	84.7	1016.0	1018.7	1014.3	299	360	1	3	10	0
	72.0	**91.6**															

Date/time	EvapCalcDaily	PR_Sum24h	TA_24h	TA_24h	TA_24h	RH_24h	RH_24h	RH_24h	PA_24h	PA_24h	PA_24h	WD_24h	WD_24h	WD_24h	WS_24h	WS_24h	WS_24h
	evap	PR_Sum24h	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Wed Jul 01 23:59:07 2009	1.1	9.8	17.4	18.7	16.3	94.5	96.3	89.8	1017.9	1018.8	1017.2	258	360	1	2	7	0
Thu Jul 02 23:59:07 2009	0.6	17.6	17.5	19.3	16.5	94.1	96.5	85.9	1013.7	1017.4	1010.2	289	360	1	3	9	1
Fri Jul 03 23:59:07 2009	0.9	1.8	17.1	20.1	14.5	82.9	94.6	63.1	1008.8	1010.4	1007.5	130	360	1	3	11	0
Sat Jul 04 23:59:07 2009	2.5	13.2	16.4	19.5	13.9	78.1	95.4	54.7	1005.3	1007.6	1004.6	140	360	1	4	12	0
Sun Jul 05 23:59:07 2009	3.0	10.6	15.4	18.2	12.5	83.8	94.7	69.9	1001.5	1004.7	999.0	131	360	1	3	11	0
Mon Jul 06 23:59:07 2009	1.9	2.4	15.9	20.1	11.8	76.8	93.2	56.1	1002.1	1006.2	997.9	101	360	1	5	15	1
Tue Jul 07 23:59:07 2009	3.2	0.0	17.0	21.3	13.6	72.1	88.3	50.9	1009.0	1013.8	1006.2	115	191	23	4	14	0
Wed Jul 08 23:59:08 2009	3.9	0.2	15.6	20.1	12.4	73.0	90.9	49.2	1016.1	1018.7	1013.8	118	221	20	3	11	0
Thu Jul 09 23:59:08 2009	3.0	0.0	15.4	19.8	10.8	72.0	89.9	51.0	1018.1	1019.0	1016.9	108	351	16	2	7	0
Fri Jul 10 23:59:08 2009	2.4	7.6	14.7	16.9	12.4	91.0	95.5	79.4	1014.1	1017.5	1010.5	166	360	1	2	10	0
Sat Jul 11 23:59:08 2009	0.9	45.6	15.9	17.0	14.9	92.7	96.4	80.2	1003.8	1010.9	995.8	190	360	1	4	18	0
Sun Jul 12 23:59:07 2009	1.1	2.0	15.5	19.6	12.8	80.3	91.4	60.0	1002.2	1003.7	998.8	63	360	1	4	13	0
Mon Jul 13 23:59:07 2009	2.8	2.8	15.3	19.1	13.1	83.0	93.2	55.7	1000.1	1003.2	997.8	186	360	1	3	11	0
Tue Jul 14 23:59:07 2009	2.7	10.8	15.3	18.8	13.2	85.9	94.2	73.3	998.8	1000.8	997.3	286	360	1	3	10	0
Wed Jul 15 23:59:07 2009	1.6	0.2	16.4	22.2	11.8	75.8	94.4	51.0	1008.0	1015.2	999.8	92	356	13	3	9	0
Thu Jul 16 23:59:07 2009	3.1	7.2	14.6	20.9	10.5	79.7	94.3	41.3	1014.3	1015.8	1012.3	132	360	1	2	9	0
Fri Jul 17 23:59:08 2009	2.6	0.0	14.9	19.4	10.8	72.2	86.8	47.0	1014.5	1015.9	1012.5	122	207	26	5	17	1
Sat Jul 18 23:59:08 2009	4.0	6.6	14.4	17.8	11.6	82.6	94.6	68.3	1011.1	1015.4	1008.5	88	360	1	2	9	0
Sun Jul 19 23:59:08 2009	1.5	0.0	15.2	19.4	11.9	76.4	92.2	49.3	1008.5	1012.0	1005.7	96	360	1	3	11	0
Mon Jul 20 23:59:08 2009	3.0	0.0	14.4	18.9	9.6	81.4	94.9	59.3	1010.4	1012.2	1005.0	160	360	1	2	9	0
Tue Jul 21 23:59:08 2009	2.2	18.6	15.8	18.6	13.8	85.9	96.0	66.0	994.9	1005.0	990.1	197	360	1	5	14	1
Wed Jul 22 23:59:08 2009	2.3	0.4	16.2	19.8	12.9	81.7	94.5	63.1	993.3	996.1	989.7	60	360	1	4	10	0
Thu Jul 23 23:59:08 2009	2.5	10.2	14.7	18.3	12.1	84.2	93.1	63.3	998.7	1002.7	995.4	60	360	1	3	11	0
Fri Jul 24 23:59:07 2009	2.0	4.8	15.0	20.1	10.7	81.3	95.1	57.9	1008.4	1016.8	1002.7	85	360	1	2	10	0
Sat Jul 25 23:59:07 2009	2.1	5.4	15.3	19.5	10.6	85.2	95.6	64.2	1017.0	1018.5	1012.1	158	360	1	3	13	0
Sun Jul 26 23:59:07 2009	2.2	11.4	15.6	17.8	13.6	82.8	95.5	69.6	1007.4	1012.1	1006.1	93	360	1	5	16	1
Mon Jul 27 23:59:07 2009	2.1	1.4	14.7	19.0	11.9	79.4	91.5	58.3	1008.5	1009.9	1006.4	65	360	1	3	11	1
Tue Jul 28 23:59:07 2009	2.6	9.2	14.6	16.3	12.7	88.9	94.4	79.1	1006.8	1009.4	1004.7	71	360	1	4	14	0
Wed Jul 29 23:59:07 2009	1.2	1.6	13.9	19.3	10.0	83.3	96.7	58.0	1007.8	1013.0	1005.2	123	360	1	2	9	0
Thu Jul 30 23:59:08 2009	1.9	0.2	13.8	18.7	9.0	76.3	92.8	51.8	1017.1	1019.2	1013.0	74	360	1	3	11	0
Fri Jul 31 23:59:08 2009	2.7	29.0	14.6	15.5	13.0	90.1	95.4	77.2	1009.9	1018.0	1004.1	223	360	1	5	15	0
	69.5	**230.6**															

Date/time	EvapCalcDaily	PR_Sum24h	TA_24h	TA_24h	TA_24h	RH_24h	RH_24h	RH_24h	PA_24h	PA_24h	PA_24h	WD_24h	WD_24h	WD_24h	WS_24h	WS_24h	WS_24h
	evap	PR_Sum24h	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Sat Aug 01 23:59:08 2009	1.3	0.0	14.7	18.7	11.1	77.7	94.4	49.6	1006.6	1010.1	1004.5	91	351	3	3	13	0
Sun Aug 02 23:59:08 2009	0.0	9.8	14.1	16.3	10.9	0.0	0.0		0.0	0.0		0	360	0	0	0	0
Mon Aug 03 23:59:07 2009	1.8	15.4	15.4	16.5	14.3	92.7	95.8	85.1	1003.8	1004.8	1002.7	181	360	1	4	13	0
Tue Aug 04 23:59:07 2009	0.9	0.0	16.1	18.9	14.3	85.6	95.9	65.3	1005.8	1008.9	1003.3	82	360	1	4	11	0
Wed Aug 05 23:59:07 2009	2.2	0.0	16.1	19.4	13.6	80.1	91.1	66.5	1012.2	1016.0	1008.8	80	360	1	4	12	1
Thu Aug 06 23:59:07 2009	2.5	0.4	15.6	19.6	12.1	80.9	93.0	61.2	1017.4	1019.8	1015.7	133	360	1	2	8	0
Fri Aug 07 23:59:07 2009	2.1	0.0	14.2	19.6	9.7	80.6	95.4	54.5	1020.3	1020.9	1019.7	73	360	1	2	9	0
Sat Aug 08 23:59:08 2009	2.3	0.0	16.7	20.1	14.8	85.7	93.4	71.6	1018.6	1020.3	1017.7	104	360	1	3	9	0
Sun Aug 09 23:59:08 2009	1.9	8.4	15.8	18.9	14.0	90.7	94.8	79.2	1016.4	1018.9	1012.5	145	360	1	2	8	0
Mon Aug 10 23:59:08 2009	1.1	0.6	16.8	19.0	14.2	86.0	95.2	72.7	1012.7	1019.1	1009.3	101	360	1	3	9	0
Tue Aug 11 23:59:08 2009	1.6	0.0	18.4	**25.7**	14.1	80.9	90.7	61.3	1021.0	1022.3	1019.2	117	360	1	3	8	0
Wed Aug 12 23:59:08 2009	3.2	1.2	18.3	21.1	14.7	86.0	92.7	76.8	1019.5	1021.0	1018.5	94	358	2	3	7	0
Thu Aug 13 23:59:08 2009	1.5	0.0	15.5	19.2	11.4	81.7	93.2	64.8	1018.9	1019.8	1016.8	202	360	1	2	6	0
Fri Aug 14 23:59:08 2009	1.8	0.8	16.9	19.5	14.8	92.2	95.5	86.0	1012.1	1016.9	1008.7	81	360	1	3	9	0
Sat Aug 15 23:59:07 2009	1.0	3.6	17.6	21.2	13.6	80.9	94.0	61.1	1009.0	1013.4	1005.0	72	360	1	4	13	0
Sun Aug 16 23:59:07 2009	2.8	0.0	16.1	19.6	12.6	79.1	90.6	60.0	1013.6	1014.1	1012.9	70	360	2	3	9	0
Mon Aug 17 23:59:07 2009	2.5	0.0	16.6	20.6	14.5	83.2	91.5	65.7	1013.8	1014.7	1012.4	110	360	1	2	7	0
Tue Aug 18 23:59:07 2009	2.0	2.0	16.8	19.1	15.6	93.2	96.0	89.0	1010.9	1014.0	1008.8	189	360	1	4	12	0
Wed Aug 19 23:59:07 2009	0.8	16.8	17.2	19.5	16.1	94.1	96.2	86.1	1005.9	1008.8	1001.3	184	360	1	4	12	1
Thu Aug 20 23:59:07 2009	1.1	16.8	15.2	19.3	12.1	82.0	96.5	57.3	1005.7	1014.3	997.9	77	360	1	4	14	0
Fri Aug 21 23:59:08 2009	2.7	2.8	13.9	18.3	9.6	77.7	88.4	61.2	1016.1	1019.1	1014.1	67	360	1	3	10	0
Sat Aug 22 23:59:08 2009	2.2	1.2	13.4	18.2	7.0	89.0	96.3	67.3	1016.6	1019.4	1010.6	257	360	1	2	10	0
Sun Aug 23 23:59:08 2009	1.6	13.0	16.2	19.5	11.6	88.3	96.6	65.7	1005.4	1010.7	1002.7	123	360	1	4	15	0
Mon Aug 24 23:59:08 2009	2.1	1.8	13.7	17.7	9.9	80.9	95.1	59.0	1002.0	1005.1	1000.5	99	360	1	3	12	0
Tue Aug 25 23:59:08 2009	2.1	4.8	14.3	18.3	9.9	81.7	95.5	53.8	1002.9	1004.9	998.2	121	360	1	3	12	0
Wed Aug 26 23:59:08 2009	2.4	21.6	16.4	18.9	12.6	85.1	95.5	70.4	999.5	1009.6	992.6	122	360	1	5	16	0
Thu Aug 27 23:59:07 2009	2.0	3.2	13.7	18.0	9.7	85.0	95.9	58.0	1007.5	1010.1	1002.7	143	360	1	4	16	0
Fri Aug 28 23:59:07 2009	2.2	0.6	13.7	17.2	11.1	74.8	86.7	58.8	1013.6	1021.2	1007.8	94	204	5	5	15	1
Sat Aug 29 23:59:07 2009	2.8	0.0	13.1	17.8	8.1	80.9	94.5	63.5	1019.9	1021.4	1016.6	90	360	1	2	8	0
Sun Aug 30 23:59:07 2009	1.7	6.8	15.9	18.0	13.3	94.0	95.7	90.0	1010.4	1016.6	1006.2	98	360	1	3	12	0
Mon Aug 31 23:59:07 2009	0.6	20.8	15.4	17.7	12.4	89.7	96.1	74.0	1000.7	1006.3	997.9	68	360	1	4	13	1
	57.1	**152.4**															

Date/time	EvapCalcDaily	PR_Sum24h	TA_24h	TA_24h	TA_24h	RH_24h	RH_24h	RH_24h	PA_24h	PA_24h	PA_24h	WD_24h	WD_24h	WD_24h	WS_24h	WS_24h	WS_24h
	evap	PR_Sum24h	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Tue Sep 01 23:59:07 2009	1.5	4.4	14.0	18.0	11.8	81.3	92.8	58.2	1000.8	1005.8	998.6	59	360	1	3	11	0
Wed Sep 02 23:59:08 2009	2.4	19.8	13.5	17.4	12.0	89.3	96.3	75.5	998.1	1005.6	990.4	127	360	1	4	16	0
Thu Sep 03 23:59:08 2009	1.3	0.4	12.8	16.7	10.5	76.8	88.6	54.7	1002.2	1005.9	998.3	90	188	11	4	11	1
Fri Sep 04 23:59:08 2009	2.7	0.0	12.5	16.8	9.2	76.5	89.4	55.4	1012.3	1018.9	1005.9	93	360	5	4	16	1
Sat Sep 05 23:59:08 2009	2.6	0.0	13.6	16.8	10.0	78.6	88.7	63.8	1020.1	1021.2	1018.8	66	360	1	3	10	0
Sun Sep 06 23:59:08 2009	1.9	12.2	14.6	15.8	13.3	89.0	94.9	76.3	1013.8	1020.6	1008.5	148	360	1	4	13	0
Mon Sep 07 23:59:07 2009	1.3	7.2	14.3	16.9	11.1	88.2	96.0	71.8	1012.5	1015.7	1008.1	191	360	1	3	13	0
Tue Sep 08 23:59:07 2009	1.4	7.0	15.2	17.1	10.6	88.7	96.5	73.1	1011.8	1022.9	1006.2	81	360	1	4	13	0
Wed Sep 09 23:59:07 2009	1.4	0.0	12.9	19.3	7.5	77.9	95.7	51.2	1030.1	1034.8	1022.9	129	352	5	2	7	0
Thu Sep 10 23:59:07 2009	2.0	0.0	13.4	19.3	8.3	80.0	94.1	55.5	1036.3	1037.4	1034.8	214	360	1	2	8	0
Fri Sep 11 23:59:07 2009	1.9	0.0	13.4	19.4	8.3	80.6	94.3	54.3	1035.5	**1037.4**	1032.8	262	360	1	2	8	0
Sat Sep 12 23:59:07 2009	2.0	0.2	13.6	19.7	8.1	84.6	96.5	61.4	1030.7	1032.9	1028.9	216	360	2	1	6	0
Sun Sep 13 23:59:07 2009	1.6	0.2	13.2	20.6	7.7	87.2	96.8	58.4	1028.6	1029.7	1027.5	157	360	1	1	5	0
Mon Sep 14 23:59:08 2009	1.5	0.2	13.4	18.9	9.2	85.1	96.5	63.4	1028.1	1028.7	1027.3	202	360	1	1	5	0
Tue Sep 15 23:59:08 2009	1.3	0.0	13.0	17.3	9.1	75.8	87.2	58.3	1026.7	1028.3	1025.2	180	360	1	3	9	0
Wed Sep 16 23:59:08 2009	2.1	0.0	14.0	20.4	10.4	78.0	87.9	52.4	1025.3	1026.4	1024.0	197	345	1	3	9	0
Thu Sep 17 23:59:08 2009	2.7	0.0	12.1	16.8	9.1	74.0	86.3	54.9	1022.6	1025.2	1020.2	239	360	1	1	8	0
Fri Sep 18 23:59:08 2009	1.7	0.0	13.3	17.5	10.6	74.4	85.4	52.6	1016.5	1020.3	1014.1	172	360	1	1	5	0
Sat Sep 19 23:59:07 2009	1.5	0.6	13.1	16.5	8.0	82.6	93.6	60.9	1016.0	1021.5	1013.2	121	360	1	2	8	0
Sun Sep 20 23:59:07 2009	1.5	0.0	11.8	16.9	7.0	80.8	93.4	61.0	1023.3	1024.3	1021.5	88	360	1	2	7	0
Mon Sep 21 23:59:07 2009	1.6	0.0	14.9	17.7	12.4	83.1	93.3	68.2	1021.6	1023.8	1019.2	54	360	1	4	14	1
Tue Sep 22 23:59:07 2009	1.9	0.0	15.9	19.1	12.6	77.6	93.3	55.1	1020.8	1023.6	1018.4	73	360	1	3	10	0
Wed Sep 23 23:59:07 2009	2.6	0.0	14.3	19.8	9.9	79.3	90.4	53.9	1024.4	1026.1	1023.2	98	360	1	2	7	0
Thu Sep 24 23:59:08 2009	2.0	0.0	12.1	18.3	7.0	81.0	95.9	53.4	1026.5	1027.6	1025.4	83	360	1	1	6	0
Fri Sep 25 23:59:08 2009	1.5	0.0	14.2	19.8	9.8	82.5	93.9	60.9	1026.5	1027.7	1025.3	96	360	1	2	7	0
Sat Sep 26 23:59:08 2009	1.6	0.0	14.0	16.0	12.3	86.3	92.4	78.3	1027.3	1027.9	1026.6	128	360	1	1	4	0
Sun Sep 27 23:59:08 2009	0.7	0.0	15.1	18.8	12.8	83.5	91.9	66.2	1028.2	1029.3	1027.2	112	359	4	2	5	0
Mon Sep 28 23:59:08 2009	1.3	0.0	14.8	18.3	13.0	81.8	88.1	67.4	1028.0	1029.4	1026.6	116	221	13	2	7	0
Tue Sep 29 23:59:08 2009	1.7	0.0	14.1	17.9	11.8	80.8	91.8	63.5	1024.3	1026.8	1022.4	124	360	1	2	7	0
Wed Sep 30 23:59:08 2009	1.5	0.0	13.7	16.7	11.6	81.2	92.3	62.6	1020.7	1022.7	1019.0	109	213	21	2	7	0
	52.8	**52.2**															

Date/time	EvapCalcDaily evap	PR_Sum24h PR_Sum24h	TA_24h Avg	TA_24h Max	TA_24h Min	RH_24h Avg	RH_24h Max	RH_24h Min	PA_24h Avg	PA_24h Max	PA_24h Min	WD_24h Avg	WD_24h Max	WD_24h Min	WS_24h Avg	WS_24h Max	WS_24h Min
Thu Oct 01 23:59:07 2009	1.5	0.0	12.8	14.8	11.0	78.8	94.1	60.1	1021.5	1023.7	1019.1	142	292	27	2	8	0
Fri Oct 02 23:59:07 2009	1.5	0.0	13.0	17.7	10.5	78.7	90.1	68.7	1020.3	1023.3	1014.6	85	175	1	3	7	0
Sat Oct 03 23:59:07 2009	1.6	0.0	13.0	16.7	10.4	81.5	92.0	66.7	1009.3	1014.6	1007.2	84	359	1	4	14	0
Sun Oct 04 23:59:07 2009	1.9	0.0	11.5	15.8	8.9	79.5	91.2	52.5	1010.6	1011.6	1009.9	108	360	1	1	4	0
Mon Oct 05 23:59:07 2009	1.2	0.2	12.3	16.3	8.4	86.1	95.6	67.9	1006.5	1009.9	1002.5	275	360	1	2	7	0
Tue Oct 06 23:59:07 2009	1.2	0.0	14.0	17.0	8.1	93.5	96.8	79.9	1000.0	1008.1	996.8	181	360	1	3	11	0
Wed Oct 07 23:59:07 2009	1.2	0.0	8.1	13.0	6.1	77.2	88.2	63.5	1011.4	1013.7	1009.8	139	236	123	1	3	0
Thu Oct 08 23:59:07 2009	0.0	0.0	10.8	14.3	7.8												
Fri Oct 09 23:59:07 2009	0.9	0.2	13.7	18.3	10.6	81.6	94.6	68.2	1008.7	1016.1	1004.5	199	360	1	4	15	0
Sat Oct 10 23:59:07 2009	0.9	0.2	12.5	18.1	7.7	86.0	97.2	58.5	1014.5	1017.7	1009.7	72	224	1	1	5	0
Sun Oct 11 23:59:07 2009	1.9	0.0	14.5	18.3	9.7	84.6	93.4	59.9	1017.5	1024.7	1014.1	99	360	1	3	12	0
Mon Oct 12 23:59:07 2009	2.0	0.0	10.7	15.7	5.3	87.4	97.0	69.0	1028.0	1029.3	1024.6	155	360	1	1	7	0
Tue Oct 13 23:59:07 2009	0.8	0.0	13.5	16.0	11.7	89.9	95.5	81.3	1028.7	1029.5	1028.0	154	360	1	1	6	0
Wed Oct 14 23:59:07 2009	0.6	0.0	13.2	14.1	12.2	85.4	92.6	80.6	1028.5	1030.3	1027.2	257	360	1	1	4	0
Thu Oct 15 23:59:07 2009	0.6	0.0	13.2	18.1	10.1	86.3	95.0	65.2	1031.9	1033.5	1030.3	252	360	79	1	4	0
Fri Oct 16 23:59:07 2009	0.7	0.0	12.7	14.0	8.6	84.7	92.0	72.3	1034.0	1035.0	1033.3	164	360	1	1	5	0
Sat Oct 17 23:59:08 2009	0.6	0.0	10.2	14.1	6.0	87.6	95.9	76.0	1029.7	1033.9	1025.3	248	360	1	2	6	0
Sun Oct 18 23:59:08 2009	0.7	0.2	12.7	13.9	11.7	88.8	93.6	83.0	1020.0	1025.4	1014.0	116	360	1	2	7	0
Mon Oct 19 23:59:08 2009	0.7	5.4	12.9	14.0	12.2	83.3	91.6	73.1	1001.7	1014.0	986.7	228	360	1	5	19	0
Tue Oct 20 23:59:08 2009	1.5	10.7	12.2	15.2	9.9	82.8	93.5	67.1	983.8	986.8	981.9	229	360	1	4	20	0
Wed Oct 21 23:59:08 2009	1.6	11.5	12.6	15.1	9.4	85.3	91.0	68.0	981.0	982.9	979.6	311	360	1	6	16	1
Thu Oct 22 23:59:07 2009	1.9	2.0	12.7	15.9	10.0	86.1	91.4	68.3	987.6	997.2	981.3	182	360	1	2	10	0
Fri Oct 23 23:59:07 2009	1.3	2.4	12.0	14.9	8.2	93.8	96.5	84.7	1000.2	1001.9	997.2	235	360	1	2	8	0
Sat Oct 24 23:59:07 2009	0.5	10.2	14.3	15.7	11.9	83.5	96.7	59.8	997.5	1005.0	992.3	119	360	1	6	22	1
Sun Oct 25 23:59:07 2009	2.3	0.0	12.6	16.4	9.1	80.0	89.9	60.1	1008.9	1013.5	1005.0	77	360	1	3	12	0
Mon Oct 26 23:59:07 2009	2.0	2.0	11.4	15.0	6.6	95.2	97.1	88.9	1012.9	1013.7	1012.0	273	360	1	2	8	0
Tue Oct 27 23:59:07 2009	0.4	7.0	14.9	15.3	13.8	92.9	97.2	88.0	1007.3	1012.0	1004.3	239	360	1	5	16	1
Wed Oct 28 23:59:08 2009	0.7	0.2	14.8	16.0	13.7	90.3	96.4	84.0	1011.8	1013.5	1008.2	182	360	1	3	11	1
Thu Oct 29 23:59:08 2009	0.8	0.4	14.9	15.3	14.4	95.6	97.0	93.2	1011.8	1013.0	1010.0	322	360	1	5	11	2
Fri Oct 30 23:59:08 2009	0.5	20.0	15.2	15.8	13.8	94.7	97.1	89.9	1009.2	1012.3	1006.7	224	360	1	5	15	0
Sat Oct 31 23:59:08 2009	0.6	4.6	14.7	17.0	13.3	89.5	95.6	79.2	1014.1	1016.2	1010.2	68	360	1	3	11	0
	34.4	**77.2**															

Date/time	EvapCalcDaily	PR_Sum24h	TA_24h	TA_24h	TA_24h	RH_24h	RH_24h	RH_24h	PA_24h	PA_24h	PA_24h	WD_24h	WD_24h	WD_24h	WS_24h	WS_24h	WS_24h
	evap	PR_Sum24h	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Sun Nov 01 23:59:08 2009	1.1	30.2	10.8	14.3	6.9	86.0	96.6	60.7	998.2	1010.2	992.6	150	360	1	4	15	0
Mon Nov 02 23:59:08 2009	1.8	1.6	9.4	11.9	6.8	87.2	93.6	77.8	997.6	1001.9	992.4	83	360	1	3	10	0
Tue Nov 03 23:59:07 2009	0.8	2.6	10.4	12.7	7.0	79.8	92.5	63.2	986.7	992.4	984.4	81	166	5	5	13	1
Wed Nov 04 23:59:07 2009	1.7	6.6	9.0	12.7	6.8	82.0	90.8	71.9	986.8	992.9	984.1	94	314	6	5	16	0
Thu Nov 05 23:59:07 2009	1.4	0.2	8.7	11.2	6.6	78.8	89.1	66.7	998.9	1003.7	993.0	107	360	1	4	13	0
Fri Nov 06 23:59:07 2009	1.4	9.0	9.1	12.6	5.4	82.6	95.4	55.7	998.0	1003.9	994.7	104	360	1	3	15	0
Sat Nov 07 23:59:07 2009	1.7	6.0	7.7	11.1	4.4	82.5	91.5	71.7	993.0	998.7	988.9	87	360	1	5	16	0
Sun Nov 08 23:59:07 2009	1.2	0.0	9.8	12.9	7.8	76.9	90.4	56.1	1010.0	1017.2	998.3	121	360	1	4	14	0
Mon Nov 09 23:59:08 2009	1.9	21.2	8.9	11.4	6.0	93.2	96.2	81.3	1015.1	1017.9	1008.8	207	360	1	2	11	0
Tue Nov 10 23:59:08 2009	0.5	0.0	8.2	11.5	4.2	84.8	95.7	70.1	1010.5	1012.1	1008.2	142	360	1	2	11	0
Thu Nov 12 23:59:08 2009	0.5	13.2	10.0	12.2	6.6	84.4	95.8	67.2	988.8	992.7	983.5	118	360	1	4	18	0
Fri Nov 13 23:59:08 2009	1.3	16.2	7.2	12.7	3.1	89.7	96.3	71.3	986.2	993.1	971.2	223	360	1	3	17	0
Sat Nov 14 23:59:07 2009	1.0	4.0	9.5	11.4	6.2	81.9	94.1	64.9	981.9	994.0	969.1	112	360	1	4	21	0
Sun Nov 15 23:59:07 2009	1.4	10.2	11.4	13.3	9.6	85.6	95.1	71.3	994.7	996.7	991.8	107	360	1	4	13	0
Mon Nov 16 23:59:07 2009	1.2	17.6	9.8	12.1	6.8	84.2	95.3	66.7	991.4	999.6	983.8	109	360	1	5	15	0
Tue Nov 17 23:59:07 2009	1.4	3.0	9.1	11.8	5.9	83.8	91.2	70.6	1000.6	1001.6	999.2	54	360	1	4	13	0
Wed Nov 18 23:59:07 2009	1.2	4.2	13.0	13.7	11.4	88.4	93.0	81.2	999.1	1001.8	996.0	48	360	1	8	21	2
Thu Nov 19 23:59:07 2009	1.2	**50.2**	13.4	13.7	12.3	92.8	94.0	90.9	993.4	998.2	991.1	86	360	1	8	22	1
Fri Nov 20 23:59:08 2009	0.7	0.0	11.0	13.1	8.5	84.7	92.0	66.3	1003.8	1010.9	991.3	126	360	1	3	13	0
Sat Nov 21 23:59:08 2009	1.3	8.9	12.0	13.6	9.1	84.4	96.2	67.4	995.5	1009.0	989.3	196	360	1	7	23	2
Sun Nov 22 23:59:08 2009	1.7	4.3	8.5	10.1	7.0	76.5	87.1	69.3	991.8	997.4	989.2	63	360	1	7	17	1
Mon Nov 23 23:59:08 2009	0.0	7.4	11.4	12.8	9.2								360				0
Tue Nov 24 23:59:08 2009	0.0	7.6	9.5	12.0	7.6	90.3	93.0	86.0	993.0	993.7	992.4	281	180	0	6	15	2
Wed Nov 25 23:59:08 2009	0.0	4.3	8.5	10.9	6.3	77.7	88.0	63.0	996.5	998.3	982.2	260	304	0	5	13	1
Thu Nov 26 23:59:07 2009	3.2	0.8	5.9	8.5	4.2	82.5	90.0	74.2	995.5	996.9	994.6	68	360	1	3	12	0
Fri Nov 27 23:59:07 2009	0.8	8.4	5.9	7.7	4.2	87.1	93.9	77.7	995.0	998.4	988.9	90	360	1	3	10	0
Sat Nov 28 23:59:07 2009	0.6	0.4	3.2	5.0	0.8	90.8	95.9	83.5	988.1	991.8	984.0	163	360	1	3	10	0
Sun Nov 29 23:59:07 2009	0.4	2.0	4.4	6.9	2.7	84.4	90.3	75.3	989.7	1001.5	983.5	145	219	72	7	18	1
Mon Nov 30 23:59:07 2009	1.0	0.0	3.0	6.5	-0.2	83.6	95.2	67.0	1009.0	1012.8	1001.5	151	360	1	3	12	0
	32.3	**240.1**															

Date/time	EvapCalcDaily	PR_Sum24h	TA_24h	TA_24h	TA_24h	RH_24h	RH_24h	RH_24h	PA_24h	PA_24h	PA_24h	WD_24h	WD_24h	WD_24h	WS_24h	WS_24h	WS_24h
	evap	PR_Sum24h	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
Tue Dec 01 23:59:08 2009	0.8	17.6	7.0	11.2	0.0	86.8	96.8	69.7	1000.1	1011.4	993.5	196	360	1	4	18	0
Wed Dec 02 23:59:08 2009	1.1	10.8	8.8	10.3	7.5	87.7	91.8	82.1	989.6	997.3	985.1	150	360	1	3	13	1
Thu Dec 03 23:59:08 2009	0.7	1.2	5.1	7.6	3.3	83.0	87.7	70.9	1003.3	1006.8	997.3	114	360	1	3	12	0
Fri Dec 04 23:59:08 2009	0.9	8.0	8.1	11.2	4.2	93.1	96.2	84.8	999.6	1006.7	990.6	194	360	1	2	11	0
Sat Dec 05 23:59:07 2009	0.5	18.6	9.6	12.0	7.7	87.6	94.7	73.2	986.7	991.6	980.5	115	360	1	5	17	1
Sun Dec 06 23:59:07 2009	1.1	3.8	7.4	9.0	5.5	80.8	87.4	68.7	987.6	992.8	982.0	53	360	1	4	15	1
Mon Dec 07 23:59:07 2009	1.2	3.6	7.0	9.0	4.7	83.5	90.0	73.3	991.8	1002.4	983.4	83	360	1	4	15	0
Tue Dec 08 23:59:07 2009	1.0	7.6	10.0	12.1	5.4	86.9	95.3	75.4	1000.7	1005.3	997.0	122	360	1	5	15	0
Wed Dec 09 23:59:07 2009	1.0	5.4	9.2	11.0	5.7	88.2	92.1	79.8	1010.9	1019.5	1005.3	60	360	1	3	12	0
Thu Dec 10 23:59:07 2009	0.6	0.4	6.3	10.1	1.0	93.0	97.8	87.4	1024.8	1026.9	1019.5	252	360	1	2	9	0
Fri Dec 11 23:59:08 2009	0.3	0.0	9.9	10.7	8.7	86.6	89.9	82.2	1026.0	1028.0	1024.9	300	360	1	5	11	2
Sat Dec 12 23:59:08 2009	0.9	0.0	8.2	9.0	5.8	79.8	85.4	70.1	1029.5	1030.8	1027.9	290	360	1	4	10	0
Sun Dec 13 23:59:08 2009	1.2	0.0	4.7	8.3	2.1	84.8	93.3	71.1	1029.6	1031.1	1027.9	259	360	1	1	7	0
Mon Dec 14 23:59:08 2009	0.4	0.0	3.7	6.9	0.6	87.4	94.8	80.6	1024.6	1028.0	1020.4	133	359	5	2	8	0
Tue Dec 15 23:59:08 2009	0.4	0.8	6.7	8.8	3.9	87.2	93.1	79.1	1017.9	1020.4	1016.9	159	349	17	3	8	0
Wed Dec 16 23:59:08 2009	0.6	0.0	5.0	7.6	3.1	87.3	92.6	74.3	1014.1	1018.3	1010.1	142	360	1	2	7	0
Thu Dec 17 23:59:07 2009	0.6	0.2	4.4	6.3	1.4	84.8	93.3	77.0	1015.4	1020.7	1010.2	184	357	1	3	11	0
Fri Dec 18 23:59:07 2009	0.6	0.0	0.5	2.2	-0.9	76.9	88.4	67.4	1021.7	1022.4	1020.8	163	266	13	3	9	0
Sat Dec 19 23:59:07 2009	0.7	0.6	2.6	6.5	-1.5	84.2	92.6	72.9	1013.5	1021.4	1004.9	99	285	29	3	11	0
Sun Dec 20 23:59:07 2009	0.6	0.0	1.1	4.1	-0.9	87.5	93.3	71.9	1001.1	1005.9	994.6	92	360	2	2	9	0
Mon Dec 21 23:59:07 2009	0.5	0.2	-0.3	4.2	-3.2	92.9	97.3	80.6	987.7	994.6	984.3	102	360	1	1	5	0
Tue Dec 22 23:59:08 2009	0.1	0.2	-0.5	4.9	-3.4	93.3	98.0	77.3	985.7	986.6	984.4	110	360	1	1	4	0
Wed Dec 23 23:59:08 2009	0.2	2.2	0.4	3.2	-2.7	94.1	97.9	87.5	983.7	986.0	982.2	202	360	1	1	7	0
Thu Dec 24 23:59:08 2009	0.1	0.0	1.2	5.4	-1.1	89.3	95.0	75.7	987.0	992.6	984.0	108	360	1	2	5	0
Fri Dec 25 23:59:08 2009	0.4	10.6	1.9	8.1	**-4.6**	93.0	97.2	83.4	993.1	994.3	990.8	179	360	1	2	13	0
Sat Dec 26 23:59:08 2009	0.3	3.6	5.0	8.4	1.0	87.2	97.2	75.1	991.7	993.1	989.8	88	360	1	3	13	0
Sun Dec 27 23:59:08 2009	0.6	0.4	4.0	6.9	-1.3	84.6	96.2	73.5	1000.9	1004.5	991.5	125	360	1	3	15	0
Mon Dec 28 23:59:08 2009	0.6	2.2	3.7	7.6	-1.7	90.1	97.3	76.6	997.3	1002.5	991.3	245	360	3	3	15	0
Tue Dec 29 23:59:07 2009	0.6	31.6	4.5	5.9	3.3	92.2	94.8	89.1	986.7	991.3	984.5	246	352	127	6	19	1
Wed Dec 30 23:59:07 2009	0.4	33.0	5.4	7.9	3.8	91.8	96.3	87.9	984.0	990.3	982.0	239	339	138	6	18	1
Thu Dec 31 23:59:07 2009	0.5	9.2	3.1	5.2	-0.3	81.4	93.2	67.8	1000.8	1006.3	990.4	208	356	1	6	21	0
	19.6	**171.8**															

Appendix E

Ambient Noise Survey 2009

Annual Ambient Noise Survey Report

at

EAST CORK LANDFILL SITE,
ROSSMORE,
CARRIGTWOHILL,
COUNTY CORK.

EPA Waste Licence Ref. No: W0022-1.

Prepared by:-

Cork County Councils,
Environmental Dept.,
Inniscarra Waterworks,
Inniscarra,
County Cork.

Nov 2009

Comhairle Contae Chorcai
Cork County Council,
Environmental Dept,
Test Report,
Inniscarra Waterworks,
Inniscarra,
County Cork.
Phone: (021) 4532700
Fax: (021) 4522777

Report Ref. No:T005

Report Issued To: Ms. Lisa Collins,
Envir. Officer,
East Cork Landfill,
Rossmore,
Carrigtwohill,
Co. Cork.

Sampling Locn.: East Cork Landfill Site **Waste Licence Ref :**W0022-1

Address: Rossmore, Carrigtwohill, Co.Cork.

This report relates only to this item.

This report shall not be reproduced except in full and only with the approval of the testing laboratory.

Report By:____________________________ **Date:**_______________

Andrew Mc Donnell,
Executive Scientist,
Environmental Directorate.

Executive Summary

An Environmental noise assessment was undertaken to assess the noise emissions from East Cork Landfill site, Rossmore, Carrigtwohill, Co. Cork.

The landfill site was not operational for the collection of waste throughout the survey periods.

A summary of the results along with pertinent limit value stipulated in Schedule G of Environmental Protection Agency Waste Licence (Ref. No. W 0022-1) at each of the six monitoring locations is presented below.

Summary of Criteria and Noise Monitoring Results

Position Ref:	Measured Leq (dBA)	Pertinent Limit Value Leq (dBA)
GG4	34	55
GG1	43	55
N4	51	55
N5	45	55
N3	44	55
N1	37	55

The results of the noise monitoring survey indicated compliance with noise emission limit values for the facility stipulated in Schedule G of Waste Licence (Ref. No. W 0022-1) at each of the six identified noise monitoring locations.

The facility is closed during night-time hours and does not contribute to noise levels in the area.

CONTENTS

Page No

1. INTRODUCTION

1.1. A noise survey was conducted at East Cork Landfill site, Rossmore, Carrigtwohill, Co. Cork on the 4^{th} , 25^{th} and 26^{th} June 2009 by the Environmental Dept. of Cork County Council.

The aim of the survey was to assess the noise impact at six locations in the vicinity of the landfill site and to determine if recorded levels were in compliance with noise limits specified in Waste licence (Ref No.:W0022-1), which pertains to this facility.

The landfill site was not operational for the collection of waste throughout the survey periods.

The weather during the monitoring periods was dry and sunny with wind speed measured at < 2m/s from a South Eastery direction on 4^{th} and 25^{th} June and South Westerly direction on the 26^{th} June 2009.

The temperature during the monitoring periods varied between 19^{o}C and 22^{o}C

The instrumentation was manned throughout the sampling intervals and comments were recorded in order to aid the interpretation of results.

2. LOCATION

2.1.The East Cork landfill site is located to the south of Rossmore Bay,Rossmore, Carrigtwohill, Co. Cork. The site is surrounded by agricultural land on a peninsula jutting out into the North Channel of Cork Harbour.

2.2. As required by Schedule F of waste licence ref no:W0022-1, Five noise monitoring locations were identified and one noise sensitive location. The locations of the stations are outlined in Table 2 and indicated in figure 4.1.

Table 2.1 Noise Monitoring Stations

MONITORING LOCATION.	***Location***
GG4	This monitoring location is located on the southern end of the site.
GG1	This monitoring location is located on the north western end of the site.
N4	This monitoring location is located next to the entrance gate directly to the north of the landfill site.
N5	This location is located at the north western boundary of the site. The landfill site is not visible from this location
N3	This location is to the east of the landfill with a line of sight to the bay. The landfill site is not visible from this location.
N1 (Noise sensitive location)	This noise sensitive location is a residential house. The landfill site is not visible from this monitoring location.

3. NOISE SURVEY

3.1. The noise survey was conducted on 4th, 25th and 26th June, 2009. The landfill site was not operational for the collection of waste during the monitoring periods.

3.2. The weather during the monitoring periods was dry and sunny with wind speed measured at < 2m/s from a South Easterly direction on 4th and 25th June and South Westerly direction on 26th June, 2009.

3.3. The survey was carried out using a Bruel & Kjaer 2260 sound level meter with enhanced sound analysis BZ7202. The instrument was calibrated before and after the survey using a known pure tone noise source. Following completion of the survey recorded data was uploaded to the computer for subsequent analysis using Bruel and Kjaer evaluator type 7820 software.

Table 3.1

Equipment	Monitor	Bruel & Kjaer type 2260 Seriel Number:2001683 *Certificate of Calibration issued by*: Bruel & Kjaer UK Ltd *Certificate Number*: C0900254
	Application Module	Enhanced Sound Analysis BZ7202
	Microphone	Bruel & Kjaer type:4189 Seriel Number: 2021258
	Time Weight.	Fast
	Freq. Weight.	'A' and 'L'
	Calibrator	Bruel & Kjaer type: 4231 Serial Number: 2094795 *Certificate of Calibration Issued by*: Bruel & Kjaer UK Ltd. *Certificate Number*: C0900242
	Software	Bruel & Kjaer Evaluator type 7820 version 4.3

3.4. 30 minute monitoring levels were recorded at stations GG4, GG1, N4, N5, N3 and Noise sensitive location N1. (See figure 4.1)

3.5. All measurements were made in accordance with *“ International standards organisation ISO 1996. Acoustics-description and measurement of Environmental noise Parts 1,2 and 3”*

4.0 NOISE SURVEY RESULTS – Arising from ambient noise monitoring conducted on 4th , 25th and 26th June, 2009.

4.1 Sampling Results

Table 4.1

Sampling Date	Sampling Location	Sampling Interval	L_{Aeq} (dB)	L_{A90} (dB)	L_{A10} (dB)	Sampling Notes
26/6/09	**GG4**	1437-1507	34	28	37	During the monitoring period no noise was audible from the landfill site. The general noise during the monitoring period was background rural noise with birds singing and what appeared to be noise from strimmers being operated in distance. Plane noise @14:52.
26/6/09	**GG1**	1359-1429	43	31	40	The dominant noise source at this location was noise from tractor operating in adjacent field. Plane noise @ 14:16. No noise audible from Landfill site.
25/6/09	**N4**	1306-1336	51	42	56	The dominant noise at this location was noise from vehicles entering and leaving the adjacent civic amenity site. Intermittant noise also from people talking, banging and birdsong in the vicinity of the monitoring Location. Plane noise @ 13:14. No noise audible from landfill site.

4.1 Sampling Results ctd:

Table 4.1 :

Sampling Date	Sampling Location	Sampling Interval	L_{Aeq} (dB)	L_{A90} (dB)	L_{A10} (dB)	Sampling Notes
4/6/09	**N5**	1526 - 1556	45	41	48	During the monitoring period noise was audible from an adjacent quarry. Noise also audible intermittently from road traffic entering the civic amenity site. No noise audible from landfill site.
4/6/09	**N3**	1448-1518	44	34	45	The dominant noise at this location was background rural noise with birds singing. 2 cars passed monitoring location during monitoring period. Bang in distance at 1450 hours, Plane noise at 1455 hours. No noise audible from Landfill site.
26/6/09	**N1 (Noise sensitive location)**	1526-1556	37	29	40	No noise from the landfill was audible at this location. The predominant noise was background rural noise with birds singing.

4.2 Sampling Results – 1/3 Octave frequency levels

Table 4.2 ctd:

Ref. N°.	Sampling Location	Octave bands (Hz) Sound Pressure Levels dB (unweighted) per band									L_{Aeq} (dB)	L_{A90} (dB)	L_{A10} (dB)
		31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**			
1	**GG4**	46	44	34	27	23	22	18	19	6	34	28	37
2	**GG1**	53	49	43	41	37	32	26	21	14	43	31	40
3	**N4**	63	58	47	44	42	39	39	39	30	51	42	56
4	**N5**	59	56	48	39	36	33	31	24	13	45	41	48
5	**N3**	63	56	45	39	35	32	30	31	28	44	34	45
6	**N1**	61	51	39	28	23	23	23	19	15	37	29	40

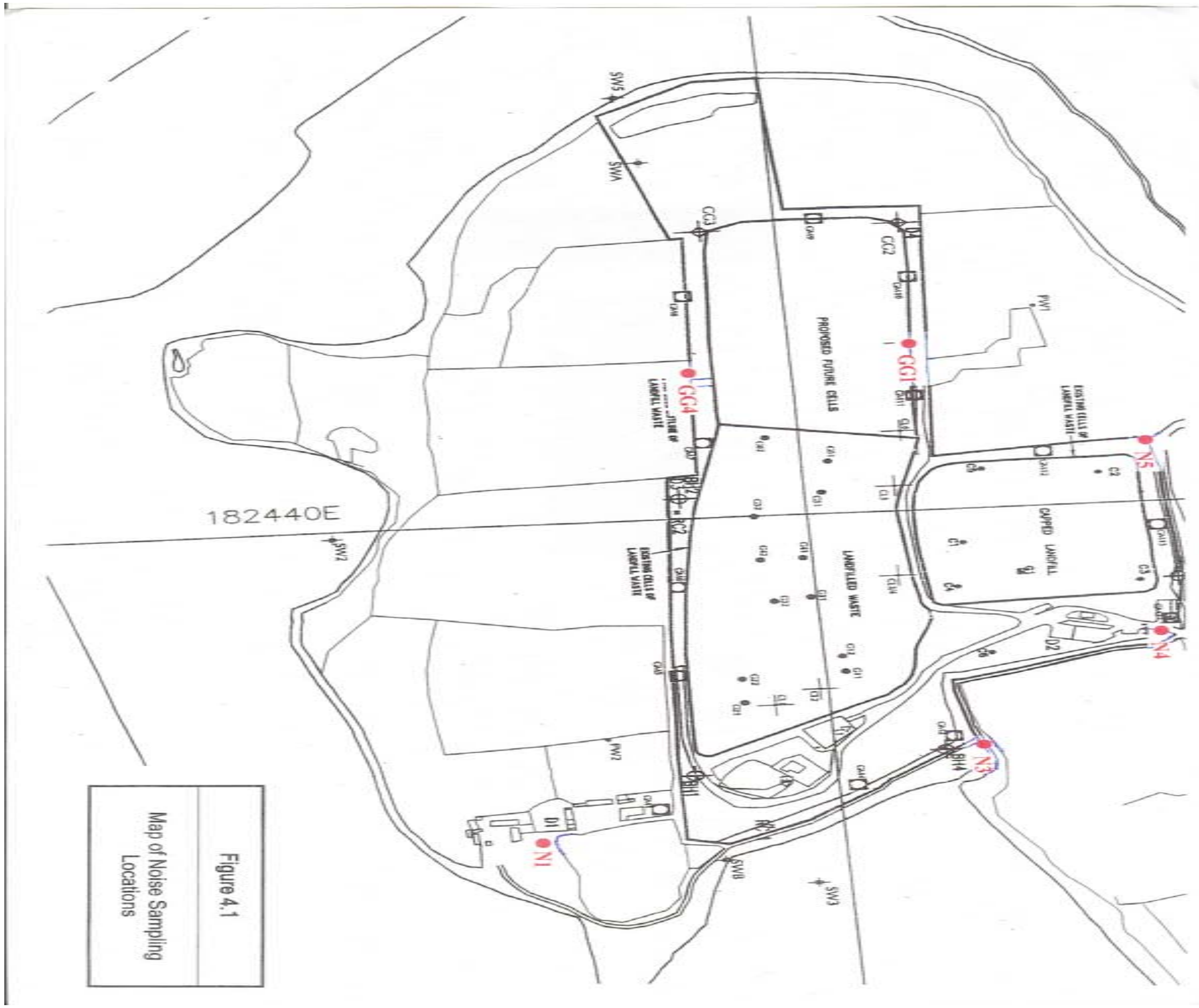
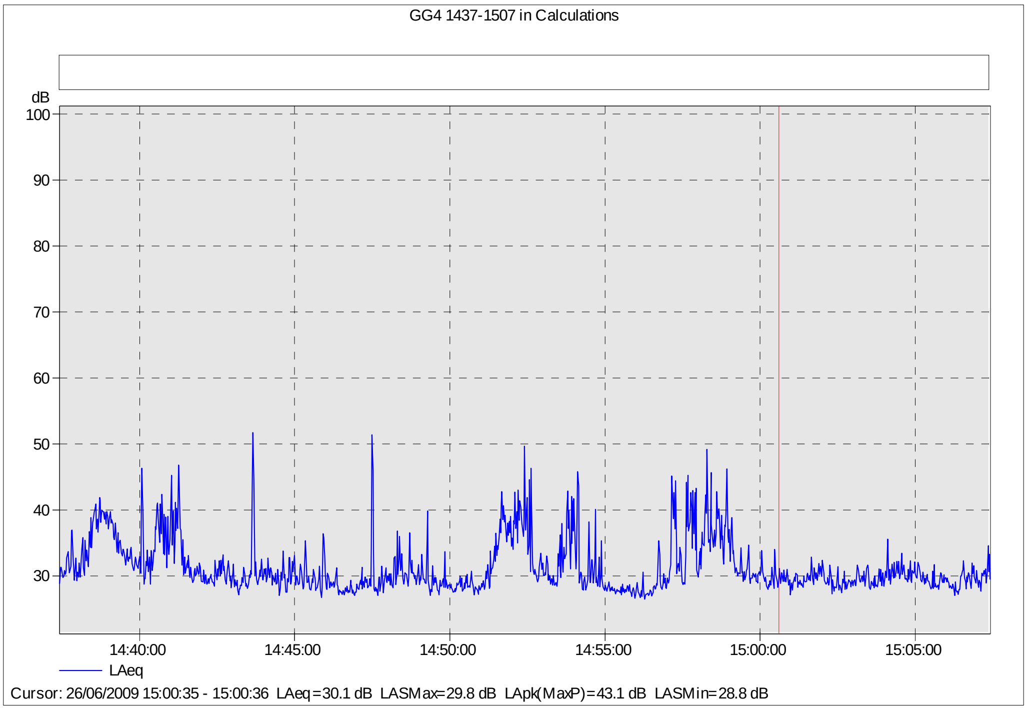
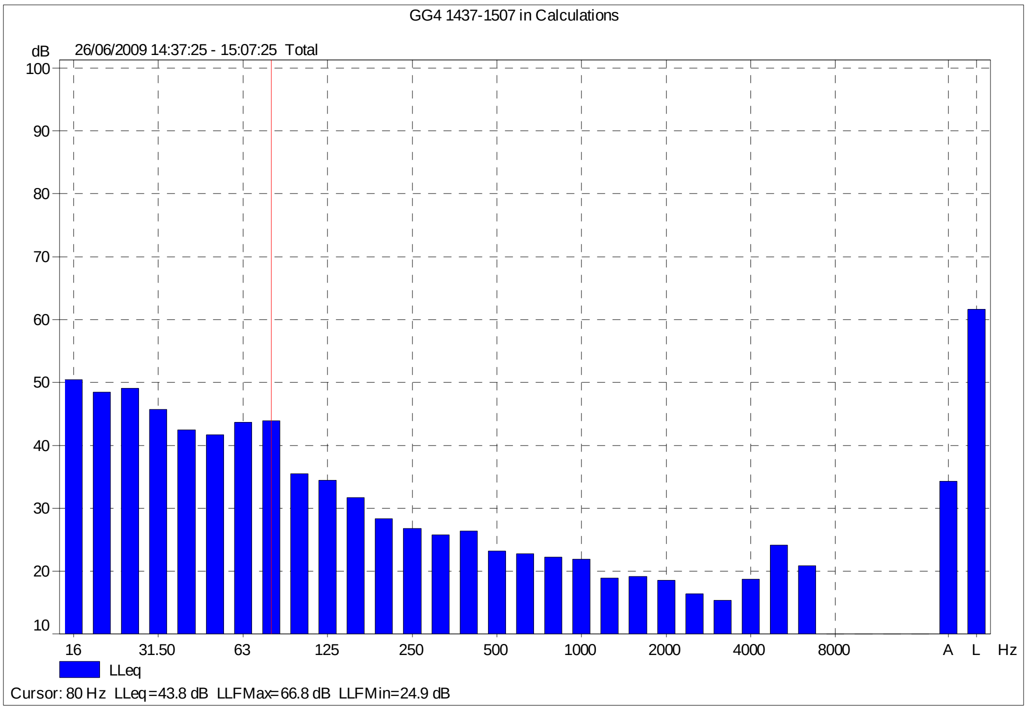


Figure 4.1
Map of Noise Sampling Locations

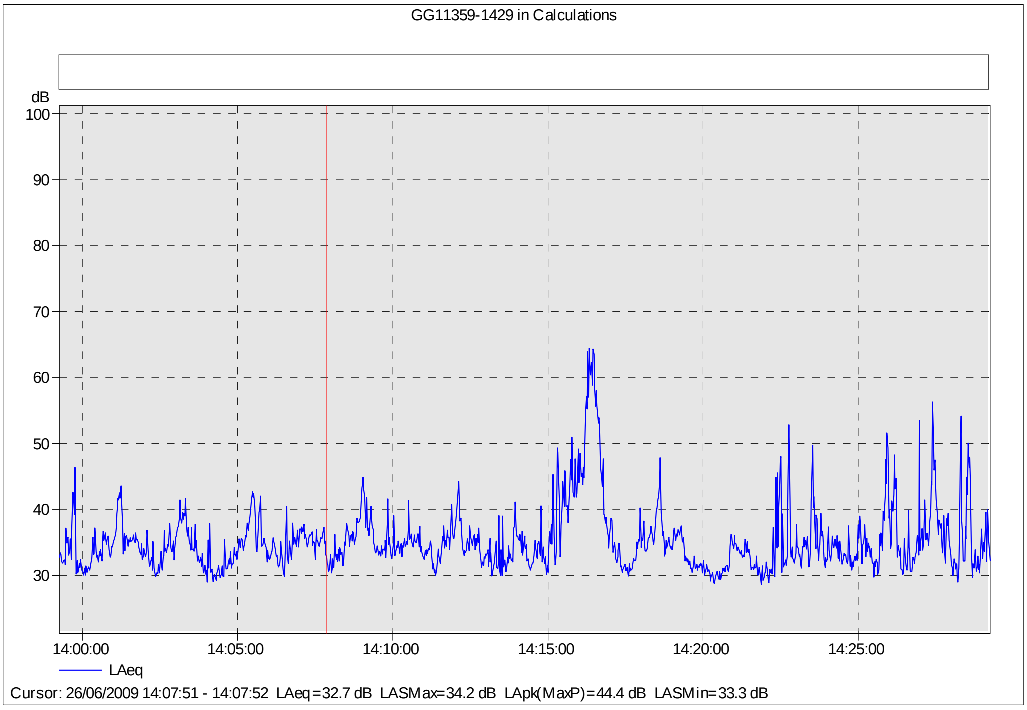
NOISE PROFILES & FREQUENCY SPECTRUMS

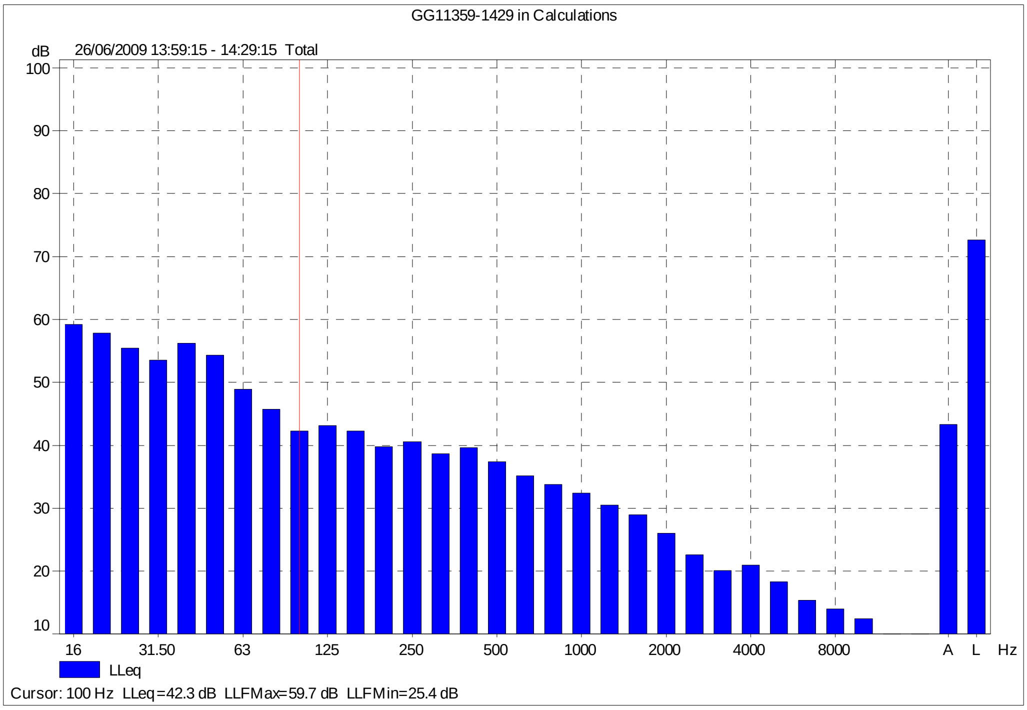
4.2.1 – Sampling Location GG4



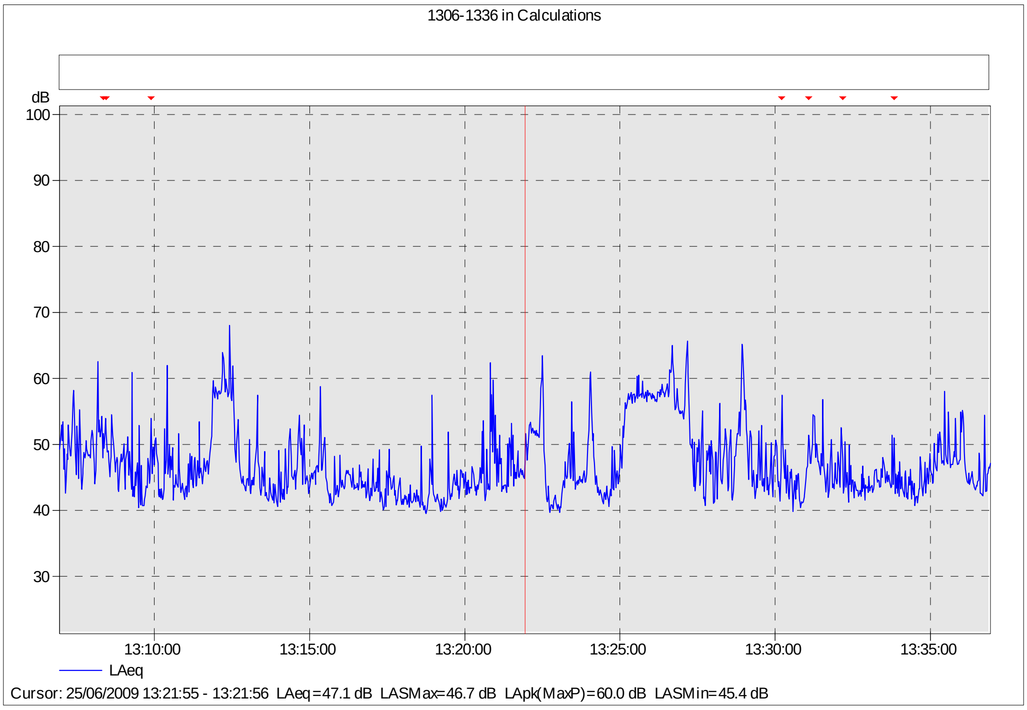


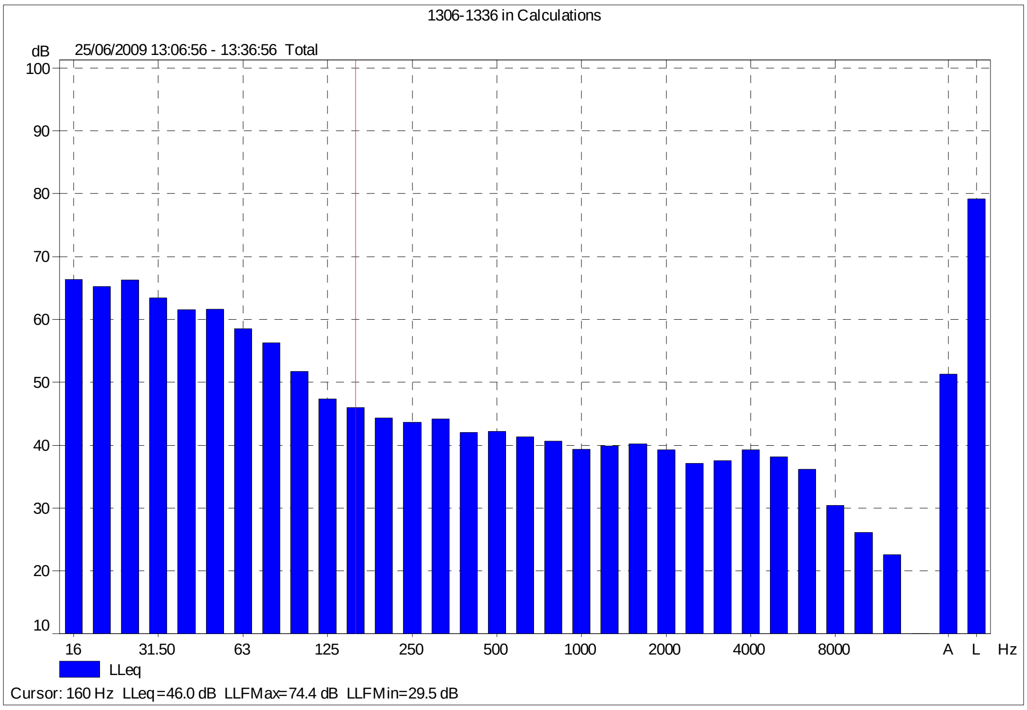
4.2.1 – Sampling Location GG1



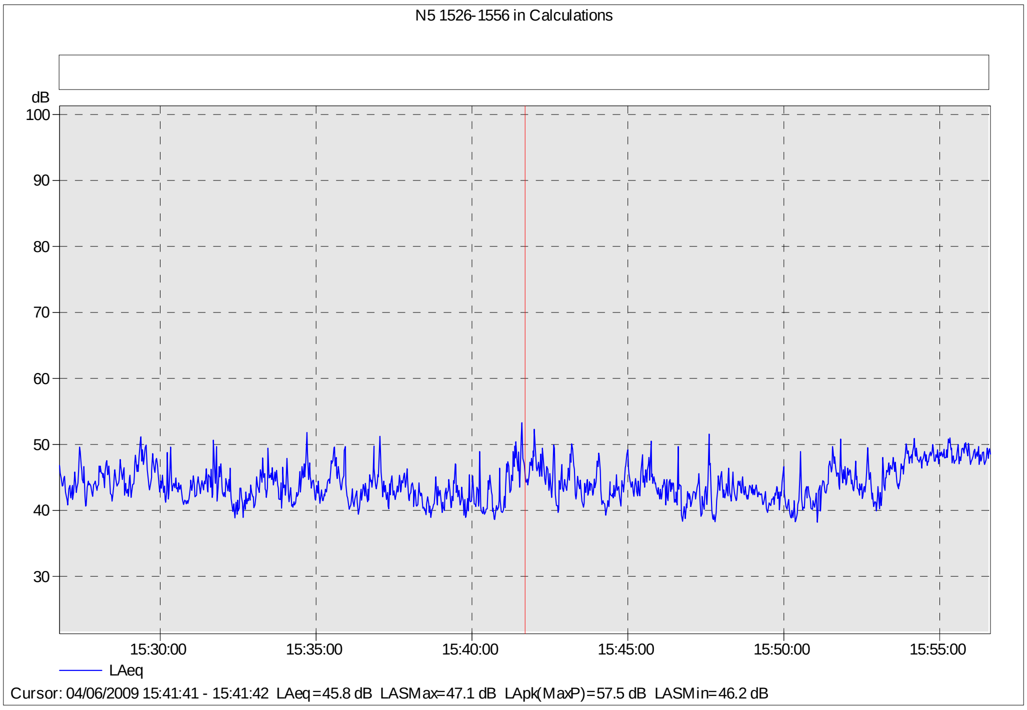


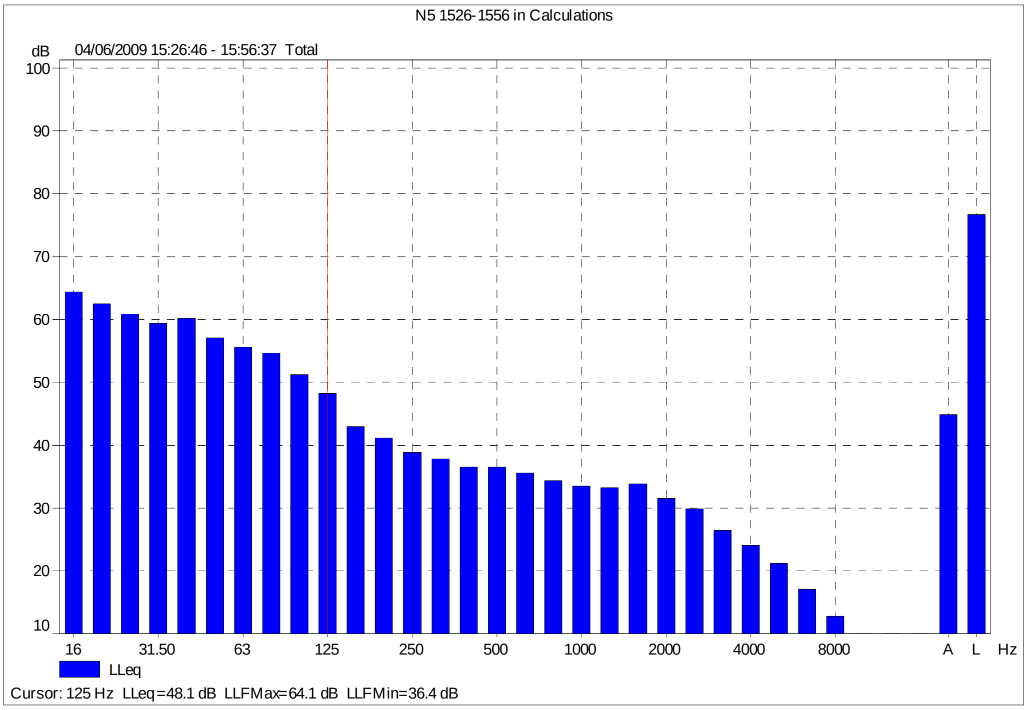
4.2.1 – Sampling Location N4



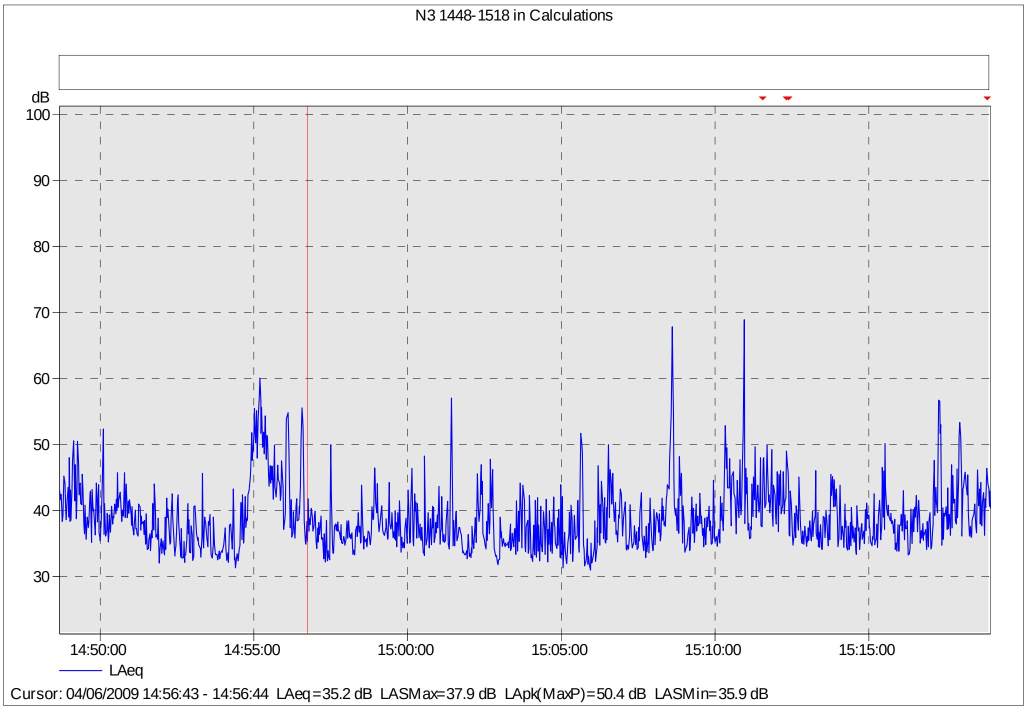


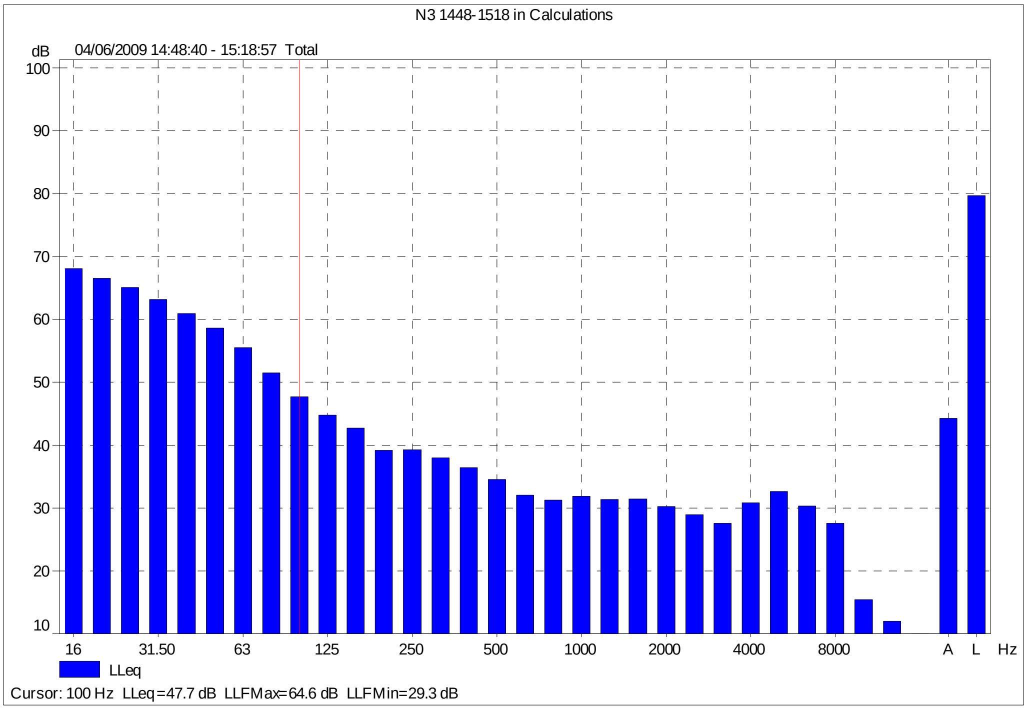
4.2.1 – Sampling Location N5



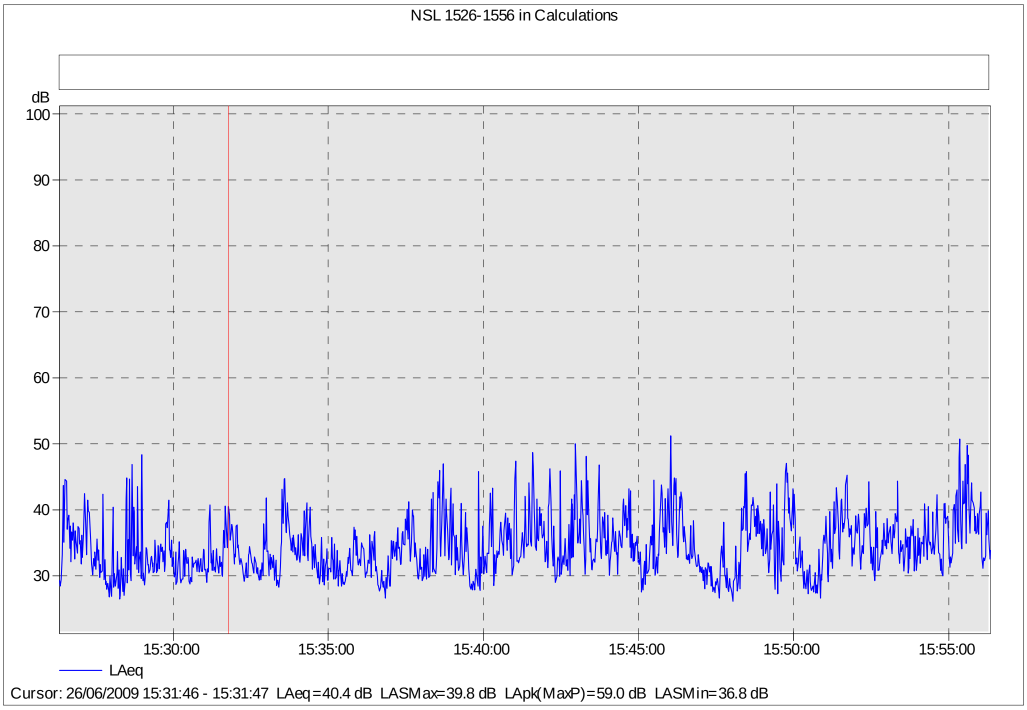


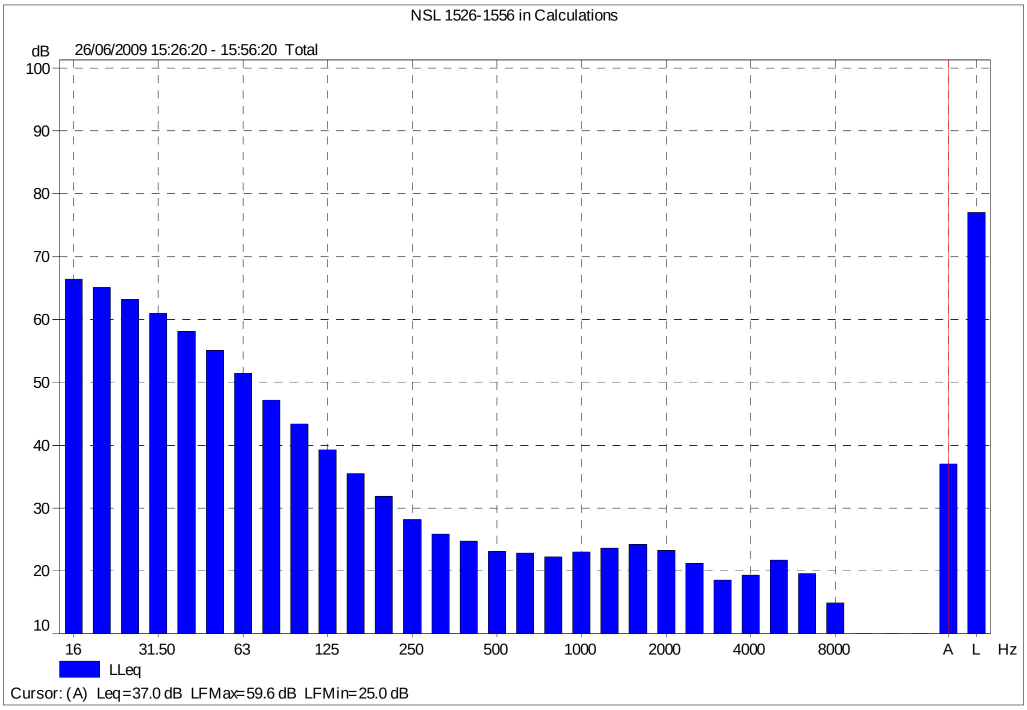
4.2.1 – Sampling Location N3





4.2.1 – Sampling Location N1 (Noise Sensitive Location)





5. DISCUSSION

5.1 Boundary Locations - Daytime monitoring

Noise levels recorded at boundary location GG4 (34 L_{Aeq}), GG1 (43 L_{Aeq}) , N4 (51 L_{Aeq}), N5 (45 L_{Aeq}), N3 (44 L_{Aeq}) and noise sensitive location **N1** (37 L_{Aeq}), were in compliance with the daytime 55 dB(A) (L_{Aeq}) limit specified in Schedule G of waste licence ref no. (W0022-1) for the East Cork Landfill site.

5.1.2 Noise Sensitive Location (NS1)

The nearest residence is located to the south of the landfill site. The noise levels recorded at this location indicated a L_{Aeq} level of 37 dB(A). This level is in compliance with the daytime licence limit stipulated for the facility. No noise was audible from the landfill site during the monitoring period. The predominant noise was background rural noise with birds singing.

5.1.3 Night-Time Compliance

The facility is closed during night-time hours and does not contribute to noise levels in the area.

5.1.4 Tonal and Impulsive Compliance

No tonal components arising from the site under investigation were audible subjectively or identified by 1/3 octave band analysis during the monitoring intervals.

No impulsive components were noted during the monitoring intervals

5.1.5. Comparison of recorded noise levels 2003 -2009.

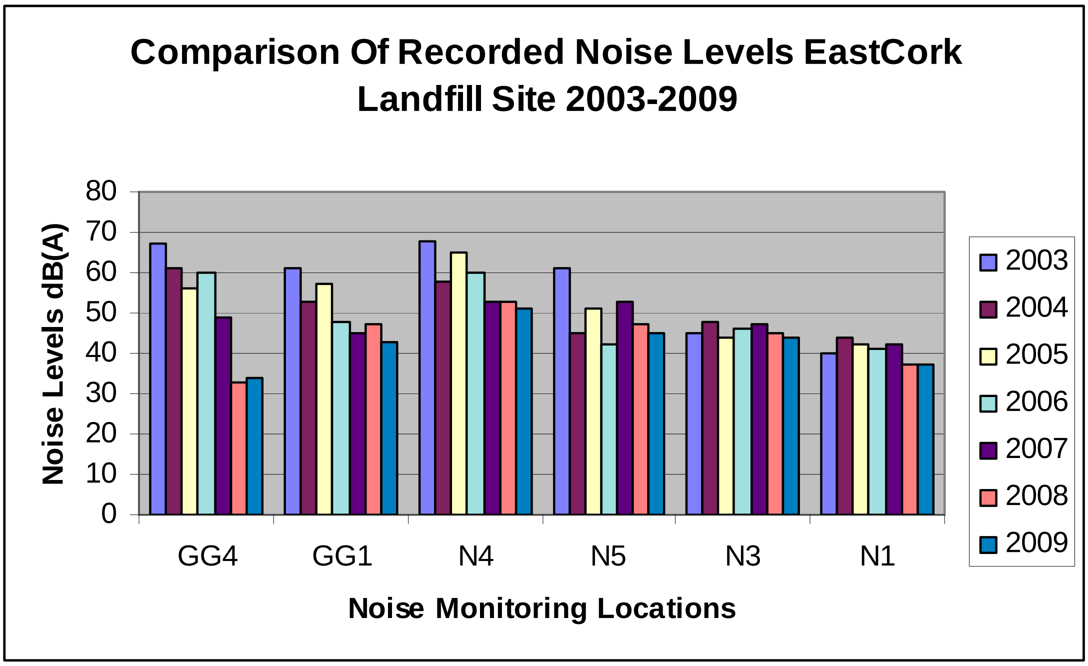


Figure 5.1

Table 5.1

Recorded Noise Levels L_{eq} dB (A)	GG4	GG1	N4	N5	N3	N1
2003	67	61	68	61	45	40
2004	61	53	58	45	48	44
2005	56	57	65	51	46	42
2006	60	48	60	42	46	41
2007	49	45	53	53	47	42
2008	33	47	53	47	45	37
2009	34	43	51	45	44	37

6. CONCLUSION

The results of the noise monitoring survey indicated compliance with noise emission limit values for the facility stipulated in Schedule G of Waste Licence (Ref. No. W 0022-1) at each of the six identified noise monitoring locations.

Appendix F

Ecology Monitoring Report

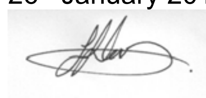
LIMOSA ENVIRONMENTAL
ECOLOGICAL AND ENVIRONMENTAL CONSULTANCY

Ecological Monitoring of East Cork Landfill

Report for

Cork County Council

December 2009

Report Reference:	RP09-GW007-06-0
Draft	Final Report
Prepared by:	L J Lewis & P J Dansie
Checked by:	L J Lewis & P J Dansie
Report Date:	December 2009
Sign-off date:	26th January 2010
Signature:	

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EXECUTIVE SUMMARY

This report presents the results of the 2009 ecological surveys and monitoring undertaken across East Cork Landfill and environs, in fulfilment of the requirements of the East Cork Landfill Waste Licence.

East Cork Landfill is situated 2.5km south of Carrigtohill, Co Cork and lies on the Rossmore Peninsula; a small peninsula that extends into the North Channel of Cork Harbour. The extensive coastal and intertidal habitats that occur around the peninsula are afforded conservation protection under two pieces of EU legislation (EU Habitats Directive and EU Birds Directive).

Ecological surveys and assessment undertaken on an annual basis include terrestrial habitats, flora and fauna, intertidal habitats (mudflats and mixed substrata shoreline), an assessment of the waterbird communities of the surrounding harbour area and a review of shellfish monitoring and water quality data obtained from the Marine Institute and Environmental Protection Agency, respectively..

In 2009, we found that habitats inside the landfill site are subject to on-going disturbance as a result of the rehabilitation process underway since the landfill's closure in 2007. However, floral species diversity remains at a similar level to previous years. A new plant was recorded this year - Yellow Bartsia *Parentucellia viscose*, a plant with a restricted distribution within Ireland and although relatively scarce, not a formally protected plant species.

Habitats outside of the landfill site continue to support a diversity of flora and fauna. Ten-year monitoring data suggests that habitats outside the landfill boundary have changed little in this period.

The intertidal survey (benthic flora and fauna) recorded communities consistent with previous annual surveys. 18 of the sites recoded a higher number of species this year in comparison with 2008 and all but one of the sites recorded a greater number of individuals. Overall the results of the current and recent previous surveys suggest a trend for increasing species diversity and abundance across the sampling sites.

Waterbird numbers within Zones A and B (Rossmore Bay and Brick Island Embayment) show great variation across the years but the overall trend is for largely stable numbers within these sites. One exception is lower recent numbers of Black-tailed Godwits which is perhaps unusual given that this species shows a trend for increase within Ireland as a whole. More detailed examination of data for the North Channel this year confirms a trend for decline in Wigeon, Pintail and Dunlin. All three of these species are also declining at national level. Overall, the study area remains one of the most important components of Cork Harbour in regard to its waterbird populations. There are no discernable trends in waterbirds numbers that could be attributed to the presence of East Cork landfill except for the obvious decline in the number of gull species since the landfill closure in 2007.

Results of sediment chemistry analysis suggest that levels of organic enrichment have decreased within recent years. Whether this trend is a result of changes in landfill procedures (as a result of landfill closure) or a result of other natural and/or anthropogenic factors is difficult to ascertain. In terms of metals analysis all sediment samples were below the national guidance levels for contaminant levels in dredged sediment, the upper level of which defines a contaminant concentration above which biological effects are anticipated to occur. Overall results were considered to be within acceptable levels and were generally similar to previous years. One site (SS3) reported the highest levels of Kjeldahl Nitrogen, Organic Carbon and 6 metals out of the 8 metals analysis. This finding would indicate that this site is being affected by some chemical inputs. This result is at variance with previous annual sampling results where there has been little evidence of any individual site having consistently higher levels of metals. However, given that metal levels can be highly variable between years and that small contaminations could occur during the sampling process, it is difficult to explain the 2009 results with confidence.

Following a review of shellfish data for the North Channel we have found no evidence of deterioration in the shellfish quality or shellfish water quality of the North Channel in recent years. The most recent data maintains favourable status for oyster production. The recorded levels of trace metals within both mussels and oysters in 2008 remained within the accepted guidance limits. Water quality parameters that have been measured during sampling of the shellfish growing areas generally conform to the guidelines set out in Council Directive 2006/113/EC indicating a good water quality status.

Recent water quality data for the North Channel shows a number of elevated readings in recent years, particularly in relation to nitrogen derived parameters (e.g. TON, DIN, NH_3, Total Ammonia). Elevated levels of these parameters were recorded at all stations. A few records of elevated PO_4 were noted and one raised level of Chlorophyll A. All other parameters were found to be within acceptable limits. Anthropogenic sources of NH_3 to seawater include sewage, industrial effluents and fertilizer run-off and it is not possible to link elevated levels within the North Channel to landfill activity as there are so many other confounding variables (i.e. other possible pollution sources).

The North Channel was previously classified as ‘Eutrophic’ by the EPA but in recent years it has retained an improved classification of ‘intermediate.’ 2008 results (EPA data), show the classification of the North Channel has dropped from intermediate to potentially eutrophic i.e. a decline in water quality standards.

Overall the results of the 2009 annual ecological monitoring report mixed results for the sampling areas and wider estuarine habitats of the North Channel. Positive results are increases in the diversity and abundance of macroinvertebrates despite the background of a decline in overall water quality of the North Channel. Local waterbird populations also remain remarkably stable given their migratory nature. Those species showing trends for decline generally also do so at a national level. Local declines in the numbers of Black-tailed Godwits *Limosa limosa islandica* could be as a result of the birds simply not being present on the sampling days (but present on other days!) but we recommend that this trend be monitored in the future.

Overall therefore there is little evidence to suggest that East Cork Landfill site has had any deleterious effects on the flora and fauna of the terrestrial and coastal habitats of Rossmore Peninsula.

1.0 INTRODUCTION

1.1 Background

Limosa Environmental was commissioned by Cork County Council to undertake ecological surveys for East Cork Landfill during 2009 in fulfilment of the requirements of the East Cork Landfill Waste Licence (Environmental Protection Agency Reg. No. 22-1, Condition 9.14):

Condition 9.14 Ecological Monitoring

Condition 9.14.1 *''The licensee shall submit to the Agency for its agreement within six months of the date of grant of this licence, proposals for the ongoing monitoring and assessment of the site and the adjoining habitats (including methods) with particular reference to the intertidal habitats (shoreline and mudflats). The scope of these proposals shall take into account the findings of the investigations required by Condition 9.13 and shall include as a minimum, monitoring of the following:*

(i) habitat quality within the Special Protection Area and proposed NHA including the usage of the intertidal areas by estuarine birds and an assessment of the relative importance of the area within the Cork Harbour SPA;

(ii) estuarine water quality and chemical analysis of estuarine sediments;

(iii) flora including macroalgae; and

(iv) macroinvertebrate fauna (including bivalves) of sediments and shoreline (hard substrate).

In addition to the above, a summary and interpretation of the significance of the results of monitoring of the shellfish growing areas in the vicinity of the landfill undertaken by the Department of the Marine and Natural Resources/Marine Institute shall be submitted to the Agency along with the Annual Ecological Report required to be submitted in accordance with schedule D: Recording and Reporting to the Agency.''

1.2 Scope of works

In fulfilment of the waste licence conditions, and following the tender brief issued by Cork County Council, the scope of works for the 2009 surveys is as follows:

- Phase 1 habitat survey of terrestrial components of the site following the 'Habitat classification of Ireland' (Fossitt, 2000). Assessment of changes in habitats and species of flora and fauna since the baseline survey undertaken in 1998.
- Intertidal survey to include estuarine sediments and shoreline; macroalgae and *Spartina* sp. distribution.
- Waterbird surveys of the intertidal mudflats surrounding Rossmore Peninsula. Assessment of the waterbird data and the relative importance of the North Channel within Cork Harbour SPA.
- Chemical analysis of estuarine sediments at pre-determined sampling points and following strict criteria as set out in the tender brief.
- Collection, collation and interpretation of EPA water quality data for the North Channel.
- Collection, collation and interpretation of shellfish monitoring data as collected by the Department of Communications, Marine & Natural Resources – Note the regulatory body has now changed and data is obtained from the Marine Institute).
- Consultation with the National Parks & Wildlife Service with regards any recent surveys or monitoring within the study area and to discuss recent trends in waterbird populations.

1.4 Report format

The 2009 report is divided into sections that correspond to the different areas of ecological surveys undertaken. Section 2 presents the results of the terrestrial habitat and botanical survey with notes on terrestrial birds and invertebrates that were recorded within the study area throughout the year. Section 3 reports on the intertidal survey that includes macroinvertebrates, flora and sediment analysis. Section 4 provides an assessment of the wintering waterbird community of Rossmore Bay, the North Channel and Brick Island embayment. Section 5 reviews shellfish and water quality data for the study area and Section 6 reviews EPA water quality data for the North Channel. Finally Section 7 presents the results of a mammal survey undertaken within the landfill site and immediate surrounding area.

Figure 1. Google Earth ™ aerial photograph of Rossmore Peninsula. The red arrow shows the location of East Cork Landfill.

2.0 TERRESTRIAL HABITAT AND BOTANICAL SURVEY OF EAST CORK LANDFILL AND ENVIRONS

2.1 Background & study area

East Cork Landfill is situated 2.5km south of Carrigtohill, Co Cork and lies on the Rossmore Peninsula; a small peninsula overlooking the North Channel of Cork Harbour (Figure 1). The landfill covers approximately 1/3 of the total land area of the peninsula, the remaining land being predominantly agricultural in nature. East Cork Landfill closed for waste acceptance in February 2007 but an area of built surfaces in the north of the site is still operational as a civic amenity centre.

2.1.1 Designated areas in the vicinity of the study area

Coastal and intertidal habitats that surround Rossmore Peninsula are considered of high ecological value. The North Channel (Great Island Channel) lies to the south of the landfill site and stretches from Little Island to Midleton and is bordered by mainland to the north and east, Great Island to the south and Fota Island to the west. Receiving its main freshwater from the Owennacurra and Dungourney Rivers (NPWS, 2001), the North Channel is an integral part of Cork Harbour and is linked to inner Lough Mahon by the Belvelly Channel and to the outer harbour by the Ballynacorra River Channel.

The North Channel is one of the most important areas within Cork Harbour in terms of its conservation value. The North Channel forms part of the Great Island Channel candidate Special Area of Conservation (cSAC) (EU Habitats Directive 92/43/EEC) (Site Code 1058) and contains several habitats that are listed on Annex I of the directive including mudflats and sandflats not covered by seawater at low tide (Code 1140). The SAC site synopsis (National Parks and Wildlife Service NPWS) is presented in Appendix 2.1.

The North Channel also forms an integral part of the Cork Harbour candidate Special Protection Area (cSPA) (Site Code 4030), an EU designation in recognition of areas of international importance for waterbirds (EU Birds Directive 79/409/EEC). The SPA site synopsis (NPWS) is presented in Appendix 2.1.

A similar area to the Cork Harbour SPA is also designated as a Ramsar Site (Site Code 835) (Ramsar Convention Bureau, 1984).

2.2 Habitat Survey Methods

The habitat survey was conducted on 16th June 2009. The habitat survey area comprised East Cork Landfill site and the surrounding terrestrial and coastal environment of Rossmore Peninsula. This study area was walked and each habitat encountered was mapped onto a field map. Habitats were classified using habitat descriptions and codes set out in the Heritage Council's "*A Guide to Habitats in Ireland*" (Fossitt, 2000). A plant species lists was compiled for habitats recorded within the landfill site and the majority of habitats in the surrounding study area, the exception being some areas of agricultural land which were either privately owned, full of arable crops or contained livestock. Target notes were made for habitats encountered, including a note as to the dominant plant species within each habitat type together with an assessment of changes in the habitat since the 2008 survey.

Throughout the text, common names are used for plant species. A list of vascular plants is presented in Appendix 2.2, with species Latin names and plant frequency of occurrence within Ireland (after Webb et al. 1996). This table also lists the habitat(s) within which each plant species were recorded. A habitat map was produced and is shown in Figure 2.

2.3 Results

Terrestrial habitats are separated into those occurring within the landfill boundaries and those occurring within the surrounding environment. Saltmarsh habitats are included here as they form the transition between land and sea. Intertidal habitats are considered in Section 3.

Landfill Habitats

The landfill site comprises four main habitats: **spoil and bare ground**, **recolonising bare ground**, **buildings and artificial surfaces**, and **semi-natural grassland. Dry meadows and grassy verges**, a**menity grassland, scrub, artificial ponds, hedgerows and treelines** are also present either within the site or on the site boundaries.

The landfill site is approached from a local road from the north and this enters into the main 'built' area of the site which includes buildings and concreted areas in association with the civic amenity area. This man-made habitat is classified as **buildings and artificial surfaces (BL3).**

Alongside the built area is a small patch of **amenity grassland (GA2)** with a sward kept short by regular mowing. Grass species dominate the sward although a variety of herbs were also recorded such as Daisy, Dandelion, Ragwort, Ribwort Plantain and Yarrow.

Between the amenity grassland and the landfill boundary fence is a dense patch of bramble **scrub (WS1),** which has remained relatively unchanged in recent years.

Directly south of the built area is a small raised area forming a triangle, either side of which the landfill track splits to go to the south-east and west. Densely vegetated in previous years, at the time of survey in 2009 this area was relatively bare of vegetation and was classified as **spoil and bare ground (ED2).** Vegetation removal was also evident around the two **artificial ponds** (lagoons) slightly south of this area.

As in previous years, the eastern boundary of the landfill site comprises a fence with intermittent cover of **scrub (WS1)** and/or **hedgerow (WL1)** habitats. Between the landfill track and this boundary is a wide expanse of **recolonising bare ground (ED3).** Classified as 'spoil and bare ground' in 2008, in June 2009 this area was in the process of vegetation recolonisation and plant cover varied from <20% to >80%. Plant species recorded included Scarlet pimpernel, Rye grass, Sea Campion and Black Medic. The plant Yellow Bartsia was recorded here and Wild Cabbage was dominant in several places. As in 2008, the naturalised and non-native species Prickly Lettuce was recorded within this habitat as well as Teasel.

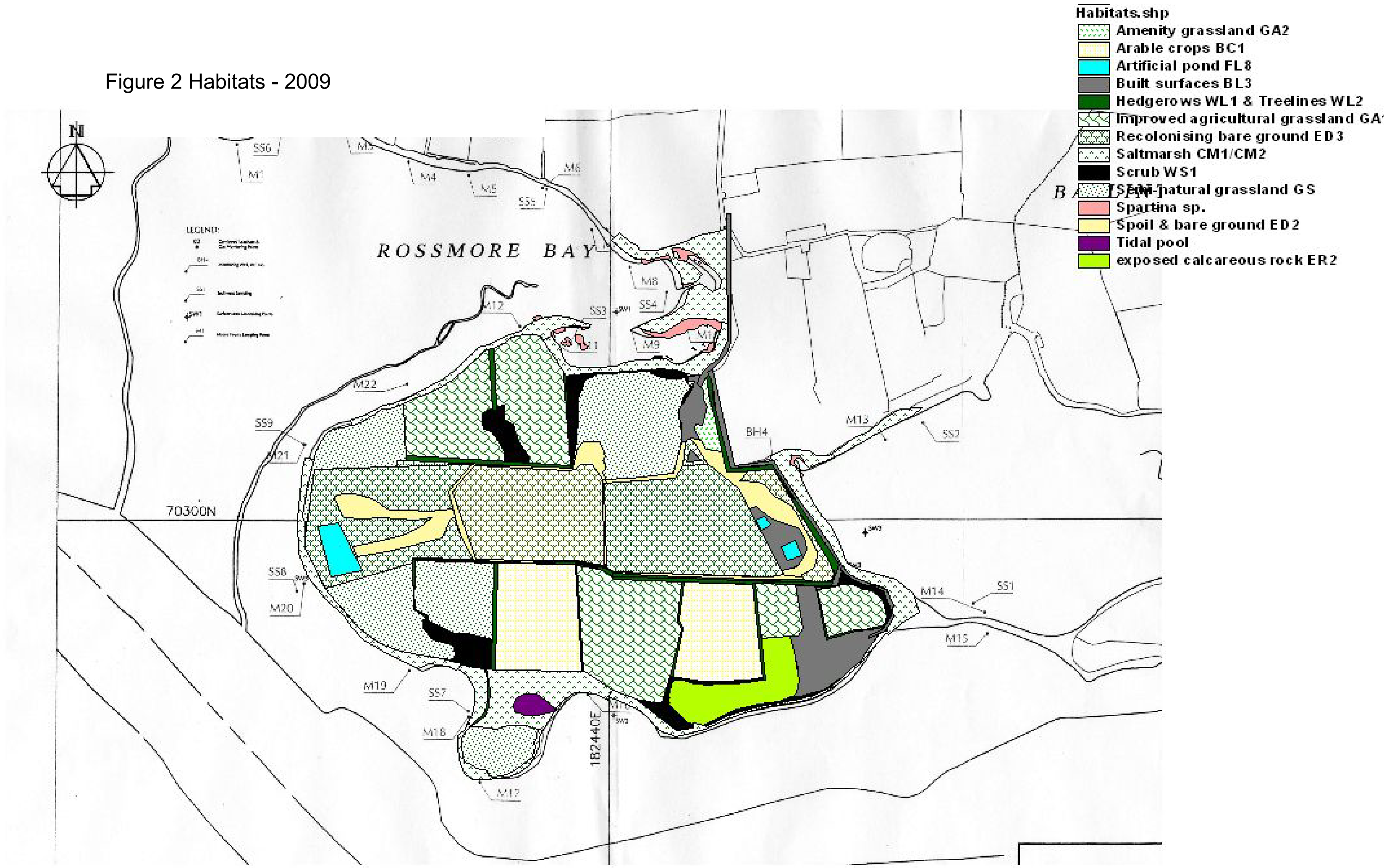
The two capped areas in the south-east and south-west of the landfill site have also now re-vegetated and are classified as recolonising bare ground (ED3). Wild Cabbage dominates the vegetation in many places. The eastern capped area appears to have re-vegetated more recently than the western area which is grassy in nature; perhaps the eastern cap having been disturbed more recently. The bird Meadow Pipit was noted to be breeding within this habitat (at minimum 5 pairs) and flocks of Linnet feed over this area. The western sloping side of the capped area in the south-west of the site is dominated by Red and White Clover and Bird's Foot Trefoil. At the time of survey these plant species were attracting many butterflies dominated by the large Painted Lady (*Vanessa cardui*).

As in previous years, the southern boundary of the landfill site remained largely unchanged from previous years with **hedgerow (WL1)** and **treeline (WL2)** habitats separating the landfill site from agricultural habitats to the south. Species include Hawthorn and Sycamore with associated scrub habitat dominated by Bramble and Nettle. As noted in previous years, a stand of the alien, invasive species Japanese Knotweed still occurs along the southern boundary although it was not recorded on the adjacent landfill cap this year. A new stand of this alien species however was recorded further west along the southern boundary at grid reference 82096 70230.

In June 2008, recent mechanical work within the site was evident in the western extent of the site close to the artificial pond (FL8), where the dominant habitat was ED2 with small patches of ED3. A year later, this area has now re-vegetated to be classified as recolonising bare ground (ED3) apart from tracks. As in recent years, the rare but introduced plant species Bristly Oxtongue was recorded in this area although perhaps less obvious this year.

The northern most capped area is mapped as GS (semi-natural grassland) as it supports a well-established grassland community that does not easily fit into habitat categories. Grasses are dominated by Yorkshire Fog, Cocksfoot and Rye Grass. The western boundary of this area is turning more towards scrub habitat with nettle and bramble dominating. On the eastern sloping edge of this habitat (behind the built surface) is a large stand of Japanese Knotweed.

Figure 2 Habitats - 2009



Habitats outside the landfill boundaries

Habitats in the surrounding environment can be divided into terrestrial habitats that occur immediately beyond the site boundaries and coastal habitats that occur around the coastline of Rossmore Peninsula (Table 1).

Table 1. Habitats within the survey area surrounding the landfill site

Terrestrial Habitats	Coastal Habitats
Improved Agricultural Grassland (GA1)	Lower Saltmarsh (CM1)
Semi-natural grassland (GS)	Upper Saltmarsh (CM2)
Hedgerows (WL1)	Mixed Substrata Shore (LR4)
Treelines (WL2)	Shingle and gravel banks (CB1)
Scrub (WS1)	
Exposed calcareous rock (ER2)	
Arable crops (BC1)	
Built surfaces (BL3)	

These habitats have changed little in recent years; changes observed on the habitat map due to improvements in mapping.

The dominant habitats in the immediate vicinity of the landfill site are agricultural which cover the remaining terrestrial element of Rossmore Peninsula. While some **arable (BC1)** fields occur to the south of the landfill site, grassland fields are classified as either **improved agricultural grassland (GA1)** or **semi-natural grassland (GS)**, the latter being a broader classification used for areas of unmanaged grassland that have been left (e.g. set-aside).

Agricultural fields are mostly bordered by **hedgerows (WL1)** with occasional **treelines (WL2). Scrub (WS1)** often occurs in association with the hedgerows and bramble and gorse scrub often dominates the boundary between the agricultural habitats and the shoreline.

Buildings and artificial surfaces (BL3) occurs on the south-eastern corner of Rossmore peninsula and comprise domestic dwellings, farm buildings, buildings associated with a former shellfish plant and domestic gardens. A man-made pond (not mapped) also occurs here.

To the south-east is an area of bare, exposed rock, bordered by scrub (predominantly gorse). The habitat is classified as **exposed calcareous rock (ER2)** and provides an interesting diversity of plants that favour limestone/calcareous habitats including Yellow-wort, a species that has a localised distribution within Ireland (Preston *et al.,* 2002). Wood Sage is also found here.

Saltmarsh habitat forms the transition between the terrestrial and intertidal (littoral) habitats that surround Rossmore peninsula; divided into **lower saltmarsh (CM1) and upper saltmarsh (CM2)** depending on their vertical location.

Saltmarsh habitat is present to varying degrees all around Rossmore Peninsula. The largest expanses occur in the inner parts of Rossmore Bay and inner sections of Brick Island Embayment (Figure 2). Lower saltmarsh in Rossmore Bay is dominated by Common Cord-grass with Glasswort and Lax-flowered Sea-lavender. Lower saltmarsh within Brick Island Embayment is dominated by Sea Purslane with occasional strands of *Spartina* sp.

Saltmarsh also occurs as an extensive habitat around a tidal pool on the southern most section of Rossmore Peninsula (Figure 2). The pool is connected to the sea via an inlet and its surrounding vegetation is dominated by Glasswort sp, Annual Sea-blite, Common Orache and Sea Beet.

Lower and upper saltmarsh also occurs in varying degrees around the shoreline of Rossmore Peninsula. Often only small patches of Glasswort are seen, in other places there are quite dense stands of Lax-flowered Sea-lavender. Where saltmarsh is not present, the upper shoreline is classified as **shingle and gravel banks (CB1).** Below the strandline the shingle and gravel community gives way to a **mixed substrata shore** (LR4) (described further in Section 3).

2.3 Discussion and Conclusions

2.3.1 General Discussion

The majority of habitats inside the landfill boundaries are artificial or modified in nature and are subject to on-going disturbance as a result of the rehabilitation process underway since the landfill's closure in 2007. The major difference in habitats between the current survey and previous year was the re-colonisation of vegetation that has occurred on areas that were previously cleared of vegetation. However, very few 'new' plant species were recorded this year. The exception perhaps was the record of Yellow Bartsia (*Parentucellia viscosa*) within the landfill site. This plant has a restricted distribution within Ireland, confined to the south-west coast (Preston *et al.,* 2002) and is relatively scarce although not a formally protected species.

Recolonising vegetation within the landfill site was shown to attract a range of wildlife from mammals (rabbits) to butterflies and birds. However in some places some nuisance plants (e.g. Wild Cabbage) were observed. In addition and of more significance is the persistence of the alien, invasive species Japanese Knotweed. First noted within the landfill site in 2004 (ASU 2004), it is now present in three locations within the site. As an aggressively competitive alien, its potential spread into the surrounding coastal habitats of high conservation importance is of concern. We further recommend that control measures are used; useful management guidelines can be found at http://www.invasivespeciesireland.com.

With regard for such factors, we recommend that landfill rehabilitation should include a habitat creation plan that considers not only the habitat within the landfill site, but also the ecological sensitivities of habitats surrounding the landfill site. For instance, accidental introduction of alien, invasive species or highly competitive native species that have the potential to spread into surrounding habitats, could affect the integrity of those habitats considered of high ecological value. Continued ecological monitoring during the site rehabilitation process would therefore be useful to assess these factors.

Outside of the landfill boundaries, the habitats continue to support a diversity of flora and fauna and no obvious differences in the extent or quality of these habitats was noted this year in comparison with recent previous annual surveys. Limosa Environmental (2008) noted that habitats outside the landfill boundary appear to have changed little in the ten-year period monitoring period.

2.3.2 Common Cord-grass (*Spartina* sp.)

Common Cord-grass has been recorded within the study area for many years as a lower saltmarsh species and is particularly prevalent within inner Rossmore Bay. This plant is an alien invasive species and first appeared in Ireland in the 1920's. Despite much debate as to the potential impacts of *Spartina* sp. on the ecology of the habitat it invades, some recent studies and observations suggest that negative impacts may not be as serious as previously predicted (McCorry *et al.,* 2003) and the spread of the species and subsequent effects appear to vary on a site by site basis.

Indeed, at Rossmore the Common Cord-grass (*Spartina* sp.) distribution appears to have changed little since the 2006 survey apart from some of the smaller patches appearing to have increased in size slightly. Some of the larger areas appear to have retracted slightly. Therefore at Rossmore, Common Cord-grass does not appear to have undergone a major invasion of the mudflat habitat and is now perhaps in a natural retraction period. Such trends for natural' die back' have been observed in other areas (e.g. Southern England) and although it is not known why, some potential reasons for decline include intolerance of anaerobic sediment which was created by the plant itself over time and density-dependent effects.

2.4 Terrestrial Birds

Bird Species within the landfill boundaries

19 bird species were recorded within the landfill site during the 2009 surveys (Appendix 2.3). The majority of these birds were recorded within hedgerow and/or scrub habitats that occur along the site boundaries, the southern boundary being of prime importance.

Bird song and activity was noted to be greater this year (during the June habitats survey) than recorded during the 2008 habitat survey; likely due to the vegetation recolonisation that has occurred in the intervening period attracting more foraging birds into the site. A Grey Heron is also a regular visitor to the lagoon in the west of the site; Grey Wagtails observed here too.

Meadow Pipits were observed to be breeding on the landfill cap in the south this year (min 5 pairs); these were observed undertaking territorial flight dives. The area of semi-natural grassland (GS) close to the built area in the north of the site (oldest capped area) provides a feeding ground for species such as Starling (*Sturnus vulgaris*) and Linnet (*Carduelis cannabina*); the latter observed in numerous flocks within this area.

Given the occurrence of breeding Meadow Pipits that are ground-nesting birds, we recommend that vegetation management of the landfill caps or mowing of the GS area in the north of the site be undertaken outside the bird breeding season in future years in order to avoid destruction of nests.

Bird Species within the surrounding environment

32 bird species were recorded in the habitats surrounding East Cork landfill site during the 2008 surveys (Appendix 2.3). This result is significantly greater than the species list compiled in 2004 (ASU, 2004) (12 terrestrial bird species) and greater than the list compiled in 1998 (23 terrestrial bird species) (Biosphere Environmental Services, 1998). This suggests that bird diversity of Rossmore Peninsula has, at minimum, remained stable.

Of note is the significant reduction in gull species and corvid species (rooks, crows) since the landfill closure in 2007. When the landfill was open several thousands of gulls could be observed within Rossmore Bay flying to and from the landfill site. They are a noticeable absentee in 2009.

2.5 Butterflies

Butterfly species recorded during 2009 fieldwork:

- **Speckled Wood** (*Pararge aegeria*) – a widespread and common species in Ireland. They are found typically in woodland clearings, along hedgerows and in grassland fields. Recorded in a number of locations during the surveys, particularly along the landfill northern boundary and hedgerows, grassland and field boundaries to the north-east and south of the site. They are a widespread and common species in Ireland and tend to be territorial.
- **Meadow Brown** (*Maniola jurtina*) - widespread and common in meadows and grassy places.
- **Painted Lady** (*Vanessa cardui*) – a large, migrant species recorded in the summer months. Particularly prevalent on the landfill cap in the west of the site.
- **Red Admiral** (*Vanessa atalanta*) - Only one sight of this species was recorded along the scrubby road side vegetation leading to the landfill entrance. Red Admirals are migrant species to Ireland. During the summer months they can be widespread, particularly in gardens, orchards and woodland margins. Their caterpillar food plant is nettle (*Urtica dioica*) where they tend to form a leaf tent of the plant
- **Large White** (*Pieris brassicae*) – observed inside the landfill site within recolonising bare ground habitat.
- **Ringlet** (*Aphantopus hyperantus*) – this species was recorded in one location – a hedgerow associated with the grassland field to the north-east of the site. This species is generally present from the end of June to the start of August although maybe for longer in good summers. They are widespread and common in damp meadows, marshes, woodland margins and along hedgerows,

being particularly fond of bramble flower. Like the Speckled Wood and Meadow Brown, their laval food plant is grasses.

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- **Orange Tip** (*Anthocharius cardamines*) – observed outside landfill boundaries within salt marsh habitat by Brick Island. A common and widespread species found in habitats such as roadsides, wet meadows and marsh.

- The Cinnabar moth (*Tyria jacobaeae*) is a brightly-coloured day-flying insect. It is coastal in distribution, found in open habitats especially sandy soils. The species was observed in abundance within the exposed calcareous rock habitats (ER2) south of the landfill. The caterpillars of this species feeds on Common Ragwort and the species has therefore been used as a bio-control fro this poisonous plant in several countries.

2.6 Mammals within the landfill site and surrounding habitats

Introduction

A terrestrial mammal survey was undertaken on the 25th June 2009. The survey area consisted of the landfill site itself, adjacent terrestrial lands to the north and the shoreline of the Rossmore peninsula.

Survey methodology consisted of walking the survey area and recording standard signs of mammal usage and activity, such as mammal tracks and footprints in soft mud, hair caught in wire fences, feeding signs or remains, burrows/dens, droppings etc.

The following discussion is a combination of desktop review, direct field observations and an evaluation of habitat suitability for mammals within the landfill and surrounding area. Mammal species are divided into 'confirmed' or 'probable' as follows:

- Confirmed species are mammals that were either seen visually during the survey or definite signs in the form of tracks, burrows, etc. were detected.
- Probable species refers to those mammal species that are likely to be present either within the landfill site itself or in the surrounding environment based on the distribution of the species, suitability of habitats present and records from the area in previous surveys (Limosa Environmental, 2006, 2007 & 2008; Harris & Yalden, 2008; Hayden and Harrington, 2000).

Results & discussion

Appendix 2.4 provides a list of species confirmed or probably using the landfill and/or surrounding area. It also shows the legal protection afforded to the species under National and International legislation.

The survey identified evidence of a total of five mammal species that use either the landfill site and/or surrounding area:

- Badger (*Meles meles*)
- Rabbit *(Oryctolagus cuniculus)*
- Fox *(Vulpes vulpes)*
- Mink *(Mustela vison)*
- Brown Rat *(Rattus norvegicus)*

Evidence of three of these mammal species were recorded within the landfill itself and all five species were recorded using the surrounding lands. In addition a further 10 mammal species are probably and 2 possibly using the surrounding lands from time to time (Appendix 2.4).

Mammal Species within the landfill boundaries

During the site survey, evidence of three mammal species was recorded within the landfill site: Rabbits (*Oryctolagus cuniculus*), Fox (*Vulpes vulpes*) and Brown Rat (*Rattus norvegicus*). Rabbits, foxes and rats are common and widespread native species but are often regarded as 'pest species'.

Based on their field signs rabbits are the most abundant within the landfill boundary. Signs were predominantly in the form of droppings (across the site), the presence of burrows, particularly in boundary banks and hedgerows and direct observations made on top of the capped landfill. Rabbits also graze on the amenity grassland close to the built surfaces in the north of the site.

Two signs of brown rat were recorded, one being droppings along the south-east boundary of the site and one dead rat observed on the western slope of the capped landfill. Overall, rat numbers appear to be low within the site likely due to the on-going programme of vermin control.

In addition to rabbits and brown rats the only other mammal species noted in the survey was one fox dropping along the northern boundary of the site. This observation is not surprising based on the number of rabbits utilising the site which a source of prey for the fox.

Brown rats and fox are known to use landfill sites and the current survey found them to be abundant along the landfill boundaries and surrounding lands. The low amount of evidence of rat population within the landfill site, as found in previous survey, is indicative of the use of pest control measures on-site. Both rabbits and rats are a key prey source for fox and the presence of fox droppings and tracks in the same locations as where rabbit signs were abundant is evident of this predator - prey interaction.

No other mammal signs were observed within the landfill boundary, which is not surprising given the level of vehicular movement and earth disturbance occurring as a consequence of the landfill rehabilitation programme. However, based on the habitats present and the type of terrain present on site, a number of other mammal species have the potential to use the site from time to time and these are outlined in Appendix 2.4.

Mammal Species within the surrounding environment

Outside the landfill boundaries, mammal evidence was more abundant. Signs of rabbits were common throughout the immediate survey area, and all along the peninsula shoreline, as were fox, brown rat, domestic dogs and to a lesser extent American mink. Rabbit droppings, tracks and burrows were observed in several locations along the shoreline, particularly to the south and north-west of the landfill, but evidence of rabbits was present continuously around the shore. Fox activity, in the form of droppings and fresh tracks, were recorded along the shoreline to the north and north-west of the landfill site boundaries. Brown rats are relatively abundant within the hedgerows along the eastern and northern boundaries of the landfill site. In addition, numerous tracks and droppings of domestic dogs were recorded along the footpath north of the landfill site.

Two mink tracks and one mink scat (dropping) was recorded in the north-east of the survey area. Similar evidence was noted in the 2006 report and it is considered likely that a single mink is intermittently using the area for foraging. The introduced American mink tend to live near water where they prey on fish, birds, small rodents and amphibians (Fairley, 2001; Bang & Dahlstrøm, 2003). It is generally regarded as a pest species however, the low amount of evidence recorded in this and previous surveys of the study area would suggest that mink are not present in high numbers and probably only use the site intermittently for foraging.

The otter seat found during the 2006 survey has been eroded further (due to natural coastal erosion) and no direct evidence of otter usage was recorded in the current survey. However, based on previous evidence of otters using the area it is likely that they still do at times, to forage on fish and shellfish and other food sources present along the shoreline. In addition to aquatic prey, otters may also take small mammal such as rats. Because of this and as noted in the 2006 Landfill Monitoring Report, this leads to concern over the use of rodenticides within the landfill site in close proximity to a known otter site, and especially the use of highly toxic 'second-generation rodenticides'. For the reason, it was recommended in the 2006 report that the East Cork Landfill adopt the use of 'first generation' anticoagulant rodenticides in place of 'second-generation' compounds.

Otters are listed as vulnerable by the IUCN Red List and are highly protected across Europe, their conservation status largely related to serious population declines attributed to habitat destruction, hunting, persecution and the effects of organochlorine pesticides, amongst other reasons (Woodroffe, 2001). Within Ireland however, otters are widespread and Ireland is considered as the European stronghold for the species (Lunnon, 1996). Otters are thus classed as being internationally important and are highly protected within Ireland, being listed on Annex II and IV of the EU Habitats Directive, Appendix II of the Berne Convention and given national legal protection under the Wildlife Act 1976 (amended 2000).

As noted in previous surveys (Limosa Environmental, 2006, 2007 & 2008) the agricultural land adjacent to the landfill site (just north-east) has an extensive rabbit population plus numerous evidence of fox activity. The old, deserted badger (*Meles meles*) sett was noted again this year and still appears to be inactive. However, approximately 200m west from the deserted sett in a bank along a track there is evidence of fresh badger digging and a new small sett (possibly an outlier) with badger 'guard' hairs at the entrance was observed. The new sett entrance had some evidence of blocking and disturbance in the relative recent past. Although badgers are considered relatively widespread within Ireland they are protected by law being listed on Appendix III of the Berne Convention and protected by the Wildlife Act 1976, (amended 2000). It is known from previous studies undertaken on vaccine development that a high density of badgers are present on Great Island opposite this site and over the years these populations have undergone periods of human related disturbance. The finding of this fresh badger activity will be notified to the National Parks and Wildlife Service in order to curtail any further disturbance to the sett.

Numerous rabbit burrows in the banks north-east of the landfill site.

Small badger sett with evidence of its entrance being blocked by stones

In addition to the mammal species recorded in the current survey it is likely that a number of other species will utilise the surrounding area based on the habitats present. These 'probable' species are listed in Appendix 2.4.

Although a specific bat survey was not undertaken as part of the current survey, a brief desktop assessment of the habitats and potential roosting sites was undertaken to highlight bat species that may potentially utilise the survey area for foraging and roosting. From this we consider that it is highly unlikely that an important bat roost would be present within the landfill site. However, based on presence of mature treelines, small areas of woodland and an abandoned building, particularly to the north-east of the site, then there is some potential for small roosts or at least temporary night roosts to be present in the surrounding area. Given the habitats present and the abundance of insect life, it is also considered likely that the surrounding area and perhaps the landfill site itself and its hedgerow boundaries are used by bats for foraging. This is most likely along the margins of the mature and semi-mature hedgerows and treelines and to a lesser extent along the shoreline. Table 2 lists the bat species that have the potential to utilise the area.

Conclusions

Overall, the mammal species recorded in the survey and their abundance is considered similar to previous years with rabbit, fox and rat being the most abundant and widespread species. Although field evidence of otters was not recorded in the current survey and the previously identified otter seat has been eroded, it is likely that otters still use the shoreline for foraging. The presence of fresh digging and a new small badger sett was notable this year, and confirms that there is still a population of badgers active in the surrounding area. Overall therefore we conclude that there has not been any significant deterioration in the mammal usage of the survey area over the years and the mammal populations do not appear to have been affected by landfill operations over time. When the landfill site is rehabilitated and natural vegetation develops over time, it is likely that mammal usage of the site will increase and that the site may provide additional suitable habitat for foraging and breeding.

Appendix 2.1

SITE SYNOPSIS: GREAT ISLAND CHANNEL SAC & NHA (SITE CODE 01058)

The Great Island Channel stretches from Little Island to Midleton, with its southern boundary being formed by Great Island. It is an integral part of Cork Harbour which contains several other sites of conservation interest. Geologically, Cork Harbour consists of two large areas of open water in a limestone basin, separated from each other and the open sea by ridges of Old Red Sandstone. Within this system, Great Island Channel forms the eastern stretch of the river basin and, compared to the rest of Cork Harbour, is relatively undisturbed. Within the site is the estuary of the Owennacurra and Dungourney Rivers. These rivers, which flow through Midleton, provide the main source of freshwater to the North Channel.

The main habitats of conservation interest are the sheltered tidal sand and mudflats and Atlantic salt meadows, both habitats listed on Annex I of the EU Habitats Directive. Owing to the sheltered conditions, the intertidal flats are composed mainly of soft muds. These muds support a range of macro-invertebrates, notably *Macoma balthica*, *Scrobicularia plana*, *Hydrobia ulvae*, *Nepthys hombergi, Nereis diversicolor* and *Corophium volutator*. Green algal species occur on the flats, especially *Ulva lactua* and *Enteromorpha* spp. Cordgrass (*Spartina* spp.) has colonised the intertidal flats in places, especially at Rossleague and Belvelly. The salt marshes are scattered through the site and are all of the estuarine type on mud substrate. Species present include Sea Purslane (*Halimione portulacoides*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Common Saltmarsh-grass (*Puccinellia maritima*), Sea Plantain (*Plantago maritima*), Greater Sea-spurry (*Spergularia media*), Sea Lavender (*Limonium humile*), Sea Arrowgrass (*Triglochin maritimum*), Mayweed (*Matricaria maritima*) and Red Fescue (*Festuca rubra*).

The site is extremely important for wintering waterfowl and is considered to contain three of the top five areas within Cork Harbour, namely North Channel, Harper's Island and Belvelly-Marino Point. Shelduck are the most frequent duck species with 800-1000 birds centred on the Fota/Marino Point area. There are also large flocks of Teal and Wigeon, especially at the eastern end. Waders occur in the greatest density north of Rosslare, with Dunlin, Godwit, Curlew and Golden Plover the commonest species. A population of about 80 Grey Plover is a notable feature of the area. All the mudflats support feeding birds; the main roost sites are at Weir Island and Brown Island and to the north of Fota at Killacloyne and Harper's Island. Ahanesk supports a roost also but is subject to disturbance. The numbers of Grey Plover and Shelduck, as given above, are of national importance.

The site is an integral part of Cork Harbour which is a wetland of international importance for the birds it supports. Overall, Cork Harbour regularly holds over 20,000 waterfowl and contains internationally important numbers of Black-Tailed Godwit (1,181) and Redshank (1,896) along with nationally important numbers of nineteen other species. Furthermore, it contains the large Dunlin (12,019) and Lapwing (12,528) flocks. All counts are average peaks, 1994/95 – 1996/97. Much of the site forms part of Cork Harbour Special Protection Area, an important bird area designated under the EU Birds Directive.

While the main land use within the site is aquaculture (Oyster farming), the greatest threats to its conservation significance come from road works, infilling, sewage outflows and possible marina developments.

The site is of major importance for the two habitats listed on the EU Habitats Directive that it contains, as well as for its important numbers of wintering waders and wildfowl. It also supports a good invertebrate fauna.

2.10.2001

SITE SYNOPSIS: CORK HARBOUR SPA (SITE CODE 4030)

Cork Harbour is a large, sheltered bay system, with several river estuaries – principally those of the Rivers Lee, Douglas, Owenboy and Owenacurra. The SPA site comprises the main intertidal areas of Cork Harbour, including all of the North Channel, the Douglas Estuary, inner Lough Mahon, Monkstown Creek, Lough Beg, the Owenboy Estuary, Whitegate Bay and the Rostellan inlet.

Owing to the sheltered conditions, the intertidal flats are often muddy in character. These muds support a range of macro-invertebrates, notably *Macoma balthica*, *Scrobicularia plana*, *Hydrobia ulvae*, *Nepthys hombergi, Nereis diversicolor* and *Corophium volutator*. Green algae species occur on the flats, especially *Ulva lactua* and *Enteromorpha* spp. Cordgrass (*Spartina* spp.) has colonised the intertidal flats in places, especially where good shelter exists, such as at Rossleague and Belvelly in the North Channel. Salt marshes are scattered through the site and these provide high tide roosts for the birds. Salt marsh species present include Sea Purslane (*Halimione portulacoides*), Sea Aster (*Aster tripolium*), Thrift (*Armeria maritima*), Common Saltmarsh-grass (*Puccinellia maritima*), Sea Plantain (*Plantago maritima*), Lax-flowered Sea-lavender (*Limonium humile*) and Sea Arrowgrass (*Triglochin maritima*). Some shallow bay water is included in the site. Cork Harbour is adjacent to a major urban centre and a major industrial centre. Rostellan Lake is a small brackish lake that is used by swans throughout the winter. The site also includes some marginal wet grassland areas used by feeding and roosting birds.

Cork Harbour is an internationally important wetland site, regularly supporting in excess of 20,000 wintering waterfowl, for which it is amongst the top five sites in the country. The five-year average annual core count for the entire harbour complex was 34,661 for the period 1996/97-2000/01. Of particular note is that the site supports an internationally important population of Redshank (1,614) – all figures given are average winter means for the 5 winters 1995/96-1999/00. A further 15 species have populations of national importance, as follows: Great Crested Grebe (218), Cormorant (620), Shelduck (1,426), Wigeon (1,750), Gadwall (15), Teal (807), Pintail (84), Shoveler (135), Red-Breasted Merganser (90), Oystercatcher (791), Lapwing (3,614), Dunlin (4,936), Black-Tailed Godwit (412), Curlew (1,345) and Greenshank (36). The Shelduck population is the largest in the country (9.6% of national total), while those of Shoveler (4.5% of total) and Pintail (4.2% of total) are also very substantial. The site has regionally or locally important populations of a range of other species, including Whooper Swan (10), Pochard (145), Golden Plover (805), Grey Plover (66) and Turnstone (99). Other species using the site include Bat-tailed Godwit (45), Mallard (456), Tufted Duck (97), Goldeneye (15), Coot (77), Mute Swan (39), Ringed Plover (51), Knot (31), Little Grebe (68) and Grey Heron (47). Cork Harbour is an important site for gulls in winter and autumn, especially Common Gull (2,630) and Lesser Black-Backed Gull (261); Black-Headed Gull (948) also occurs.

A range of passage waders occur regularly in autumn, including Ruff (5-10), Spotted Redshank (1-5) and Green Sandpiper (1-5). Numbers vary between years and usually a few of each of these species over-winter.

The wintering birds in Cork Harbour have been monitored since the 1970s and are counted annually as part of the I-WeBS scheme.

Cork Harbour has a nationally important breeding colony of Common Tern (3-year mean of 69 pairs for the period 1998-2000, with a maximum of 102 pairs in 1995). The birds have nested in Cork Harbour since about 1970, and since 1983 on various artificial structures, notably derelict steel barges and the roof of a Martello Tower. The birds are monitored annually and the chicks are ringed.

Extensive areas of estuarine habitat have been reclaimed since about the 1950s for industrial, port-related and road projects, and further reclamation remains a threat. As Cork Harbour is adjacent to a major urban centre and a major industrial centre, water quality is variable, with the estuary of the River Lee and parts of the Inner Harbour being somewhat eutrophic. However, the polluted conditions may not be having significant impacts on the bird populations. Oil pollution from shipping in Cork Harbour is a general threat. Recreational activities are high in some areas of the harbour, including jet skiing which causes disturbance to roosting birds.

Cork Harbour has is of major ornithological significance, being of international importance both for the total numbers of wintering birds (i.e. > 20,000) and also for its population of Redshank. In addition, there are at least 15 wintering species that have populations of national importance, as well as a nationally important breeding colony of Common Tern. Several of the species which occur regularly are listed on Annex I of the E.U. Birds Directive, i.e. Whooper Swan, Golden Plover, Bar-Tailed Godwit, Ruff and Common Tern. The site provides both feeding and roosting sites for the various bird species that use it.

Appendix 2.2

Latin and common names of plants are given for all species recorded within or adjacent to the landfill site during the 2009 habitat survey. Species names and nomenclature follow Stace (1997) (*i.e.* that used in *Flora Atlas* (Preston *et al*. 2000), and frequency of occurrence in Ireland follows Webb *et al*. (1996).

Habitats: FL8 (artificial pond); GA1 (improved agricultural grassland); GA2 (amenity grassland); GS (semi-natural grassland); GS2 (dry meadows and grassy verges); WL1 (hedgerows); WL2 (treelines); WS1 (scrub); ER2 (exposed calcareous rock); ED2 (spoil & bare ground); ED3 (recolonising bare ground); BC1 (arable crops); CM1 (lower saltmarsh); CM2 (Upper saltmarsh).

Latin Name	Common Name	Frequency of occurrence in Ireland	Habitat where recorded
Acer pseudoplatanus	Sycamore	Abundant	WL1, WL2
Achillea millefolium	Yarrow	Abundant	GA2, CM2
Agrostis stolonifera	Creeping Bent	Abundant	GA2, CM2,
Anagallis arvensis	Scarlet Pimpernel	Occasional to frequent	ED3, ED2,
Anthyllis vulneraria	Kidney Vetch	Frequent near coast	CM2
Armeria maritima	Thrift	Frequent	CM2, CM1
Arrhenatherum elatius	False Oat-grass	Abundant	GA2, WS1, GS2, GS,
Aster tripolium	Sea Aster	Very frequent	CM2
Atriplex portulacoides	Sea Purslane	Locally abundant E & S, rare W & N	CM1
Atriplex patula	Common Orache	Frequent	CM2
Bellis perennis	Daisy	Abundant	GA2
Beta vulgaris subsp. *maritima*	Sea Beet	Widespread but occasional	CM1, CM2
Blackstonia perfoliata	Yellow-wort	locally frequent in centre, rare in south-west.	ER2
Brassica oleracea	Wild Cabbage	-	ED3, ED2
Buddleja davidii	Butterfly-bush	Frequent in Cork, non-native	WL1, WL1, WS, ER2
Calystegia sepium	Hedge Bindweed	Frequent	ED3, WL1,
Calystegia soldanella	Sea Bindweed	Rare in S & E	CM2
Capsella bursa-pastoris	Shepherd's-purse	Abundant	ED3
Carex species	Sedge species	-	CM2
Centaura nigra	Common Knapweed	Abundant	ED3
Centaurium erythraea	Common Centaury	Very frequent near the sea	ER2, CM2
Cerastium fontanum	Common Mouse-ear	Abundant	ED3
Cirsium vulgare	Spear Thistle	Abundant	WL1,
Chamaerion angustifolium	Rosebay Willowherb	Locally frequent	ED3, WL1
Chenopodium album agg.	Fat-hen	Frequent	ED3, ER2
Cirsium arvense	Creeping Thistle	Abundant	ED3
Cirsium vulgare	Spear Thistle	Abundant	ED3, WL1
Cochleria officinale	Common Scurvey-grass	Frequent	CM2
Crataegus monogyna	Hawthorn	Locally frequent	WL1, WL2
Dactylis glomerata	Cock's-foot	Abundant	GS2, GS
Digitalis purpurea	Foxglove	Very frequent	ED3
Elytrigia repens	Common Couch	Abundant	GS2, GS
Epilobium hirsutum	Great Willowherb	Very frequent	WL1
Fallopia japonica	Japanese Knotweed	Frequent, increasing	ED3, WL1,
Festuca rubra	Red Fescue	Abundant	CM2
Fraxinus excelsior	Ash	Frequent	WL1, WL2
Fumaria officinalis	Common Fumitory	Frequent near the east coast, rarer elsewhere	ED3
Geranium dissectum	Cut-leaved Crane's-bill	Very frequent	ED3
Geranium robertianum	Herb Robert	Abundant	ED3
Geum urbanum	Wood Avens	Frequent	WL
Hedera helix	Ivy	Widespread and abundant	WL
Heracleum sphondylium	Hogweed	Abundant	WS1, WL1
Hieracium sp.	Hawkweed sp.	Frequent	ED3
Holcus lanatus	Yorkshire Fog	Abundant	GA2, ED3, GS

Lactuca serriola	Prickly Lettuce	-	ED3, CM2
Leontodon autumnalis	Autumn Hawkbit	Frequent	ED3, GA2
Leucanthemum vulgare	Oxeye daisy	Abundant	ED3
Limonium humile	Lax-flowered Sea-lavender	Abundant	CM1, CM2
Lolium perenne	Perennial Rye-grass	Abundant	GS
Lonicera periclymenum	Honeysuckle	Frequent and widespread	WL1
Lotus corniculatus	Bird's-foot Trefoil	Abundant	ED3, WL1, CM2
Malus sylvestris	Crab Apple	-	WL2
Malva sylvestris	Common Mallow	Frequent in south	ED3
Matricaria discoidea	Pineappleweed	abundant	ED3
Papaver rhoeas	Common Poppy	Occasional/frequent	ED2 ED3
Parentucellia vicosa	Yellow Bartsia	-	ED3
Petasites hybridus	Butterbur	Frequent but local	WS1, ED3, ED2
Picris echioides	Bristly Oxtongue	Very rare (introduced)	ED3
Plantago coronopus	Buck's-horn Plantain	Very frequent	CM2
Plantago lanceolata	Ribwort Plantain	Abundant	GA2, ED3, GS
Plantago major	Greater Plantain	Abundant	ED2
Plantago maritima	Sea Plantain	Very frequent	CM2, CM1
Poa annua	Annual Meadow-grass	Abundant	ED3, CM2
Polygonum aviculare agg	Knotgrass	Abundant	ED2, ED3,
Poplus sp.	Popular sp.	-	WL2
Potentilla anserina	Silverweed	Abundant	ED3
Potentilla erecta	Tormentil	Abundant	GS2, ED2, ED3,
Potentilla reptans	Creeping Cinquefoil	Frequent in south and centre, rarer in north	CM2
Prunella vulgaris	Self Heal	Abundant	CM2
Pteridium aquilinum	Bracken	abundant	WL1
Puccinella maritima	Common Saltmarsh-grass	Very frequent	CM1, CM2
Ranunculus repens	Creeping Buttercup	Abundant	GA2, ED3,
Reseda luteola	Weld	Frequent	
Rosa canina	Dog Rose	Very frequent	WL1
Rubus fruticosus agg.	Bramble	Abundant	WS1, ED3,
Rumex acetosa	Common Sorrel	Abundant	ED3, GS2,
Rumex obtusifolius	Broad-leaved Dock	Abundant	WS1, ED3,
Sagina maritima	Sea Pearlwort	Occasional	CM2
Sambucus nigra	Elder	Frequent	WL1, WL2
Salicornia species	Glasswort species	Frequent	CM1
Salix sp.	Willow	Frequent	WL1, WL2
Scrophularia nodosa	Common Figwort	Very frequent	ED3,
Senecio jacobaea	Common Ragwort	Abundant	GA2, GS2, WS1, ED3, WL1, ER2
Senecio vulgaris	Groundsel	Very frequent	ED3,
Silene uniflora	Sea Campion	Very frequent	ED3, CM2
Sinapis arvensis	Charlock	Frequent	ED3
Sonchus oleraceus	Smooth Sow-thistle	Frequent	GS2
Sonchus asper	Prickly Sow-thistle	Very frequent	ED3
Spartina anglica	Common Cord-grass	Locally abundant	CM1
Spergularia marina	Lesser Sea-spurrey	Very frequent	CM1, CM2
Stachys sylvatica	Hedge Woundwort	Very frequent	ED3
Stellaria media	Common Chickweed	Abundant	ED2
Suaeda maritima	Annual Sea-blite	Frequent	CM1
Taraxacum officinale	Dandelion	Abundant	GA2
Trifolium pratense	Red Clover	Abundant	WL1
Trifolium repens	White Clover	Abundant	CM2
Triglochin maritimum	Sea Arrowgrass	Very frequent	CM2, CM1
Tripleurospermum inodorum	Scentless Mayweed	Disturbed ground, occasional	ED3
Tripleurospermum maritimum	Sea Mayweed	Very frequent	CM2
Ulex europaeus	Gorse	Abundant	WS1, WL1, ER2
Urtica dioica	Common Nettle	Abundant	ED3, WS1, WL1,
Verbascum thapsus	Great Mullein	Locally frequent in south	WL1
Veronica persica	Common Field-speedwell	Abundant	ED3
Vicia cracca	Tufted Vetch	Abundant	WL1

Appendix 2.3

Terrestrial bird species recorded inside East Cork Landfill and within the surrounding environment.

Birds of conservation concern are listed as per Lynas et al. (2007):- Criteria: SPEC = European conservation status.

Bird Species	Observed inside landfill boundaries	Observed outside landfill boundaries	Listed on Birds Of Conservation Concern (Lynas *et al.,* 2007))
Blackbird *Turdus merula*	*	*	
Blue Tit *Parus caeruleus*	*	*	
Bullfinch *Pyrrhula pyrrhula*		*	
Chaffinch *Fringilla coelebs*	*	*	
Chiffchaff *Phylloscopus collybita*	*	*	
Coal Tit *Parus ater*		*	
Dunnock *Prunella modularis*	*	*	
Goldcrest *Regulus regulus*		*	
Goldfinch *Carduelis carduelis*		*	
Great Tit *Parus major*	*	*	
Greenfinch *Carduelis chloris*	*	*	
Grey Heron			
Grey Wagtail	*		
Hooded Crow *Corvus corone cornix*		*	
Jackdaw *Corvus monedula*		*	
Kestrel *Falco tinnunculus*		*	Amber-list (SPEC)
Linnet *Carduelis cannabina*	*	*	Amber-list (SPEC)
Long-tailed Tit *Aegithalos caudatus*		*	
Magpie *Pica pica*	*	*	
Meadow Pipit *Anthus pratensis*	*	*	
Pheasant *Phasianus colchicus*		*	
Pied Wagtail *Motacilla alba*		*	
Raven *Corvus corax*		*	
Robin *Erithacus rubecula*	*	*	
Rook *Corvus frugilegus*	*	*	
Sand Martin *Riparia riparia*	*	*	Amber-list (SPEC)
Song Thrush *Turdus philomelos*	*	*	
Snipe *Gallinago gallinago*		*	Amber-list (SPEC)
Starling *Sturnus vulgaris*	*	*	Amber-list (SPEC)
Stonechat *Saxicola torquata*		*	
Swallow *Hirundo rustica*	*	*	Amber-list (SPEC)
Willow Warbler *Phylloscopus trochilus*		*	
Wood Pigeon *Columba palumbus*	*	*	
Wren *Troglodytes troglodytes*	*	*	

Appendix 2.4

Mammals confirmed or probably using the landfill and/or surrounding area.

Species	Indication of population	Level of Protection	Likelihood of Presence
American Mink	Found throughout Ireland	None; an exotic species	Probable in surrounding area
Badger	Found throughout Ireland	Irish Red Data Book 'Internationally Important'. Protected under Wildlife Act, 1976 & Wildlife (Amendment) Act 2000	Confirmed in surrounding area
Brown Rat	Found throughout Ireland	None	Confirmed in landfill and surrounding area
Fox	Found throughout Ireland	Considered a pest species; hunted	Confirmed in landfill and surrounding area
Hedgehog	Found throughout Ireland	Irish Red Data Book 'Internationally Important'. Appendix III of the Bern Convention. Protected under Wildlife Act, 1976 & Wildlife (Amendment) Act 2000	Probable in landfill and surrounding area
House Mouse	Found throughout Ireland	None	Probable in landfill and surrounding area
Irish Hare	Found throughout Ireland	Irish Red Data Book 'Internationally important'. Annex V of the Habitats Directive. Appendix III Bern Convention. Protected under Wildlife Act, 1976 & Wildlife (Amendment) Act 2000	Possible in surrounding area
Irish Stoat	Found throughout Ireland	Appendix III of the Bern Convention. Protected under Wildlife Act, 1976 & Wildlife (Amendment) Act 2000	Probable in landfill and surrounding area
Otter	Found throughout Ireland	Irish Red Data Book 'Internationally important'. Annex II & IV of the Habitats Directive. Protected under Wildlife Act, 1976 & Wildlife (Amendment) Act 2000. Appendix II of the Bern Convention	Probable, at least occasionally in surrounding area (as been noted previously)
Pygmy Shrew	Found throughout Ireland	Appendix III of the Bern Convention. Protected under Wildlife Act, 1976 & Wildlife (Amendment) Act 2000	Probable in landfill and surrounding area
Rabbit	Found throughout Ireland	None	Confirmed in landfill and surrounding area
Wood Mouse	Found throughout Ireland	None	Probable in surrounding area
Brown Long Eared Bat	Widely distributed in Ireland	Irish Red Data Book 'Internationally Important'. Annex IV, EU Habitats Directive. Appendix II, Bern Convention.	Probable in surrounding area
Common Pipistrelle	Widely distributed and abundant in Ireland	Irish Red Data Book 'Internationally Important'. Annex IV, EU Habitats Directive. Appendix II, Bern Convention	Probable in surrounding area
Leislers' Bat	Widely distributed and abundant in Ireland	Irish Red Data Book 'Internationally Important'. Annex IV, EU Habitats Directive. Appendix II, Bern Convention	Probable in surrounding area
Soprano Pipistrelle	Widely distributed and abundant in Ireland	Irish Red Data Book 'Internationally Important'. Annex IV, EU Habitats Directive. Appendix II, Bern Convention	Probable in surrounding area

Species	Indication of population	Level of Protection	Likelihood of Presence
Natterer's Bat	Widely distributed but not abundant in Ireland	Irish Red Data Book 'Indeterminate Status'. Annex IV, EU Habitats Directive. Appendix II, Bern Convention	Possible in surrounding area

3.0 INTERTIDAL SURVEY OF ROSSMORE BAY AND PENINSULA

3.1 Introduction

The annual landfill monitoring programme has ensured that the same intertidal sites are sampled every year and the results are therefore comparable across the years. The survey includes the following components:

- An assessment of the fauna and flora of the hard shore and intertidal mudflats of Rossmore Bay, Rossmore Peninsula (North Channel) and the Brick Island Embayment (core sampling and quadrat survey).
- Sediment chemical analysis.
- Sediment particle size analysis (granulometry).

3.2 Methodology

The intertidal survey was undertaken on15/09/2009, 18/09/2009 and 01/10/2009 at locations around Rossmore Peninsula, Rossmore Bay and Brick Island Embayment (Figure 3).

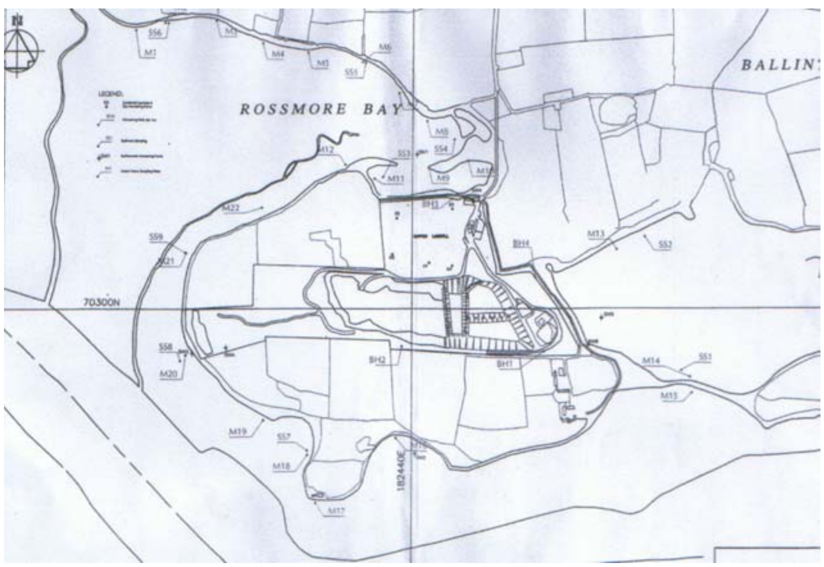


Figure 3 Rossmore Bay and position of intertidal sampling sites. Macrofaunal sampling sites are numbered M1 to M22; sediment sampling sites for chemical analysis are numbered SS1 to SS9 (figure reproduced from Cork County Council).

3.2.1 Core sampling

Core-samples were taken at 22 sites (Sites M1 – M22, Figure 3). The location of each sampling site was determined with a hand-held GPS and cross-referenced with the grid reference from previous annual surveys (Note - the grid reference was taken on the hard shore directly above the mudflat where the cores were taken).

Initially a qualitative assessment was made of each core sampling location. This included recording physical features such as: sediment type (i.e. mud, sandy mud, muddy sand or sand), presence and depth of the anoxic layer, proximity of the river channel and/or drainage channels/creeks, presence of standing water and visible signs of fauna on the sediment surface.

In line with methodology adopted previously, a single core sample was taken from each site. Core sampling followed standard methodology, each sample being taken with a $0.01m^2$ cylindrical core to a depth of 15cm (Dalkin & Barnett, 2001). The samples were sieved within low-tide channels on site using a 0.5-mm mesh stainless steel sieve and placed into labelled, watertight plastic bags for transport.

Laboratory processing began with each sample being washed over a 0.5mm-mesh sieve with tap water to clean the sample. Each sample was placed into a white plastic tray for sorting (visual screening of the tray). Macroinvertebrate species detected by eye were placed into labelled sample storage containers with 70% Ethanol.

Sample identification proceeded with the use of a dissecting microscope (Brunel BZM x10 – x20 zoom stereomicroscope). Identification keys (e.g. Hayward & Ryland, 1995) were consulted where necessary. All invertebrates were subsequently counted and their relative abundance determined.

3.2.2 Rocky shore/upper littoral survey

Sampling of the rocky or upper intertidal habitat was undertaken at the 22 sampling sites used for core sampling (Figure 3). Three replicate quadrats (measuring 0.5m x 0.5m = area $0.25m^2$) were positioned randomly within the mid-shore zone. Within each quadrat, algal cover was recorded as % cover. Fauna were either counted directly (in the case of larger individuals) or recorded as % cover (in the case of barnacles).

The % cover of flora within quadrats is presented as an average within the three quadrats. Similarly, the abundance of barnacles is also presented as average % cover. In the case of other fauna, the average abundance within three quadrats was determined, this then extrapolated to numbers/m^2 and the result presented as per the SACFOR Scale (following the Marine Nature Conservation Review SACFOR Abundance Scale, Connor *et al.,* 2004): S (Superabundant); A (Abundant); C (Common); F (Frequent); O (Occasional); R (Rare).

Marine biotope codes were assigned to sampling sites (both soft sediment and hard shore habitats) as per the Marine Biotope Classification of Britain and Ireland (Connor *et al.,* 2004). A biotope is defined as the 'physical habitat together with its characteristic community of plants and/or animals' (Connor *et al.,* 1997).

3.2.3 Sediment chemical and physical analysis

Sediment samples were taken at 9 No. sampling sites (Figure 3) on 15/09/2009. A single control sample was also taken; sample 10 being a duplicate of sample site 5. Sample site locations were the same as used in previous years; sample locations located using a hand-held GPS (Table 3.1).

Table 3.1 Location of sediment sampling sites as recorded with a hand-held GPS.

Sampling Site	Easting (m)	Northing (m)
1	182966	070163
2	182828	070433
3	182339	070565
4	182500	070650
5	182352	070794
6	181915	070880
7	182186	069992
8	182000	070221
9	181996	070458
10	182352	070794

At each site, small scoops of sediment (to a depth no greater than 10cm) were taken for organic carbon and granulometry analysis. A small sample of surface sediment was taken with a plastic scoop and packaged separately for metals analysis.

All samples were put into clean, sterile, plastic bags and labelled. Samples for chemical analysis were placed into a cool box for transport (via courier) to City Analysts, Dublin. Samples for granulometry analysis were placed into a container and delivered to Aquatic Services Unit (UCC) in Cork.

Laboratory analyses are described in Table 3.2.

Table 3.2 Sediment Chemical and Physical Analyses

PARAMETER	METHOD OF ANALYSIS	UNITS
Granulometry	Sieving	% Coarse Sand (2mm – 710ųm) % Medium Sand (710 ųm – 250 ųm), % Fine Sand (250 ųm - 63 ųm), % Silt/Clay (< 63 ųm)
Organic Carbon	Loss on Ignition (LOI)	%
Kjeldahl Nitrogen	Kjeldahl digestion and automated ammonia analysis	mg/g
Arsenic	Atomic adsorption spectrometry (AAS)	mg/kg
Cadmium	Atomic adsorption spectrometry (AAS)	mg/kg
Chromium	Atomic adsorption spectrometry (AAS)	mg/kg
Copper	Atomic adsorption spectrometry (AAS)	mg/kg
Lead	Atomic adsorption spectrometry (AAS)	mg/kg
Nickel	Atomic adsorption spectrometry (AAS)	mg/kg
Zinc	Atomic adsorption spectrometry (AAS)	mg/kg
Mercury	Atomic adsorption spectrometry (AAS)	mg/kg

3.3 Results & Discussion

3.3.1 Intertidal flora and fauna

Habitats

The 22 intertidal sample locations aim to give a representation of the physical and biological conditions present, ranging from the more exposed sites around the tip of Rossmore Peninsula to the relative shelter of sites within Brick Island Embayment or inner Rossmore Bay. A summary of the physical and biological conditions present at the sites is given in Table 3.3.

As found in previous years, the sites are characterised by an intertidal zone consisting of an upper shore of cobbles/pebbles which extends vertically towards a mudflat. A zonation in particle size from the upper to lower hard shore can be observed at the majority of sites, with the upper shore comprising typically of larger cobbles and pebbles and occasional boulders which become progressively smaller down shore where pebbles and finer gravels dominate the zone just above the mudflat. In some cases there is no clear division between the hard (rock) littoral habitat and the soft (sediment) littoral habitat, as gravels and pebbles merge into the mudflat (e.g. Site M15). Sites M10 and M11 are different in that they have no 'hard' shore and saltmarsh dominates above the mudflat habitat.

For the purpose of this assessment the 'hard shore' intertidal habitat is classified, according to Fossitt (2000) as a 'mixed substrata shore' (LR4). The mudflat habitat varies from 'mud shore' (LS4) to 'muddy sand shore' (LS3). Inner and more sheltered areas such as Rossmore Bay and Brick Island embayment are characterised by soft sediment (silt/clay) as a result of the low energy environment leading to deposition of fine silt/clay particles. These inner areas are also characterised by the presence of Common Cord Grass *Spartina* sp. (See Section 2). More exposed areas, such as the outer Rossmore Peninsula are characterised by coarser sandier particles.

Fauna and flora of the hard shore line

Flora and faunal species recorded during the quadrat survey are presented in Table 3.4.

A common feature of mixed substrata shorelines is the growth of fucoid algae (Fossitt, 2000) as seen at 20 out of the 22 sampling sites, the only two sites where it was not noted was in the saltmarsh dominated habitats of sites M10 and M11. The brown alga Egg Wrack (*Ascophyllum nodosum*) dominated most sites, with varying amounts of Bladder Wrack (*Fucus vesiculosis*) and to a lesser extent Channelled Wrack (*Pelvetia canaliculata*).

The green alga *Enteromorpha* was recorded at six sites upon the hard shore, although its presence was predominantly due to being washed up with the tide. Algal mats of *Enteromorpha* occurred upon the mudflat habitat at nine sites.

As found in previous years, the red alga *Polysiphonia lanosa* occurs as an epiphytic species (growing upon) Egg Wrack around Rossmore Peninsula and was recorded at six of the 22 sites.

Faunal species observed during the quadrat survey of the hard shore included barnacles *Semibalanus balanoides* and *Elminius modestus,* the latter generally being the dominant species*,* Shore crabs (*Carcinus maenas*), Littorinid periwinkles, amphipod crustaceans (Talitridae (Sandhoppers) and Gammaridae). Blue Mussels (*Mytilus edulis*) were recorded at two sites (M16 and M17).

The dominant marine biotopes assigned to the mixed substrata shoreline (hard shore) are similar to those found in previous years as follows:

- ***Ascophyllum nodosum* and *Fucus vesiculosis* on variable salinity mid eulittoral rock' (LR.LLR.FVS.AscVS**) – this biotope describes the dominant macroalgal species recorded but also the faunal community associated with it that includes winkles (*Littorina littorea, L. obtusata),* Barnacles (*Semibalanus balanoides and Elminius modestus*), occasional Mussels (*Mytilus edulis*) and Shore Crabs (*Carcinus maenas*).
- **Ephemeral green and red seaweeds on variable salinity and/or disturbed mixed substrata (LR.FLR.Eph.EphX)** –describes areas where green macroalgae (e.g. *Enteromorpha*) is present in a layer overlying pebbles and cobbles and/or mud/gravel.
- ***Fucus vesiculosis* on mid-eulittoral variable salinity boulders and stable mixed substrata (LR.LLR.Fves.VS)** – describes areas where a distinct zone of Bladder Wrack occurred.

Other observed biotopes include:

- **Saltmarsh (LS.LMp.S**m) – describes the saltmarsh community on the upper shore.
- **Strandline (LS.Lsa.St)** – a line of decomposing seaweed (wrack) left behind by a falling tide.
- **Shingle (pebble) and gravel shores (LS.LCS.Sh)** – a higher biotope code that could be used for areas with no further distinguishing characteristics/species.
- ***Pelvetia canaliculata* on sheltered, variable salinity littoral fringe rock (LR.LLR.FVS.PelVS) –**narrow band of Channel Wrack (*Pelvetia canaliculata*) found occasionally above the macroalgal zone.
- **Yellow and grey lichens on supralittoral rock (LR.FLR.Lic.YG)** – lichens growing on upper shore (supralittoral) rocks.
- ***Verrucaria maura* on littoral fringe rock (LR.FLR.LIV.Ver)** – characteristic black lichen growing on supralittoral rock.

Table 3.3 Overview of macrofauna sampling sites (M1-M22)

Sites	Hard Shore	Lower Mudflat
M1 – M7 Northern shore of Rossmore Bay.	Sites characterised by an upper zone of barren stones and cobbles, a narrow (*c* 0.5m) zone of Channel Wrack (*Pelvetia caniculata*) followed by a zone of Egg Wrack (*Ascophyllum nodosum*) and lesser cover of Bladder Wrack (*Fucus vesiculosis*). Sometimes there is separate zones of Egg Wrack and Bladder Wrack e.g. Site M2 & 3. An algal mat (*Enteromorpha* sp.) was present as the hard shore merges into the soft sediment and was observed within hard shore quadrats at M2 - 4.	Occasional algal mat present (*Enteromorpha* sp.). At M2 - 4 the mat extended out by c15-20m and was approx 3cm in depth. The mat is much reduced in sites M5 – 7 though still present. Epifauna included: *Hydrobia ulvae,* casts of Lugworm (*Arenicola marina*) and visible signs of Ragworm (*Hediste diversicolor*). Worm casts density 1 per 0.25 m^2.
M8 – M9 Inner Rossmore Bay	Upper zone of saltmarsh followed by a zone of washed up *Enteromorpha* that merges into *Egg and Bladder Wrack zone.* As in the previous year there was an abundance of empty bivalve shells below M9 along with red alga *Polysiphonia*.	Patchy algal mat present. Soft mud (silt/clay) sediment. Visible worm holes. Upper mudflat dominated by dense aggregations of juvenile Lugworms (*A. marina*); worm casts density ~ 1 per 0.25 m^2.
M10 – M11 Inner Rossmore Bay	No hard shore present, saltmarsh dominated by Sea Purslane; few cobbles only above M11, no flora or faunal zonation present.	Patchy algal mat present. Soft mud (silt/clay) sediment. Lugworms (*A. marina*) worm casts present at site M10 density ~ 0.5 per 0.25 m^2.
M12 & M16 – M22	Wider shoreline, saltmarsh above, zone of cobbles and pebbles then a zone of Egg Wrack/Bladder Wrack. Egg wrack usually dominates. The red alga *Polysiphonia lanosa* present as an epiphyte upon the Egg Wrack at site M8 & 22.	Sediment varies from soft silt/clay at M12 to muddy sand (silty sand) (e.g. M20, M22). Fauna observed included Lugworm casts, *H. ulvae*, feeding marks of the bivalve *Scrobicularia plana.* Lugworm casts more abundant than most other sites density ~ 2 per 0.25 m but fewer at sites

		M17 & 19 where density ~ 0.5 per 0.25 m
M15 Brick Island	Upper shore boulders & cobbles with saltmarsh above; then a zone of patchy Egg Wrack followed by a zone of Bladder wrack. A mixed wrack zone on the lower shore just above the mudflat. Gravely shore - the gravel extending into the mudflat.	Sandy mud. Lugworm casts present, no algal mat.
M13 & M14 Brick Island Embayment	At both sites, saltmarsh above, dominated by Sea Purslane and Lax-flowered Sea Lavender. M13 exhibits a *c*10m zone of barren cobbles followed by narrow zone of Egg Wrack before the Egg Wrack zone with patchy areas of *Enteromorpha* sp leading out to the mud flat. M14 has a narrow zone of barren cobbles above, followed by a thin zone of Egg and Bladder wrack with patchy *Enteromorpha* sp. then the mudflat.	Soft silt/clay sediment. Some washed-up *Enteromorpha* sp. at both sites.

Table 3.4 Fauna of the hard shoreline of sampling sites M1 – M22.
Flora and Barnacles are presented as average % cover (average cover within 3 replicate quadrats). The red alga *Polysiphonia lanosa* is recorded as present/absent (X). Numbers of other faunal were averaged and then presented as per the SACFOR Scale (see Section 3.2.2). Sites M10 and M11 lack a hard shore and no visible epifauna was recorded.

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Flora																						
(average % cover)																						
Ascophyllum nodosum	87	40	50	30	83	53	85	21	70			54	75	30	54	70	21	45	66	20	75	61
Fucus vesiculosis	13	55	25	23	8	15	2	26				16	20	8	12	15	50	18	25	43	14	25
Enteromorpha sp. (filamentous)		10	15					2	<1				<2	30		< 2			<2			<5
Enteromorpha sp. (ulva type)	<1			2					<1					<5								
Presence/Absence																						
Polysiphonia lanosa			X					X	X				X					X				X
Fauna																						
Barnacles (% cover)	18	5	20	15	7	10	2	<1								< 1	<1		2		2	10
Other fauna (SACFOR Scale)																						
Mytilus edulis			R													R	F					
Amphipods	F	F	C	F	F	O	F	O	O		F	O	O	O	O	F	O		O	O	F	F
Carcinus maenas		F	C	C		C	F		C		C	R				C			R	F	R	C
Littorina spp. (3 species)	F	O		O	O	F	R					C		R	F	O		O	O		F	C
Arenicola marina (Casts)			X												X		X			X	X	X

Flora and fauna of the mudflats

The green macroalga *Enteromorpha* was recorded upon the mudflat at nine sampling sites. Similar to previous years, the mats were, in the majority of cases (M4, M8, M9, M13, M16, M19 & M22), thin and patchy on the mudflat. The exceptions were Sites M2, M3 and M14 which had a mat that was more extensive and thick (5 - 8cm deep).

Core-sample macroinvertebrates recorded within samples are shown in Table 3.5. A total 17 invertebrate taxa were found within the 22 sediment core samples. The major marine macroinvertebrate groups were represented (i.e. Worms, Molluscs and Crustaceans) although worms dominated in terms of diversity (Table 3.6).

Species richness, (a measure of the total number of species or taxa per sample) varied from one to eight across all sampling stations. Species richness was generally highest within Rossmore Bay sites and lower at sites along the southern shore of Rossmore Peninsula (North Channel). This pattern is the same as reported in previous annual monitoring. Invertebrate abundance (number of individuals) was greatest within Rossmore Bay, the exception being site M6 which recorded the joint lowest species abundance along with M15. Overall the 2009 survey results show that species diversity and abundance across the sites is greater than in previous years – 18 of the sites recoded a higher number of species this year in comparison with 2008 and all but one of the sites recorded a greater number of individuals.

Oligochaete worms were the most abundant species with the highest frequency of occurrence being present at 20 of the 22 sites. The second most frequent taxa were Spionidae worms – found within 15 sites (six more sites than recorded in previous annual surveys). These tiny and very fragile worms were identified to family level only as key identifying features such as the palps are lost/damaged easily during the sieving process.

There was also an increase in the number of the Ragworm *Hediste diversicolor*, which was recorded at 11 sites in the current survey, whereas at only 2 sites in 2008. The polychaete worm *Ampharete acutifrons* was found at 8 sampling sites (M1-5, M7, M10 & M22). Numbers found were slightly lower in most of the sites than in 2008, although numbers up to 22 per core (site M4) are regarded as 'superabundant' on the MNCR SACFOR abundance scale.

The crustacean amphipod *Corophium volutator* again showed a clustered distribution within Rossmore Bay being recorded at 7 sites, clustering in numbers around Sites M9 to M12. A with single Corophium amphipod was recorded at sites M5, M17 & M22.

The mud snail *Hydrobia ulvae* was the most abundant and frequent species recorded in 2008, occurring at nine sites. This year it was recorded at eight sites and the numbers and locations remain generally the same as the previous year.

Biotopes assigned to mudflat sampling sites:

Table 3.5 shows the littoral sediment biotopes that were assigned to the core sampling sites. Biotope assignment is not necessarily a straightforward process as in many cases the combination of sediment type and macroinvertebrate species found, do not fit neatly into the classification. In such cases, the biotopes that are the 'best-fit' are used.

Table 3.5 Littoral sediment biotopes assigned to the sampling sites.

Site	Site Overview	Biotope	Rationale
M1 to M11 M12 to M18	Silt clay sediment predominantly (sometimes sandy mud) dominated by polychaete worms, and *Hydrobia ulvae* and oligochaetes.	**LS.Lmu.MEst** Polychaete/bivalve dominated mid estuarine mud shores	An upper biotope code used to describe mid estuarine shores of silt clay or silty mud sediment with rich communities of polychaetes, bivalves & oligochaetes.
M18 – M22	Muddy sand sediment with a diverse range of polychaetes, bivalves, amphipods and gastropods.	**LS.LSa.MuSa** Polychaete/bivalve dominated muddy sand shores	An upper biotope code used to cover a range of biotopes that could occur. Lack of replicated sampling precludes the confident assignment of biotopes.

Table 3.6 Benthic macrofauna recorded in 2009. Abundance per core (numbers/0.01m^2)

Taxa	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22
Phylum Annelida																						
Class Polychaeta																						
Hediste diversicolor	3		1			1	1	1				13	3		1	2					9	2
Hediste diversicolor juv.			2			1		1				10	3									1
Nepthys sp.				2						1		1										1
Nepthys hombergi	1		1																			
Nepthys caecea																	1					
Spionid indent.			7	7	20	4	9	3		11		12	4	6		6	2		3		8	11
Arenicola marina			1							2												1
Ampharete acutifrons	5	2	7	22	6		6			1												1
Class Oligochaeta																						
Oligochaetes	24	13	2	2	3		7	52	70	2		28	17	98	5	3	4	49	8	6	6	4
Phylum Mollusca																						
Class Gastropoda																						
Hydrobia ulvae	6	23	4	2			2													2	8	1
Littorina littorea																					1	
Class Bivalvia																						
Cerastoderma edule		1																			1	
Scrobicularia plana					1												1		1			
Macoma balthica																					1	
Phylum Crustacea																						
Order Amphipoda																						
Corophium volutator					1				34	7	58	6					1					2
Gammarus locusta											2		1									
Order Decapoda																						
Palaemon sp.								1														
Carcinus maenas								1	1				1									
Total No. Individuals	**39**	**39**	**25**	**35**	**31**	**6**	**25**	**59**	**105**	**24**	**60**	**70**	**29**	**104**	**6**	**11**	**9**	**49**	**12**	**8**	**34**	**24**
Total No. Species/taxa	**5**	**4**	**7**	**5**	**5**	**2**	**5**	**5**	**3**	**6**	**2**	**5**	**5**	**2**	**2**	**3**	**5**	**1**	**3**	**2**	**7**	**8**

Intertidal flora and fauna – Discussion

The sampling sites cover two broad habitat types, that of 'hard shore' classified as a 'mixed substrata shore' (Fossitt, 2000), and the lower littoral sediment (mudflat), classified as a 'mud shore.' This combination of 'hard' and 'soft' element to the littoral habitat results in the species diversity being increased above that of a typical mudflat habitat alone. These habitats provide important foraging habitat for wildfowl and wading birds plus a range of other fauna species, including mammals that use this habitat for foraging during both high and low tide periods plus as roosting and resting places.

The species recorded in the current survey included some characteristic infaunal species of a mid-estuarine shore which is subject to variable salinity but does not undergo the extreme changes in salinity which occurs at the head of an estuary where there is a large freshwater input. The 2009 results showed that both species diversity and overall abundance was greater than in 2009 than in recent previous years; higher abundance largely attributed to increased numbers of oligochaetes.

As noted in previous reports, a single core sample at each site may not be reflective of the true diversity or abundances that occur in the site area. Lack of replication also made the assignment of biotopes difficult therefore in the main, higher biotope codes were used to describe the overall community and sediment type.

In 2008 Limosa Environmental undertook a seven year review of the data from previous reports which date back to 2002. The findings of the long term review found that: *'both over a short time period (three years) and a longer time period (seven years) the intertidal flora and fauna of the study area, both hard shore and mudflat, have remained largely stable'.* The 2008 report also noted a *'trend for increasing diversity over the past two years, as evidenced by the core sampling results'*.

This discussion will therefore proceed by comparing the findings of the 2009 results with results from recent annual surveys.

- Hard Shore flora and fauna

The findings of the current survey shows that there as been little change on previous years with the macroalgal community of the mixed substrata shoreline again being dominated by Egg Wrack (*Ascophyllum nodosum*) with variable amounts of Bladder Wrack (*Fucus vesiculosis*). The green macroalga *Enteromorpha* sp. was again present in varying amounts throughout the sampling sites as shown in previous years. Overall the macroalgal community does not appear to have changed in the past three years.

Faunal species diversity of the mixed substrata shore generally shows little change over recent years with largely the same species common present each year. However the current survey did record increases in the densities of some species compared with other recent annual surveys. It is difficult to comment on records prior to 2006 as surveys did not record abundance or densities (only presence or absence) but notable increases include the Shore crab (*Carcinus maenas*) which was recorded at thirteen sites in the current survey, but only in nine sites in 2006, two sites in 2007 and seven sites in 2008. Littorinid Periwinkles were present at 14 of the 22 sites this year, compared with only 8 sites in 2008. Similarly, casts of the Lugworm (*Arenicola marina*) were found at 6 sites in the current survey whereas in 2008 they were recorded at one or two sites.

The core distribution of barnacles has remained generally the same being clustered along the northern shore of Rossmore Bay.

Overall these results may simply reflect natural spatial and temporal variation in the species. However, as the general trend over time as been for increases in species frequency and density, this may also indicate a trend for improvement over time.

- Core sampling macroinvertebrates

The on-going trend is for an increase in species diversity. 17 species were recorded during 2009 compared to 15 species in 2008, 16 species in 2007 and 12 species in 2006.

Species richness was generally highest within the Rossmore Bay sites and lower at sites along the southern shore of Rossmore Peninsula (North Channel) as found in previous annual surveys.

A notable result this year was the relative abundance of species at each site – being generally higher than in previous years.

The most notable increase was in *Oligochaete* worms which were the most abundant and frequently occurring species. Although more numerous than in recent previous years, they were only 'superabundant' in a few sites and in the main would not be classed as a proliferation. Proliferations of oligochaetes can suggest organic enrichment or pollution but this would be at variance with other results found (e.g. sediment organic matter See Section 3.3.2).

Overall the 2009 survey results show that species diversity and abundance across the sites is greater than in previous years – 18 of the sites recoded a higher number of species this year in comparison with 2008 and all but one of the sites recorded a greater number of individuals.

3.3.2 Intertidal sediment analysis

Granulometry

Results of granulometry (sediment particle size) analysis are shown in Table 3.7.

Six out of ten samples taken during 2009 comprised silt-clay sediment (fine mud) the other four sites of sandy silt (sandy mud). Of these, Sites SS1 and SS2 in Brick Island embayment and Sites SS5 and SS6 in Rossmore Bay had the greatest proportion of fine particles (i.e. particles < 63 ɥm in size). Sites SS7 and SS8 had the greatest proportion of fine sand.

The results for Sites SS5 and SS10 are very similar (Site SS10 being a control replicate of SS5).

In general, the visual and physical examination of sediment undertaken during core-sampling field work agrees with the results of the granulometry analysis e.g. Site M21 assigned in the field as 'sandy mud' and adjacent sample Site SS8 is given an assignment of sandy-mud following granulometry analysis.

Table 3.7 Granulometry Results 2009

Site	% Gravel > 2mm	% Coarse Sand 2mm – 710 ɥm	% Medium Sand 710 ɥm – 250 ɥm	% Fine Sand 250 ɥm – 63 ɥm	% Silt/Clay < 63 ɥm	Substrate Type
SS1	0.4	0	0.3	0.2	99.1	Silt-clay
SS2	0	0.1	0.2	11.4	88.3	Silt-clay
SS3	0.8	0.6	1.4	33.3	63.9	Silt-clay
SS4	3.3	0.2	0.7	38.9	56.9	Sandy silt (sandy mud)
SS5	0.3	1.6	0.9	21	76.2	Silt-clay
SS6	0	0.1	0.2	35.8	63.9	Silt-clay
SS7	0	0.7	1.1	43.6	54.6	Sandy silt (sandy mud)
SS8	0	0.2	1.4	42.3	56.1	Sandy silt (sandy mud)
SS9	36.1	6	1.6	13.3	43	Sandy silt (sandy mud)
SS10	0.7	1.6	1.1	18.9	77.7	Silt-clay

Sediment chemical analysis

Results of the sediment chemical analyses are shown in Table 3.8.

Table 3.8 Sediment Chemical Analysis

Parameter	Units	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10
Organic Carbon	%	1.70	2.10	1.90	1.70	1.60	1.50	1.60	1.40	1.80	1.60
Kjeldahl Nitrogen	mg/g N	0.235	0.210	0.970	0.165	0.195	0.058	0.403	0.235	0.045	0.050
Arsenic	mg/kg	6.70	7.70	9.20	5.10	7.10	7.30	6.50	8.20	9.80	6.10
Cadmium	mg/kg	1.2	1.5	1.9	1.0	1.2	1.3	1.1	1.1	1.1	1.3
Chromium	mg/kg	18	21	27	14	17	19	16	17	18	18
Copper	mg/kg	13	16	17	46	20	17	12	11	11	22
Lead	mg/kg	22.13	27.40	42.33	28.88	24.34	26.78	21.01	19.87	19.91	25.01
Nickel	mg/kg	13.2	15.2	19.1	12.0	14.0	16.9	12.2	13.9	13.6	14.3
Zinc	mg/kg	68.9	82.4	102.8	69.0	76.6	83.3	73.6	62.8	63.0	78.5
Mercury	mg/kg	0.36	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35

% Organic Carbon
Carbon is a basic constituent of all organic compounds and the carbon in plant and animal tissue eventually breaks down to become organic matter. Organic content of sediment is closely correlated with sediment particle size; higher organic matter contents being found in muddy sediments (Durrell et al., 2005).

Organic carbon values within the ten sediment samples for 2009 ranged from 1.40% (SS8) to 2.10% (SS2). As values greater than 5% generally indicate a level of organic enrichment (e.g. Hansen & Kristensen, 1997), results of the 2009 sampling suggest a relatively low sediment organic content with no organic enrichment. Although the result for 2009 are slightly higher in some sites than in 2008 that are still significantly lower than reported in other years.

Kjeldahl Nitrogen
Kjeldahl Nitrogen is a measure of ammonia plus organic nitrogen. The un-ionised ammonium ion (NH^3) is regarded as the most toxic form of ammonia and generally increases in aquatic environments with lower levels of dissolved oxygen and reduced salinity. The source of ammonia to tidal waters is linked to sewage treatment plants, agricultural run-off and industrial effluents.

Levels of Kjeldahl Nitrogen found within sediment samples for 2009 ranged from 0.045 mg/g N (SS9) to 0.970 mg/g N (SS3). All of the results are significantly lower across all sites than in any previous years of sampling which may indicate an analysis error. However, this was checked with the laboratory and they confirm the results are correct. The levels recorded are well within the considered normal range for an estuary that is subject to a variety of anthropogenic influences.

Table 3.9 Kjeldahl Nitrogen (mg/g N) - current and previous results.

	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9
2009	0.235	0.210	0.970	0.165	0.195	0.058	0.403	0.235	0.045
2008	1.00	1.00	1.60	1.40	1.30	1.30	2.80	2.40	3.40
2007	1.87	2.28	2.729	2.563	2.008	0.967	2.822	1.531	1.047
2006	1.04	0.98	1.10	0.98	0.98	0.49	1.06	0.66	0.99
2004	1.80	1.25	2.18	2.38	1.70	1.57	2.13	1.50	1.45
2002	1.80	1.25	2.18	2.38	1.70	1.57	2.13	1.50	1.45

Metals

There are no national sediment quality guidelines (SQG's) for *in-situ* marine sediment quality. Therefore the results of the sediment metal analyses were compared against national standards drawn up for dredged sediments (Cronin *et al.,* 2006) and other SQG's drawn up by the Netherlands, UK, Norway, Canada and Australia. These standards are shown in Appendix 3.1.

- Arsenic

All values for arsenic recorded in 2009 sediment samples are below the upper level (Level 2) of the national standard guidance levels for contaminant in dredged sediment. Level 2 defines a contaminant concentration above which biological effects are anticipated to occur (Appendix 3.1). Two samples SS3 and SS9 were slightly above the lower level (Level 1) that defines a concentration of a contaminant in sediment below which biological effects would not be anticipated. With the exception of the stringent Canadian CCME standards (1992), of which SS2, SS8 and SS6 were slightly above the 7.24 mg/kg level and SS3 and SS9 being 9.2 and 9.3 mg/kg respectively, all samples were within the other international guidance levels. Overall, results from 2009 and 2008 are greater than recorded in previous annual surveys (Table 3.10).

Table 3.10 Arsenic levels (mg/kg) - current and previous results.

	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9
2009	6.70	7.70	9.20	5.10	7.10	7.30	6.50	8.20	9.80
2008	4.60	7.20	<1.00	6.30	5.00	9.50	7.30	4.90	6.00
2007	0.313	0.328	0.48	0.237	0.434	0.37	0.113	0.175	0.303
2006	2.21	2.32	1.04	2.68	1.70	2.42	1.90	2.80	2.70
2004	1.88	2.15	3.04	1.67	1.23	0.93	1.17	2.67	0.86

- Cadmium

All sediment samples contained levels below the upper level (Level 2) of the national standard guidance levels for contaminant in dredged sediment of 7.2 mg/kg. However, all were above the 2008 results and the lower level (Level 1) of 0.7 mg/kg,

- Chromium

The chromium results for 2009 range between 14 – 27 mg/kg which are slightly higher than in 2008 but are significantly lower than those recorded in 2007. All values recorded are below all threshold guidance, with the exception of SS2 and SS3 which are slightly higher than the most stringent In-house MAFF levels as shown in Appendix 3.1.

- Copper

All samples except SS4 (46 mg/kg) are below the upper and lower national standard guidance levels for contaminant in dredged sediment. SS5 (20 mg/kg) is slightly above the stringent Canadian CCME standards (18.7 mg/kg) and meeting the UK MAFF In-house threshold values (20 mg/kg). Overall, 2009 results for copper are higher than in 2008 but lower than in 2007.

- Lead

Lead results for 2009 ranged from 19.87 to 42.33 mg/kg. All samples are below the upper and lower national standard guidance levels for contaminant in dredged sediment. Site SS3 had levels above the more stringent UK MAFF in-house guidance threshold (25 mg/kg), Canadian CCME standard 30 mg/kg) and Norwegian standard (<30 mg/kg). A further three samples were also above the UK MAFF in-house guidance threshold. Overall the results are slightly higher than results recorded in previous years.

- Nickel

All results for 2009 are below threshold guidance levels, with the exception of the stringent UK MAFF in-house guidance threshold of 10 mg/kg, of which no sample was below. The results for 2009 are slightly higher than 2008, but generally lower than results recorded in 2007.

- Zinc

2009 results for zinc (range 62.8 – 102.8 mg/kg) are generally within threshold guidance levels, although only SS8 and SS9 were below the UK MAFF in-house guidance threshold of 65 mg/kg. The 2009 results are slightly higher than recent previous years, although significantly lower than levels recorded in 2004.

- Mercury

All sediment samples contained levels below 0.25 mg/kg but analysis is not sensitive enough to ascertain lower levels and hence compare with stringent sediment quality criteria.

Overall conclusions of the chemical sediment analysis

The on-going trend is for a reduction in the levels of organic enrichment at sampling sites within recent years. Whether this trend is a result of changes in landfill procedures (as a result of landfill closure) or a result of other natural and/or anthropogenic factors is difficult to ascertain.

In terms of metals analysis, all samples were below the national guidance levels for contaminant levels in dredged sediment, the upper level of which defines a contaminant concentration above which biological effects are anticipated to occur. Although a few samples were found to be slightly higher than the lower level and the more stringent UK MAFF in-house guidance thresholds and Canadian CCME standards, overall the results are considered to be within acceptable levels and are generally similar to previous years. However, note that a true comparison of trends is difficult as metal levels can be highly variable between years.

One site, SS3, reported the highest levels of Kjeldahl Nitrogen, Organic Carbon and 6 metals out of the 8 metals analysis, with only SS9 having higher level of Arsenic. This finding of high levels across all sediment sample parameters would suggest that this site in Rossmore Bay is being affected by some chemical inputs. In previous years there has been little evidence of this or any individual site having consistently higher levels of metals. Further, and as noted above, metal levels can be highly variable between years due to sediment metal take up and release mechanisms. Therefore it is unclear whether the higher results this year are as a result of external influences impacting this site or small contaminations during the sampling process.

Appendix 3.1

Sediment Quality Guidance Criteria

There are currently no Irish sediment quality guidelines (SQG's) for *in-situ* sediment quality. Therefore, as a national standard, we use the guidance levels for contaminant levels in dredged sediment (Cronin *et al.,* 2006). The lower level (Level 1) defines a concentration (i.e. guidance value) of a contaminant in sediment below which biological effects would not be anticipated. The upper level (Level 2) defines a contaminant concentration above which biological effects are anticipated to occur.

Irish SQG's for dredged sediment (Cronin *et al.,* 2006)

	Units	Lower level	Upper Level
Arsenic	mg/kg^{-1}	9	70
Cadmium	mg/kg^{-1}	0.7	4.2
Chromium	mg/kg^{-1}	120	370
Copper	mg/kg^{-1}	40	110
Lead	mg/kg^{-1}	60	218
Mercury	mg/kg^{-1}	0.2	0.7
Nickel	mg/kg^{-1}	21	60
Zinc	mg/kg^{-1}	160	410

Further SQG's have been developed around the world and we also refer to these in this assessment.

(a) The UK MAFF In-house standards, the Dutch Target values and the Norwegian Classification are all standards for dredged sediment.
(b) The Canadian CCME (1999) and the ANZECC/ARMCANX Guidelines (2000) were published as part of freshwater and marine water quality guidelines.

(a)

	Units	Dutch Target Values	Dutch Intervention Values	UK MAFF In-house	Norwegian Class 1
Arsenic	mg/kg^{-1}	29	55	40	<20
Cadmium	mg/kg^{-1}	0.8	12	0.2	<0.25
Chromium	mg/kg^{-1}	100	380	20	<70
Copper	mg/kg^{-1}	35	190	20	<35
Lead	mg/kg^{-1}	85	530	25	<30
Mercury	mg/kg^{-1}	0.3	10	0.15	<0.15
Nickel	mg/kg^{-1}	35	210	10	<30
Zinc	mg/kg^{-1}	140	720	65	<150

(b)

	Units	Canadian CCME (1992)	Australian ANZECC/ARMCANZ (2000)	
			high	Low
Arsenic	mg/kg^{-1}	7.24	20	70
Cadmium	mg/kg^{-1}	0.7	1.5	10
Chromium	mg/kg^{-1}	52.3	80	370
Copper	mg/kg^{-1}	18.7	65	270
Lead	mg/kg^{-1}	30.2	50	220
Mercury	mg/kg^{-1}	0.13	0.15	1
Nickel	mg/kg^{-1}	-	21	52
Zinc	mg/kg^{-1}	124	200	410

4.0 WATERBIRD SURVEY AND ASSESSMENT

4.1 Methodology

The waterbird assessment scope of works comprises

- Waterbird surveys of two survey zones (Zones A and B) following established methodology for East Cork Landfill annual monitoring:-
  - Zone A covers Rossmore Bay from its innermost reaches westwards to its 'junction' with the North Channel
  - Zone B covers the mudflats partially enclosed by the Brick Island Peninsula (Brick Island Embayment) (Figure 4).

  Surveys were undertaken on 21 October, 5th November, 23rd November and 7th December 2009. On each visit five - six hours of waterbird observations were made, alternating between Zone A and Zone B. The 30-minute observation time was split into 20 minutes for recording observations and 10 minutes for walking between vantage points.

  Waterbird surveys were carried out using a telescope (20-60 x zoom lens) and binoculars (x 50) and in (almost all cases) calm and clear weather conditions.

- Bird surveys of the North Channel including Rossmore Bay and the Brick Island Embayment.

  On two occasions (12th October and 11th December 2009) waterbird surveys were undertaken within four survey zones A-D, as shown in Figure 4. In addition to Rossmore Bay and Brick Island Embayment, this survey also includes a section of the North Channel that lies to the south of Rossmore Peninsula.

- Review of annual count data from the Irish Wetland Bird Survey (I-WeBS) for count areas (sub-sites of Cork Harbour) that are located close to Rossmore Peninsula.

- Consultation of relevant literature and local records pertaining to the study area.

4.2 Overview of Cork Harbour and waterbirds

Cork Harbour is the largest estuarine habitat on the south coast of Ireland. The large expanses of intertidal mudflats and associated wetland habitats of Cork Harbour provide important feeding and roosting areas for migratory wintering wading birds and wildfowl (Smiddy *et al.,* 1995). Consequently the main intertidal areas of Cork Harbour are designated as a Special Protection Area (SPA) (Site Code 4030). The site qualifies for designation because it is an internationally important wetland site under established criteria of the Ramsar Convention Bureau (1984) including that it regularly supports in excess of 20,000 waterbirds during winter.

Currently the sixth most important wetland site in the country, Cork Harbour supported an average 29,509 waterbirds between 2002 and 2007 (Boland et al., 2008). Cork Harbour also supports wintering populations of Golden Plover and Little Egret, species listed on Annex I of the EU Birds Directive together with Little Egret and Common Terns, during the breeding season (Wilson *et al.,* 2000). In addition, the harbour supports nationally or internationally important numbers of several waterbird species during winter.

The Irish Wetland Bird Survey (I-WeBS) has been in place in Ireland since 1994. The primary objective of this and the UK counterpart (WeBS) is to monitor the numbers and distribution of non-breeding waterbirds populations across Britain and Ireland. All major wetland sites are covered and the surveys, undertaken by volunteers, comprise monthly counts of sites between the months of September and March each year.

Cork Harbour has been counted as part of I-WeBS since the beginning (winter 1994/95). As a large complex site, it is subdivided into a number of smaller count sections, of which the North Channel is one. The North Channel is then further subdivided into five smaller count sub-sites:

- North Channel – Ballintubbrid (W 810 702) – the largest sub-site and running directly south of Rossmore peninsula.
- Weir Island (W 810 710)
- Brick Island (W820 700)
- Ballintubbrid (W840 702)
- Rathcoursey & Ahanesk (W870 700)

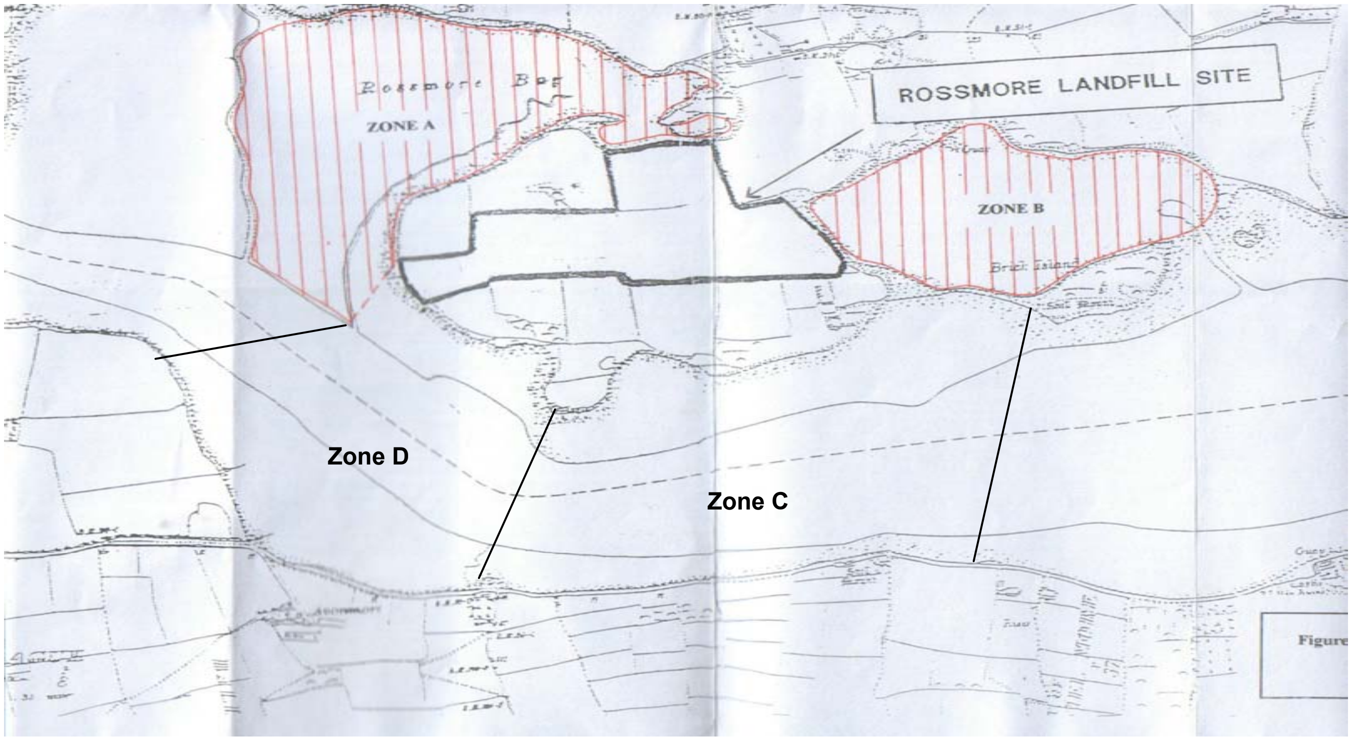


Figure 4 Estuarine Bird Survey Zones A-D

4.3 Data assessment and presentation

Throughout the text, common names are used for bird species. A list of all bird species recorded during the waterbird surveys is shown in Appendix 4.1.

- Data analysis & presentation

Waterbirds were counted and recorded according to the zone within which they were observed. The time of the tidal cycle is important in assessing waterbird presence and distribution. Each replicate count was therefore assigned a tidal period based on the following categories:
Tide 1: Initial tidal ebb
Tide 2: tidal ebb approaching and including low water,
Tide 3: initial tidal inflow, and
Tide 4: tidal inflow approaching high water.

These categories allow some comparisons to be made between counts by only comparing/contrasting species/numbers that occurred during the same tidal period.

A variety of data analyses were undertaken. For the repeat surveys of Zone A and B we calculated mean (average) numbers for selected species observed within the same tidal stages across the count season. These were shown together with peak numbers observed. Note that averaging across a season is slightly erroneous as the species concerned are migratory and numbers therefore will increase from the start of the season. However as only 3 months are involved, we show average numbers by way of representing the 'typical' numbers observed within the count zone but also show the range (min-max).

In the majority of cases, trends were assessed by 'eye-balling' the data. However, when examining trends in waterbird numbers for the North Channel (I-WeBS dataset) we employed an indexing and trend analysis for selected waterbird species. This method is described in Box 4.1.

Box 4.1

Trend analysis was undertaking by first converting the raw count data (annual peak data) into an index number. An index number can be defined as a measure of population size at a specific spatial scale in a year expressed in relation to the size of the population at the same spatial scale in an arbitrarily selected base year (2003/04 in our case) (Leech et al., 2002). Index numbers therefore increase as the number of individuals, relative to the number recorded in the base year, increases. Trends in population size were then compared by comparing index numbers across successive years. Trend analysis was used which simply fitted a trend line or line-of-best-fit to the data points. The equation of that straight line was then obtained ($y = mx + c$). The equation is then used to work out the % difference in index number from the baseline to final data point. The equation *(Yi – Y / Y)*100* is used to calculate the percentage change in index values from one year to the next.

- Legislation and conservation status

In terms of waterbird species conservation importance, the species recorded during the 2009 surveys were assessed in light of national and international legislation and with reference to 'Birds of Conservation Concern in Ireland' (Lynas et al., 2007):

Legislation concerning birds:

Council Directive of 2 April 1979 on the Conservation of Wild Birds (79/409/EEC) ('Birds Directive') :- this directive relates to the conservation of all species of naturally occurring birds in the wild. The directive lays down protection, management and control of these species and lays down rules for their exploitation. The directive applies to the birds, their eggs, nests and habitats.
This legislation is behind the designation of Special Protection Areas (SPAs).
This directive also lists particularly vulnerable bird species on Annex I for whom protection must be given via protection of their habitats.

Wildlife Act, 1976 and Wildlife Amendment Act (2000):- Principal national legislation which protects all bird species, their nests and eggs.

Red Data Lists:

Status of Birds in Ireland: an analysis of conservation concern (Lynas *et al.,* 2007).

The assessment covers all current Irish birds. Several criteria were used to determine population status: global conservation status, European conservation status, decline in population, decline in breeding range, decline in population during non-breeding season, historical decline in breeding population, breeding rarity, localised breeding and non-breeding species and international importance during breeding and non-breeding season.

- Waterbird Population Assessment

Waterbird populations at various spatial scales can be assessed with reference to national and international threshold levels. A site of national importance regularly holds 1% of the estimated national population of a species. A site of international importance is defined as regularly holding 20,000 waterbirds and/or regularly holding 1% of the individuals in a population of a species or subspecies. The same criteria are used to define Ramsar Sites (Ramsar Convention Bureau, 1984).

In the same way, a waterbird species that occurs in numbers that correspond to 1% or more of the individuals in a national population of a species or subspecies are said to occur in 'nationally important numbers.' A waterbird species that occurs in numbers that correspond to 1% or more of the individuals in the worldwide population of a species or subspecies are said to occur in 'internationally important numbers.'

Current population threshold values are published in Crowe et al. (2008) and Wetlands International (2006) (national and international respectively). Therefore waterbird populations that occur across the sites surveyed as part of the annual monitoring of East Cork Landfill can be assessed with reference to these thresholds.

4.4 Survey Results & Discussion

4.4.1 Waterbird species diversity

A list of all waterbird species recorded during the surveys is shown in Appendix 4.1. This reveals that three Annex I species were recorded (Little Egret, Golden Plover & Bar-Tailed Godwit). Six red-listed species and 14 amber-listed species of conservation concern were recorded.

A good range of species were recorded representing several waterbird families: Gaviidae (divers), Podicipedidae (grebes), Anatidae (swans, geese and ducks), Haematopodidae (oystercatchers), Charadriidae (plovers and lapwings), Scolopacidae (sandpipers and allies) and Laridae (gulls and terns). Although, Cormorant, Little Egret and Grey Heron are not strictly waterbirds, they are included within this grouping.

An additional and notable species recorded this year was the Leach's Petrel (*Oceanadroma leucorhoa*). This small dark seabird is classed as a passage visitor (Sept-Oct) and a reasonably rare occurrence within sheltered inshore areas, most likely blown towards land as a result of recent bad storms.

4.4.2 Waterbird surveys around Rossmore Peninsula (Zones A-D)

Data from the two bird surveys covering the four zones (Zones A, B, C & D) are given in Table 4.1. The first count (12th October) was taken around the tidal period of High tide and initial tidal ebb. The second count (11th December) was taken around the tidal period of Low tide and initial tidal inflow. Despite these differences in tidal periods, similar species were observed during both counts; a notable difference being the presence of a single Whimbrel in October. This is a staging species (stop-over on the way to another area) usually observed during autumn and therefore its absence during the December count is not unusual.

The data shows that Zone A (Rossmore Bay) supported more birds on both count occasions, with notably more Oystercatchers and Curlew within this zone than any other. Shelduck, although absent in the October count, were considerable more numerous within Zone A in December than any of the other three zones. This result is not surprising given the wider expanse of intertidal mudflat present within Rossmore Bay, in contrast to the narrower intertidal zone present round the peninsula (Zones C & D). Zone B (Brick Island Embayment) was the second most important count zone in December, largely due to high numbers of Black-tailed godwit and Redshank, but recorded relatively few birds during the October count. One must remember however, that these counts represent single 'snap-shot' views of the waterbird assemblages using the areas

Of note, and as mentioned in the 2008 report, was the significantly lower number of gull species present, in contrast to recent previous years when very large numbers (thousands) were present in the area. This is almost certainly due to the closure of the landfill to waste acceptance; gulls and crows being known to be attracted by active landfills (Watson & Hack, 2000).

Table 4.1 Data from the North Channel bird surveys (including Rossmore Bay and the Brick Island Embayment; Zones A, B, C & D).

	12th October 2009				11th December 2009			
	Zone A	**Zone B**	**Zone C**	**Zone D**	**Zone A**	**Zone B**	**Zone C**	**Zone D**
Time	11.20	13.10	12.32	12.13	08.25	10.20	9.55	9.20
Tidal time	4	1	1	4	3	4	3	3
Great-crested Grebe							2	2
Red-breasted Merganser							2	1
Shelduck					116	11		27
Teal					63	5		10
Cormorant	8	2	16	6	2		5	6
Little Egret	1		3	5	1			
Grey Heron	1		1	1	1			
Oystercatcher	80	11	8	28	69	19	12	15
Ringed Plover						34		
Lapwing								40
Dunlin	45		85	28	40		38	
Black-tailed godwit	9	4	35	23	37	79		12
Whimbrel	1							
Curlew	47	9	5	12	19	7		8
Redshank	13	11	24	20	98	68	19	24
Turnstone		4					34	
Black-headed Gull	30	8	10	13	8		1	2
Lesser Black-backed Gull	4		1					
Herring Gull					2			2
Total No. Species	**11**	**7**	**10**	**9**	**12**	**7**	**8**	**12**
TOTAL	**239**	**49**	**188**	**136**	**456**	**223**	**113**	**149**

4.4.3 Waterbird surveys of Zones A and B

Count data from the repeat surveys of Zone A (Rossmore Bay) and Zone B (Brick Island Embayment) are shown in Appendix 4.2. As Irish Wetland Bird Survey counts focus on high tide waterbird distribution and numbers, we aimed to record waterbird numbers during low water periods, hence the majority of counts are from the tidal stages 1 and 2 (tidal flow approaching LT).

Overall, 18 waterbird species were recorded within Zone A and 21 within Zone B. This is slightly up on last year (16 and 14 species respectively within Zones A and B in 2008) and shows a consistency across the years for which monitoring has taken place. Table 4.2a and 4.2b shows summary data for selected species recorded within Zone A and Zone B during Tidal Stage 2. Data is also shown for 2008. This dataset highlights that looking at average (mean) data alone is erroneous because the counts are highly variable as shown by the large standard deviation and ranges. This data does suggest however, lower numbers of

Black-tailed Godwit within Zone A during the low-tide period than those recorded during 2008. The 2008 report also noted an apparent decline in the numbers of Black-tailed Godwit. Dunlin, although recorded in lower abundance this year are highly variable and their peak number (381) is in a similar range to 2008. Shelduck, Oystercatcher, Curlew and Redshank appear relatively stable within this zone.

Few trends are evident for Zone B, the majority of species highly variable but reasonably stable. However, there is a trend for higher numbers of Dunlin and Redshank within Zone B compared with 2008.

Of note was the record of Lapwing and Golden Plover on one occasion (7th December) within Zone B. These species were not recorded during 2007 or 2008. Both Lapwing and Golden Plover are species that feed within grassland as well as on tidal flats. This variability means that they are not totally reliant on the intertidal system which enables them to range more widely across the wider Cork Harbour site. Lack of observations of these species in recent years is therefore more likely due to the snap-shot surveys simply not recording these species on the survey days, rather than any real change in numbers or distribution.

A further interesting observation was a Snipe roost along the shore of the road leading to Brick Island. This was observed on both 23rd November and 7th December. The Snipe were roosting amongst the wrack (seaweed).

Table 4.2a Mean bird numbers (± SD standard deviation) within **Zone A** during tidal **Stage 2** (tidal ebb approaching and including LT) plus the range (minimum-maximum). Also shows data from 2008 for the same tidal stage. (n) = number of counts.

Species	Mean ± S. D (n) 2009	Range (min-max)		Mean ± S. D (n) (2008)	Peak no (Tidal Stage 2) 2008
Shelduck	14 ± 21 (15)	0 – 62		41 ± 24 (4)	63
Oystercatcher	16 ± 9 (15)	0 – 28		15 ± 6 (4)	25
Dunlin	38 ± 96 (12)	0 - 381		319 ± 179 (3)	526
Black-tailed godwit	1 ± 2 (15)	0 - 6		33 ± 1 94)	35
Curlew	11 ± 5 (15)	0 - 19		4 ± 2 (4)	6
Redshank	56 ± 34 (15)	6 - 112		69 ± 5 (4)	76

Table 4.2b Mean bird numbers (± SD standard deviation) within **Zone B** during tidal **Stage 2** (tidal ebb approaching and including LT) plus the range (minimum-maximum). Also shows data from 2008 for the same tidal stage. (n) = number of counts.

Species	Mean ± S. D (n)	Range (min-max)	Mean ± S. D (n) (2008)	Peak no (Tidal Stage 2) 2008
Shelduck	1 ± 1 (14)	0 - 3	0	0
Oystercatcher	18 ± 5 (14)	0 - 32	8 ± 4 (4)	13
Dunlin	17 ± 35 (14)	0 - 108	2 ± 3 (4)	6
Black-tailed godwit	4 ± 5 (14)	0 - 19	4 ± 4 (4)	9
Curlew	12 ± 3 (14)	8 - 17	4 ± 1 (4)	7
Redshank	61 ± 28 (14)	21 - 105	22 ± 10 (4)	30

Table 4.3 shows the peak number of total waterbirds recorded on each of the survey days. This reveals that on all but one occasion (7th December) Zone A supported more waterbirds than Zone B; not particularly surprising given the greater size (area) of Rossmore Bay in comparison to Brick Island Embayment.

Table 4.3 Peak total waterbirds. Number in brackets refers to the tidal period.

Count Date	Zone A	Zone B
21/10/2009	148 (2)	176 (1)
05/11/2009	256 (3)	127 (2)
23/11/2009	557 (2)	339 (2)
07/12/2009	344 (2)	371 (1)

To examine the data further and to compare across years we extracted the peak numbers of waterbirds recorded within Zones A and B across all tidal stages. This is shown in Table 4.4 with data from previous years for comparison. This data suggests that Shelduck, Dunlin, Curlew and Redshank are relatively stable with no trend for decline apparent within the two count zones. However it also reveals a possible decline in the number of Oystercatchers that occur within Zone A and an apparent decline in the number of Black-tailed Godwits occurring within both zones. Oystercatchers and Black-tailed Godwits can both range widely across a site and both utilise a variety of intertidal and terrestrial habitats (grassland) and hence trends are difficult to confirm. Neither species show a trend for decline at national level (Crowe et al., 2008). However this site-level trend was also noted in 2008 and future monitoring work should continue to assess this pattern.

Table 4.4 Peak numbers of selected waterbird species recorded within Zones A and B during 2009 and in recent previous annual surveys. Red = suggested trend for decline; green = possible increase; blue = stable/no trend. (2008/2009 data - number in bracket refers to tidal period when peak count was recorded).

	2009	2008	2007	2006	2005		2009	2008	2007	2006	2005
	A	A	A	A	A		B	B	B	B	B
Shelduck	62	95	78	97	181		26	71	1	12	15
Oystercatcher	28	46	32	80	233		39	20	22	25	25
Dunlin	381	1300	470	200	685		108	824	29	353	400
Black-tailed godwit	6	35	80	60	30		22	15	18	74	79
Curlew	24	8	16	14	103		22	12	22	21	10
Redshank	110	108	97	139	160		128	69	50	51	40

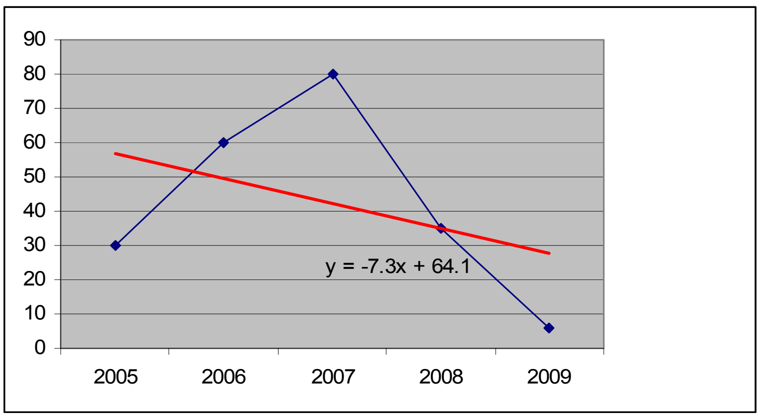


Figure 5. Peak numbers of Black-tailed godwit within Zone A 2005 – 2009. Trend line (line-of-best-fit) also shown in red.

4.4.4 Review of data from the Irish Wetland Bird Survey (I-WeBS)

I-WeBS count sub-sites that are closest to East Cork Landfill are Brick Island (directly east), Ballintubbrid (south) and Weir Island (to the west). The most recent I-WeBS data for these sites (2003/04 – 2007/08) is shown in Appendix 4.2 together with the combined data for the entire North Channel subsite.

Sub-site: North Channel - Ballintubbrid

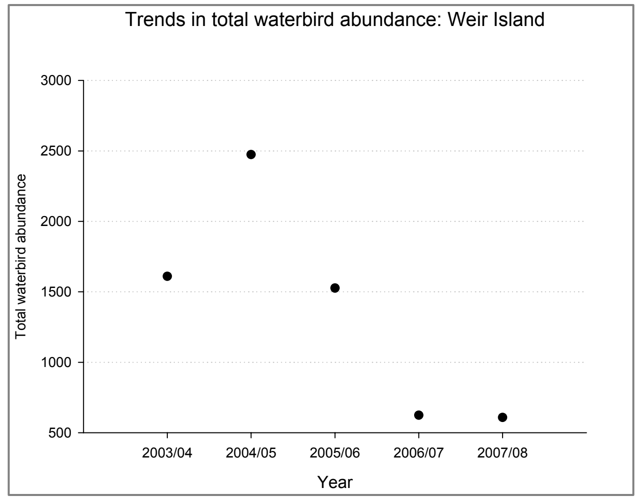
This is the largest sub-site in the North Channel, extending from Ballintubbrid in the east, to Fota Island in the west. This sub-site supports 26 regularly occurring waterbird species including Annex I species Little Egret and Golden Plover. Current data (averaged across the period 2003/04 – 2007/08) shows that two species occur in nationally-important numbers (Shelduck and Red-breasted Merganser) compared with four species that occurred in nationally-important numbers during the period 2002/03 – 2006/07.

Numbers of total waterbirds within this sub-site have been relatively consistent across the period 2004/05 – 2006/07 (at around 2,000 waterbirds) but a lower total abundance in 2007/08 (1,011) has brought the five-year average to 1,824 waterbirds.

Sub-site: Weir Island

Weir Island continues to support 17 regularly-occurring waterbird species according to the recent I-WeBS data (averaged across 2003/04 – 2007/08). The island site is particularly important for Shelduck, Oystercatcher and Dunlin. In line with data from the landfill monitoring, the I-WeBS data also shows a decline in abundance of Lapwing and Golden Plover in recent years.

The average total number of waterbirds also appears to have declined across the recent five-year period as a result of low abundances recorded in the winters 2006/07 and 2007/08.



Sub-site: Brick Island

Brick Island (Zone B in the landfill monitoring survey programme) is an important roost site and intertidal mudflat feeding habitat; particularly as the embayment drains and floods slowly due to the narrow tidal entrance which results in the mudflat being uncovered for longer when the tide ebbs in, than some other intertidal areas close by.

This relatively small sub-site regularly supports 18 waterbird species during winter, the most numerous species being Dunlin, Black-tailed godwits and Redshanks. In terms of overall numbers, the dataset shows great inter-annual variability with no observable trend in either direction.

Entire Count Unit: The North Channel (sub-sites combined)

- Waterbirds that occur in internationally important numbers

Current data (2003/04 – 200/08) shows that the North Channel does not currently support any waterbird species in internationally important numbers. Previous reviews that reported internationally important numbers of Black-tailed godwits were correct at the time but the international threshold has since been raised to 470 birds (Wetlands International, 2006) resulting in the North Channel sub-site wintering population no longer qualifying.

- Waterbirds that occur in nationally important numbers.

Current data shows that the North Channel supports 6 species in nationally important numbers: Shelduck, Wigeon, Red-breasted Merganser, Black-tailed Godwit, Redshank and Greenshank. Pintail and Dunlin were considered of national importance in recent previous years but numbers were recorded in low abundance during 2007/08 which lowered the recent 5-year average to below the national threshold.

- Total waterbird numbers wintering within the North Channel

Recent I-WeBS data shows that the North Channel supports 34 regularly occurring waterbird species during winter, which is consistent with previous years. Four regularly-occurring species are listed on Annex I of the EU Birds Directive: Little Egret, Golden Plover, Bar-tailed Godwit and Kingfisher.

The five-year average of 6,410 total waterbirds equates to approximately 20% of the total wintering (non-breeding) waterbird population of Cork Harbour, hence the North Channel is a very important component of the overall wetland site.

Table 4.5 Total waterbird numbers and the five-year average recorded for the North Channel.

	2003/04	2004/05	2005/06	2006/07	2007/08	Average 2003/04 - 2007/08
North Channel (sub-sites combined)	8, 728	6,293	6,509	4,793	4,956	6, 410

In terms of increasing or decreasing total numbers, data for total waterbirds (above) and particularly the most recent seasons (2006/07 & 2007/08) perhaps suggest a decline in overall numbers. However, examination of longer-term data (from previous annual reports) is not possible because data obtained in previous years did not include total waterbird numbers.

- Waterbird species showing a trend for increase or decrease within the North Channel

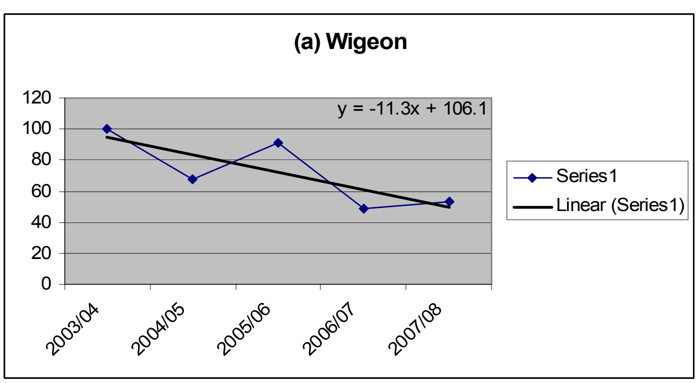
The 2008 ecological report suggested a possible decline in the numbers of Pintail, Dunlin and Black-tailed Godwit within the North Channel. However recent data, suggests Black-tailed godwit numbers are relatively stable; consistent with the national trend for this species. Pintail and Dunlin, together with Wigeon appear, by 'eye-balling' the data, to have declined within the North Channel therefore trend analysis (See Section 4.2 for data analysis methods) was used to examine this trend further.

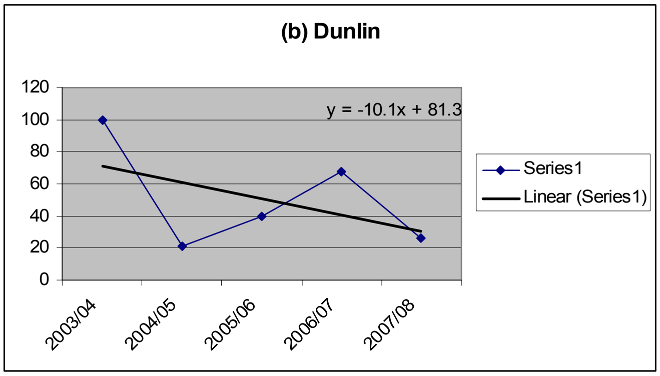
Table 4.6 Mean peak counts of selected waterbirds in the North Channel (2003/04 – 2007/08).

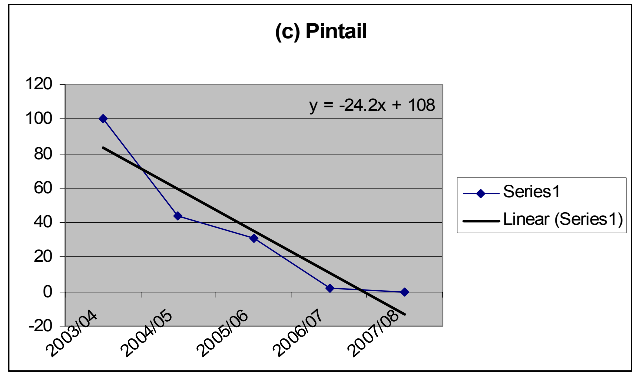
Species	2003/04	2004/05	2005/06	2006/07	2007/08
Little Egret	33	44	34	45	33
Shelduck	798	589	455	446	249
Wigeon	1295	883	1184	631	687
Pintail	45	20	14	1	0
Red-breasted Merganser	44	45	42	35	33
Oystercatcher	661	348	555	320	444
Golden Plover	1560	1264	502	416	882
Lapwing	884	586	997	710	926
Dunlin	1545	318	616	1047	400
Black-tailed Godwit	92	394	287	211	209
Redshank	468	497	468	512	417

Figure 6 a-c shows the results of this analysis and confirms that all three species have declined within the North Channel over the past five years. The percentage change in numbers for the species are as follows: Wigeon (-53%); Dunlin (-62) and Pintail (-112%). It is of note that all three species are also declining on a national

Figure 6. 5-year population trend for (a) Wigeon (b) Dunlin and (c) Pintail within Cork Harbour's North Channel. Trend line (line-of-best-fit) and equation worked on indexed values (See Section 4.2 for methodological details).







- *The relative importance of three sub-sites within the North Channel*

Table 4.6 shows the total annual waterbird numbers and the five-year average for the three North Channel sub-sites considered within this report, plus the North Channel count unit as a whole.

Table 4.7 Total waterbird numbers and the five-year average at the North Channel and at three sub-sites.

	2003/04	2004/05	2005/06	2006/07	2007/08	Average	% Contribution
North Channel – whole site	8, 728	6,293	6,509	5, 556	4,956	6,410	-
North Channel – Ballintubbrid	2,349	1,724	2,121	1,915	1,011	1,824	28
Weir Island	1,610	2,473	1,526	624	608	1,368	21
Brick Island	881	205	322	764	188	472	7

The North Channel – Ballintubbrid sub-site supports on average nearly 30% of the waterbirds in the entire North Channel. Weir Island supports just over 20% and Brick Island, a comparatively smaller sub-site, supports about c 7% of the average numbers of waterbirds in the North Channel as a whole.

Table 4.8 gives average peak counts of selected bird species within the three sub-sites reviewed, together with the average peak counts for the entire North Channel count unit.

This highlights the importance of the North Channel – Ballintubbrid sub-site which supports over 50% of the Shelduck and 47% of the Redshanks recorded in the entire North Channel area. This subsite is also the most important for Pintail and Red-breasted Merganser. Interestingly, Weir Island is the most important subsite for Redshank, supporting 50% of the total North Channel population. This subsite is also the most important for Dunlin.

Table 4.8 Current I-WeBS data (2003/04 – 2007/08) for Cork Harbour North Channel showing average counts of selected bird species within three sub-sites (North-Channel – Ballintubbrid, Weir Island and Brick Island) and the average counts for the North Channel count unit as a whole. * National Importance.

Species	North Channel – Ballintubbrid	Weir Island	Brick Island	North Channel Entire Count Unit
Shelduck	271	122	29	507
Wigeon	237	64	24	936
Pintail	16			16
Red-breasted Merganser	35		1	40
Dunlin	107	245	205	785
Black-tailed Godwit	66	43	36	239
Redshank	227	242	59	478

4.5 Final conclusions of the waterbird surveys and assessment

Waterbird numbers within Zones A and B (Rossmore Bay and Brick Island Embayment) show great variation across the years but the overall trend is for largely stable numbers within these sites. One exception is lower recent numbers of Black-tailed Godwits which is perhaps unusual given that this species shows a trend for increase within Ireland as a whole (Crowe et al., 2008).

More detailed examination of data for the North Channel this year confirms a trend for decline in Wigeon, Pintail and Dunlin. All three of these species are also declining at national level.

Overall, the study area remains one of the most important components of Cork Harbour in regard to its waterbird populations. There are no discernable trends in waterbirds numbers that could be attributed to the presence of East Cork landfill except for the obvious decline in the number of gull species since the landfill closure in 2007.

Appendix 4.1

Waterbird species recorded during the waterbird counts undertaken across the survey area, 2009

Birds of Conservation Concern – Criteria: IUCN (Global conservation status), SPEC (European conservation status); BDp, BDMp (decline in population); BDr, BDMr (decline in breeding range); WDp, WDMp (decline in population during non-breeding season); HD (historical decline in breeding population); BR (breeding rarity); BL (localised breeding); WL (non-breeding species); BI (international importance during breeding season); WI (international importance during non-breeding season).

Bird Species	Listed on Birds Of Conservation Concern (Lynas *et al.,* 2007)	Listed on Annex I of EU Birds Directive (79/409/EEC)
Bar-tailed Godwit *Limosa lapponica*	Red-list (BDp, BDr)	*
Black-Headed Gull *Larus ridibundus*	Red-list (BDp, BDr)	
Black-tailed Godwit *Limosa limosa*	Amber-list (SPEC, WL)	
Common Gull *Larus canus*	Amber-list (SPEC, BDMr, BL)	
Cormorant *Phalacrocorax carbo*	Amber-list (BL)	
Curlew *Numenius arquata*		
Dunlin *Calidris alpina*	Amber-list (SPEC, WL)	
Golden Plover *Pluvialis apricaria*	Red-list (BDp)	*
Great Black-backed gull *Larus marinus*	Amber-list (BDMp)	
Great Crested Grebe *Podiceps cristatus*	Amber-list (WL)	
Grey Heron *Ardea cinerea*		
Greenshank *Tringa nebularia*	Amber-list (BR, WI)	
Herring Gull *Larus argentatus*	Red-list (BDp)	
Lapwing *Vanellus vanellus*	Red-list (BDp)	
Lesser Black-backed gull *Larus fuscus*	Amber-list (BL)	
Little Egret *Egretta garzetta*		*
Mallard *Anas platyrhynchios*		
Mute Swan *Cygnus olor*		
Oystercatcher *Haematopus ostralegus*	Amber-list (WL)	
Red-breasted Merganser *Mergus serrator*		
Redshank *Tringa totanus*	Red-list (HD, SPEC, WL)	
Ringed Plover *Charadrius hiaticula*	Amber-list (WI)	
Shelduck *Tadorna tadorna*	Amber-list (WL)	
Snipe *Gallinago gallinago*	Amber-list (SPEC)	
Teal *Anas crecca*	Amber-list (BDMr)	
Turnstone *Arenartia interpres*		
Whimbrel *Numenius phaeopus*		
Wigeon *Anas penelope*	Amber-list (WL)	

Appendix 4.2

Waterbird Survey Data

Data tables show waterbird species recorded together with the time of survey, tidal time and the stage of the tide.

21st October 2009	A	A	A	A	A	A	B	B	B	B	B	B
Count Time	10:20	11:20	12:20	13:20	14:20	15:20	10:50	11:50	12:50	13:50	14:50	15:50
Time of High Tide (Cobh)	07:52	07:52	07:52	07:52	07:52	07:52	07:52	07:52	07:52	07:52	07:52	07:52
Time of Low Tide (Cobh)	14:20	14:20	14:20	14:20	14:20	14:20	14:20	14:20	14:20	14:20	14:20	14:20
Tidal state at count	1	2	2	2	2	3	1	2	2	2	3	3
Little Egret	1	0	2	2	0	2	0	1	1	2	2	3
Grey Heron	0	0	0	1	1	1	0	0	0	0	1	0
Shelduck	0	0	4	4	4	0	0	0	0	0	0	0
Wigeon	0	0	0	0	0	0	0	1	0	0	0	0
Red-breasted Merganser	0	0	0	0	0	0	1	0	0	0	0	0
Oystercatcher	26	7	2	0	5	8	39	32	13	19	28	32
Ringed Plover	0	0	3	4	0	0	0	3	8	7	7	7
Dunlin	0	0	0	38	25	4	0	1	3	4	3	4
Black-tailed Godwit	2	2	3	6	6	0	18	6	3	0	3	2
Curlew	4	2	9	11	11	19	22	15	8	13	17	12
Redshank	26	36	53	66	59	96	83	28	54	36	36	65
Greenshank	0	1	2	4	0	0	3	3	1	0	2	2
Turnstone	81	27	64	0	0	8	0	0	0	0	12	0
Black-headed Gull	7	4	5	4	3	6	7	5	7	7	10	7
Common Gull	0	0	1	0	0	0	2	1	0	0	0	0
Lesser Black-backed Gull	0	0	0	0	0	0	0	0	0	0	3	0
Great Black-backed Gull	0	0	0	0	0	0	1	0	0	0	1	1
Totals	**147**	**79**	**148**	**140**	**114**	**144**	**176**	**96**	**98**	**88**	**125**	**135**

5th Nov 2009	A	A	A	A	A	A	B	B	B	B	B	B
Count Time	10:00	11:00	12:00	13:00	14:00	15:00	10:30	11:30	12:30	13:30	14:30	15:30
Time of High Tide (Cobh)	06:31	06:31	06:31	06:31	06:31	06:31	06:31	06:31	06:31	06:31	06:31	06:31
Time of Low Tide (Cobh)	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00	13:00
Tidal state at count	2	2	2	2	3	3	2	2	2	3	3	3
Cormorant	1	0	0	1	7	0	0	0	0	0	0	0
Little Egret	0	0	0	0	1	1	0	0	0	1	0	1
Shelduck	0	0	3	8	9	9	0	0	2	2	0	0
Red-breasted Merganser	0	0	0	0	0	0	9	0	0	0	0	0
Oystercatcher	26	15	13	16	18	25	20	17	16	17	17	19
Ringed Plover	19	29	30	24	29	23	0	0	0	0	0	0
Dunlin	24	0	1	0	1	15	0	0	0	0	0	3
Snipe	1	0	0	0	0	0	0	0	0	0	0	0
Black-tailed Godwit	0	0	0	0	0	0	0	2	0	2	2	0
Curlew	10	19	15	11	19	24	11	12	10	8	7	10
Redshank	53	85	64	15	90	110	66	25	35	41	17	27
Greenshank	1	1	0	0	0	0	2	0	0	1	0	2
Turnstone	0	12	13	0	48	47	0	0	0	0	0	2
Black-headed Gull	4	2	2	2	5	2	12	31	5	3	3	4
Common Gull	2	3	1	0	0	0	7	1	2	0	1	0
Lesser Black-backed Gull	0	0	0	0	0	0	0	0	0	1	0	0
Totals	**141**	**166**	**142**	**77**	**227**	**256**	**127**	**88**	**70**	**76**	**47**	**68**

23rd November 2009	A	A	A	A	A	B	B	B	B	B
Count Time	11:33	12:33	13:33	14:33	15:33	12:03	13:03	14:03	15:03	16:03
Time of High Tide (Cobh)	09:07	09:07	09:07	09:07	09:07	09:07	09:07	09:07	09:07	09:07
Time of Low Tide (Cobh)	15:33	15:33	15:33	15:33	15:33	15:33	15:33	15:33	15:33	15:33
Tidal state at count	1	2	2	2	2	2	2	2	2	3
Great Crested Grebe	0	0	0	0	0	1	1	1	1	1
Leach's Petrel	1	0	0	0	0	0	0	0	0	0
Cormorant	0	0	0	0	0	0	1	0	0	0
Little Egret	0	1	1	0	1	1	1	0	0	2
Grey Heron	0	0	1	0	0	0	0	0	0	0
Mute Swan	0	0	0	0	0	1	1	0	0	0
Shelduck	0	0	4	34	31	3	2	0	0	0
Wigeon	0	4	31	28	21	7	4	0	0	0
Red-breasted Merganser	0	0	0	0	0	5	2	0	0	2
Oystercatcher	27	28	28	18	24	9	15	18	21	26
Ringed Plover	0	12	22	2	22	21	8	0	0	0
Dunlin	0	0	51	0	381	108	89	6	0	0
Snipe	0	0	0	0	0	1	0	10	12	18
Bar-tailed Godwit	0	0	0	0	0	1	1	2	0	0
Curlew	5	3	6	13	22	17	17	16	14	2
Redshank	17	9	6	25	50	101	105	93	21	37
Greenshank	2	0	0	1	0	4	0	1	0	2
Turnstone	6	57	1	26	3	46	0	0	0	0
Black-headed Gull	2	1	0	0	0	12	3	1	1	1
Common Gull	0	0	0	1	1	0	0	0	2	0
Great Black-backed Gull	0	0	0	0	1	1	0	1	0	0
Totals	**60**	**115**	**151**	**148**	**557**	**339**	**250**	**149**	**72**	**91**

7th December 2009	A	A	A	A	A	B	B	B	B	B
Count Time	10:54	11:54	12:54	13:54	14:54	11:24	12:24	13:24	14:24	15:24
Time of High Tide (Cobh)	08:54	08:54	08:54	08:54	08:54	08:54	08:54	08:54	08:54	08:54
Time of Low Tide (Cobh)	15:25	15:25	15:25	15:25	15:25	15:25	15:25	15:25	15:25	15:25
Tidal state at count	1	1	2	2	2	1	2	2	2	2
Great Crested Grebe	0	0	3	0	0	0	0	0	0	0
Cormorant	0	0	2	5	4	1	2	1	0	0
Little Egret	0	0	1	1	1	0	1	0	0	0
Shelduck	2	0	62	56	0	26	4	2	2	2
Wigeon	0	58	73	69	49	14	14	14	14	14
Mallard	0	0	0	4	0	0	0	0	0	0
Red-breasted Merganser	0	0	0	0	0	2	2	2	0	0
Oystercatcher	1	19	24	28	19	21	13	17	20	24
Ringed Plover	0	2	5	33	33	0	26	7	0	0
Golden Plover	0	0	0	0	0	0	38	75	0	0
Lapwing	0	0	0	0	0	0	4	3	3	3
Dunlin	0	4	44	12	6	88	14	23	0	1
Snipe	0	0	0	0	0	0	5	10	13	13
Black-tailed Godwit	1	0	0	0	0	22	7	0	19	12
Bar-tailed Godwit	0	0	0	0	0	0	1	0	1	0
Curlew	2	4	16	13	18	9	11	14	7	11
Redshank	25	48	97	110	112	128	85	73	69	71
Greenshank	1	2	2	1	0	2	1	1	0	1
Turnstone	0	31	0	0	17	34	28	0	0	0
Black-headed Gull	4	3	3	7	4	19	1	4	1	1
Common Gull	0	1	0	1	0	5	0	0	0	0
Great Black-backed Gull	0	0	2	4	0	0	0	0	0	0
Totals	**36**	**172**	**334**	**344**	**263**	**371**	**257**	**246**	**149**	**153**

Appendix 4.3

Data from the Irish Wetland Bird Survey (I-WeBS) (provided by BirdWatch Ireland)

I-WeBS

Weir Island

Species	1% National	1% International	2003/04	2004/05	2005/06	2006/07	2007/08	Peak	Mean
Mute Swan	110	110					2	2	0
Shelduck	150	3,000	174	151	106	92	89	174	122
Wigeon	820	15,000	102	87	42	38	50	102	64
Teal	450	5,000	2	27	34	8	2	34	15
Mallard	380	20,000	2		3	2	2	3	2
Little Grebe	25	4,000				3		3	1
Great Crested Grebe	55	3,600		1				1	0
Cormorant	140	1,200		1	6	1		6	2
Little Egret		1,300	3	5	2	2	8	8	4
Grey Heron	30	2,700	3	1	1	1	1	3	1
Oystercatcher	680	10,200	297	156	243	153	83	297	186
Ringed Plover	150	730	4				2	4	1
Golden Plover	1,700	9,300		1224				1,224	245
Grey Plover	65	2,500	1					1	0
Lapwing	2,100	20,000	148	32	210			210	78
Knot	190	4,500	12		60	6		60	16
Curlew Sandpiper				1				1	0
Dunlin	880	13,300	536	243	314	132		536	245
Snipe		20,000			1	2	4	4	1
Black-tailed Godwit	140	470	62	62	68	6	16	68	43
Curlew	550	8,500	36	120	73	47	12	120	58
Greenshank	20	2,300	2	6	1	1		6	2
Redshank	310	3,900	196	334	335	87	259	335	242
Turnstone	120	1,500	30	22	27	43	78	78	40
Total Wildfowl & waders			**1,610**	**2,473**	**1,526**	**624**	**608**	**2,473**	**1,368**

Brick Island

Species	1% National	1% International	2003/04	2004/05	2005/06	2006/07	2007/08	Peak	Mean
Shelduck	150	3,000	2	3	37	81	21	81	29
Wigeon	820	15,000	36	25	6	18	33	36	24
Teal	450	5,000	15	12	42	4	11	42	17
Mallard	380	20,000		2	18		2	18	4
Red-breasted Merganser	35	1,700	2		2	2		2	1
Great Crested Grebe	55	3,600	1		1	1		1	1
Cormorant	140	1,200	2	1	1		1	2	1
Little Egret		1,300	1	1	1	2	6	6	2
Grey Heron	30	2,700		1			1	1	0
Oystercatcher	680	10,200	11	7	9	14	14	14	11
Lapwing	2,100	20,000	103	24	36	70		103	47
Dunlin	880	13,300	590		70	367		590	205
Snipe		20,000	2		16		6	16	5
Black-tailed Godwit	140	470	36	14	8	87	33	87	36
Curlew	550	8,500	24	10	9	6	10	24	12
Greenshank	20	2,300	5	3	2	6	2	6	4
Redshank	310	3,900	51	64	27	106	47	106	59
Turnstone	120	1,500		38	36		1	38	15
Kingfisher					1			1	0
Total Wildfowl & waders			**881**	**205**	**322**	**764**	**188**	**881**	**472**

* Note there has been a taxonomic change within the wildfowl, which are now headed by swans and geese.

The counts presented in the table refer to the peak counts of species in each I-WeBS season.
Site peak and mean are calculated as the peak and mean of peak counts respectively over the seasons specified. Blank cells within columns which contain positive values for one or more species constitute zero for those species.

Cork Harbour subsites (Rathcoursey & Ahanesk, Weir Island, Ballintubbrid, Brick Island and North Channel – Ballintubbrid) combined

Species	1% National	1% International	2003/04	2004/05	2005/06	2006/07	2007/08	Peak	Mean
Mute Swan	110	110	7	2	4	2	2	7	3
Canada Goose					1			1	0
Shelduck	150	3,000	798	589	455	446	249	798	507
Wigeon	820	15,000	1,295	883	1,184	631	687	1,295	936
Gadwall	20	600	2					2	0
Teal	450	5,000	247	493	507	242	168	507	331
Mallard	380	20,000	160	97	135	109	51	160	110
Pintail	20	600	45	20	14	1		45	16
Shoveler	25	400	4	13	2	4	5	13	6
Tufted Duck	370	12,000					2	2	0
Eider	30	12,830	1		1	1		1	1
Goldeneye	95	11,500					1	1	0
Red-breasted Merganser	35	1,700	44	45	42	35	33	45	40
Great Northern Diver		50				1	2	2	1
Little Grebe	25	4,000	10	18	12	14	15	18	14
Great Crested Grebe	55	3,600	41	29	44	31	41	44	37
Cormorant	140	1,200	244	81	58	91	62	244	107
Shag							7	7	1
Little Egret		1,300	33	44	34	45	35	45	38
Grey Heron	30	2,700	25	34	37	35	16	37	29
Moorhen	20		2	2	2	1	1	2	2
Coot	330	17,500	9					9	2
Oystercatcher	680	10,200	661	348	555	320	444	661	466
Ringed Plover	150	730	6		8	13	2	13	6
Golden Plover	1,700	9,300	1,560	1,264	502	416	882	1,560	925
Grey Plover	65	2,500	7	1	3	6	5	7	4
Lapwing	2,100	20,000	884	586	997	710	927	997	821
Knot	190	4,500	12		60	55		60	25
Curlew Sandpiper				2	3	1		3	1
Dunlin	880	13,300	1,545	318	616	1,047	400	1,545	785
Ruff		12,500	1					1	0
Snipe		20,000	38		28	14	11	38	18
Black-tailed Godwit	140	470	92	394	287	211	209	394	239
Bar-tailed Godwit	160	1,200		1	20	2		20	5
Whimbrel		2,000			2	1		2	1
Curlew	550	8,500	391	433	347	436	171	436	356
Spotted Redshank		900				1		1	0
Greenshank	20	2,300	25	25	20	33	17	33	24
Redshank	310	3,900	468	497	468	542	417	542	478
Turnstone	120	1,500	71	74	61	59	104	104	74
Mediterranean Gull						1		1	0
Black-headed Gull		20,000	1,321	72		50		1,321	289
Common Gull		16,000	62	46				62	22
Lesser Black-backed Gull		4,500	185	242		29		242	91
Herring Gull		13,000		7		57		57	13
Great Black-backed Gull		4,800	55	30		7		55	18
Sandwich Tern						2		2	0
Kingfisher				1	2		1	2	1
Total Wildfowl & waders			**8,728**	**6,293**	**6,509**	**5,556**	**4,966**	**8,728**	**6,410**

* Note there has been a taxonomic change within the wildfowl, which are now headed by swans and geese.

The counts presented in the table refer to the peak counts of species in each I-WeBS season.
Site peak and mean are calculated as the peak and mean of peak counts respectively over the seasons specified. Blank cells within columns which contain positive values for one or more species constitute zero for those species.

I-WeBS

North Channel - Ballintubbrid

Species	1% National	1% International	2003/04	2004/05	2005/06	2006/07	2007/08	Peak	Mean
Mute Swan	110	110	7		2			7	2
Shelduck	150	3,000	514	258	264	311	8	514	271
Wigeon	820	15,000	403	226	338	210	8	403	237
Gadwall	20	600	2					2	0
Teal	450	5,000	110	193	196	87	3	196	118
Mallard	380	20,000	19	18	9	43	17	43	21
Pintail	20	600	45	20	14	1		45	16
Shoveler	25	400	2	2				2	1
Tufted Duck	370	12,000					2	2	0
Eider	30	12,830	1		1	1		1	1
Red-breasted Merganser	35	1,700	38	45	32	33	25	45	35
Great Northern Diver		50				1	2	2	1
Little Grebe	25	4,000	2	6	4	4		6	3
Great Crested Grebe	55	3,600	16	24	37	29	29	37	27
Cormorant	140	1,200	24	22	15	31	21	31	23
Shag							3	3	1
Little Egret		1,300	19	20	17	27	6	27	18
Grey Heron	30	2,700	12	14	21	25	6	25	16
Coot	330	17,500	9					9	2
Oystercatcher	680	10,200	343	143	225	161	280	343	230
Ringed Plover	150	730	6					6	1
Golden Plover	1,700	9,300	3			2		3	1
Grey Plover	65	2,500	4		3	2	1	4	2
Lapwing	2,100	20,000	46	170	250	26	264	264	151
Knot	190	4,500				55		55	11
Dunlin	880	13,300	121	50	200	45	120	200	107
Snipe		20,000	2		2			2	1
Black-tailed Godwit	140	470	15	50	50	148	65	148	66
Bar-tailed Godwit	160	1,200			8			8	2
Whimbrel		2,000			1	1		1	0
Curlew	550	8,500	260	207	134	295	46	295	188
Greenshank	20	2,300	15	8	8	16	10	16	11
Redshank	310	3,900	270	216	260	331	56	331	227
Turnstone	120	1,500	41	32	30	30	39	41	34
Mediterranean Gull						1		1	0
Black-headed Gull		20,000	1321	72		50		1,321	289
Common Gull		16,000	62	46				62	22
Lesser Black-backed Gull		4,500	185	242		29		242	91
Herring Gull		13,000		7		57		57	13
Great Black-backed Gull		4,800	55	30		7		55	18
Sandwich Tern						2		2	0
Common Tern									
Total Wildfowl & waders			**2,349**	**1,724**	**2,121**	**1,915**	**1,011**	**2,349**	**1,824**

* Note there has been a taxonomic change within the wildfowl, which are now headed by swans and geese.

The counts presented in the table refer to the peak counts of species in each I-WeBS season.
Site peak and mean are calculated as the peak and mean of peak counts respectively over the seasons specified. Blank cells within columns which contain positive values for one or more species constitute zero for those species.

5.0 REVIEW OF SHELLFISH DATA

5.1 Background to Shellfish Monitoring

To ensure the quality of shellfish for human consumption, Ireland has put in place a number of controls in relation to waters used for shellfish cultivation and harvesting (Lucey, 2007). Up until 2006 these controls were driven by European Communities (Live Bivalve Molluscs) (Health Conditions for Production and Placing on the Market) Regulations of 1996 (S.I. No. 147 of 1996) which implemented the EU Directive 91/492/EEC. On the 1st January 2006 these regulations were replaced by EC Hygiene Regulations 'laying down specific rules for food of animal origin' (Nos. 852/853/854 of 2004).

The Shellfish Waters Directive 2006/113/EC and earlier Directive 79/923/EEC, on the quality required of shellfish waters was implemented into Ireland by EC (Quality of Shellfish Waters) Regulations of 2006 (S.I. No. 268 of 2006). The aim of the Shellfish Waters Directive is to protect and/or improve shellfish waters in order to support shellfish life and growth. It is designed to protect the aquatic habitat of bivalve and gastropod molluscs, which include oysters, mussels, cockles, scallops and clams. The regulations set out waters that are to be designated as 'shellfish growing areas' and the requirements for seawater sampling and monitoring of trace metals and organohalogens from designated shellfish waters. Physical, chemical and microbiological sampling requirements that designated shellfish waters must either comply with or endeavor to improve, are also set under the regulations.

In February 2009 the European Communities (Quality of Shellfish Waters) (Amendment) Regulation 2009, (SI 55 of 2009), provided for an additional 49 designated shellfish growing areas. Under the 2009 Regulations, Cork Harbour's Great Island North Channel is now legally designated as a shellfish growing area and is required to meet the monitoring requirement set out in S.I. No. 268 of 2006. Although prior to this Cork Harbour had not been legally designated, regular monitoring of the waters had been undertaken by the Marine Institute for a number of years.

In accordance with the above EU Directives and National legislation, Ireland carries out ongoing programmes for monitoring shellfish, their waters and shellfish growing and harvesting operations, including:

- **Contaminants in shellfish and shellfish waters** – monitoring is undertaken annually by the Marine Institute in part fulfilment of EU Directive (91/492/EEC) that controls the production and public sale of live bivalve molluscs and EU Directive (79/923/EEC) that is concerned with the quality of shellfish waters. Contaminants include trace metals, Polychlorinated biphenyls (PCB's) and Organochlorines (OCP's).

- **National Marine Biotoxin Monitoring Programme (DCMNR/FSAI)** – under Council Directive 853/2004, Ireland is required to monitor shellfish harvesting areas for the presence of toxins produced by some species of phytoplankton. The Programme covers the toxins, Diarrhetic Shellfish Poisoning (DSP), Azaspiracid poisoning (AZP), Paralytic Shellfish Poisoning (PSP) and Amnesic Shellfish Poisoning (ASP). Other toxins are also tested for on an ongoing basis. Under the Council Directive live bivalve molluscs, echinoderms, tunicates and marine gastropods (e.g. whelks and periwinkles) must be tested for biotoxins, this includes both commercially farmed and wild species.

  In Ireland the main bivalve species are mussels, native and pacific oysters, razorfish, scallops, clams and cockles. The Department of Communications, Marine and Natural Resources (DCMNR) is contracted by the FSAI to implement the Marine Biotoxin Monitoring Programme. The Marine Institute is the National Biotoxin Reference Laboratory and carries out marine biotoxin testing on behalf of the DCMNR.

- **Microbiological quality of shellfish waters** - the Sea Fisheries Protection Authority (SFPA) implements EU Directives on the quality of shellfish waters. European Regulations Nos. 852/2004, 853/2004 and 854/2004 have surpassed EU Directive 91/492/EEC in laying down the conditions for the production and public sale of live bivalve molluscs. In addition shellfish harvesting areas are required to be classified according to the shellfish microbiological standards: Class A (no restrictions; can be collected for direct human consumption); Class B (depurated, heat treated or relayed to meet Class A standards), Class C (relay in a clean area for at least 2 months prior to sale), Class D (harvesting prohibited).

5.2 Review of data for Cork Harbour North Channel

5.2.1 Contaminants in shellfish and shellfish waters

The level of contaminants within shellfish tissue is a good indicator of levels present within the water column, therefore providing valuable information as to the quality of the shellfish and the waters in which they were grown (Boyle *et al.,* 2006). While metals such as zinc, copper, iron, nickel and chromium are natural components of biological tissues, others such as mercury, lead and arsenic have no known biological role. Any metal however, if present at a sufficiently high level can pose a toxicological threat (Marine Institute, 1999).

Up until 2006 data on trace metal concentrations in shellfish were published annually as a Marine Institute Publication '*Trace metal concentrations in shellfish from Irish waters,* Marine Environment and Health Series.' Since then data has been obtained directly from the Marine Institute under Licence Agreement Number 2008/216 dated 14/10/2008.

The data received for the North Channel (2008 data, Appendix 5.1) was compared with the available reference (guidance) limits presented within Table 5.1. Based on this comparison the recorded levels of trace metals and other compounds show that all data were considered to be within the accepted parameter guidance limits and no level was recorded that was approaching the acceptable limit.

Contaminant	Values and Units (wet weight)
Cadmium	1.0 mg kg^{-1}
Copper	20 mg kg^{-1} (60 mg kg^{-1} for oysters)
Lead	1.5 mg kg^{-1}
Mercury	0.5 mg kg^{-1}
p,p' DDT & metabolites	500 ɥg kg^{-1}
HCB	50 ɥg kg^{-1}
Α and β HCH	50 ɥg kg^{-1}
Lindane (gamma HCH)	100 ɥg kg^{-1}
PCB 28	80 ɥg kg^{-1}
PCB 52	80 ɥg kg^{-1}
PCB 101	80 ɥg kg^{-1}
PCB 138	100 ɥg kg^{-1}
PCP 153	100 ɥg kg^{-1}
PCB 180	80 ɥg kg^{-1}

Table 5.1 Synopsis of the strictest guidance and standard values applied by various OSPAR countries for contaminants in shellfish together with European legislation levels (Regulation 466/2001/EEC as amended by Commission regulation 221/2002/EEC and 1881/2006/EC for mercury, cadmium and lead (Data source: Glynn et *al.,* 2004 and Boyle *et al.,* 2006).

Oysters are known to accumulate high levels of zinc in their tissues under natural conditions. Data in Appendix 5.1 shows significantly greater levels of zinc in oysters (*C. gigas*) than in Blue Mussels (*M. edulis*). There is currently no set European limits for zinc levels within shellfish tissues, but sample data for mussels in Appendix 5.1 is within the OSPAR background range of 11.6 – 30 mg/kg and the levels recorded are not considered elevated.

In the absence of guidance limits, the remaining data in Appendix 5.1 were compared against pervious reviews of contaminants in shellfish (e.g. Marine Institute, 1999) and no data point is considered to be abnormally elevated.

As noted above in February 2009 the European Communities (Quality of Shellfish Waters) (Amendment) Regulation 2009, (SI 55 of 2009), provided for an additional 49 designated shellfish growing areas of which Cork Great Island North Channel is one. Therefore from 2009 Cork Great Island North Channel is now legally required to meet the monitoring and limit values for shellfish water quality set out in S.I. No. 268 of 2006 (Appendix 5.2). Following a request from the Marine Institute at the time of writing no specific data on the shellfish water quality for Cork Habour's North Channel was available. However, based on the recorded level of contaminants within both mussels and oysters in 2008, the status of the shellfish water is considered to be good and no levels were found to be elevated based on the available guidance limits for mussels and oysters. A review of EPA water quality data within the North Channel is provided in Section 6 of this report.

5.2.2 Biotoxins

Ireland is obliged under European legislation (Regulation (EC) No 854/2004) to have a National Marine Biotoxin Monitoring Programme (DCMNR/FSAI). Under this programme Ireland monitors shellfish harvesting areas for the presence of toxins produced by some species of phytoplankton. The programme covers toxins including Diarrhetic Shellfish Poisoning (DSP), Azaspiracid poisoning (AZP), Paralytic Shellfish Poisoning (PSP) and Amnesic Shellfish Poisoning (ASP). Other toxins are also tested for on an ongoing basis. Maximum limits for biotoxins (paralytic shellfish poison, diarrhetic shellfish poisonins, amnesic shellfish poison and azaspiracids) in shellfish are laid down by the Commission Regulation 853/2004 and shown in Table 5.2.

Samples of shellfish are analysed routinely for the presence of these toxin groups using both biological and chemical test methods. In addition, water samples are collected from shellfish sites and the number of known toxin producing phytoplankton species and harmful/nuisance phytoplanktonic species is determined via light microscopy.

Table 5.2: Biotoxins and Regulatory Limits

BIOTOXIN	REGULATORY LIMIT	TEST METHOD
DSP	Must not be Positive < 16µg Okadaic acid equivalents / 100g flesh	Biological Bioassay Chemical LCMS
AZP	< 16µg azaspiracid equivalents /100g flesh	Chemical LCMS
PSP	Must not be Positive	Biological Bioassay
ASP	< 250 mg Domoic Acid/ 1 g whole flesh < 20 mg Domoic Acid/ 1g flesh in edible parts under restricted harvesting	Chemical HPLC

Specific data for Cork Harbour North Channel sampling in 2009 was not available at the time of writing. However, the FSAI website shows the status of shellfish production areas based on the most recent data provided by the Marine Institute. A review of this data on 01/09/2009 showed an 'open' status for the Pacific Oyster aquaculture facility in the North Channel and a 'closed' status for mussels, the latter status has remained since 2005 (http://www.fsai.ie/sfma). Due to this, harvesting of mussels in the North Channel is currently prohibited due to a naturally occurring toxin PSP within the wild population.

The most recent data presented in the Status of Irish Aquaculture 2007 Report (Merc Consultants, 2008) found that of the 158 samples analysed for PSP toxins, all were below the regulatory level. The highest level measured was 39µg/STXdiHCL100g-1 whole flesh in a sample of mussels collected in Cork Harbour at the end of June 2007.

Regulation (EC) No 854/2004 requires that production areas must be monitored periodically to check for, among other things, the presence of toxin-producing plankton as well as biotoxins in live bivalve molluscs. The aim of the Phytoplankton Monitoring Programme is to analyse marine water samples from aquaculture production areas and to gather information on the phytoplankton communities present in the water (Merc Consultants, 2008). Unfortunately, no phytoplankton data from the National Phytoplankton Monitoring Programme was available for Cork Harbour for 2009 as no samples were submitted. However, data for 2007 showed no observed presence of toxin-producing plankton and no toxicity events due to PSP. This was the first year that a bloom of *Alexandrium spp*. had not been detected since monitoring commenced at Cork Harbour, which previously had become toxic regularly during the summer for a couple of weeks.

5.2.3 Microbiological quality of shellfish waters – Shellfish Production Areas

The Shellfish Production Area currently operating within the Cork Habour North Channel (Area CK-CH-NC), is licensed to produce Pacific Oyster (*Crassostrea gigas*) and Native Oyster (*Ostrea edulis*) (source www.fsaI.ie). The Sea Fisheries Protection Authority (SFPA) has recently reclassified Shellfish Production Areas in Ireland following a review of Micro Data from 01 Jan 2006 to 01 Jan 2009 in accordance with the criteria laid down in EU Regulations 853 and 854 of 2004, (as adopted by Statutory Instrument 336 of 2006). The new re-classification is presented below.

Category	Microbiological	Standard Treatment Required
A*	<230 *E. coli* per 100g flesh and intra-valvular liquid.	May go direct for human consumption.
B	<4,600 *E. coli* per 100g flesh and intra-valvular liquid.	Must be depurated, heat treated or relayed to meet class A requirements.
C	<46,000 *E. coli* per 100g of flesh and intra-valvular liquid.	Relay for two months to meet class A or Brequirements – may also be heat treated.
D	>46,000 *E. coli* per 100g of flesh and intra-valvular liquid.	Harvesting prohibited

The most up-to-date Bivalve Mollusc Production Area Listing for Ireland classifies Cork Harbour - North Channel as a Class B Shellfish Production Area (Table 5.3). This requires that oysters harvested from the area need to be depurated, heat treated or relayed before going for human consumption.

Table 5.3 Classified Bivalve Mollusc Production Areas in Ireland (1st September 2009) (www.sfpa.ie)

Cork Harbour	Between 8°16.4' W and 8° 15.6' W.	North Channel West	Oysters	Class B
	Between 8°14.6'W and 8°13.2'W.	North Channel East	Oysters	Class B

Conclusion

Following a review of shellfish data for the North Channel we have found no evidence of deterioration in the shellfish quality or shellfish water quality of the North Channel in recent years. The most recent data maintains favourable status for oyster production. The recorded levels of trace metals within both mussels and oysters in 2008 remained within the accepted guidance limits. Although no specific trace metal water quality data was available, based on the trace metals present within the meat samples the shellfish water quality is also considered to be within acceptable limits. Water quality parameters that have been measured during sampling of the shellfish growing areas generally conform to the guidelines set out in Council Directive 2006/113/EC indicating a good water quality status.

The SFPA review of microbiological quality data of shellfish waters in shellfish production areas classifies Cork Harbour - North Channel as a Class B Shellfish Production Area. This requires that oysters harvested from the area need to be depurated, heat treated or relayed before going for human consumption. An 'open' status remains for the Pacific Oyster aquaculture facility in the North Channel and a 'closed' status for mussels in terms of biotoxin levels, the latter due to a naturally occurring toxin PSP within the wild population. However, data for 2007 found no presence of toxin-producing plankton and no toxicity events due to PSP in Cork Harbour. This was the first year that did not record a bloom of *Alexandrium* sp. since monitoring first commenced in Cork Harbour.

Appendix 5.1

Shellfish Data – Contaminants in shellfish – data supplied by the Marine Institute September 2009.

	Cork Harbour - N & E Channels	Cork Harbour - East Channel	Cork Great Island North Channel
Sample Site			
M.I.Reference No.	ENV/08/083	ENV/08/084	ENV/08/146
Sampling date	29/10/2008	29/10/2008	10/12/2008
Latitude (N)	51° 52.86	51° 51.08	51° 52.98
Longitude (W)	8° 15.56	8° 16.82	8° 14.64
Species sampled	*M. edulis*	*M. edulis*	*C. gigas*
Number individuals	47	49	25
Method of cultivation	bed	bed	trestle
Water Parameters			
Temperature (°C)	8.53	10.5	
Salinity	27	26.6	
pH	7.74	7.74	
Dissolved oxygen (% saturation)	99	142	
Dissolved oxygen (mg/l))	9.72	13.4	
Shellfish			
shell length range (mm)	42 - 58	42 - 60	79 - 147
shell mean length (mm)	50.6	51.8	113
shell length std dev (mm)	3.50	3.80	18.5
Meat lipids (%)			1.45
Meat water content (%)	72.5	76.3	81.2
Metals mg kg^{-1} (ppm) wet weight			
silver	<0.01	<0.003	0.59
arsenic	2.09	2.13	2.03
cadmium	0.1	0.07	0.19
chromium	0.09	0.09	0.1
copper	1.9	2.4	19.8
mercury	0.03	0.02	0.03
nickel	<0.13	<0.13	<0.13
lead	0.39	0.55	0.27
zinc	16	21.1	291
PCBs ųg kg-1 (ppb) wet weight			
CB congener 101			1.3
CB congener 105			<0.02
CB congener 118			0.61
CB congener 153			1.03
CB congener 156			<0.11
CB congener 180			0.05
CB congener 28			0.19
CB congener 31			0.63
CB congener 52			0.25
CB congener 138+163			1.03
Cyclodienes ųg kg-1 (ppb) wet weight			
aldrin			0.07
cis-chlordane			0.06

dieldrin	0.24
oxychlordane	0.02
trans-chlordane (gamma-chlordane)	<0.09
trans-nonachlor	0.13
DDTs ųg kg-1 (ppb) wet weight	
DDE (p,p')	0.92
DDT (o,p')	0.05
DDT (p,p')	0.23
TDE (p,p') = DDD (p,p')	0.54
Hexachlorocyclohexanes ųg kg-1 (ppb) wet weight	
alpha-HCH (alpha-hexachlorocyclohexane)	<0.0008
beta-HCH (beta-hexachlorocyclohexane)	<0.004
gamma-HCH (gamma-hexachlorocyclohexane)	0.07
Organochlorines ųg kg-1 (ppb) wet weight	
alpha-endosulfan	<0.0008
hexachlorobenzene	<0.11
heptachlor epoxide	0.02
heptachlor	0.03
Pesticides ųg kg-1 (ppb) wet weight	
endosulfan sulfate	<0.09

Appendix 5.2

SCHEDULE 2

SHELLFISH WATERS MANDATORY VALUES

Parameter	*Unit of Measurement*	*Standard/Value*	*Reference Method of analysis or inspection*	*Frequency of sampling*
pH	pH unit	Not less than 7 nor greater than 9	Electrometry	Quarterly Measured in situ at the time of sampling.
Temperature	Degrees Celsius		Thermometry	Quarterly Measured in situ at the time of sampling.
Coloration (After Filtration)	Milligrams per litre	A discharge affecting shellfish waters must not cause the colour of the waters after filtration to deviate by more than 10 milligrams per litre from the colour of waters not so affected.	Filter through a 0.45 micrometre membrane. Photometric method, using the platinum/cobalt scale.	Quarterly
Suspended solids	Milligrams per litre	A discharge affecting shellfish waters must not cause the suspended solids content of the waters to exceed by more than 30 per cent the suspended solids content of waters not so affected.	Filtration through a 0.45 micrometre membrane, drying at 105 degrees Celsius and weighing. Centrifuging (for at least 5 minutes, with mean acceleration 2,800 to 3,200g), drying at 105 degrees Celsius and weighing.	Quarterly
Salinity	Practical salinity units	(a) less that 40 practical salinity units, and (b) discharges affecting shellfish waters must not cause the salinity of the waters to exceed by more than 10 per cent the salinity of waters not so affected.	Conductimetry	Monthly
Dissolved oxygen	Saturation per cent	(a) equal to or greater than 70 per cent (average value) (b) no individual measurement to indicate a value less than 60 per cent unless it can be established that there are no harmful consequences for the development of shellfish colonies. Should an individual measurement indicate a value less than 70 per cent, measurements must be repeated.	Winkler's method or electrochemical method	Monthly, with a minimum of one sample representative of low oxygen conditions on the day of sampling. However, where major daily variations are suspected, a minimum of two samples in one day must be taken.
Petroleum hydrocarbons		Hydrocarbons must not be present in the shellfish waters in such quantities as will— (a) produce a visible film on the surface of the water or a deposit on the shellfish, or both, or (b) have harmful effects on the shellfish.	Visual examination	Quarterly

Organohalo-genated substances Polychlorinated biphenyls Polychlorinated Biphenyls: Sum of ICES 7CBs	 $\mu g.litre\text{-}1^{-1}$ (seawater) $\mu g.kilogram\text{-}1^{-1}$ wet weight @ 1 per cent lipid (shellfish flesh)	 0.30 300.00 The concentration of each substance in the shellfish water or in the shellfish flesh must not reach or exceed a level, which has harmful effects on the shellfish and their larvae.	Gas chromatography after extraction with suitable solvents and purification.	Half-yearly
Metals (Dissolved): Arsenic Cadmium Chromium Copper Lead Mercury Nickel Silver Zinc	$\mu g.litre^{-1}$ (seawater)	 40.00 5.00 30.00 10.00 20.00 0.40 50.00 10.00 200.00 The concentration of each substance in the shellfish water must not exceed a level that gives rise to harmful effects on the shellfish and their larvae. The synergic effects of these metals must be taken into consideration.	Spectrometry of atomic absorption preceded, when appropriate, by concentration or extraction, or both.	Half-yearly
Faecal coliforms	Number of faecal coliforms per 100 millilitres		Method of dilution with fermentation in liquid substrates in at least three tubes in three dilutions. Subculturing of the positive tubes on a confirmation medium. Count according to MPN (most probable number). Incubation temperature 44°C ± 0.5°C.	Quarterly
Substances affecting the taste of shellfish		The concentrations of such substances in shellfish waters or in shellfish flesh must be limited so that the taste of shellfish is not impaired.	Examination of the shellfish by tasting.	If the presence of any of these substances is presumed.

SCHEDULE 4

SHELLFISH WATERS GUIDE VALUES

Parameter	*Unit of Measurement*	*Standard/Value*
pH	pH unit	
Temperature	Degrees Celsius	A discharge affecting shellfish must not cause the temperature of the waters to exceed by more than 2 degrees Celsius the temperatures of waters not so affected.
Coloration (after filtration)	Milligrams per litre	
Suspended solids	Milligrams per litre	
Salinity	Practical salinity units	12 to 38 practical salinity units.
Dissolved oxygen	Saturation per cent	Equal to or greater than 80 per cent (average value)
Petroleum hydrocarbons		
Organohalogenated substances: Polychlorinated biphenyls: Sum of ICES 7CBs	 μg.kilogram^{-1} wet weight @ 1 per cent lipid (shellfish flesh)	 100.00 The concentration of each substance in the shellfish flesh must be so limited that it contributes to the high quality of shellfish products.
Metals: Arsenic Cadmium Chromium Copper Lead Mercury Nickel Silver Zinc	Milligrams/ kilogram-1^{-1} dry weight (shellfish flesh)	 30.00 5.00 6.00 400.00 7.50 1.00 5.00 15.00 4000.00 The concentration of each substance in the shellfish flesh must be so limited that it contributes to the high quality of shellfish products.
Faecal coliforms	Number of faecal coliforms per 100 millilitres	Equal to or less than 300 in the shellfish flesh and intervalvular liquid
Substances affecting the taste of shellfish		

6.0 REVIEW OF EPA WATER QUALITY DATA

6.1 Overview

This report presents the findings of a review of the Environmental Protection Agency (EPA) Estuarine and Coastal Water Quality Monitoring programme data for the period 2003 – 2008. This monitoring programme is carried out in conjunction with local authorities and the Marine Institute, a major objective being to assess the eutrophic status of the coastal waters.

Five EPA sampling stations are located in relatively close proximity to East Cork Landfill (Table 6.1).

Table 6.1 EPA sampling stations in closest proximity to East Cork Landfill:

Station Number	Name	Grid Reference	Location
LE410	Belvelly Bridge	W 179 708	Approx 2.8 km west of Rossmore Peninsula
LE420	North Channel, Weir Island Pylons	W 814 703	Approx 700m west of Rossmore Peninsula
LE430	North Channel, Brick Island	W 833 697	Approx 250 east of Rossmore Peninsula
LE440	North Channel 'Red Shed'	W 845 697	Approx 1.7km east of Rossmore peninsula
LE450	North Channel Bagwells Hill	W 860 699	Approx 3.2 km east of Rossmore Peninsula

6.2 Review of EPA water quality data for Cork Harbour North Channel

The most recently available water quality data for the North Channel covers the period 2006 – 2008 (data kindly provided by Shane O'Boyle, Environmental Protection Agency in November 2009). Summary data for the North Channel is shown in Table 6.2 and the full data set is given in Table 6.3.

The data were assessed in relation to available guidance limits (e.g. McGarrigle *et al*., 2002; Toner *et al.,* 2005; Quality of Shellfish Waters Regulations, 1994-2009).

Table 6.2 Summary water quality data for Cork Harbour North Channel 2006 – 2008 (data kindly provided by the EPA).

	DO %	BOD	TON	NH_3	Free NH_3	DIN	PO_4	Chlorophyll a
Minimum	83.6	0.5	0.00	0.010	0.0008	0.015	2	0.25
Maximum	129	4.0	39.90	0.323	0.0277	40.08	54	28.80
Median	101	1.9	0.2	0.0.54	0.0019	0.320	10	8.30

- **Dissolved Oxygen (DO)** - the accepted range for intermediate (brackish) waters is between 70 and 130 % saturation (Toner *et al.,* 2005). No water quality sample records exceeded the upper limit during the period 2006 – 2008. One sample in June 2008 came close to this upper limit shown in Table 6.2 as the maximum value for all samples taken of 129%. Based on the data the DO levels for the sampling period are all within the accepted range at all five sampling stations.
- **Biological Oxygen Demand (BOD)** – A BOD level of greater than 4 mg/l is considered acceptable for intermediate (brackish) waters. Based on a review of the BOD levels in the samples taken between 2006-2008 all samples were below the accepted limit and only three samples were found to have a level of 4 mg/l.
- **Total Organic Nitrogen (TON)** - A limit range of <3 mg/l of TON is considered acceptable for intermediate waters and a lower limit of 1 mg/l is a target limit for good quality waters. Levels of >1 mg/l are shown in Table 6.3. A total 19 out of the 81 samples taken recorded levels of > 1 mg/l and 6 recorded levels > 3 mg/l over the sampling period.
- **Total Ammonia (NH_3) –** refers to the sum of ammonia (NH_3) and the ionised form (NH_4^+). Low-level ammonia nitrogen may be present in water naturally as a result of the biological decay of plant and animal matter. Anthropogenic sources to seawater include sewage and industrial effluents and fertilizer run-off. Background levels in seawater may range between 0.001 – 0.05 mg/l. Levels recorded in The North Channel between 2006-2008 range from 0.010 - 0.323 mg/l (Table 6.2). Levels below 0.2 mg/l are generally considered to be acceptable for freshwaters bodies, although a level of <0.1 mg/l may be more acceptable for intermediate water. All values over this level are

highlighted in Table 6.3. A total of 13 out of 81 samples taken were recorded as having NH_3 levels greater than 0.1 mg/l between 2006 -2008..

- The unionized form of ammonia (NH_3) '**free ammonia'** is extremely toxic to fish, concentrations in water increase with rising temperature and pH levels and decrease with rising salinities. Due to this a guidance limit of <0.02 mg/l is considered acceptable, although a lower limit of <0.004 mg/l is often used as a desirable target value. For the data review all sample in Table 6.3 show levels below 0.02 mg/l and therefore considered to be within acceptable levels and only 12c of the 81 samples taken were above the 0.004 mg/l limit.
- **Dissolved inorganic nitrogen (DIN) (mg/l N^2)** - elevated levels are highlighted in Table 6.3; a total of 15 samples recorded elevated readings > 1.4 mg/l N^2 at median salinity 17psu).
- **Phosphorous** - the recommended level of total phosphorus in estuaries and coastal ecosystems to avoid algal blooms is 0.01 to 0.1 mg/l (US EPA) (equivalent to 10 – 100 ųg/l P). Within Ireland a limit range of 30 - 100 ųg/l P is considered acceptable. All levels in Table 6.3 are within the acceptable upper level of 100 ųg/l P with 15 out of the 81 samples taken being above the lower 30 ųg/l P limit.
- **Chlorophyll *a*** - within Intermediate waters, levels that exceed 15 mg/m^3 (median) or 30 mg/m^3 (90 percentile) are deemed high (Toner *et al.,* 2005). The Marine Institute (1999) identifies values of 10-25 mg/m^3 as 'medium' and >25 mg/m^3 as high. Only one sample was recorded to have levels above 25 mg/m^3 in Table 6.2.
- **pH** - the pH of most natural waters lies between 6.0 and 8.5 (Chapman, 1996) and extreme values in ph are deleterious to the aquatic system and may lead to knock-on effects on fauna e.g. fish. Between 2006 – 2008 pH readings at the five sampling stations range between pH 7.9 and pH 8.4; all within acceptable levels.

Discussion & Conclusions

Recent water quality data for the North Channel shows a number of elevated readings in recent years, particularly in relation to nitrogen derived parameters (e.g. TON, DIN, NH_3., Total Ammonia). Elevated levels of these parameters were recorded at all stations, although only Total Ammonia was elevated at station 440. Few records of elevated levels of PO_4 were also noted and one raised level of Chlorophyll A. All other parameters were found to be within acceptable limits.

Anthropogenic sources of NH_3 to seawater include sewage, industrial effluents and fertilizer run-off and it is not possible to link elevated levels within the North Channel to landfill activity as there are so many other confounding variables (i.e. other possible pollution sources).

The North Channel was previously classified as 'Eutrophic' by the EPA, how ever in recent years it has retained an improved classification of 'intermediate' across EPA assessment periods 1999 – 2003 and 2002 – 2007. Based on the 2008 results the classification of the North Channel has dropped from intermediate to potentially eutrophic.

Table 6.3 Water quality data for Cork Harbour North Channel 2006 – 2008 (data kindly provided by the EPA). Recent (2008) data is shown in blue, levels that exceed accepted guidelines are highlighted in yellow.

Station No	Survey Date	Salinity S ‰	Temp S °C	pH	DO S % Sat	B.O.D. mg/l O2	TON mg/l N	NH3 mg/l N	Free NH3 mg/l N	DIN mg/l N	PO4 µg/l P	Chlorophyll a mg/m
LE410	13/08/08	0.44	13.2	7.89	97	4	2.61	0.323	0.0071371	2.933	21	28.8
LE420	23/05/06	28.29	12.45	7.93	91.7	1.4	0.49	0.085	0.0019428	0.575	9.9	5.8
LE420	23/05/06	28.36	12.4		91.6		0.49	0.085	0.0019428	0.575	9.9	5.8
LE420	22/06/06	32.12	15.57	8.15	92.7	3	0.145	0.082	0.003865	0.227	15	7.6
LE420	22/06/06	32.12	15.65		91.6		0.145	0.082	0.003865	0.227	15	7.6
LE420	20/07/06	33.24	20.18	8.18	105.2	2	39.9	0.176	0.0122717	40.076	9.9	11.9
LE420	20/07/06	33.23	20.02		102.8		39.9	0.176	0.0122717	40.076	9.9	11.9
LE420	27/02/07	24.48	9.29	8.09	92.8	1.5	1.4	0.064	0.001649	1.464	49	0.99
LE420	27/02/07	25.47	9.05	8.09	91.5	1.5	1.4	0.064	0.0016188	1.464	49	0.99
LE420	12/06/07	32.62	19.44	8.17	83.6	1.6	0.088	0.069	0.0044727	0.157	27	
LE420	10/07/07	30.5	14.95	8.31	110.9	3.1	0.06	0.0199	0.001275	0.0799	9.9	4.8
LE420	10/07/07	30.38	14.92	8.31	112.9	3.1	0.06	0.0199	0.0012722	0.0799	9.9	4.8
LE420	21/08/07	30.44	15.4	8.19	102.7	4	0.206	0.045	0.0022887	0.251	9.9	8.8
LE420	21/08/07	30.45	15.4	8.19	102.1	4	0.206	0.045	0.0022887	0.251	9.9	8.8
LE420	29/01/08	25.39	9.13	7.89	92.2	0.499	1.45	0.079	0.0012785	1.529	35	1.76
LE420	29/01/08	26.91	9.13	7.89	92.3	0.499	1.45	0.079	0.0012785	1.529	35	1.76
LE420	10/06/08	32.16	18.34	8.4	122.5	3.7	0.0049	0.115	0.0113316	0.1199	4.99	20.4
LE420	10/06/08	32.16	17.42	8.4	120.5	3.7	0.0049	0.115	0.010641	0.1199	4.99	20.4
LE420	29/07/08	30.68	18.14	8.24	100.8	1.3	0.079	0.04	0.002758	0.119	11	12.7
LE420	29/07/08	30.86	18.08	8.24	101.2	1.3	0.079	0.04	0.0027465	0.119	11	12.7
LE420	13/08/08	27.34	15.67	8.09	97.7	2.2	0.346	0.089	0.0036988	0.435	11	14.1
LE420	13/08/08	27.41	15.69	8.09	96.3	2.2	0.346	0.089	0.0037042	0.435	11	14.1
LE430	23/05/06	29.21	12.08	7.99	92.8		0.445	0.085	0.0021632	0.53	9.9	5.3
LE430	23/05/06	29.57	11.85		91.7		0.445	0.085	0.0021632	0.53	9.9	5.3
LE430	22/06/06	31.96	15.71	8.14	92.7		0.163	0.059	0.0027477	0.222	9.9	11.5
LE430	22/06/06	32.35	15.29		88.7		0.163	0.059	0.0027477	0.222	9.9	11.5
LE430	20/07/06	33.50	19.31	8.17	102.5		38.2	0.079	0.0050748	38.279	9.9	12.4
LE430	20/07/06	33.48	19.17		102.5		38.2	0.079	0.0050748	38.279	9.9	12.4

LE430	27/02/07	24.30	9.25	8.1	92.7		1.3	0.110	0.0028899	1.41	36	0.99
LE430	27/02/07	24.30	9.25	8.1	92.7		1.3	0.110	0.0028899	1.41	36	0.99
LE430	12/06/07	33.00	18.58	8.2	98.9		0.097	0.02	0.0013035	0.117	13	
LE430	10/07/07	30.63	14.91	8.33	121		0.11	0.0199	0.0013279	0.1299	9.9	3.7
LE430	10/07/07	31.19	14.69	8.33	118.2		0.11	0.0199	0.0013072	0.1299	9.9	3.7
LE430	21/08/07	30.23	15.09	8.2	108.1		0.394	0.066	0.0033555	0.46	9.9	10.3
LE430	21/08/07	30.84	15.28	8.2	106.1		0.394	0.066	0.003402	0.46	9.9	10.3
LE430	29/01/08	27.04	9.13	7.91	91.6	0.499	1.32	0.054	0.0009145	1.374	34	0.249
LE430	29/01/08	28.21	9.19	7.91	92.3	0.499	1.32	0.054	0.0009188	1.374	34	0.249
LE430	10/06/08	32.45	17.32	8.38	124.6		0.0049	0.315	0.0277388	0.3199	4.99	19.1
LE430	10/06/08	32.45	16.49	8.38	116.9		0.0049	0.315	0.0261856	0.3199	4.99	19.1
LE430	29/07/08	31.70	17.48	8.23	102	1.5	0.085	0.036	0.0023189	0.121	9	9.1
LE430	29/07/08	31.81	17.42	8.23	101.2	1.5	0.085	0.036	0.0023091	0.121	9	9.1
LE430	13/08/08	28.91	15.62	8.15	104.9		0.285	0.032	0.0015138	0.317	2.49	23.6
LE430	13/08/08	29.08	15.61	8.15	103.3		0.285	0.032	0.0015127	0.317	2.49	23.6
LE440	23/05/06	30.35	11.65	7.98	91.7	0.999	0.37	0.084	0.0020231	0.454	10	4.6
LE440	23/05/06	30.38	11.57		91.8		0.37	0.084	0.0020231	0.454	10	4.6
LE440	22/06/06	32.97	14.85	8.14	94.4	2.8	0.133	0.064	0.0027999	0.197	9.9	11.6
LE440	22/06/06	32.96	14.8		93.9		0.133	0.064	0.0027999	0.197	9.9	11.6
LE440	20/07/06	33.75	18.76	8.15	100.7		0.015	0.075	0.004438	0.09	9.9	8.3
LE440	20/07/06	33.79	18.56		101		0.015	0.075	0.004438	0.09	9.9	8.3
LE440	12/06/07	33.3	17.89	8.21	102.7		0.056	0.0199	0.001263	0.0759	10	
LE440	10/07/07	31.83	14.49	8.25	116.4	1.7	0.11	0.0199	0.0010814	0.1299	9.9	6.6
LE440	10/07/07	31.96	14.34	8.25	116.2	1.7	0.11	0.0199	0.0010697	0.1299	9.9	6.6
LE440	21/08/07	30.85	14.98	8.15	106.7		0.355	0.0199	0.0008986	0.3749	9.9	6
LE440	21/08/07	31.35	15.16	8.15	98.8		0.355	0.0199	0.0009105	0.3749	9.9	6
LE440	10/06/08	32.45	17.59	8.37	129		0.0049	0.0099	0.0008694	0.0148	4.99	16.4
LE440	10/06/08	32.45	16.22	8.37	116.9		0.0049	0.0099	0.0007904	0.0148	4.99	16.4
LE440	29/07/08	32.18	17.1	8.23	103.6	0.499	0.062	0.027	0.0016931	0.089	7	5.5
LE440	29/07/08	32.45	16.88	8.23	103.3	0.499	0.062	0.027	0.0016669	0.089	7	5.5
LE440	13/08/08	28.34	15.65	8.15	108.4	3.3	0.343	0.029	0.0013748	0.372	7	23.3
LE440	13/08/08	29.30	15.56	8.15	101.5	3.3	0.343	0.029	0.0013659	0.372	7	23.3

LE450	23/05/06	29.74	11.6	7.98	89.4		0.387	0.085	0.0020394	0.472	9.9	2.2
LE450	23/05/06	29.77	11.59		89.5		0.387	0.085	0.0020394	0.472	9.9	2.2
LE450	22/06/06	32.95	14.85	8.15	94.6		0.124	0.041	0.0018339	0.165	9.9	11.2
LE450	22/06/06	33.20	14.56		96		0.124	0.041	0.0018339	0.165	9.9	11.2
LE450	20/07/06	33.71	18.69	8.16	100.3	1.8	25.5	0.257	0.0154679	25.757	9.9	8.8
LE450	20/07/06	33.88	18.352		102.3		25.5	0.257	0.0154679	25.757	9.9	8.8
LE450	27/02/07	26.30	9.27	8.11	92.3		1.08	0.134	0.0036062	1.214	54	0.99
LE450	27/02/07	29.59	9.06	8.11	93.3		1.08	0.134	0.0035483	1.214	54	0.99
LE450	12/06/07	33.33	17.87	8.21	104.4		0.05	0.0199	0.0012612	0.0699	9.9	
LE450	10/07/07	32.15	14.22	8.23	116.9	2.1	0.67	0.0199	0.0010147	0.6899	9.9	6.9
LE450	10/07/07	32.64	13.79	8.23	119.1	2.1	0.67	0.0199	0.0009833	0.6899	9.9	6.9
LE450	21/08/07	31.40	15.07	8.1	102.2	2.9	0.257	0.0199	0.0008094	0.2769	9.9	4.6
LE450	21/08/07	32.83	14.72	8.1	98.5	2.9	0.257	0.0199	0.000789	0.2769	9.9	4.6
LE450	29/01/08	27.88	9.23	7.93	93		1.44	0.049	0.0008751	1.489	34	0.249
LE450	29/01/08	29.64	9.3	7.93	92.7		1.44	0.049	0.0008799	1.489	34	0.249
LE450	10/06/08	32.65	16.94	8.33	126.3	2.7	0.014	0.0099	0.0007627	0.0239	4.99	13.1
LE450	10/06/08	32.65	16.94	8.33	126.3	2.7	0.014	0.0099	0.0007627	0.0239	4.99	13.1
LE450	29/07/08	32.31	17	8.23	103.3	1.7	0.062	0.03	0.001868	0.092	6	5.8
LE450	29/07/08	32.66	16.73	8.23	104.4	1.7	0.062	0.03	0.0018326	0.092	6	5.8
LE450	13/08/08	29.22	15.38	8.14	105.1		0.356	0.029	0.0013186	0.385	2.49	17.4
LE450	13/08/08	30.66	15.9	8.14	101.9		0.356	0.029	0.0013693	0.385	2.49	17.4

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Appendix G

Monitoring of Flare Flue Gas Emissions July & November 2009

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AIR EMISSION TESTING OF ONE LANDFILL FLARE LOCATED IN EAST CORK LANDFILL, ROSSMORE, CARRIGTOHILL, CO. CORK

PERFORMED BY ODOUR MONITORING IRELAND ON BEHALF OF CORK COUNTY COUNCIL

PREPARED BY:	Dr. John Casey
ATTENTION:	Mr. Jerome O' Brien
REFERENCE:	Waste licence W0022-01
DATE:	03rd July 2009
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1. Introduction

This report has been prepared by Odour Monitoring Ireland and contains the results of emission testing carried out on 1 No. enclosed ground flare at East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork. The emission testing was carried out in compliance with the requirements of *Waste licence W0022-01*.

Odour Monitoring Ireland was requested by East Cork Landfill to perform emission testing of the one flare stack located within East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork. The parameters listed in *Table 1.1* were monitored using the appropriate instrumentation as illustrated in *Table 1.1*.

Table 1.1. Monitored parameters and techniques for East Cork Landfill Enclosed flare.

Sample location	Parameter	Analytical method
1 Landfill Flares outlet	Volumetric airflow rate & Temperature (^{0}C)	Pitot in accordance with EN13284-1 and K type thermocouple and PT100 Theoretical calculated for Landfill flare
1 Landfill Flares outlet	Oxides of nitrogen (NO_X), Carbon monoxide (CO), Carbon dioxide (CO_2), Sulphur dioxide (SO_2), and Oxygen (O_2)	Flue gas analyser, Testo 350/454 MXL
1 Landfill Flares outlet	TA Luft Organics	Charcoal tube/GCMS
1 Landfill Flares outlet	Total Hydrocarbons	Portable Signal 3030PM FID calibrated with Propane
1 Landfill Flares outlet	Hydrogen chloride and hydrogen fluoride	Impinger train containing 0.10 molar sodium hydroxide and deionised water solution in accordance EN1911 and EPA 26A

This report presents details of this monitoring programme. This environmental monitoring was carried out by Dr. John Casey, Odour Monitoring Ireland on the 10th June 2009. Methodology, Results, Discussion and Conclusions are presented herein.

2. Materials and Methods

This section provides brief details of the methodology employed to perform emission testing of the landfill flare stack located in East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork.

2.1 Volumetric flow rate and temperature measurement

The volumetric flow rate of the landfill flare was determined from theoretically calculated total volumetric flow rates using the assumptions presented in *Appendix II*. The inlet landfill gas velocity measurements were calculated from the CEMS monitoring system within the landfill flare control building. Temperature traverse measurements were performed across the stack in one plane only. Only one plane was possible due to access port issues. A magnesium oxide K type and PT100 thermocouple was used for measuring temperature in the landfill flares and gas utilisation engines.

2.2 In stack analysis

Flue gas analysis was performed using a pre-calibrated Testo 350 MXL/454 flue gas analyser. Concentrations of oxygen, sulphur dioxide, carbon dioxide, temperature, carbon monoxide and oxides of nitrogen were measured using electrochemical cells within the analyser box and all data was logged electronically in 1 minute intervals during the sampling exercise. Data was downloaded from the control handheld using the Com soft software and average concentrations calculated are presented within. All results presented are at 273.15 K, 101.3 kPa on a dry gas basis.

2.3 TA Luft Organics

In order to obtain samples for speciated VOC assessment, a static sampling method was used where air samples were collected in pre-conditioned Tedlar sampling bags using a vacuum sampling device. The sampler operates on the “lung principle” whereby the air is removed from a rigid container around the bag by a battery powered SKC vacuum pump filling the bag inside.

All sample bags were pre-flushed with sample air in order to prevent any reductions in the actual VOC due to sample bag surface binding. A leak check was preformed on the sample setup by placing a Primary flow calibrator inline. Once sample acquisition was completed, the sample bag was transferred to another location and connected to the sample pump, tube and Primary flow calibrator. A charcoal/anasorb sorbent was chosen to efficiently bind and pre-concentrate speciated VOC for analysis by GCMS in accordance with established and accredited methodologies. Sealed SKC sorbent tubes (SKC 226-09) were used throughout the study to maintain repeatability and integrity. In addition, the sorbent tube has a second plug to detect any breakthrough. All sampling for speciated VOC’s was preformed in accordance with methodologies discussed within EN 13649:2002.

2.4 Heated Flame Ionisation Detector-Total hydrocarbon concentration (THC) determination

A heated portable FID (Signal) (Test method EN12619:1999 and EN13526:2002), heated line, controller and data logger was used to analyse the duct air stream for total hydrocarbon concentration. Once stabilised and calibrated using span gas (Propane-800 ppm; European standard), a sintered probe connected to a 181 ^{0}C heated line was place in the air stream. After stabilisation, the data logger was activated and commences reading. The FID remained analysing continuously for approximately 45 minutes in the duct air stream. Results were presented as mg [THC] m^{-3} as propane.

An FID operates on the principle where influent contaminated gas is mixed with hydrogen and the mixture is burned at the tip of a jet with air or oxygen. Ions and free electrons are formed in the flame and enter a gap between two electrodes, the flame jet and a collector, mounted 0.5-1.0 centimetres above the flame tip. A potential (400 volts) is applied across the two electrodes and with the help of produced ions, a very small current flows between the two electrodes. When an organic substance is introduced this is burned in the flame; a complex process takes place in which positively charged carbon species and electrons are formed. The current is greatly increased and therefore the sample is detected. The FID is a mass flow detector, its response depending directly on the flow rate of the carrier gas. Its response also varies with applied voltage and the temperature of the flame.

The following procedure was used for operating the FID:

1. The FID was switched on and the oven temperature and sample line temperature were allowed to stabilise. The set-point temperatures were 180 ^{0}C sample line temperature and 200^{0}C oven temperature. This took approximately 45 minutes.
2. The Hydrogen/He fuel and Propane calibration gases (50 and 500 ppm) were attached to the instrument.
3. Once temperatures had stabilised, the instrument was started and the ignition procedure was commenced.
4. Once ignited, the sample procedure was commenced and any VOC upon the sample line was baked off.
5. The analyser was zero calibrated and span calibrated. Zero air is supplied via the clean air filter. There is less than 1% of range or 1.60 mg/m^3 in eight hours whichever is greater (see Section 6.1 of EN12619:1999 and Section 6.2.1 EN13526:2001.
6. The analyser calibration procedure was rechecked and recorded,
7. The sample line was checked by presenting calibration gas in the sample line. The value was confirmed to be the value and recorded. This reading must be less than 5% difference from the span/zero reading.
8. The probe was inserted into the stack.
9. The data logger was commenced (10 second intervals) and manual readings were taking and recorded (every 10 minutes).
10. The instrument was re-spanned every approximately 60 minutes to confirm calibration reading and to isolate any drift.
11. The recorded concentrations were converted for ppm TOC propane to mg/m^3 TOC using the equation contained in Annex E and F of EN12619:1999 and EN13526:2002, respectively.

The analyser is MCERT and TUV approved. The MCERTS certification covers EN12619:1999 and EN13526:2002.

2.5 Hydrogen chloride (HCL) and Hydrogen fluoride (HF) analysis

Volatile chloride and fluoride gas concentrations were determined using an impinger train containing 0.10 molar sodium hydroxide and deionised water solution, in which such gases are readily soluble. The sampling methodology was based upon USEPA Method 26 and the European Standard, EN 1911. Small sorption liquid volumes were used to attain lower limits of detection. Impingers were placed in series to ensure effective trapping of chloride and fluoride gas concentrations.

The sampling probe was placed within the stack and sample air was drawn through a heated sample line and two glass midget impingers containing 0.1 molar Sodium hydroxide positioned in series. Sampled solutions were sealed and transported to the UKAS accredited laboratory for analysis via ion chromatography (RPS Analytical laboratory, Manchester, UK). The results of mg m^{-3} have been converted to mg Nm^{-3} at 273.15 K, 101.3 kPa.

3. Results-Emission testing.

3.1 Sampling time

Table 3.1 summarises the sampling time that was carried out on the individual stacks. *Table 3.2* illustrates the inlet landfill gas parameters as characterised from the CEMS analyser system operating within the landfill flare control building. Additionally, manual monitoring was performed using a GA2000 landfill gas analyser.

All outlet gas samples were taken approximately 1.80 metres below the top of the stack for the landfill flare No.1. All sampling was performed through the existing 25mm sampling ports on the landfill flare. A one-plane oxygen and temperature traverse was performed to assess any difference in oxygen concentrations and temperature across the sampling plane. Temperature and Oxygen differences were less than the 15% deviation level as recommended by the UK Environmental Agency (Guidance for monitoring enclosed Landfill flares, 2002).

3.2 Volumetric flow rate

Table 3.3 summarises the theoretical airflow rate calculations for the Landfill gas flare No. 1. *Table 3.3* includes the exhaust volumetric airflow rate expressed in $m^3 hr^{-1}$ at both actual and standard reference conditions of 273.15 K, 101.3 kPa (i.e. standard temperature and pressure).

3.3 Flue gas concentrations

Flue gas concentrations were monitored using a pre-calibrated Testo 350/454 MXL flue gas analyser. The results of SO_2, NO_x as NO_2 + NO, CO, and O_2 are presented in *Table 3.4*. The results of ppm have been converted to mg Nm^{-3} at 273.15 K, 101.3 kPa, on a dry gas basis with correction for oxygen content. In accordance with EPA flare monitoring requirements, Oxygen correction to 3% should be performed for landfill gas flares. The average temperature of the gas analyser on the day of sampling was 280.15 K.

3.4 TA Luft Organics

Total non-methane volatile organic compound (TNMVOC) concentrations were monitored using sorbent tubes and analysis by GCMS. The results of TNMVOC's are presented in *Table 3.4.* The results are presented as mg Nm^{-3} at 273.15 K, 101.3 kPa, with correction for oxygen content. In accordance with EPA flare/gas utilisation engine monitoring requirements, Oxygen correction to 3% and 5% should be performed for landfill gas flares and gas utilisation engines, respectively. The average temperature of the sampling tubes on the day of sampling was 283.15 K.

For the concentration of TOC adsorbed on to the charcoal tube, the mass amount of absorbed volatile organic carbon was measured using gas chromatography flame ionisation detector (GC-FID). Once the sampled volume is known, the mass concentration of VOC within the sampled gas could be calculated.

3.5 Total hydrocarbon concentration (THC)

THC concentrations were monitored using a pre-calibrated Signal 3030 PM analyser. The results of THC are presented in *Table 3.4.* The results of ppm have been converted to mg Nm^{-3} at 273.15 K, 101.3 kPa, on a wet gas basis with correction for oxygen content. Conversion from ppm to mg m^{-3} was performed using a 1.60 multiplication factor for propane. In accordance with EPA monitoring requirements, Oxygen correction to 3% should be performed for landfill flares. The average temperature of the FID on the day of sampling was 454 K.

3.6 Hydrogen chloride (HCL) and Hydrogen fluoride (HF)

Hydrogen chloride and hydrogen fluoride concentrations were monitored using an impinger train containing 0.1 molar sodium hydroxide and deionised water solution, in which such gases are readily soluble. The results of hydrogen chloride and hydrogen fluoride are presented in *Table 3.4.* The results of mg m^{-3} have been converted to mg Nm^{-3} at 273.15 K, 101.3 kPa, with correction for oxygen content. In accordance with EPA flare/gas utilisation engine monitoring requirements, Oxygen correction to 3% should be performed for landfill gas flares.

Table 3.1. Sampling time runs on the 10^{th}June 2009.

Parameter	**Approx. Sampling period for 1 No. landfill flare**
Volumetric air flow rate	Theoretically calculated
SO_2	45 minutes
NO_x	45minutes
CO	45 minutes
O_2	45 minutes
CO_2	45 minutes
Stack gas temp	45 minutes
TA Luft organics	45 minutes
THC	45 minutes
HF / HCL	45 minutes

Table 3.2. Characteristics of raw inlet landfill gas to the 1 No. Enclosed Landfill flare gas burner.

Inlet compound identity	**Enclosed flare Unit**	**Unit values**
CH_4	29.60	%
CO_2	27.50	%
O_2	0.90	%
Total Landfill gas Volumetric airflow rate	417	m^3/hr

Table 3.3. Theoretically calculated landfill gas exhaust volume and physical characteristics from 1 No. Landfill flare.

Parameter	Enclosed flare Unit
Total Volumetric methane loading (m^3/hr)	123
Total Volumetric Oxygen loading (m^3/hr)	3.70
Ratio to complete combustion of methane assuming no excess Oxygen	9.97
Oxygen concentration level in flue gas (%)	8.12
Flue gas temperature (Kelvin)[1]	1,318
Theoretical Volumetric exhaust airflow rate (m^3/h)	2,688
Normalised average exhaust airflow rate (Nm^3/h)[2]	557

Notes: [1] denoted converted from degrees Celsius to Kelvin (^{0}C + 273.15);
[2] denotes normalised to 273.15 Kelvin and 101.3 kPa.

Table 3.4. Emission value results from the measurement of emissions from the landfill gas flare burner.

Parameter	Measured	Units	Adjusted units (mg/m^3)	Normalised Volumetric flow rate (m^3N/hr)	Oxygen corrected emission conc to 3 %(mgN/m^3)[2]	Mass emission rate (kg/hr) at 3 % O_2[2]	Emission limits
Carbon monoxide (CO)	2.00	ppm	2.50	557	3.50	0.002	<50 mg/m^3
Temperature	1045.00	degrees	1318.15	557	-	-	>1273 K
Oxygen (O_2)	8.12	%	8.12	557	-	-	-
Total NOx [as NO_2]	15.00	ppm	30.80	557	43.14	0.024	<200 mg/m^3
Sulphur dioxide (SO_2)	66.00	ppm	188.57	557	264.12	0.147	-
CO_2	9.15	%	9.15	557	-	-	-
THC as Carbon	4.00	ppm	6.40	557	14.91	0.008	<20 mg/Nm^3
Average Hydrogen chloride	4.11	mg/m^3	4.11	557	4.87	0.003	<50 mg/m^3
Average Hydrogen fluoride	0.28	mg/m^3	0.28	557	0.33	0.000	<5 mg/m^3
TaLuft Class I, II, III organics	3.00	mg/m^3	3.00	557	4.20[3]	0.002	<20 mg/m^3

Notes: [1] denotes refer to *Appendix II* for Oxygen correction calculations.
[2] denotes units normalised to 3% O_2 for flare.
[3] denotes limit values for TA Luft Organics Class I 20 mg/m^3, Class II 100 mg/m^3, Class 150 mg/m^3 total concentrations recorded are less then Class I.

4. Discussion of results

Tables 3.1 to *3.4* present the results of the emission monitoring carried out on the landfill flare stack burner located in East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork.

There was very little variation at one traverse in oxygen and flue gas temperature profiles across the stack during the monitoring exercise (i.e. less than 15% as recommended by the Environment Agency, UK (Environment Agency, 2002)).

A high temperature Inconel 625 and ceramic probe (Testo, Germany) was used to prevent variations in CO emissions data. Normal stainless steel probes when subjected to temperatures above 600^0C can release CO from within the structure of the material and cause the recording of erroneous results (Environment Agency, 2002).

Correction of data to 3% oxygen was performed. Due to possible inaccuracies in airflow rate measurement, it was not possible to determine the oxygen intake of the flare through the louver system using measurement. Since the volume of intake air required for complete combustion was known and the oxygen concentration in the exhaust flue gas was known, the volume of intake excess fuel air could be manually and theoretically calculated through numerous iterations using the Solver program (i.e. Microsoft Excel). This allows for the calculation of the volume of intake excess air through the louver landfill flare intake system. These calculations were validated through use of the published Environment Agency equation (see *Eqn 8.3.1*) (Environment Agency, 2002).

Landfill methane destruction efficiency was calculated using the inlet methane loading concentration and the exhaust total organic carbon concentration as presented in *Table 3.4*. As can be observed, the landfill flares is achieving a methane destruction efficiency of greater than 99%. Typical reported concentrations of methane from landfill flare burner systems are in the order of 0.040% to 0.52%. The complete combustion of methane results in the formation of CO_2 and H_2O. The incomplete combustion of methane results in the formation of carbon monoxide. Carbon monoxide concentration levels were low in the flue gas of the landfill flare.

5. Conclusion

The following conclusions can be drawn from this study:

1. A theoretically exhaust flue gas volume was calculated for landfill gas flare.
2. NO_x, SO_2, CO, O_2, HCL, HF and TOC monitoring and analysis was carried out in accordance with specified requirements;
3. All data was standardised to 273.15 Kelvin, 101.3 kPa;
4. All data is presented as Oxygen corrected to 3% (v/v) using the appropriate equations as presented in *Section 8.3*;
5. NO_x as NO_2, CO, HCL, HF and TOC were in compliance for the landfill gas flare exhaust stack and within the emission limit values contained within Waste licence W0022-01 – Schedule G3.

6. References

1. Environment Agency. (2002). Guidance for Monitoring Enclosed Landfill Gas Flares. www.environment-agency.co.uk
2. McVay, M., (2003). Personal communication. Environment Agency, Wales, UK.

7. *Appendix I* - Sampling, analysis and calculation details

7.1.1 Location of Sampling

East Cork Landfill Facility, Rossmore, Carraigtwohill, Co. Cork

7.1.2 Date & Time of Sampling

10th June 2009

7.1.3 Personnel Present During Sampling

Dr. John Casey, Odour Monitoring Ireland, Trim, Co. Meath.

7.1.4 Instrumentation

Testo 350 MXL/454 in stack analyser;
L type pitot and thermocouples;
Testo 400 handheld and appropriate probes.
Ceramic and Inconel 625 sampling probes.
Portable Signal 3030PM FID calibrated with Propane.
Impinger train and static sampling device.

8. *Appendix II* - Example calculations and conversions

8.1 Conversion of 15 PPM Oxides of nitrogen to mg m^{-3} at 273.15 Kelvin and 101.3 kPa (STP) for landfill flare No. 1

1 mole of an ideal gas occupies 22.4 litres at standard temperature and pressure of 273.15 Kelvin[1] and 101.3 kPa (STP), where a mole of any substance is equal to its molecular mass and expressed in grams.

This is known as molar mass (i.e. the volume occupied by one gram mole of a gas at STP).

Using the average recorded concentration (in ppm) for NO_2 during the survey, the conversion is as follows:

1 mole of NO_2 occupies 22.4 litres @ STP

46 grams (Molecular weight of NO_2) occupies 22.4 litres @ STP

mg m^{-3} NO_2 = 15.00 ppm $\times$ 46 / 22.40 = 30.80 mg N m^{-3}

8.2 Additional calculations and correction of Oxygen concentration measured to reference Oxygen concentration of 3% (v/v) for 30.80 mg N m^{-3} of NO_X as NO_2 for landfill flare No. 1

If excess air is added to an enclosed landfill flare (i.e. to promote better combustion), measured flue gas emission concentration of non-combustion species will fall. Emission concentrations appear to be reducing, whilst in reality mass emission rates have remained constant (Environment Agency, 2002). Therefore, it is necessary to compare concentrations at a standard oxygen concentration.

The relationship between the measured oxygen concentration and measured emission species concentration is non-linear as oxygen from air is added or removed. For example, a halving of the flue gas oxygen content does not result in a doubling of the emission concentration. The oxygen concentration in the flue gases is a measure of the excess air over that required for theoretical complete combustion (i.e. stiochiometric air requirement). Therefore, the measured oxygen level is a measure of the dilution of the flue gases from the stoichiometric condition. The concentration of oxygen in dry air is 20.9% (v/v) and the proportion of excess air (X/V) can therefore be calculated from the following:

$$\frac{X}{V} = \frac{(O_2)_m}{(20.9 - (O_2)_m)} \quad \textbf{(Eqn 8.3.1)}$$

Where: X is the volume of excess air (m^3);
V is the stoichiometric volume of the flue gas (m^3);
$(O_2)_m$ is the percentage of oxygen (v/v) in the flue gas (on a dry basis).

If we know and calculate the following:

The volume of landfill gas was 417 m^3 hr^{-1} with a methane and oxygen concentration of 29.60% (v/v) and 0.90%(v/v) as taken from the landfill gas analyser.

This equates to a methane and oxygen volume of 123 m^3 hr^{-1} and 3.7 m^3 hr^{-1}, respectively.

The stiochiometric ratio of oxygen to methane for combustion is **2:1** as shown below:

$$\mathbf{1}CH_4 + \mathbf{2}O_2 + 7.52\ N_2 \longrightarrow CO_2 + 2H_2O + 7.52\ N_2 + \text{Heat} + \text{Light}$$

Ambient air contains 20.9% (v/v) oxygen, therefore stiochiometric volume ratio of air required for complete combustion of methane is **9.97 times** methane volume.

Since the volume of oxygen in inlet landfill gas and stiochiometric ratio required is known, the total amount of intake air required for complete combustion is:

$$(123\ m^3\ h^{-1} \times 9.97) - 3.7\ m^3\ hr^{-1} = \mathbf{1{,}222\ m^3\ hr^{-1}}. \ (\textbf{Eqn 8.3.2})$$

Therefore the total volume of flue gases exhausted through stack assuming total combustion and 0% (v/v) oxygen in flue gas is:

Volume of landfill gas + Volume of Inlet air = Total Volume of flue gas

417 m^3 hr^{-1} + 1,222 m^3 hr^{-1} = **1,639 m^3 hr^{-1} (Eqn 8.3.3)**

In reality excess inlet air is taken into the landfill flare gas burner to ensure this combustion.

The measured oxygen concentration within the flue gas of the landfill flare in the landfill was 8.12% (v/v) dry gas basis.

Therefore excess amounts of inlet air are being taken in through the louver system. As the airflow rate measurement may be highly inaccurate a back calculation method is used to calculate the amount of excess air taken into the flare burner using known combustion volume and flue gas Oxygen concentration % (v/v). This is shown below:

The following units are known:

- Volume of flue gas assuming total combustion and 0% (v/v) oxygen in flue gas outlet $V_{Flue\ gas}$ = 1,639 m^3 hr^{-1};
- Volume of measured excess Oxygen % (v/v) in flue gas outlet $(O_2)_{outlet}$ = 8.12% (v/v);
- Volume of excess inlet air to increase flue gas to measured Oxygen % (v/v) concentration V_{inlet} = unknown
- Oxygen concentration in inlet air $(O_2)_{inlet}$ = 20.90% (v/v)

Using a back calculation formula, and numerous iterations using Solver formula equation in Microsoft Excel, the volume of excess air added to the landfill flare burner system is V_{inlet} = 1,044 m^3 hr^{-1} which equates to a total excess Oxygen volume $(O_2)_{volume}$ = 218 m^3 hr^{-1}. Based on this, the calculated total volume of flue gas from the landfill flare would be 2,688 m^3 hr^{-1}.

The following simple equation illustrates validation of the assumptions used and calculated:

$$\%O_{2Outlet} = \left(\frac{O_{2volume}}{V_{Fluegas} + V_{inlet}}\right) \times 100 \quad \textbf{(Eqn 8.3.4)}$$

Referring back to *Equation 8.3.1*, the percentage proportion of excess air can then be calculated as below:

$$\left(\frac{1044}{1639} = \frac{8.12}{20.90 - 8.12}\right) \times 100 \quad \textbf{(Eqn 8.3.5)}$$

Therefore the percentage proportion of excess air over required fuel air is 63%. *Equation 8.3.5* could also be used to calculate the volume of excess air.

Since the volume of excess air into the landfill flare burner is known, then the ratio of overall intake air over intake landfill gas can be calculated:

$$Ratio_{air} = \frac{1044 m^3 hr^{-1}}{417 m3 / hr} \quad \textbf{(Eqn 8.3.6)}$$

Therefore Ratio $_{air}$ = 2.50which can be expressed as **1:2.50**.

For oxygen correction, the following calculation can be performed:

$$C_r = C_m \times \frac{(20.9 - (O_2)_r)}{(20.9 - (O_2)_m)} \text{ (\textbf{Eqn 8.3.7})}$$

Where: C_r = referenced concentration;
C_m= measured concentration;
$(O_2)_r$ = reference oxygen concentration (3% (v/v) for Landfill flare burners);
$(O_2)_m$ = measured oxygen concentration in flue gas (8.12% (v/v)).

Hence the equation can be written as follows:

$$C_r = C_m \times \frac{17.9\%}{12.78\%} = C_r = C_m \times 1.40 \text{ (\textbf{Eqn 8.3.8})}$$

For a NO_X as NO_2 concentration of 30.80 mg Nm^{-3} then the oxygen corrected value (3% (v/v)) would be as follows:

$C_r = 30.80 \times 1.40$ **= 43.13 mg N m^{-3} at referenced to 3% oxygen (v/v) dry gas.**

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PREFORMED BY ODOUR MONITORING IRELAND ON BEHALF OR CORK COUNTY COUNCIL

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<u>Project:</u> Air emission testing of one Landfill flare located in East Cork Landfill, Rossmore, Carraigtwohill, Co. Cork.

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1. Introduction

This report has been prepared by Odour Monitoring Ireland and contains the results of emission testing carried out on 1 No. Enclosed ground flare at East Cork Landfill, Rossmore, Carraigtwohill, Co. Cork. The emission testing was carried out in compliance with the requirements of Waste licence W022-01.

Odour Monitoring Ireland was commissioned by Mr. Jerome O Brien, Environment Section, Cork County Council to perform emission testing of the 1 landfill gas flare stack located within East Cork Landfill, Rossmore, Carraigtwohill, Co. Cork. The parameters listed in *Table 1.1* were monitored using the appropriate instrumentation as illustrated in *Table 1.1*. Due to both sampling and safety constraints particulates monitoring was not carried upon the flare stack. Firstly, monitoring of particulates on such a source will not reveal any meaningful results due to the high temperature on the emission source causing mechanical issues with the particulates sampling train (temp in excess of 600 deg C). In addition, health and safety issues around working with such equipment in such high temperature conditions will result in severe health and safety risk. Since particulates are not an issue from such sources (burning gas), this sampling was not performed due to this health and safety risk.

Table 1.1. Monitored parameters and techniques for East Cork Landfill 1 No. Enclosed flare, East Cork Landfill, Rossmore, Carraigtwohill, Co. Cork.

Sample location	Parameter	Analytical method
1 Landfill Flare outlet	Volumetric airflow rate & Temperature (^{0}C)	Pitot on inlet in accordance with EN13284-1 where possible. MGO coated K type thermocouple and PT100 Volumetric airflow rate theoretical calculated for Landfill flare.
1 Landfill Flare outlet	Oxides of nitrogen (NO_X as NO_2), Carbon monoxide (CO), Carbon dioxide (CO_2), Sulphur dioxide (SO_2), and Oxygen (O_2)	Flue gas analyser, Testo 350/454 MXL
1 Landfill Flare outlet	Total non methane VOC's (TNMVOC)	Portable Signal 3030PM FID calibrated with Propane in accordance with EN13526:2002 non- methane hydrocarbon cutter. Charcoal tube/GCMS
1 Landfill Flare outlet	Total Volatile Organic Carbon (TOC)	Portable Signal 3030PM FID calibrated with Propane in accordance with EN13526:2002.
1 Landfill Flare outlet	Hydrogen chloride and hydrogen fluoride	Impinger train containing 0.10 molar sodium hydroxide and deionised water solution in accordance EN1911, EN15271:2006 and EPA 26A

This report presents details of this monitoring programme. This environmental monitoring was carried out Dr. Brian Sheridan, Odour Monitoring Ireland on the 17th November 2009. Methodology, Results, Discussion and Conclusions are presented herein.

2. Materials and Methods

This section provides brief details of the methodology employed to perform emission testing of one landfill flare and stack located in East Cork Landfill, Rossmore, Carraigtwohill, Co. Cork.

2.1 Volumetric flow rate and temperature measurement

The volumetric flow rate of the landfill flare was determined from theoretically calculated total volumetric flow rates using the assumptions presented in *Appendix II*. The inlet landfill gas velocity measurements were calculated from the CEMS monitoring system within the landfill flare control building. In addition, airflow measurement was performed on the inlet header gas main using a pitot tube and differential manometer connected to a Testo 454/350 MxL. Temperature traverse measurements were performed across the stack in one plane only. Only one plane was possible due to access port issues. A magnesium oxide K type and PT100 thermocouple was used for measuring temperature in the landfill flare.

2.2 In stack analysis of flue gases

Flue gas analysis was performed using a pre-calibrated Testo 350 MXL/454 flue gas analyser. Concentrations of oxygen, sulphur dioxide, carbon dioxide, temperature, carbon monoxide and oxides of nitrogen were measured using electrochemical cells within the analyser box and all data was logged electronically in 1 minute intervals during the sampling exercise. Data was downloaded from the control handheld using the Com soft software and average concentrations calculated are presented within. All results presented are at 273.15 K, 101.3 kPa on a dry gas basis.

2.3 Total non-methane volatile organic compounds (TNMVOC)

In order to measure total non-methane VOC, a total non-methane hydrocarbon cutter was placed in line with and MCERTS certified FID whereby concentrations of total volatile organic carbon and total non-methane organic were displayed digitally upon the display. This allowed for the calculation of total non-methane VOC's. All results are presented in mg/Nm^3 as propane which is in accordance with the EN13526:2002 and EN12619:1999.

Additionally in order to obtain samples for speciated VOC assessment, a static sampling method was used where air samples were collected in pre-conditioned Tedlar sampling bags using a vacuum sampling device and dynamic dilution device (i.e. Dynasampler). The sampler operates on the "lung principle" whereby the air is removed from a rigid container around the bag by a battery powered SKC vacuum pump filling the bag inside.

All sample bags were pre-flushed with sample air in order to prevent any reductions in the actual VOC due to sample bag surface binding. A leak check was preformed on the sample setup by placing a Primary flow calibrator inline. Once sample acquisition was completed, the sample bag was transferred to another location and connected to the sample pump, tube and Primary flow calibrator. A two bed sorbent was chosen to efficiently bind and pre-concentrate speciated VOC for analysis by GCMS in accordance with established and accredited methodologies. Sealed sorbent tubes were used throughout the study to maintain repeatability and integrity. All sampling for speciated VOC's was preformed in accordance with methodologies discussed within EN 13649:2002.

In order to pre-concentrate speciated VOC upon each sorbent, a pre-calibrated controlled volume of sample air was drawn through each tube by a SKC pump for a period 30 to 40 minutes. Each SKC pump was pre-calibrated with their specific sorbent using a Bios Primary flow calibrator (NIST traceable certified). Each pump was calibrated to a flow of between 90 to 110 ml min^{-1} depending on the sample, sample pump and sorbent tube as recommended by the sorbent manufactured, analysing laboratory and sampling/test methodology. When sampling was completed all tube were sealed and stored in flexible airtight containers and transported to the laboratory.

2.4 Heated Flame Ionisation Detector-Total hydrocarbon concentration (THC) determination

A heated portable FID (MCERT certified), heated line, controller and data logger was used to analyse the duct air stream for total hydrocarbon concentration. Once stabilised and calibrated using span gas (Propane-500 ppm), a sintered probe connected to a 181 ^{0}C heated line was place in the air stream. After stabilisation, the data logger was activated and commences reading. The FID remained analysing continuously for approximately 45 minutes in the duct air stream. Results were presented as mgC/m^3 as propane. All sampling was performed in accordance with methodologies contained within EN 13526:2002 and EN12619:1999.

An FID operates on the principle where influent contaminated gas is mixed with hydrogen and the mixture is burned at the tip of a jet with air or oxygen. Ions and free electrons are formed in the flame and enter a gap between two electrodes, the flame jet and a collector, mounted 0.5-1.0 centimetres above the flame tip. A potential (400 volts) is applied across the two electrodes and with the help of produced ions, a very small current flows between the two electrodes. When an organic substance is introduced this is burned in the flame; a complex process takes place in which positively charged carbon species and electrons are formed. The current is greatly increased and therefore the sample is detected. The FID is a mass flow detector, its response depending directly on the flow rate of the carrier gas. Its response also varies with applied voltage and the temperature of the flame.

2.5 Hydrogen chloride (HCL) and Hydrogen fluoride (HF) analysis

Volatile chloride and fluoride gas concentrations were determined using an impinger train containing 0.10 molar sodium hydroxide and deionised water solution, in which such gases are readily soluble. The sampling methodology was based upon USEPA Method 26, EN15371:2006 and the European Standard, EN 1911. Small sorption liquid volumes were used to attain lower limits of detection. Impingers were placed in series to ensure effective trapping of chloride and fluoride gas concentrations.

The sampling probe was placed within the stack and sample air was drawn through a heated sample line and two glass midget impingers containing 0.10 molar Sodium hydroxide positioned in series. Sampled solutions were sealed and transported to the UKAS accredited laboratory for analysis via ion chromatography (RPS Analytical laboratory, Manchester, UK). The results of mg/m^3 have been converted to mg Nm^{-3} at 273.15 K, 101.3 kPa.

3. Results-Emission testing.

This section will present the results of the monitoring exercise.

3.1 Sampling time

Table 3.1 summarises the sampling times for stack monitoring. *Table 3.2* illustrates the inlet landfill gas parameters as characterised from the CEMS analyser system operating within the landfill flare control building. In addition, manual monitoring was performed using a GA2000 landfill gas analyser. The total volume of landfill gas utilised by the landfill flare during monitoring was 365 m^3/hr.

All outlet gas samples were taken approximately 1.20 metres below the top of the stack for the landfill flare. All sampling was performed through the existing 25mm and 100 mm sampling ports on the landfill flare. A one-plane oxygen and temperature traverse was performed to assess any difference in oxygen concentrations and temperature across the sampling plane. Temperature and Oxygen differences were less than the 15% deviation level as recommended by the UK Environmental Agency (Guidance for monitoring enclosed Landfill flares, 2002).

3.2 Volumetric flow rate results

Sampling for airflow rate was not performed in accordance with EN13284-1:2002 due to sample port position and access restrictions on the landfill flare. *Table 3.3* summarises the theoretical airflow rate calculations for the Landfill gas flare. *Table 3.4* includes the stack velocity, expressed in metres per second (m/s) and exhaust volumetric airflow rate expressed in m^3/hr at both actual and standard reference conditions of 273.15 K, 101.3 kPa (i.e. standard temperature and pressure).

3.3 Flue gas concentration results

Flue gas concentrations were monitored using a pre-calibrated Testo 350/454 MXL flue gas analyser. The results of SO_2, NO_x as NO_2 + NO, CO, and O_2 are presented in *Table 3.4.* The results of ppm have been converted to mg Nm^{-3} at 273.15 K, 101.3 kPa, on a dry gas basis with correction for oxygen content. In accordance with EPA flare monitoring requirements, Oxygen correction to 3% should be performed for landfill gas flare. The average temperature of the gas analyser on the day of sampling was 284.15 K.

3.4 Total hydrocarbon concentration (TOC) results

THC concentrations were monitored using a pre-calibrated FID analyser. The results of THC are presented in *Table 3.4.* The results of ppm have been converted to mgC/Nm^3 at 273.15 K, 101.3 kPa, with correction for oxygen content. Conversion from ppm to mgC/Nm^3 was performed using a 1.60 multiplication factor for propane. In accordance with EPA monitoring requirements, Oxygen correction to 3% should be performed for a landfill flare. The average temperature of the FID on the day of sampling was 454 K.

3.5 Total non-methane volatile organic compound (TNMVOC)

Table 3.4 illustrates the results of the continuous non-methane volatile organic compounds (TNMVOC) the monitoring locations. The monitoring of TNMVOC was performed using a TNMVOC hydrocarbon cutter and a continuous monitoring Flame ionisation detector operated in accordance with EN13526:2002 and using sorbent tube analysis by GCMS. The monitoring of THC will provide the total hydrocarbon concentration including any propane or methane fraction within the airstream. The use of a hydrocarbon cutter facilitates the removal of the methane and propane fraction from the airstream and the presented results therefore consist of the non-methane fraction only. As can be observed the overall concentration of total non-methane VOC's (TNMVOC) are within emission limits as set out in Schedule G.3 of Waste licence W022-01.

3.6 Hydrogen chloride (HCL) and Hydrogen fluoride (HF)

Hydrogen chloride and hydrogen fluoride concentrations were monitored using an impinger train containing 0.10 molar sodium hydroxide and deionised water solution, in which such gases are readily soluble. The results of hydrogen chloride and hydrogen fluoride are presented in *Table 3.4.* The results of mg/m^3 have been converted to mg/Nm^3 at 273.15 K, 101.3 kPa, with correction for oxygen content. In accordance with EPA flare, Oxygen correction to 3% should be performed for a landfill gas flare.

Table 3.1. Sampling time runs on the 17th November 2009 for monitoring of landfill flare.

Parameter	Approx. Sampling period for 1 landfill flare
Inlet CH_4	45 minutes
Inlet O_2	45 minutes
Volumetric air flow rate	Theoretically calculated
SO_2	45 minutes
NO_x	45 minutes
CO	45 minutes
O_2	45 minutes
CO_2	45 minutes
Stack gas temp	45 minutes
TNMVOC	45 minutes
TOC	45 minutes
HF/HCL	45 minutes

Table 3.2. Characteristics of raw inlet gas to one enclosed Landfill flare gas burner.

Inlet compound identity	Compound loading Landfill flare	Unit values
CH_4	31	%
CO_2	28	%
O_2	1.10	%
Total Landfill gas volumetric airflow rate	365	m^3/hr

Table 3.3. Theoretically calculated landfill gas exhaust volume and physical characteristics from the Landfill flare.

Parameter	Enclosed flare
Total Volumetric methane loading (m^3/hr)	113
Total Volumetric Oxygen loading (m^3/hr)	4
Ratio to complete combustion of methane assuming no excess Oxygen	9.57
Oxygen concentration level in flue gas (%)	10.10
Flue gas temperature (Kelvin)[2]	1,303
Theoretical calculated Volumetric exhaust airflow rate (m^3/h)	2,794
Normalised average exhaust airflow rate ($Nm^3\ h^{-1}$)[3]	585

Notes: [1] denotes data from 17th November 2009.
[2] denoted converted from degrees Celsius to Kelvin (^{0}C + 273.15);
[3] denotes normalised to 273.15 Kelvin and 101.3 kPa.

Table 3.4. Emission value results for one landfill gas flare.

Landfill Flare No. 1	Conc.	Units	Adjusted units (mg/m^3)	Volumetric flow rate (m^3N/hr)	Emission conc (mgN/m^3)	Oxygen corrected emission conc for flare to 3% (mgN/m^3)[1]	Mass emission rate (kg/hr)	Emission limit Values
TNMVOC	2.10	mg/Nm^3	2.10	585	2.25	3.74	0.0010	<20 mg/Nm^3
TOC	4.10	mgC/m^3	6.56	585	6.56	10.87	0.0040	<10 mg/Nm^3
HCL	3.26	mg/m^3	3.26	585	4.45	7.38	0.0030	<50 mg/Nm^3 (at mass flow > 0.30 kg/hr)
HF	0.14	mg/m^3	0.14	585	0.19	0.32	0.00010	<5 mg/Nm^3 (at mass flow > 0.050 kg/hr)
Temperature	1030	degrees	1303.00	-	-	-	-	>1273 K
CO	4.00	ppm	5.00	585	5.00	8.29	0.0030	<50 mg/Nm^3
O_2	10.10	%	10.10	-	-	-	-	-
Total NO_X as NO_2	20.00	ppm	41.07	585	41.07	68.07	0.024	<150 mg/Nm^3
SO_2	39.00	ppm	111.43	585	111.43	184.68	0.065	-
CO_2	9.14	%	9.14	-	-	-	-	-
Volumetric airflow rate (Nm^3/hr)	585	-	-	-	-	455	-	--
Inlet methane concentration	2.21E+05	mg/m^3	2.21E+05	113.15	2.46E+05	-	-	--
Methane destruction Eff	99	%	-	-	-	-	-	--

Notes: [1] denotes refer to *Appendix II* for Oxygen correction calculations.

4. Discussion of results

Tables 3.1 to *3.4* present the results of the emission monitoring carried out on the landfill flare stack burner located in East Cork Landfill, Rossmore, Carraigtwohill, Co. Cork.

There was very little variation at one traverse in oxygen and flue gas temperature profiles across the stack during the monitoring exercise (i.e. less than 15% as recommended by the Environment Agency, UK (Environment Agency, 2002)).

A high temperature Inconel 625 and ceramic probe (Testo, Germany) was used to prevent variations in CO emissions data. Normal stainless steel probes when subjected to temperatures above 600^0C can release CO from within the structure of the material and cause the recording of erroneous results (Environment Agency, 2002).

Correction of data to 3% oxygen was performed. Due to possible inaccuracies in airflow rate measurement, it was not possible to determine the oxygen intake of the flare through the louver system using measurement. Since the volume of intake air required for complete combustion was known and the oxygen concentration in the exhaust flue gas was known, the volume of intake excess fuel air could be theoretically calculated through numerous iterations using the Solver program (i.e. Microsoft Excel). This allows for the calculation of the volume of intake excess air through the louver landfill flare intake system. These calculations were validated through use of the published Environment Agency equation (see *Eqn 8.3.1*) (Environment Agency, 2002).

Landfill methane destruction efficiency was calculated using the inlet methane loading concentration and the exhaust total organic carbon concentration as presented in *Table 3.4*. As can be observed, the landfill flares is achieving a methane destruction efficiency of greater than 99%. Typical reported concentrations of methane from landfill flare burner systems are in the order of 0.040% to 0.52%. The complete combustion of methane results in the formation of CO_2 and H_2O. The incomplete combustion of methane results in the formation of CO. CO concentration levels was low in the flue gas of the landfill flare.

5. Conclusion

The following conclusions can be drawn from this study:

1. A theoretically exhaust flue gas volume was calculated for the landfill flare.
2. NO_x as NO_2, SO_2, CO, O_2, TNMVOC, HCL/HF and TOC monitoring and analysis was carried out in accordance with specified requirements;
3. All data was standardised to 273.15 Kelvin, 101.3 kPa;
4. All data is presented as Oxygen corrected to 3% (v/v) using the appropriate equations as presented in *Section 8.2*;
5. CO, NO_x as NO_2, TNMVOC, TOC and HCL/HF in the exhaust gas of the landfill flare were in compliance with the emission limit values contained in Schedule G.3 of Waste licence W022-01.

6. References

1. Environment Agency. (2002). Guidance for Monitoring Enclosed Landfill Gas Flares. www.environment-agency.co.uk
2. McVay, M., (2003). Personal communication. Environment Agency, Wales, UK.
3. ISO 10780, (1984). Stationary source emissions-Measurement of velocity and volume flow rate of gas streams in ducts.

- IS EN13526:2002-Stationary source emissions-Determination of the mass concentration of total gaseous organic carbon in flue gases from solvent using processes-Continuous flame ionisation detector method.
- IS EN12619:1999-Stationary source emissions-Determination of the mass concentration of total gaseous organic carbon at low concentrations in flue gases-Continuous flame ionisation detector method.
- I.S. EN13649:2002-Stationary source emissions-Determination of the mass concentration of individual gaseous organic compounds-Activated carbon and solvent desorption method.

7. *Appendix I-*Sampling, analysis and calculation details

7.1.1 Location of Sampling

East Cork Landfill, Rossmore, Carraigtwohill, Co. Cork.

7.1.2 Date & Time of Sampling

17th November 2009

7.1.3 Personnel Present During Sampling

Dr. Brian Sheridan, Odour Monitoring Ireland, Trim, Co. Meath.

7.1.4 Instrumentation

Testo 350 MXL/454 in stack analyser;
Federal Method 2 S type pitot and MGO coated thermocouple;
L type pitot tube
Testo 400 handheld and appropriate probes.
Ceramic and Inconel 625 sampling probes.
Portable Signal 3030PM FID calibrated with Propane with non-methane hydrocarbon cutter.
SKC sample pumps and Bios Primary calibrator

8. *Appendix II*-Example calculations and conversions

8.1 Conversion of 20 ppm Oxides of nitrogen to mg Nm^{-3} at 273.15 Kelvin and 101.3 kPa (STP) for Landfill flare 1

1 mole of an ideal gas occupies 22.4 litres at standard temperature and pressure of 273.15 Kelvin[1] and 101.3 kPa (STP), where a mole of any substance is equal to its molecular mass and expressed in grams.

This is known as molar mass (i.e. the volume occupied by one gram mole of a gas at STP).

Using the average recorded concentration (in ppm) for NO_2 during the survey, the conversion is as follows:

1 mole of NO_2 occupies 22.4 litres @ STP

46 grams (Molecular weight of NO_2) occupies 22.4 litres @ STP

mg/m^3 NO_2 = 20 ppm × 46 / 22.4 = 41 mg/Nm^3

Notes:
[1]denotes conversion of ^0C to Kelvin: $^0C + 273$ = Kelvin, normalisation temperature is the recorded temperature of the stack analyser

8.2 Additional calculations and correction of Oxygen concentration measured to reference Oxygen concentration of 3% (v/v) for 41 mg/Nm^3 of NO_X as NO_2 for Landfill flare.

If excess air is added to an enclosed landfill flare (i.e. to promote better combustion), measured flue gas emission concentration of non-combustion species will fall. Emission concentrations appear to be reducing, whilst in reality mass emission rates have remained constant (Environment Agency, 2002). Therefore, it is necessary to compare concentrations at a standard oxygen concentration.

The relationship between the measured oxygen concentration and measured emission species concentration is non-linear as oxygen from air is added or removed. For example, a halving of the flue gas oxygen content does not result in a doubling of the emission concentration. The oxygen concentration in the flue gases is a measure of the excess air over that required for theoretical complete combustion (i.e. stiochiometric air requirement). Therefore, the measured oxygen level is a measure of the dilution of the flue gases from the stoichiometric condition. The concentration of oxygen in dry air is 20.9% (v/v) and the proportion of excess air (X/V) can therefore be calculated from the following:

$$\frac{X}{V} = \frac{(O_2)_m}{(20.9-(O_2)_m)} \quad \textbf{(Eqn 8.3.1)}$$

Where: X is the volume of excess air (m^3);
V is the stoichiometric volume of the flue gas (m^3);
$(O_2)_m$ is the percentage of oxygen (v/v) in the flue gas (on a dry basis).

If we know and calculate the following:

The volume of landfill gas was 365 m^3/hr with a methane and oxygen concentration of 31% (v/v) and 1.10 %(v/v) as taken from the landfill gas analyser.

This equates to a methane and oxygen volume of 113 m^3/hr and 4 m^3/hr, respectively.

The stiochiometric ratio of oxygen to methane for combustion is **2:1** as shown below:

$$\mathbf{1}CH_4 + \mathbf{2}O_2 + 7.52\,N_2 \longrightarrow CO_2 + 2H_2O + 7.52\,N_2 + \text{Heat} + \text{Light}$$

Ambient air contains 20.9% (v/v) oxygen, therefore stiochiometric volume ratio of air required for complete combustion of methane is **9.57 times** methane volume.

Since the volume of oxygen in inlet landfill gas and stiochiometric ratio required is known, the total amount of intake air required for complete combustion is:

$$(113\ m^3\ h^{-1} \times 9.57) - 4\ m^3/hr = \mathbf{1{,}079m^3/hr}.\ (\textbf{Eqn 8.3.2})$$

Therefore the total volume of flue gases exhausted through stack assuming total combustion and 0% (v/v) oxygen in flue gas is:

Volume of landfill gas + Volume of Inlet air = Total Volume of flue gas

365 m^3/hr + 1,079 m^3/hr = 1,444 **m^3/hr (Eqn 8.3.3)**

In reality excess inlet air is taken into the landfill flare gas burner to ensure this combustion.

The measured oxygen concentration within the flue gas of the landfill flare in East Cork Landfill was 10.10 % (v/v**)** dry gas basis.

Therefore excess amounts of inlet air are being taken in through the louver system. As the airflow rate measurement may be highly inaccurate a back calculation method is used to calculate the amount of excess air taken into the flare burner using known combustion volume and flue gas Oxygen concentration % (v/v). This is shown below:

The following units are known:

- Volume of flue gas assuming total combustion and 0% (v/v) oxygen in flue gas outlet $V_{Flue\ gas}$ = 1,444 m^3/hr;
- Volume of measured excess Oxygen % (v/v) in flue gas outlet $(O_2)_{outlet}$ = 10.10% (v/v);
- Volume of excess inlet air to increase flue gas to measured Oxygen % (v/v) concentration V_{inlet} = unknown
- Oxygen concentration in inlet air $(O_2)_{inlet}$ = 20.9% (v/v)

Using a back calculation formula, and numerous iterations using Solver formula equation in Microsoft Excel, the volume of excess air added to the landfill flare burner system is V_{inlet} = 1,350 m^3/hr which equates to a total excess Oxygen volume $(O_2)_{volume}$ = 282 m^3/hr. Based on this, the calculated total volume of flue gas from the landfill flare would be **2,794 m^3/hr.**

The following simple equation illustrates validation of the assumptions used and calculated:

$$\%O_{2Outlet} = \left(\frac{O_{2volume}}{V_{Fluegas} + V_{inlet}}\right) \times 100 \quad \textbf{(Eqn 8.3.4)}$$

Referring back to *Equation 8.3.1*, the percentage proportion of excess air can then be calculated as below:

$$\left(\frac{1350}{1444} = \frac{10.10}{20.9 - 10.10}\right) \textbf{(Eqn 8.3.5)}$$

Therefore the percentage proportion of excess air over required fuel air is near 94%. *Equation 8.3.5* could also be used to calculate the volume of excess air.

Since the volume of excess air into the landfill flare burner is known, then the ratio of overall intake air over intake landfill gas can be calculated:

$$Ratio_{air} = \frac{1{,}350 m^3 hr^{-1}}{365 m3 / hr} \quad \textbf{(Eqn 8.3.6)}$$

Therefore $Ratio_{air}$ = 3.69 which can be expressed as **1:3.69**. This is a common occurrence in landfill flare burners although a value closer to 9 is more frequent.

For oxygen correction, the following calculation can be performed:

$$C_r = C_m \times \frac{(20.9 - (O_2)_r)}{(20.9 - (O_2)_m)}$$ (**Eqn 8.3.7**)

Where: C_r = referenced concentration;
C_m= measured concentration;
$(O_2)_r$ = reference oxygen concentration (3% (v/v) for Landfill flare burners);
$(O_2)_m$ = measured oxygen concentration in flue gas (10.10% (v/v)).

Hence the equation can be written as follows:

$$C_r = C_m \times \frac{17.9\%}{10.80\%} = C_r = C_m \times 1.66$$ (**Eqn 8.3.8**)

For a NO_2 concentration of 41 mg/Nm^3 then the oxygen corrected value (3% (v/v)) would be as follows:

$C_r = 41 \times 1.66$ **= 68.06 mg/Nm^3 referenced to 3% oxygen (v/v) dry gas.**

APPENDIX H

Statement of Environmental Emissions for 2009

Environmental Protection Agency

| PRTR# : W0022 | Facility Name : East Cork Landfill Site | Filename : W0022_2009(1).xls | Return Year : 2009 |

AER Returns Worksheet

Version 1.1.10

REFERENCE YEAR	2009

1. FACILITY IDENTIFICATION

Parent Company Name	Cork County Council
Facility Name	East Cork Landfill Site
PRTR Identification Number	W0022
Licence Number	W0022-01

Waste or IPPC Classes of Activity

No.	class_name
3.5	Specially engineered landfill, including placement into lined discrete cells which are capped and isolated from one another and the environment.
3.1	Deposit on, in or under land (including landfill).
3.11	Blending or mixture prior to submission to any activity referred to in a preceding paragraph of this Schedule.
3.12	Repackaging prior to submission to any activity referred to in a preceding paragraph of this Schedule.
3.13	Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced.
3.4	Surface impoundment, including placement of liquid or sludge discards into pits, ponds or lagoons.
3.7	##
4.10	The treatment of any waste on land with a consequential benefit for an agricultural activity or ecological system.
4.11	Use of waste obtained from any activity referred to in a preceding paragraph of this Schedule.
4.13	Storage of waste intended for submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where such waste is produced.
4.2	Recycling or reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes).
4.3	Recycling or reclamation of metals and metal compounds.
4.4	Recycling or reclamation of other inorganic materials.
4.9	Use of any waste principally as a fuel or other means to generate energy.

Address 1	Rossmore
Address 2	Carrigtohill
Address 3	County Cork
Address 4	
Country	Ireland
Coordinates of Location	-8.25588 51.8851
River Basin District	IESW
NACE Code	3821
Main Economic Activity	Treatment and disposal of non-hazardous waste
AER Returns Contact Name	Jerome O'Brien (W0022)
AER Returns Contact Email Address	jerome.obrien@corkcoco.ie
AER Returns Contact Position	Senior Executive Engineer, South Cork Division
AER Returns Contact Telephone Number	021 4533934

AER Returns Contact Mobile Phone Number	086 8355143
AER Returns Contact Fax Number	021 4533880
Production Volume	0.0
Production Volume Units	
Number of Installations	1
Number of Operating Hours in Year	2368
Number of Employees	3
User Feedback/Comments	
Web Address	www.corkcoco.ie

2. PRTR CLASS ACTIVITIES

Activity Number	Activity Name
5(d)	Landfills
5(c)	Installations for the disposal of non-hazardous waste
5(d)	Landfills
50.1	General

3. SOLVENTS REGULATIONS (S.I. No. 543 of 2002)

Is it applicable?	No
Have you been granted an exemption ?	No
If applicable which activity class applies (as per Schedule 2 of the regulations) ?	NIL
Is the reduction scheme compliance route being used ?	NIL

4.1 RELEASES TO AIR

| PRTR# : W0022 | Facility Name : East Cork Landfill Site | Filename : W0022_2009(1).xls | Return Year : 2009 | 23/04/2010 10:15

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

RELEASES TO AIR									
POLLUTANT		METHOD				QUANTITY			
			Method Used						
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
01	**Methane (CH4)**	M	PER	infrared analyser	0.0	6227.42	0.0	6227.42
02	Carbon monoxide (CO)	M	PER	flue gas analyser	0.0	19.72	0.0	19.72
03	Carbon dioxide (CO2)	M	PER	infrared analyser	0.0	14469.22	0.0	14469.22
07	Non-methane volatile organic compounds (NMVOC)	M	PER	flue gas analyser	0.0	12.56	0.0	12.56
08	Nitrogen oxides (NOx/NO2)	M	PER	flue gas analyser	0.0	186.41	0.0	186.41
11	Sulphur oxides (SOx/SO2)	M	PER	flue gas analyser	0.0	755.35	0.0	755.35

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING PRTR POLLUTANTS

RELEASES TO AIR								
POLLUTANT		METHOD			QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION C : REMAINING POLLUTANT EMISSIONS (As required in your Licence)

RELEASES TO AIR								
POLLUTANT		METHOD			QUANTITY			
			Method Used					
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

Additional Data Requested from Landfill operators

For the purposes of the National Inventory on Greenhouse Gases, landfill operators are requested to provide summary data on landfill gas (Methane) flared or utilised on their facilities to accompany the figures for total methane generated. Operators should only report their Net methane (CH4) emission to the environment under T(total) KG/yr for Section A: Sector specific PRTR pollutants above. Please complete the table below:

Landfill: East Cork Landfill Site

Please enter summary data on the quantities of methane flared and / or utilised	**T (Total) kg/Year**	**M/C/E**	**Method Used** **Method Code**	**Designation or Description**	**Facility Total Capacity m3 per hour**	
Total estimated methane generation (as per site model)	586726.9	M	PER	metred reading/av quality production	N/A	
Methane flared	580499.47	M	PER	metred reading/av quality production	1000.0	(Total Flaring Capacity)
Methane utilised in engine/s	0.0				0.0	(Total Utilising Capacity)
Net methane emission (as reported in Section A above)	6227.42	M	PER	metred reading/av quality production	N/A	

4.2 RELEASES TO WATERS

| PRTR# : W0022 | Facility Name : East Cork Landfill Site | Filename : W0022_2009(1).xls | Return Year : 2009 | 23/04/2010 10:15

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

Data on ambient monitoring of storm/surface water or groundwater, conducted as part of your licence requirements, should NOT be submitted under AER / PRTR Reporting as this only concerns Releases from your facility

RELEASES TO WATERS								
POLLUTANT					QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING PRTR POLLUTANTS

RELEASES TO WATERS								
POLLUTANT					QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION C : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

RELEASES TO WATERS								
POLLUTANT					QUANTITY			
			Method Used					
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

4.3 RELEASES TO WASTEWATER OR SEWER

| PRTR# : W0022 | Facility Name : East Cork Landfill Site | Filename : W0022_2009(1).xls | Return Yea 23/04/2010 10:17

SECTION A : PRTR POLLUTANTS

OFFSITE TRANSFER OF POLLUTANTS DESTINED FOR WASTE-WATER TREATMENT OR SEWER

POLLUTANT		METHOD			QUANTITY			
			Method Used		Leachate Lagoon			
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
06	Ammonia (NH3)	M	PER	weighing/laboratory	9381.7	9381.7	0.0	0.0
18	Cadmium and compounds (as Cd)	M	PER	weighing/laboratory	0.318	0.318	0.0	0.0
79	Chlorides (as Cl)	M	PER	weighing/laboratory	11965.8	11965.8	0.0	0.0
15	Chlorofluorocarbons (CFCs)	M	PER	weighing/laboratory	0.281	0.281	0.0	0.0
20	Copper and compounds (as Cu)	M	PER	weighing/laboratory	0.183	0.183	0.0	0.0
83	Fluorides (as total F)	M	PER	weighing/laboratory	162.6	162.6	0.0	0.0
82	Cyanides (as total CN)	M	PER	weighing/laboratory	0.183	0.183	0.0	0.0
23	Lead and compounds (as Pb)	M	PER	weighing/laboratory	0.147	0.147	0.0	0.0
21	Mercury and compounds (as Hg)	M	PER	weighing/laboratory	0.006	0.006	0.0	0.0
13	Total phosphorus	M	PER	weighing/laboratory	4.9	4.9	0.0	0.0
12	Total nitrogen	M	PER	weighing/laboratory	6.7	6.7	0.0	0.0
24	Zinc and compounds (as Zn)	M	PER	weighing/laboratory	0.6	0.6	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

OFFSITE TRANSFER OF POLLUTANTS DESTINED FOR WASTE-WATER TREATMENT OR SEWER

POLLUTANT		METHOD			QUANTITY			
			Method Used					
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
303	BOD	M	PER	weighing/laboratory	834.2	834.2	0.0	0.0
305	Calcium	M	PER	weighing/laboratory	1776.0	1776.0	0.0	0.0
306	COD	M	PER	weighing/laboratory	14821.0	14821.0	0.0	0.0
357	Iron	M	PER	weighing/laboratory	2.3	2.3	0.0	0.0
320	Magnesium	M	PER	weighing/laboratory	957.7	957.7	0.0	0.0
321	Manganese (as Mn)	M	PER	weighing/laboratory	2.15	2.15	0.0	0.0
327	Nitrate (as N)	M	PER	weighing/laboratory	36.15	36.15	0.0	0.0
338	Potassium	M	PER	weighing/laboratory	3144.0	3144.0	0.0	0.0
343	Sulphate	M	PER	weighing/laboratory	205.7	205.7	0.0	0.0
240	Suspended Solids	M	PER	weighing/laboratory	2560.3	2560.3	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

4.4 RELEASES TO LAND

SECTION A : PRTR POLLUTANTS

RELEASES TO LAND							
POLLUTANT		METHOD			QUANTITY		
			Method Used				
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year
					0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

RELEASES TO LAND							
POLLUTANT		METHOD			QUANTITY		
			Method Used				
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year
					0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

5. ONSITE TREATMENT & OFFSITE TRANSFERS OF WASTE | PRTR# : W0022 | Facility Name : East Cork Landfill Site | Filename : W0022_2009(1).xls | Return Year : 2009 | 23/04/2010 10:18

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Transfer Destination	European Waste Code	Hazardous	Quantity (Tonnes per Year)	Description of Waste	Waste Treatment Operation	Method Used M/C/E	Method Used	Location of Treatment	Haz Waste : Name and Licence/Permit No of Next Destination Facility Non Haz Waste: Name and Licence/Permit No of Recover/Disposer	Haz Waste : Address of Next Destination Facility Non Haz Waste: Address of Recover/Disposer	Name and License / Permit No. and Address of Final Recoverer / Disposer (HAZARDOUS WASTE ONLY)	Actual Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
Within the Country	**20 03 01**	**No**	1991.0	mixed municipal waste	D5	M	Weighed	Onsite in Ireland	Cork County Council,W0068-02	Foxhole,".",Youghal,Co Cork,Ireland		
Within the Country	15 01 01	No	85.0	cardboard packaging	R3	M	Weighed	Onsite in Ireland	Veolia Ltd,W0173-01	Forge Hill,Kinsale Rd,Cork,".",Ireland		
Within the Country	20 01 01	No	117.0	paper & news	R3	M	Weighed	Onsite in Ireland	greenstar Ltd,W0136-02	Sarsfield Court Industrial Estate,".",Glanmire,Co Cork,Ireland		
Within the Country	15 01 07	No	45.0	glass bottles	R5	M	Weighed	Onsite in Ireland	Mr Binman,W0061-01	Luddenmore,Grange,Kilmallock,Co Limerick,Ireland		
Within the Country	20 01 02	No	17.0	plate glass	R5	M	Weighed	Onsite in Ireland	MSM Recycling Ltd,W0079-01	Cookstown Industrial Estate,41,Tallaght,Co Dublin,Ireland		
Within the Country	20 01 40	No	154.0	scrap metals	R4	M	Weighed	Onsite in Ireland	Pouladuff Dismantlers Ltd,CK/0584/01	Pouladuff Rd,Togher,Cork,".",Ireland		
Within the Country	15 01 02	No	25.0	plastic packaging	R5	M	Weighed	Onsite in Ireland	Green Dragon Recycling Ltd,CK/09/0629/01	Corbally North,".",Glanmire,Co Cork,Ireland		
Within the Country	20 01 11	No	8.0	textiles	R5	M	Weighed	Onsite in Ireland	MSM Recycling Ltd,W0079-01	Cookstown Industrial Estate,41,Tallaght,Co Dublin,Ireland		
Within the Country	20 01 38	No	315.0	wood	R3	M	Weighed	Onsite in Ireland	CTO Environmental Solutions Ltd,CK/09/0018/02	Kinsale Rd Landfill,South City Link Rd,Cork,".",Ireland		
Within the Country	16 06 01	Yes	4.44	lead acid batteries	R6	M	Weighed	Onsite in Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland	KMK Metals Ltd,W0133-03,Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland
Within the Country	16 06 02	Yes	0.93	Ni Cd batteries	R13	M	Weighed	Onsite in Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland	KMK Metals Ltd,W0133-03,Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland
Within the Country	13 02 08	Yes	10.24	engine oil & lubricants	R9	M	Weighed	Onsite in Ireland	Enva Ltd,W0184-01	Clonminam Industrial Estate,".",Portlaoise,Co Laois,Ireland	Enva Ltd,W0184-01,Clonminam Industrial Estate,".",Portlaoise,Co Laois,Ireland	Clonminam Industrial Estate,".",Portlaoise,Co Laois,Ireland
Within the Country	20 01 25	No	0.86	edible oils & fats	R9	M	Weighed	Onsite in Ireland	Enva Ltd,W0184-01	Clonminam Industrial Estate,".",Portlaoise,Co Laois,Ireland		
Within the Country	20 01 28	No	4.76	household paint	R1	M	Weighed	Onsite in Ireland	Enva Ltd,W0184-01	Clonminam Industrial Estate,".",Portlaois,Co Laois,Ireland		
Within the Country	20 03 03	No	2.86	street cleaning residue	D5	M	Weighed	Onsite in Ireland	Cork County Council,W0068-02	Foxhole,".",Youghal,Co Cork,Ireland		
Within the Country	20 01 23	Yes	29.9	fridges & freezers	R4	M	Weighed	Onsite in Ireland	KMK Metals Ltd,W133-03	Cappincur indistrial Estate,".",Tullamore,Co Offaly,Ireland	KMK Metals Ltd,W133-03,Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland
Within the Country	20 01 36	No	81.64	white goods	R4	M	Weighed	Onsite in Ireland	KMK Metals Ltd ,W0133-03	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland		
Within the Country	20 01 35	Yes	58.94	CRT	R4	M	Weighed	Onsite in Ireland	KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland	KMK Metals Ltd,W0133-03,Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland
Within the Country	20 01 36	No	156.65	small appliances	R4	M	Weighed	Onsite in Ireland	KMK Metals Lts,W0133-03	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland		

Transfer Destination	European Waste Code	Hazardous	Quantity (Tonnes per Year)	Description of Waste	Waste Treatment Operation	Method Used		Location of Treatment	Haz Waste : Name and Licence/Permit No of Next Destination Facility Non Haz Waste: Name and Licence/Permit No of Recover/Disposer	Haz Waste : Address of Next Destination Facility Non Haz Waste: Address of Recover/Disposer	Name and License / Permit No. and Address of Final Recoverer / Disposer (HAZARDOUS WASTE ONLY)	Actual Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
						M/C/E	Method Used					

* Select a row by double-clicking the Description of Waste then click the delete button

NACE_Group	NACE_SubGroup	NACE_Code	NACE_Description	NACE_ISIC
12	0	0	Manufacture of tobacco products	1200
36	0	0	Water collection, treatment and supply	3600
37	0	0	Sewerage	3700
39	0	0	Remediation activities and other waste management services	3900
75	0	0	Veterinary activities	7500
92	0	0	Gambling and betting activities	9200
97	0	0	Activities of households as employers of domestic personnel	9700
99	0	0	Activities of extraterritorial organisations and bodies	9900
02	1	0	Silviculture and other forestry activities	0210
05	1	0	Mining of hard coal	0510
06	1	0	Extraction of crude petroleum	0610
07	1	0	Mining of iron ores	0710
09	1	0	Support activities for petroleum and natural gas extraction	0910
13	1	0	Preparation and spinning of textile fibres	1311
16	1	0	Sawmilling and planing of wood	1610
19	1	0	Manufacture of coke oven products	1910
21	1	0	Manufacture of basic pharmaceutical products	2100*
24	1	0	Manufacture of basic iron and steel and of ferro-alloys	2410*
29	1	0	Manufacture of motor vehicles	2910
41	1	0	Development of building projects	4100*
49	1	0	Passenger rail transport, interurban	4911
50	1	0	Sea and coastal passenger water transport	5011
51	1	0	Passenger air transport	5110
52	1	0	Warehousing and storage	5210
53	1	0	Postal activities under universal service obligation	5310
55	1	0	Hotels and similar accommodation	5510*
56	1	0	Restaurants and mobile food service activities	5610
60	1	0	Radio broadcasting	6010
61	1	0	Wired telecommunications activities	6110
68	1	0	Buying and selling of own real estate	6810*
69	1	0	Legal activities	6910
70	1	0	Activities of head offices	7010
74	1	0	Specialised design activities	7410
78	1	0	Activities of employment placement agencies	7810
80	1	0	Private security activities	8010
81	1	0	Combined facilities support activities	8110
85	1	0	Pre-primary education	8510*
86	1	0	Hospital activities	8610

87	1	0	Residential nursing care activities	8710
88	1	0	Social work activities without accommodation for the elderly and disabled	8810
98	1	0	Undifferentiated goods-producing activities of private households for own use	9810
02	2	0	Logging	0220
05	2	0	Mining of lignite	0520
06	2	0	Extraction of natural gas	0620
10	2	0	Processing and preserving of fish, crustaceans and molluscs	1020
13	2	0	Weaving of textiles	1312
14	2	0	Manufacture of articles of fur	1420
15	2	0	Manufacture of footwear	1520
18	2	0	Reproduction of recorded media	1820
19	2	0	Manufacture of refined petroleum products	1920
20	2	0	Manufacture of pesticides and other agrochemical products	2021
21	2	0	Manufacture of pharmaceutical preparations	2100*
23	2	0	Manufacture of refractory products	2391
24	2	0	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel	2410*
26	2	0	Manufacture of computers and peripheral equipment	2620
27	2	0	Manufacture of batteries and accumulators	2720
29	2	0	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	2920
30	2	0	Manufacture of railway locomotives and rolling stock	3020
32	2	0	Manufacture of musical instruments	3220
33	2	0	Installation of industrial machinery and equipment	3320
41	2	0	Construction of residential and non-residential buildings	4100*
45	2	0	Maintenance and repair of motor vehicles	4520
49	2	0	Freight rail transport	4912
50	2	0	Sea and coastal freight water transport	5012
53	2	0	Other postal and courier activities	5320
55	2	0	Holiday and other short-stay accommodation	5510*
59	2	0	Sound recording and music publishing activities	5920
60	2	0	Television programming and broadcasting activities	6020
61	2	0	Wireless telecommunications activities	6120
64	2	0	Activities of holding companies	6420
65	2	0	Reinsurance	6520
68	2	0	Renting and operating of own or leased real estate	6810*
69	2	0	Accounting, bookkeeping and auditing activities; tax consultancy	6920
71	2	0	Technical testing and analysis	7120
72	2	0	Research and experimental development on social sciences and humanities	7220
73	2	0	Market research and public opinion polling	7320
74	2	0	Photographic activities	7420

78	2	0	Temporary employment agency activities	7820
80	2	0	Security systems service activities	8020
82	2	0	Activities of call centres	8220
85	2	0	Primary education	8510*
87	2	0	Residential care activities for mental retardation, mental health and substance abuse	8720
94	2	0	Activities of trade unions	9420
98	2	0	Undifferentiated service-producing activities of private households for own use	9820
01	3	0	Plant propagation	0130
02	3	0	Gathering of wild growing non-wood products	0230
13	3	0	Finishing of textiles	1313
20	3	0	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	2022
25	3	0	Manufacture of steam generators, except central heating hot water boilers	2513
26	3	0	Manufacture of communication equipment	2630
28	3	0	Manufacture of agricultural and forestry machinery	2821
30	3	0	Manufacture of air and spacecraft and related machinery	3030
32	3	0	Manufacture of sports goods	3230
35	3	0	Steam and air conditioning supply	3530
47	3	0	Retail sale of automotive fuel in specialised stores	4730
50	3	0	Inland passenger water transport	5021
55	3	0	Camping grounds, recreational vehicle parks and trailer parks	5520
56	3	0	Beverage serving activities	5630
61	3	0	Satellite telecommunications activities	6130
64	3	0	Trusts, funds and similar financial entities	6430
65	3	0	Pension funding	6530
66	3	0	Fund management activities	6630
74	3	0	Translation and interpretation activities	7490*
78	3	0	Other human resources provision	7830
80	3	0	Investigation activities	8030
81	3	0	Landscape service activities	8130
82	3	0	Organisation of conventions and trade shows	8230
84	3	0	Compulsory social security activities	8430
87	3	0	Residential care activities for the elderly and disabled	8730
02	4	0	Support services to forestry	0240
25	4	0	Manufacture of weapons and ammunition	2520
26	4	0	Manufacture of consumer electronics	2640
27	4	0	Manufacture of electric lighting equipment	2740
30	4	0	Manufacture of military fighting vehicles	3040
32	4	0	Manufacture of games and toys	3240
45	4	0	Sale, maintenance and repair of motorcycles and related parts and accessories	4540

50	4	0	Inland freight water transport	5022
77	4	0	Leasing of intellectual property and similar products, except copyrighted works	7740
01	5	0	Mixed farming	0150
25	5	0	Forging, pressing, stamping and roll-forming of metal; powder metallurgy	2591
32	5	0	Manufacture of medical and dental instruments and supplies	3250
49	5	0	Transport via pipeline	4930
20	6	0	Manufacture of man-made fibres	2030
26	6	0	Manufacture of irradiation, electromedical and electrotherapeutic equipment	2660
85	6	0	Educational support activities	8550
01	7	0	Hunting, trapping and related service activities	0170
23	7	0	Cutting, shaping and finishing of stone	2396
26	7	0	Manufacture of optical instruments and photographic equipment	2670
26	8	0	Manufacture of magnetic and optical media	2680
09	9	0	Support activities for other mining and quarrying	0990
27	9	0	Manufacture of other electrical equipment	2790
46	9	0	Non-specialised wholesale trade	4690
55	9	0	Other accommodation	5590
61	9	0	Other telecommunications activities	6190
74	9	0	Other professional, scientific and technical activities n.e.c.	7490*
79	9	0	Other reservation service and related activities	7990
86	9	0	Other human health activities	8690
87	9	0	Other residential care activities	8790
11	0	1	Distilling, rectifying and blending of spirits	1101
31	0	1	Manufacture of office and shop furniture	3100*
62	0	1	Computer programming activities	6201
90	0	1	Performing arts	9000*
91	0	1	Library and archives activities	9101
96	0	1	Washing and (dry-)cleaning of textile and fur products	9601
01	1	1	Growing of cereals (except rice), leguminous crops and oil seeds	0111
03	1	1	Marine fishing	0311
08	1	1	Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate	0810*
10	1	1	Processing and preserving of meat	1010*
14	1	1	Manufacture of leather clothes	1410*
15	1	1	Tanning and dressing of leather; dressing and dyeing of fur	1511
17	1	1	Manufacture of pulp	1701*
18	1	1	Printing of newspapers	1811*
20	1	1	Manufacture of industrial gases	2011*
22	1	1	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres	2211
23	1	1	Manufacture of flat glass	2310*

25	1	1	Manufacture of metal structures and parts of structures	2511*
26	1	1	Manufacture of electronic components	2610*
27	1	1	Manufacture of electric motors, generators and transformers	2710*
28	1	1	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	2811
30	1	1	Building of ships and floating structures	3011
32	1	1	Striking of coins	3211*
33	1	1	Repair of fabricated metal products	3311
35	1	1	Production of electricity	3510*
38	1	1	Collection of non-hazardous waste	3811
42	1	1	Construction of roads and motorways	4210*
43	1	1	Demolition	4311
45	1	1	Sale of cars and light motor vehicles	4510*
46	1	1	Agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-fi	4610*
47	1	1	Retail sale in non-specialised stores with food, beverages or tobacco predominating	4711
58	1	1	Book publishing	5811
59	1	1	Motion picture, video and television programme production activities	5911
63	1	1	Data processing, hosting and related activities	6311
64	1	1	Central banking	6411
65	1	1	Life insurance	6511
66	1	1	Administration of financial markets	6611
71	1	1	Architectural activities	7110*
72	1	1	Research and experimental development on biotechnology	7210*
73	1	1	Advertising agencies	7310*
77	1	1	Renting and leasing of cars and light motor vehicles	7710*
79	1	1	Travel agency activities	7911
82	1	1	Combined office administrative service activities	8211
84	1	1	General public administration activities	8411
93	1	1	Operation of sports facilities	9311*
94	1	1	Activities of business and employers membership organisations	9411
95	1	1	Repair of computers and peripheral equipment	9511
01	2	1	Growing of grapes	0121
03	2	1	Marine aquaculture	0321
07	2	1	Mining of uranium and thorium ores	0721
16	2	1	Manufacture of veneer sheets and wood-based panels	1621
17	2	1	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	1702
22	2	1	Manufacture of plastic plates, sheets, tubes and profiles	2220*
25	2	1	Manufacture of central heating radiators and boilers	2512*
28	2	1	Manufacture of ovens, furnaces and furnace burners	2815
35	2	1	Manufacture of gas	3520*

38	2	1	Treatment and disposal of non-hazardous waste	3821
42	2	1	Construction of utility projects for fluids	4220*
43	2	1	Electrical installation	4321
46	2	1	Wholesale of grain, unmanufactured tobacco, seeds and animal feeds	4620*
47	2	1	Retail sale of fruit and vegetables in specialised stores	4721*
51	2	1	Freight air transport	5120*
52	2	1	Service activities incidental to land transportation	5221
56	2	1	Event catering activities	5621
58	2	1	Publishing of computer games	5820*
66	2	1	Risk and damage evaluation	6621
70	2	1	Public relations and communication activities	7020*
77	2	1	Renting and leasing of recreational and sports goods	7721
81	2	1	General cleaning of buildings	8121
84	2	1	Foreign affairs	8421
86	2	1	General medical practice activities	8620*
93	2	1	Activities of amusement parks and theme parks	9321
95	2	1	Repair of consumer electronics	9521
10	3	1	Processing and preserving of potatoes	1030*
14	3	1	Manufacture of knitted and crocheted hosiery	1430*
23	3	1	Manufacture of ceramic tiles and flags	2392*
24	3	1	Cold drawing of bars	2410*
27	3	1	Manufacture of fibre optic cables	2731
29	3	1	Manufacture of electrical and electronic equipment for motor vehicles	2930*
38	3	1	Dismantling of wrecks	3830*
43	3	1	Plastering	4330*
45	3	1	Wholesale trade of motor vehicle parts and accessories	4530*
46	3	1	Wholesale of fruit and vegetables	4630*
49	3	1	Urban and suburban passenger land transport	4921
68	3	1	Real estate agencies	6820*
77	3	1	Renting and leasing of agricultural machinery and equipment	7730*
85	3	1	General secondary education	8521
01	4	1	Raising of dairy cattle	0141*
10	4	1	Manufacture of oils and fats	1040*
20	4	1	Manufacture of soap and detergents, cleaning and polishing preparations	2023*
23	4	1	Manufacture of ceramic household and ornamental articles	2393*
24	4	1	Precious metals production	2420*
28	4	1	Manufacture of metal forming machinery	2822*
46	4	1	Wholesale of textiles	4641*
47	4	1	Retail sale of computers, peripheral units and software in specialised stores	4741*

49	4	1	Freight transport by road	4923*
85	4	1	Post-secondary non-tertiary education	8530*
10	5	1	Operation of dairies and cheese making	1050*
20	5	1	Manufacture of explosives	2029*
23	5	1	Manufacture of cement	2394*
24	5	1	Casting of iron	2431*
26	5	1	Manufacture of instruments and appliances for measuring, testing and navigation	2651
27	5	1	Manufacture of electric domestic appliances	2750*
46	5	1	Wholesale of computers, computer peripheral equipment and software	4651
47	5	1	Retail sale of textiles in specialised stores	4751
85	5	1	Sports and recreation education	8541
01	6	1	Support activities for crop production	0161
10	6	1	Manufacture of grain mill products	1061
23	6	1	Manufacture of concrete products for construction purposes	2395*
25	6	1	Treatment and coating of metals	2592*
46	6	1	Wholesale of agricultural machinery, equipment and supplies	4653
47	6	1	Retail sale of books in specialised stores	4761*
10	7	1	Manufacture of bread; manufacture of fresh pastry goods and cakes	1071*
25	7	1	Manufacture of cutlery	2593*
46	7	1	Wholesale of solid, liquid and gaseous fuels and related products	4661
47	7	1	Retail sale of clothing in specialised stores	4771*
10	8	1	Manufacture of sugar	1072
47	8	1	Retail sale via stalls and markets of food, beverages and tobacco products	4781
08	9	1	Mining of chemical and fertiliser minerals	0891
10	9	1	Manufacture of prepared feeds for farm animals	1080*
13	9	1	Manufacture of knitted and crocheted fabrics	1391
23	9	1	Production of abrasive products	2399*
25	9	1	Manufacture of steel drums and similar containers	2599*
28	9	1	Manufacture of machinery for metallurgy	2823
30	9	1	Manufacture of motorcycles	3091
32	9	1	Manufacture of brooms and brushes	3290*
42	9	1	Construction of water projects	4290*
43	9	1	Roofing activities	4390*
47	9	1	Retail sale via mail order houses or via Internet	4791
63	9	1	News agency activities	6391
64	9	1	Financial leasing	6491
82	9	1	Activities of collection agencies and credit bureaus	8291
88	9	1	Child day-care activities	8890*
94	9	1	Activities of religious organisations	9491

11	0	2	Manufacture of wine from grape	1102*
31	0	2	Manufacture of kitchen furniture	3100*
62	0	2	Computer consultancy activities	6202*
90	0	2	Support activities to performing arts	9000*
91	0	2	Museums activities	9102*
96	0	2	Hairdressing and other beauty treatment	9602
01	1	2	Growing of rice	0112
03	1	2	Freshwater fishing	0312
08	1	2	Operation of gravel and sand pits; mining of clays and kaolin	0810*
10	1	2	Processing and preserving of poultry meat	1010*
14	1	2	Manufacture of workwear	1410*
15	1	2	Manufacture of luggage, handbags and the like, saddlery and harness	1512
17	1	2	Manufacture of paper and paperboard	1701*
18	1	2	Other printing	1811*
20	1	2	Manufacture of dyes and pigments	2011*
23	1	2	Shaping and processing of flat glass	2310*
25	1	2	Manufacture of doors and windows of metal	2511*
26	1	2	Manufacture of loaded electronic boards	2610*
27	1	2	Manufacture of electricity distribution and control apparatus	2710*
28	1	2	Manufacture of fluid power equipment	2812
30	1	2	Building of pleasure and sporting boats	3012
32	1	2	Manufacture of jewellery and related articles	3211*
33	1	2	Repair of machinery	3312
35	1	2	Transmission of electricity	3510*
38	1	2	Collection of hazardous waste	3812
42	1	2	Construction of railways and underground railways	4210*
43	1	2	Site preparation	4312*
46	1	2	Agents involved in the sale of fuels, ores, metals and industrial chemicals	4610*
58	1	2	Publishing of directories and mailing lists	5812
59	1	2	Motion picture, video and television programme post-production activities	5912
63	1	2	Web portals	6312
65	1	2	Non-life insurance	6512
66	1	2	Security and commodity contracts brokerage	6612
71	1	2	Engineering activities and related technical consultancy	7110*
73	1	2	Media representation	7310*
77	1	2	Renting and leasing of trucks	7710*
79	1	2	Tour operator activities	7912
84	1	2	Regulation of the activities of providing health care, education, cultural services and other social servi	8412
93	1	2	Activities of sport clubs	9312

94	1	2	Activities of professional membership organisations	9412
95	1	2	Repair of communication equipment	9512
01	2	2	Growing of tropical and subtropical fruits	0122
03	2	2	Freshwater aquaculture	0322
16	2	2	Manufacture of assembled parquet floors	1622*
17	2	2	Manufacture of household and sanitary goods and of toilet requisites	1709*
22	2	2	Manufacture of plastic packing goods	2220*
28	2	2	Manufacture of lifting and handling equipment	2816
35	2	2	Distribution of gaseous fuels through mains	3520*
38	2	2	Treatment and disposal of hazardous waste	3822
42	2	2	Construction of utility projects for electricity and telecommunications	4220*
43	2	2	Plumbing, heat and air conditioning installation	4322
46	2	2	Wholesale of flowers and plants	4620*
47	2	2	Retail sale of meat and meat products in specialised stores	4721*
51	2	2	Space transport	5120*
52	2	2	Service activities incidental to water transportation	5222
66	2	2	Activities of insurance agents and brokers	6622
70	2	2	Business and other management consultancy activities	7020*
77	2	2	Renting of video tapes and disks	7722
81	2	2	Other building and industrial cleaning activities	8129*
84	2	2	Defence activities	8422
86	2	2	Specialist medical practice activities	8620*
95	2	2	Repair of household appliances and home and garden equipment	9522
10	3	2	Manufacture of fruit and vegetable juice	1030*
23	3	2	Manufacture of bricks, tiles and construction products, in baked clay	2392*
24	3	2	Cold rolling of narrow strip	2410*
27	3	2	Manufacture of other electronic and electric wires and cables	2732
29	3	2	Manufacture of other parts and accessories for motor vehicles	2930*
38	3	2	Recovery of sorted materials	3830*
43	3	2	Joinery installation	4330*
45	3	2	Retail trade of motor vehicle parts and accessories	4530*
46	3	2	Wholesale of meat and meat products	4630*
49	3	2	Taxi operation	4922*
68	3	2	Management of real estate on a fee or contract basis	6820*
77	3	2	Renting and leasing of construction and civil engineering machinery and equipment	7730*
85	3	2	Technical and vocational secondary education	8522
01	4	2	Raising of other cattle and buffaloes	0141*
10	4	2	Manufacture of margarine and similar edible fats	1040*
20	4	2	Manufacture of perfumes and toilet preparations	2023*

23	4	2	Manufacture of ceramic sanitary fixtures	2393*
24	4	2	Aluminium production	2420*
46	4	2	Wholesale of clothing and footwear	4641*
47	4	2	Retail sale of telecommunications equipment in specialised stores	4741*
49	4	2	Removal services	4923*
85	4	2	Tertiary education	8530*
10	5	2	Manufacture of ice cream	1050*
20	5	2	Manufacture of glues	2029*
23	5	2	Manufacture of lime and plaster	2394*
24	5	2	Casting of steel	2431*
26	5	2	Manufacture of watches and clocks	2652
27	5	2	Manufacture of non-electric domestic appliances	2750*
46	5	2	Wholesale of electronic and telecommunications equipment and parts	4652
47	5	2	Retail sale of hardware, paints and glass in specialised stores	4752
85	5	2	Cultural education	8542
01	6	2	Support activities for animal production	0162
10	6	2	Manufacture of starches and starch products	1062
23	6	2	Manufacture of plaster products for construction purposes	2395*
25	6	2	Machining	2592*
46	6	2	Wholesale of machine tools	4659*
47	6	2	Retail sale of newspapers and stationery in specialised stores	4761*
10	7	2	Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes	1071*
25	7	2	Manufacture of locks and hinges	2593*
46	7	2	Wholesale of metals and metal ores	4662
47	7	2	Retail sale of footwear and leather goods in specialised stores	4771*
10	8	2	Manufacture of cocoa, chocolate and sugar confectionery	1073
47	8	2	Retail sale via stalls and markets of textiles, clothing and footwear	4782
08	9	2	Extraction of peat	0892
10	9	2	Manufacture of prepared pet foods	1080*
13	9	2	Manufacture of made-up textile articles, except apparel	1392
25	9	2	Manufacture of light metal packaging	2599*
28	9	2	Manufacture of machinery for mining, quarrying and construction	2824
30	9	2	Manufacture of bicycles and invalid carriages	3092
64	9	2	Other credit granting	6492
82	9	2	Packaging activities	8292
94	9	2	Activities of political organisations	9492
11	0	3	Manufacture of cider and other fruit wines	1102*
31	0	3	Manufacture of mattresses	3100*
62	0	3	Computer facilities management activities	6202*

90	0	3	Artistic creation	9000*
91	0	3	Operation of historical sites and buildings and similar visitor attractions	9102*
96	0	3	Funeral and related activities	9603
01	1	3	Growing of vegetables and melons, roots and tubers	0113
10	1	3	Production of meat and poultry meat products	1010*
14	1	3	Manufacture of other outerwear	1410*
18	1	3	Pre-press and pre-media services	1812*
20	1	3	Manufacture of other inorganic basic chemicals	2011*
23	1	3	Manufacture of hollow glass	2310*
28	1	3	Manufacture of other pumps and compressors	2813*
32	1	3	Manufacture of imitation jewellery and related articles	3212
33	1	3	Repair of electronic and optical equipment	3313
35	1	3	Distribution of electricity	3510*
42	1	3	Construction of bridges and tunnels	4210*
43	1	3	Test drilling and boring	4312*
46	1	3	Agents involved in the sale of timber and building materials	4610*
58	1	3	Publishing of newspapers	5813*
59	1	3	Motion picture, video and television programme distribution activities	5913
84	1	3	Regulation of and contribution to more efficient operation of businesses	8413
93	1	3	Fitness facilities	9311*
01	2	3	Growing of citrus fruits	0123
16	2	3	Manufacture of other builders' carpentry and joinery	1622*
17	2	3	Manufacture of paper stationery	1709*
22	2	3	Manufacture of builders' ware of plastic	2220*
28	2	3	Manufacture of office machinery and equipment (except computers and peripheral equipment)	2817
35	2	3	Trade of gas through mains	3520*
46	2	3	Wholesale of live animals	4620*
47	2	3	Retail sale of fish, crustaceans and molluscs in specialised stores	4721*
52	2	3	Service activities incidental to air transportation	5223
84	2	3	Justice and judicial activities	8423*
86	2	3	Dental practice activities	8620*
95	2	3	Repair of footwear and leather goods	9523
24	3	3	Cold forming or folding	2410*
27	3	3	Manufacture of wiring devices	2733
43	3	3	Floor and wall covering	4330*
46	3	3	Wholesale of dairy products, eggs and edible oils and fats	4630*
77	3	3	Renting and leasing of office machinery and equipment (including computers)	7730*
01	4	3	Raising of horses and other equines	0142
23	4	3	Manufacture of ceramic insulators and insulating fittings	2393*

24	4	3	Lead, zinc and tin production	2420*
46	4	3	Wholesale of electrical household appliances	4649*
47	4	3	Retail sale of audio and video equipment in specialised stores	4742
20	5	3	Manufacture of essential oils	2029*
24	5	3	Casting of light metals	2432*
47	5	3	Retail sale of carpets, rugs, wall and floor coverings in specialised stores	4753
85	5	3	Driving school activities	8549*
01	6	3	Post-harvest crop activities	0163
23	6	3	Manufacture of ready-mixed concrete	2395*
46	6	3	Wholesale of mining, construction and civil engineering machinery	4659*
47	6	3	Retail sale of music and video recordings in specialised stores	4762
10	7	3	Manufacture of macaroni, noodles, couscous and similar farinaceous products	1074
25	7	3	Manufacture of tools	2593*
46	7	3	Wholesale of wood, construction materials and sanitary equipment	4663*
47	7	3	Dispensing chemist in specialised stores	4772*
10	8	3	Processing of tea and coffee	1079*
08	9	3	Extraction of salt	0893
13	9	3	Manufacture of carpets and rugs	1393
25	9	3	Manufacture of wire products, chain and springs	2599*
28	9	3	Manufacture of machinery for food, beverage and tobacco processing	2825
11	0	4	Manufacture of other non-distilled fermented beverages	1102*
90	0	4	Operation of arts facilities	9000*
91	0	4	Botanical and zoological gardens and nature reserves activities	9103
96	0	4	Physical well-being activities	9609*
01	1	4	Growing of sugar cane	0114
14	1	4	Manufacture of underwear	1410*
18	1	4	Binding and related services	1812*
20	1	4	Manufacture of other organic basic chemicals	2011*
23	1	4	Manufacture of glass fibres	2310*
28	1	4	Manufacture of other taps and valves	2813*
33	1	4	Repair of electrical equipment	3314
35	1	4	Trade of electricity	3510*
46	1	4	Agents involved in the sale of machinery, industrial equipment, ships and aircraft	4610*
58	1	4	Publishing of journals and periodicals	5813*
59	1	4	Motion picture projection activities	5914
01	2	4	Growing of pome fruits and stone fruits	0124
16	2	4	Manufacture of wooden containers	1623
17	2	4	Manufacture of wallpaper	1709*
28	2	4	Manufacture of power-driven hand tools	2818

46	2	4	Wholesale of hides, skins and leather	4620*
47	2	4	Retail sale of bread, cakes, flour confectionery and sugar confectionery in specialised stores	4721*
52	2	4	Cargo handling	5224
84	2	4	Public order and safety activities	8423*
95	2	4	Repair of furniture and home furnishings	9524
24	3	4	Cold drawing of wire	2410*
43	3	4	Painting and glazing	4330*
46	3	4	Wholesale of beverages	4630*
77	3	4	Renting and leasing of water transport equipment	7730*
01	4	4	Raising of camels and camelids	0143
23	4	4	Manufacture of other technical ceramic products	2393*
24	4	4	Copper production	2420*
46	4	4	Wholesale of china and glassware and cleaning materials	4649*
24	5	4	Casting of other non-ferrous metals	2432*
47	5	4	Retail sale of electrical household appliances in specialised stores	4759*
01	6	4	Seed processing for propagation	0164
23	6	4	Manufacture of mortars	2395*
46	6	4	Wholesale of machinery for the textile industry and of sewing and knitting machines	4659*
47	6	4	Retail sale of sporting equipment in specialised stores	4763
46	7	4	Wholesale of hardware, plumbing and heating equipment and supplies	4663*
47	7	4	Retail sale of medical and orthopaedic goods in specialised stores	4772*
10	8	4	Manufacture of condiments and seasonings	1079*
13	9	4	Manufacture of cordage, rope, twine and netting	1394
25	9	4	Manufacture of fasteners and screw machine products	2599*
28	9	4	Manufacture of machinery for textile, apparel and leather production	2826
11	0	5	Manufacture of beer	1103*
01	1	5	Growing of tobacco	0115
20	1	5	Manufacture of fertilisers and nitrogen compounds	2012
28	1	5	Manufacture of bearings, gears, gearing and driving elements	2814
33	1	5	Repair and maintenance of ships and boats	3315*
46	1	5	Agents involved in the sale of furniture, household goods, hardware and ironmongery	4610*
01	2	5	Growing of other tree and bush fruits and nuts	0125
28	2	5	Manufacture of non-domestic cooling and ventilation equipment	2819*
47	2	5	Retail sale of beverages in specialised stores	4722
84	2	5	Fire service activities	8423*
95	2	5	Repair of watches, clocks and jewellery	9529*
46	3	5	Wholesale of tobacco products	4630*
77	3	5	Renting and leasing of air transport equipment	7730*
01	4	5	Raising of sheep and goats	0144

24	4	5	Other non-ferrous metal production	2420*
46	4	5	Wholesale of perfume and cosmetics	4649*
23	6	5	Manufacture of fibre cement	2395*
46	6	5	Wholesale of office furniture	4659*
47	6	5	Retail sale of games and toys in specialised stores	4764
46	7	5	Wholesale of chemical products	4669*
47	7	5	Retail sale of cosmetic and toilet articles in specialised stores	4772*
10	8	5	Manufacture of prepared meals and dishes	1075
13	9	5	Manufacture of non-wovens and articles made from non-wovens, except apparel	1399*
28	9	5	Manufacture of machinery for paper and paperboard production	2829*
11	0	6	Manufacture of malt	1103*
01	1	6	Growing of fibre crops	0116
20	1	6	Manufacture of plastics in primary forms	2013*
33	1	6	Repair and maintenance of aircraft and spacecraft	3315*
46	1	6	Agents involved in the sale of textiles, clothing, fur, footwear and leather goods	4610*
01	2	6	Growing of oleaginous fruits	0126
47	2	6	Retail sale of tobacco products in specialised stores	4723
46	3	6	Wholesale of sugar and chocolate and sugar confectionery	4630*
01	4	6	Raising of swine/pigs	0145
24	4	6	Processing of nuclear fuel	2420*
46	4	6	Wholesale of pharmaceutical goods	4649*
46	6	6	Wholesale of other office machinery and equipment	4659*
46	7	6	Wholesale of other intermediate products	4669*
47	7	6	Retail sale of flowers, plants, seeds, fertilisers, pet animals and pet food in specialised stores	4773*
10	8	6	Manufacture of homogenised food preparations and dietetic food	1079*
13	9	6	Manufacture of other technical and industrial textiles	1399*
28	9	6	Manufacture of plastic and rubber machinery	2829*
11	0	7	Manufacture of soft drinks; production of mineral waters and other bottled waters	1104
20	1	7	Manufacture of synthetic rubber in primary forms	2013*
33	1	7	Repair and maintenance of other transport equipment	3315*
46	1	7	Agents involved in the sale of food, beverages and tobacco	4610*
01	2	7	Growing of beverage crops	0127
46	3	7	Wholesale of coffee, tea, cocoa and spices	4630*
01	4	7	Raising of poultry	0146
46	4	7	Wholesale of furniture, carpets and lighting equipment	4649*
46	7	7	Wholesale of waste and scrap	4669*
47	7	7	Retail sale of watches and jewellery in specialised stores	4773*
46	1	8	Agents specialised in the sale of other particular products	4610*
01	2	8	Growing of spices, aromatic, drug and pharmaceutical crops	0128

46	3	8	Wholesale of other food, including fish, crustaceans and molluscs	4630*
46	4	8	Wholesale of watches and jewellery	4649*
47	7	8	Other retail sale of new goods in specialised stores	4773*
31	0	9	Manufacture of other furniture	3100*
62	0	9	Other information technology and computer service activities	6209
96	0	9	Other personal service activities n.e.c.	9609*
01	1	9	Growing of other non-perennial crops	0119
14	1	9	Manufacture of other wearing apparel and accessories	1410*
22	1	9	Manufacture of other rubber products	2219
23	1	9	Manufacture and processing of other glass, including technical glassware	2310*
33	1	9	Repair of other equipment	3319
45	1	9	Sale of other motor vehicles	4510*
46	1	9	Agents involved in the sale of a variety of goods	4610*
47	1	9	Other retail sale in non-specialised stores	4719
58	1	9	Other publishing activities	5819
64	1	9	Other monetary intermediation	6419
66	1	9	Other activities auxiliary to financial services, except insurance and pension funding	6619
72	1	9	Other research and experimental development on natural sciences and engineering	7210*
82	1	9	Photocopying, document preparation and other specialised office support activities	8219
93	1	9	Other sports activities	9319
01	2	9	Growing of other perennial crops	0129
07	2	9	Mining of other non-ferrous metal ores	0729
16	2	9	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials	1629
17	2	9	Manufacture of other articles of paper and paperboard	1709*
22	2	9	Manufacture of other plastic products	2220*
25	2	9	Manufacture of other tanks, reservoirs and containers of metal	2512*
28	2	9	Manufacture of other general-purpose machinery n.e.c.	2819*
43	2	9	Other construction installation	4329
47	2	9	Other retail sale of food in specialised stores	4721*
52	2	9	Other transportation support activities	5229
56	2	9	Other food service activities	5629
58	2	9	Other software publishing	5820*
66	2	9	Other activities auxiliary to insurance and pension funding	6629
77	2	9	Renting and leasing of other personal and household goods	7729
81	2	9	Other cleaning activities	8129*
93	2	9	Other amusement and recreation activities	9329
95	2	9	Repair of other personal and household goods	9529*
10	3	9	Other processing and preserving of fruit and vegetables	1030*
14	3	9	Manufacture of other knitted and crocheted apparel	1430*

43	3	9	Other building completion and finishing	4330*
46	3	9	Non-specialised wholesale of food, beverages and tobacco	4630*
49	3	9	Other passenger land transport n.e.c.	4922*
77	3	9	Renting and leasing of other machinery, equipment and tangible goods n.e.c.	7730*
01	4	9	Raising of other animals	0149
23	4	9	Manufacture of other ceramic products	2393*
28	4	9	Manufacture of other machine tools	2822*
46	4	9	Wholesale of other household goods	4649*
20	5	9	Manufacture of other chemical products n.e.c.	2029*
47	5	9	Retail sale of furniture, lighting equipment and other household articles in specialised stores	4759*
85	5	9	Other education n.e.c.	8549*
23	6	9	Manufacture of other articles of concrete, plaster and cement	2395*
46	6	9	Wholesale of other machinery and equipment	4659*
47	7	9	Retail sale of second-hand goods in stores	4774
10	8	9	Manufacture of other food products n.e.c.	1079*
47	8	9	Retail sale via stalls and markets of other goods	4789
08	9	9	Other mining and quarrying n.e.c.	0899
13	9	9	Manufacture of other textiles n.e.c.	1399*
23	9	9	Manufacture of other non-metallic mineral products n.e.c.	2399*
25	9	9	Manufacture of other fabricated metal products n.e.c.	2599*
28	9	9	Manufacture of other special-purpose machinery n.e.c.	2829*
30	9	9	Manufacture of other transport equipment n.e.c.	3099
32	9	9	Other manufacturing n.e.c.	3290*
42	9	9	Construction of other civil engineering projects n.e.c.	4290*
43	9	9	Other specialised construction activities n.e.c.	4390*
47	9	9	Other retail sale not in stores, stalls or markets	4799
63	9	9	Other information service activities n.e.c.	6399
64	9	9	Other financial service activities, except insurance and pension funding n.e.c.	6499
82	9	9	Other business support service activities n.e.c.	8299
88	9	9	Other social work activities without accommodation n.e.c.	8890*
94	9	9	Activities of other membership organisations n.e.c.	9499

Activity_Group	Activity_SubGroup	Activity_Code	Activity_Name	Capacity_Threshold
1	NA	a	Mineral oil and gas refineries	
1	NA	b	Installations for gasification and liquefaction	
1	NA	c	Thermal power stations and other combustion installations	With a heat input of 50 megawatts (MW)
1	NA	d	Coke ovens	
1	NA	e	Coal rolling mills	With a capacity of 1 tonne per hour
1	NA	f	Installations for the manufacture of coal products and solid smokeless fuel	
2	c	i	Hot-rolling mills	With a capacity of 20 tonnes of crude steel per hour per hour
2	c	ii	Smitheries with hammers	With an energy of 50 kilojoules per hammer, where the calorific power used exceeds 20 MW
2	c	iii	Application of protective fused metal coats	With an input of 2 tonnes of crude steel per hour
2	c	x	test	
2	e	i	For the production of non-ferrous crude metals from ore,concentrates or secondary raw materials by metallurgical,chemical or electrolytic processes	
2	e	ii	For the smelting, including the alloying, of non-ferrous metals, including recovered products (refining,	With a melting capacity of 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals
2	NA	a	Metal ore (including sulphide ore) roasting or sintering installations	
2	NA	b	Installations for the production of pig iron or steel (primary or secondary melting) including continuous Hot-rolling mills Smitheries with hammers	With a capacity of 2,5 tonnes per hour
2	NA	c	Application of protective fused metal coats	
2	NA	d	Ferrous metal foundries	With a production capacity of 20 tonnes per day
2	NA	f	Installations for surface treatment of metals and plastic materials using an electrolytic or chemical pro	Where the volume of the treatment vats equals 30 m3
3	c	i	Cement clinker in rotary kilns	With a production capacity of 500 tonnes per day
3	c	ii	Lime in rotary kilns	With a production capacity of 50 tonnes per day
3	c	iii	Cement clinker or lime in other furnaces	With a production capacity of 50 tonnes per day
3	NA	a	Underground mining and related operations	
3	NA	b	Opencast mining and quarrying	Where the surface of the area effectively under extractive operation equals 25 hectares
3	NA	d	Installations for the production of asbestos and the manufacture of asbestos-based products	
3	NA	e	Installations for the manufacture of glass, including glass fibre	With a melting capacity of 20 tonnes per day
3	NA	f	Installations for melting mineral substances, including the production of mineral fibres	With a melting capacity of 20 tonnes per day
3	NA	g	Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refract	With a production capacity of 75 tonnes per day, or with a kiln capacity of 4 m3 and with a setting density per kiln of 300 kg/n
4	a	i	Simple hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic)	
4	a	ii	Oxygen-containing hydrocarbons such as alcohols, aldehydes, ketones, carboxylic acids, esters, acetates, ethers, peroxides, epoxy resins	
4	a	iii	Sulphurous hydrocarbons	
4	a	iv	Nitrogenous hydrocarbons such as amines, amides, nitrous compounds, nitro compounds or nitrate compounds, nitriles, cyanates, isocyanates	
4	a	ix	Synthetic rubbers	
4	a	v	Phosphorus-containing hydrocarbons	
4	a	vi	Halogenic hydrocarbons	
4	a	vii	Organometallic compounds	
4	a	viii	Basic plastic materials (polymers, synthetic fibres and cellulose-based fibres)	
4	a	x	Dyes and pigments	
4	a	xi	Surface-active agents and surfactants	
4	b	i	Gases, such as ammonia, chlorine or hydrogen chloride,fluorine or hydrogen fluoride, carbon oxides, sulphur compounds,nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride	
4	b	ii	Acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids	
4	b	iii	Bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide	
4	b	iv	Salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate	
4	b	v	Non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon, silicon carbide	
4	NA	a	##	
4	NA	b	##	
4	NA	c	Chemical installations for the production on an industrial scale of phosphorous-, nitrogen- or potassium-based fertilisers (simple or compound fertilisers)	
4	NA	d	Chemical installations for the production on an industrial scale of basic plant health products and of biocides	
4	NA	e	Installations using a chemical or biological process for the production on an industrial scale of basic pharmaceutical products	
4	NA	f	Installations for the production on an industrial scale of explosives and pyrotechnic products	
5	NA	a	Installations for the recovery or disposal of hazardous waste	Receiving 10 tonnes per day
5	NA	b	Installations for the incineration of non-hazardous waste in the scope of Directive 2000/76/EC of the E	With a capacity of 3 tonnes per hour
5	NA	c	Installations for the disposal of non-hazardous waste	With a capacity of 50 tonnes per day
5	NA	d	Landfills	Receiving 10 tonnes per day or with a total capacity of 25 000 tonnes
5	NA	e	Installations for the disposal or recycling of animal carcasses and animal waste	With a treatment capacity of 10 tonnes per day
5	NA	f	Urban waste-water treatment plants	With a capacity of 100 000 population equivalents
5	NA	g	Independently operated industrial waste-water treatment plants which serve one or more activities of t	With a capacity of 10 000 m3 per day
50	NA	1	General	
6	NA	a	Industrial plants for the production of pulp from timber or similar fibrous materials	
6	NA	b	Industrial plants for the production of paper and board and other primary wood products (such as chip	With a production capacity of 20 tonnes per day
6	NA	c	Industrial plants for the preservation of wood and wood products with chemicals	With a production capacity of 50 m3 per day
7	a	i	Installations for the intensive rearing of poultry or pigs (i)	With 40 000 places for poultry
7	a	ii	Installations for the intensive rearing of poultry or pigs (ii)	With 2 000 places for production pigs (over 30 kg)
7	a	iii	Installations for the intensive rearing of poultry or pigs (iii)	With 750 places for sows

7	NA	b	Intensive aquaculture	With a production capacity of 1 000 tonnes of fish or shellfish per year
8	b	i	Animal raw materials (other than milk)	With a finished product production capacity of 75 tonnes per day
8	b	ii	Vegetable raw materials	With a finished product production capacity of 300 tonnes per day (average value on a quarterly basis)
8	NA	a	Slaughterhouses	With a carcass production capacity of 50 tonnes per day
8	NA	c	Treatment and processing of milk	With a capacity to receive 200 tonnes of milk per day (average value on an annual basis)
9	NA	a	Plants for the pre-treatment (operations such as washing, bleaching, mercerisation) or dyeing of fibres	With a treatment capacity of 10 tonnes per day
9	NA	b	Plants for the tanning of hides and skins	With a treatment capacity of 12 tonnes of finished product per day
9	NA	c	Installations for surface treatment of substances,objects or products using organic solvents,in particul	With a consumption capacity of 150 kg per hour or 200 tonnes per year
9	NA	d	Installations for the production of carbon (hard-burnt coal) or electro-graphite by means of incineration or graphitisation	
9	NA	e	Installations for the building of, and painting or removal of paint from ships	With a capacity for ships 100 m long

Emission Type : Air

Category Specific PRTR Pollutants

Pollutant_Number	Pollutant_Name	Pollutant_Lookup
55	1,1,1-trichloroethane	55 - 1,1,1-trichloroethane
06	Ammonia (NH3)	06 - Ammonia (NH3)
17	Arsenic and compounds (as A	17 - Arsenic and compounds (as
18	Cadmium and compounds (as	18 - Cadmium and compounds (a
03	Carbon dioxide (CO2)	03 - Carbon dioxide (CO2)
02	Carbon monoxide (CO)	02 - Carbon monoxide (CO)
19	Chromium and compounds (a	19 - Chromium and compounds (
20	Copper and compounds (as C	20 - Copper and compounds (as
42	Hexachlorobenzene (HCB)	42 - Hexachlorobenzene (HCB)
04	Hydro-fluorocarbons (HFCs)	04 - Hydro-fluorocarbons (HFCs)
23	Lead and compounds (as Pb)	23 - Lead and compounds (as Pb
21	Mercury and compounds (as I	21 - Mercury and compounds (as
01	Methane (CH4)	01 - Methane (CH4)
22	Nickel and compounds (as Ni)	22 - Nickel and compounds (as N
08	Nitrogen oxides (NOx/NO2)	08 - Nitrogen oxides (NOx/NO2)
05	Nitrous oxide (N2O)	05 - Nitrous oxide (N2O)
07	Non-methane volatile organic	07 - Non-methane volatile organic
86	Particulate matter (PM10)	86 - Particulate matter (PM10)
47	PCDD + PCDF (dioxins + fura	47 - PCDD + PCDF (dioxins + fur
48	Pentachlorobenzene	48 - Pentachlorobenzene
10	Sulphur hexafluoride (SF6)	10 - Sulphur hexafluoride (SF6)
11	Sulphur oxides (SOx/SO2)	11 - Sulphur oxides (SOx/SO2)
53	Tetrachloromethane (TCM)	53 - Tetrachloromethane (TCM)
24	Zinc and compounds (as Zn)	24 - Zinc and compounds (as Zn)

Air Lookup	
From Row A	4
To Row A	27
Start Cell A	3
From Row B	30
To Row B	71
Start Cell B	29
Water Lookup	
From Row A	75
To Row A	143
Start Cell A	74
From Row B	146
To Row B	148
Start Cell B	145
Offsite Xfers Lookup	
From Row	152
To Row	242
Start Cell	151
Land Lookup	
From Row	246
To Row	336
Start Cell	245

Remaining PRTR Pollutants

Pollutant_Number	Pollutant_Name	Pollutant_Lookup
56	1,1,2,2-tetrachloroethane	56 - 1,1,2,2-tetrachloroethane
44	1,2,3,4,5,6-hexachlorocyclohe	44 - 1,2,3,4,5,6-hexachlorocyclohexane(HCH)
34	1,2-dichloroethane (EDC)	34 - 1,2-dichloroethane (EDC)
26	Aldrin	26 - Aldrin
61	Anthracene	61 - Anthracene
81	Asbestos	81 - Asbestos
62	Benzene	62 - Benzene

28	Chlordane	28 - Chlordane
29	Chlordecone	29 - Chlordecone
79	Chlorides (as Cl)	79 - Chlorides (as Cl)
80	Chlorine and inorganic compo	80 - Chlorine and inorganic compounds (as HCl)
15	Chlorofluorocarbons (CFCs)	15 - Chlorofluorocarbons (CFCs)
33	DDT	33 - DDT
70	Di-(2-ethyl hexyl) phthalate (D	70 - Di-(2-ethyl hexyl) phthalate (DEHP)
35	Dichloromethane (DCM)	35 - Dichloromethane (DCM)
36	Dieldrin	36 - Dieldrin
39	Endrin	39 - Endrin
65	Ethyl benzene	65 - Ethyl benzene
66	Ethylene oxide	66 - Ethylene oxide
84	Fluorine and inorganic compo	84 - Fluorine and inorganic compounds (as HF)
40	Halogenated organic compou	40 - Halogenated organic compounds (as AOX)
16	Halons	16 - Halons
41	Heptachlor	41 - Heptachlor
90	Hexabromobiphenyl	90 - Hexabromobiphenyl
14	Hydrochlorofluorocarbons (HC	14 - Hydrochlorofluorocarbons (HCFCs)
85	Hydrogen cyanide (HCN)	85 - Hydrogen cyanide (HCN)
45	Lindane	45 - Lindane
46	Mirex	46 - Mirex
68	Naphthalene	68 - Naphthalene
49	Pentachlorophenol (PCP)	49 - Pentachlorophenol (PCP)
09	Perfluorocarbons (PFCs)	09 - Perfluorocarbons (PFCs)
71	Phenols (as total C)	71 - Phenols (as total C)
50	Polychlorinated biphenyls (PC	50 - Polychlorinated biphenyls (PCBs)
72	Polycyclic aromatic hydrocarb	72 - Polycyclic aromatic hydrocarbons (PAHs)
52	Tetrachloroethylene (PER)	52 - Tetrachloroethylene (PER)
73	Toluene	73 - Toluene
59	Toxaphene	59 - Toxaphene
54	Trichlorobenzenes (TCBs)(all	54 - Trichlorobenzenes (TCBs)(all isomers)
57	Trichloroethylene	57 - Trichloroethylene
58	Trichloromethane	58 - Trichloromethane
60	Vinyl chloride	60 - Vinyl chloride
78	Xylenes	78 - Xylenes

Emission Type : Water

Category Specific PRTR Pollutants

Pollutant_Number	Pollutant_Name	Pollutant_Lookup
44	1,2,3,4,5,6-hexachlorocyclohe	44 - 1,2,3,4,5,6-hexachlorocyclohexane(HCH)
34	1,2-dichloroethane (EDC)	34 - 1,2-dichloroethane (EDC)
25	Alachlor	25 - Alachlor
26	Aldrin	26 - Aldrin
61	Anthracene	61 - Anthracene
17	Arsenic and compounds (as A	17 - Arsenic and compounds (as As)
81	Asbestos	81 - Asbestos
27	Atrazine	27 - Atrazine
62	Benzene	62 - Benzene
91	Benzo(g,h,i)perylene	91 - Benzo(g,h,i)perylene
63	Brominated diphenylethers (P	63 - Brominated diphenylethers (PBDE)
18	Cadmium and compounds (as	18 - Cadmium and compounds (as Cd)
28	Chlordane	28 - Chlordane
29	Chlordecone	29 - Chlordecone
30	Chlorfenvinphos	30 - Chlorfenvinphos
79	Chlorides (as Cl)	79 - Chlorides (as Cl)
31	Chloro-alkanes, C10-C13	31 - Chloro-alkanes, C10-C13
32	Chlorpyrifos	32 - Chlorpyrifos
19	Chromium and compounds (a	19 - Chromium and compounds (as Cr)
20	Copper and compounds (as C	20 - Copper and compounds (as Cu)
82	Cyanides (as total CN)	82 - Cyanides (as total CN)
33	DDT	33 - DDT
70	Di-(2-ethyl hexyl) phthalate (D	70 - Di-(2-ethyl hexyl) phthalate (DEHP)
35	Dichloromethane (DCM)	35 - Dichloromethane (DCM)
36	Dieldrin	36 - Dieldrin
37	Diuron	37 - Diuron
38	Endosulphan	38 - Endosulphan
39	Endrin	39 - Endrin
65	Ethyl benzene	65 - Ethyl benzene
88	Fluoranthene	88 - Fluoranthene
83	Fluorides (as total F)	83 - Fluorides (as total F)
40	Halogenated organic compou	40 - Halogenated organic compounds (as AOX)
41	Heptachlor	41 - Heptachlor
90	Hexabromobiphenyl	90 - Hexabromobiphenyl

42	Hexachlorobenzene (HCB)	42 - Hexachlorobenzene (HCB)
43	Hexachlorobutadiene (HCBD)	43 - Hexachlorobutadiene (HCBD)
89	Isodrin	89 - Isodrin
67	Isoproturon	67 - Isoproturon
23	Lead and compounds (as Pb)	23 - Lead and compounds (as Pb)
45	Lindane	45 - Lindane
21	Mercury and compounds (as H	21 - Mercury and compounds (as Hg)
46	Mirex	46 - Mirex
68	Naphthalene	68 - Naphthalene
22	Nickel and compounds (as Ni)	22 - Nickel and compounds (as Ni)
64	Nonylphenol and Nonylphenol	64 - Nonylphenol and Nonylphenol ethoxylates (NP/NPEs)
87	Octylphenols and Octylphenol	87 - Octylphenols and Octylphenol ethoxylates
69	Organotin compounds (as tota	69 - Organotin compounds (as total Sn)
47	PCDD + PCDF (dioxins + fura	47 - PCDD + PCDF (dioxins + furans)(as Teq)
48	Pentachlorobenzene	48 - Pentachlorobenzene
49	Pentachlorophenol (PCP)	49 - Pentachlorophenol (PCP)
71	Phenols (as total C)	71 - Phenols (as total C)
50	Polychlorinated biphenyls (PC	50 - Polychlorinated biphenyls (PCBs)
72	Polycyclic aromatic hydrocarb	72 - Polycyclic aromatic hydrocarbons (PAHs)
51	Simazine	51 - Simazine
52	Tetrachloroethylene (PER)	52 - Tetrachloroethylene (PER)
53	Tetrachloromethane (TCM)	53 - Tetrachloromethane (TCM)
73	Toluene	73 - Toluene
12	Total nitrogen	12 - Total nitrogen
76	Total organic carbon (TOC) (a	76 - Total organic carbon (TOC) (as total C or COD/3)
13	Total phosphorus	13 - Total phosphorus
74	Tributyltin and compounds	74 - Tributyltin and compounds
54	Trichlorobenzenes (TCBs)(all	54 - Trichlorobenzenes (TCBs)(all isomers)
57	Trichloroethylene	57 - Trichloroethylene
58	Trichloromethane	58 - Trichloromethane
77	Trifluralin	77 - Trifluralin
75	Triphenyltin and compounds	75 - Triphenyltin and compounds
60	Vinyl chloride	60 - Vinyl chloride
78	Xylenes	78 - Xylenes
24	Zinc and compounds (as Zn)	24 - Zinc and compounds (as Zn)
Remaining PRTR Pollutants		

Pollutant_Number	Pollutant_Name	Pollutant_Lookup
66	Ethylene oxide	66 - Ethylene oxide
07	Non-methane volatile organic	07 - Non-methane volatile organic compounds (NMVOC)
59	Toxaphene	59 - Toxaphene

Emission Type : Offsite Transfers

PRTR Pollutants

Pollutant_Number	Pollutant_Name	Pollutant_Lookup
55	1,1,1-trichloroethane	55 - 1,1,1-trichloroethane
56	1,1,2,2-tetrachloroethane	56 - 1,1,2,2-tetrachloroethane
44	1,2,3,4,5,6-hexachlorocyclohe	44 - 1,2,3,4,5,6-hexachlorocyclohexane(HCH)
34	1,2-dichloroethane (EDC)	34 - 1,2-dichloroethane (EDC)
25	Alachlor	25 - Alachlor
26	Aldrin	26 - Aldrin
06	Ammonia (NH3)	06 - Ammonia (NH3)
61	Anthracene	61 - Anthracene
17	Arsenic and compounds (as A	17 - Arsenic and compounds (as As)
81	Asbestos	81 - Asbestos
27	Atrazine	27 - Atrazine
62	Benzene	62 - Benzene
91	Benzo(g,h,i)perylene	91 - Benzo(g,h,i)perylene
63	Brominated diphenylethers (P	63 - Brominated diphenylethers (PBDE)
18	Cadmium and compounds (as	18 - Cadmium and compounds (as Cd)
03	Carbon dioxide (CO2)	03 - Carbon dioxide (CO2)
02	Carbon monoxide (CO)	02 - Carbon monoxide (CO)
28	Chlordane	28 - Chlordane
29	Chlordecone	29 - Chlordecone
30	Chlorfenvinphos	30 - Chlorfenvinphos
79	Chlorides (as Cl)	79 - Chlorides (as Cl)
80	Chlorine and inorganic compo	80 - Chlorine and inorganic compounds (as HCl)
31	Chloro-alkanes, C10-C13	31 - Chloro-alkanes, C10-C13
15	Chlorofluorocarbons (CFCs)	15 - Chlorofluorocarbons (CFCs)
32	Chlorpyrifos	32 - Chlorpyrifos
19	Chromium and compounds (a	19 - Chromium and compounds (as Cr)
20	Copper and compounds (as C	20 - Copper and compounds (as Cu)
82	Cyanides (as total CN)	82 - Cyanides (as total CN)
33	DDT	33 - DDT

70	Di-(2-ethyl hexyl) phthalate (D	70 - Di-(2-ethyl hexyl) phthalate (DEHP)
35	Dichloromethane (DCM)	35 - Dichloromethane (DCM)
36	Dieldrin	36 - Dieldrin
37	Diuron	37 - Diuron
38	Endosulphan	38 - Endosulphan
39	Endrin	39 - Endrin
65	Ethyl benzene	65 - Ethyl benzene
66	Ethylene oxide	66 - Ethylene oxide
88	Fluoranthene	88 - Fluoranthene
83	Fluorides (as total F)	83 - Fluorides (as total F)
84	Fluorine and inorganic compo	84 - Fluorine and inorganic compounds (as HF)
40	Halogenated organic compou	40 - Halogenated organic compounds (as AOX)
16	Halons	16 - Halons
41	Heptachlor	41 - Heptachlor
90	Hexabromobiphenyl	90 - Hexabromobiphenyl
42	Hexachlorobenzene (HCB)	42 - Hexachlorobenzene (HCB)
43	Hexachlorobutadiene (HCBD)	43 - Hexachlorobutadiene (HCBD)
04	Hydro-fluorocarbons (HFCs)	04 - Hydro-fluorocarbons (HFCs)
14	Hydrochlorofluorocarbons (HC	14 - Hydrochlorofluorocarbons (HCFCs)
85	Hydrogen cyanide (HCN)	85 - Hydrogen cyanide (HCN)
89	Isodrin	89 - Isodrin
67	Isoproturon	67 - Isoproturon
23	Lead and compounds (as Pb)	23 - Lead and compounds (as Pb)
45	Lindane	45 - Lindane
21	Mercury and compounds (as H	21 - Mercury and compounds (as Hg)
01	Methane (CH4)	01 - Methane (CH4)
46	Mirex	46 - Mirex
68	Naphthalene	68 - Naphthalene
22	Nickel and compounds (as Ni)	22 - Nickel and compounds (as Ni)
08	Nitrogen oxides (NOx/NO2)	08 - Nitrogen oxides (NOx/NO2)
05	Nitrous oxide (N2O)	05 - Nitrous oxide (N2O)
07	Non-methane volatile organic	07 - Non-methane volatile organic compounds (NMVOC)
64	Nonylphenol and Nonylphenol	64 - Nonylphenol and Nonylphenol ethoxylates (NP/NPEs)
87	Octylphenols and Octylphenol	87 - Octylphenols and Octylphenol ethoxylates
69	Organotin compounds (as tota	69 - Organotin compounds (as total Sn)
86	Particulate matter (PM10)	86 - Particulate matter (PM10)

47	PCDD + PCDF (dioxins + fura	47 - PCDD + PCDF (dioxins + furans)(as Teq)
48	Pentachlorobenzene	48 - Pentachlorobenzene
49	Pentachlorophenol (PCP)	49 - Pentachlorophenol (PCP)
09	Perfluorocarbons (PFCs)	09 - Perfluorocarbons (PFCs)
71	Phenols (as total C)	71 - Phenols (as total C)
50	Polychlorinated biphenyls (PC	50 - Polychlorinated biphenyls (PCBs)
72	Polycyclic aromatic hydrocarb	72 - Polycyclic aromatic hydrocarbons (PAHs)
51	Simazine	51 - Simazine
10	Sulphur hexafluoride (SF6)	10 - Sulphur hexafluoride (SF6)
11	Sulphur oxides (SOx/SO2)	11 - Sulphur oxides (SOx/SO2)
52	Tetrachloroethylene (PER)	52 - Tetrachloroethylene (PER)
53	Tetrachloromethane (TCM)	53 - Tetrachloromethane (TCM)
73	Toluene	73 - Toluene
12	Total nitrogen	12 - Total nitrogen
76	Total organic carbon (TOC) (a	76 - Total organic carbon (TOC) (as total C or COD/3)
13	Total phosphorus	13 - Total phosphorus
59	Toxaphene	59 - Toxaphene
74	Tributyltin and compounds	74 - Tributyltin and compounds
54	Trichlorobenzenes (TCBs)(all	54 - Trichlorobenzenes (TCBs)(all isomers)
57	Trichloroethylene	57 - Trichloroethylene
58	Trichloromethane	58 - Trichloromethane
77	Trifluralin	77 - Trifluralin
75	Triphenyltin and compounds	75 - Triphenyltin and compounds
60	Vinyl chloride	60 - Vinyl chloride
78	Xylenes	78 - Xylenes
24	Zinc and compounds (as Zn)	24 - Zinc and compounds (as Zn)

Emission Type : Land

PRTR Pollutants

Pollutant_Number	Pollutant_Name	Pollutant_Lookup
55	1,1,1-trichloroethane	55 - 1,1,1-trichloroethane
56	1,1,2,2-tetrachloroethane	56 - 1,1,2,2-tetrachloroethane
44	1,2,3,4,5,6-hexachlorocyclohe	44 - 1,2,3,4,5,6-hexachlorocyclohexane(HCH)
34	1,2-dichloroethane (EDC)	34 - 1,2-dichloroethane (EDC)
25	Alachlor	25 - Alachlor
26	Aldrin	26 - Aldrin
06	Ammonia (NH3)	06 - Ammonia (NH3)

61	Anthracene	61 - Anthracene
17	Arsenic and compounds (as A	17 - Arsenic and compounds (as As)
81	Asbestos	81 - Asbestos
27	Atrazine	27 - Atrazine
62	Benzene	62 - Benzene
91	Benzo(g,h,i)perylene	91 - Benzo(g,h,i)perylene
63	Brominated diphenylethers (P	63 - Brominated diphenylethers (PBDE)
18	Cadmium and compounds (as	18 - Cadmium and compounds (as Cd)
03	Carbon dioxide (CO2)	03 - Carbon dioxide (CO2)
02	Carbon monoxide (CO)	02 - Carbon monoxide (CO)
28	Chlordane	28 - Chlordane
29	Chlordecone	29 - Chlordecone
30	Chlorfenvinphos	30 - Chlorfenvinphos
79	Chlorides (as Cl)	79 - Chlorides (as Cl)
80	Chlorine and inorganic compo	80 - Chlorine and inorganic compounds (as HCl)
31	Chloro-alkanes, C10-C13	31 - Chloro-alkanes, C10-C13
15	Chlorofluorocarbons (CFCs)	15 - Chlorofluorocarbons (CFCs)
32	Chlorpyrifos	32 - Chlorpyrifos
19	Chromium and compounds (a	19 - Chromium and compounds (as Cr)
20	Copper and compounds (as C	20 - Copper and compounds (as Cu)
82	Cyanides (as total CN)	82 - Cyanides (as total CN)
33	DDT	33 - DDT
70	Di-(2-ethyl hexyl) phthalate (D	70 - Di-(2-ethyl hexyl) phthalate (DEHP)
35	Dichloromethane (DCM)	35 - Dichloromethane (DCM)
36	Dieldrin	36 - Dieldrin
37	Diuron	37 - Diuron
38	Endosulphan	38 - Endosulphan
39	Endrin	39 - Endrin
65	Ethyl benzene	65 - Ethyl benzene
66	Ethylene oxide	66 - Ethylene oxide
88	Fluoranthene	88 - Fluoranthene
83	Fluorides (as total F)	83 - Fluorides (as total F)
84	Fluorine and inorganic compo	84 - Fluorine and inorganic compounds (as HF)
40	Halogenated organic compou	40 - Halogenated organic compounds (as AOX)
16	Halons	16 - Halons
41	Heptachlor	41 - Heptachlor

90	Hexabromobiphenyl	90 - Hexabromobiphenyl
42	Hexachlorobenzene (HCB)	42 - Hexachlorobenzene (HCB)
43	Hexachlorobutadiene (HCBD)	43 - Hexachlorobutadiene (HCBD)
04	Hydro-fluorocarbons (HFCs)	04 - Hydro-fluorocarbons (HFCs)
14	Hydrochlorofluorocarbons (HC	14 - Hydrochlorofluorocarbons (HCFCs)
85	Hydrogen cyanide (HCN)	85 - Hydrogen cyanide (HCN)
89	Isodrin	89 - Isodrin
67	Isoproturon	67 - Isoproturon
23	Lead and compounds (as Pb)	23 - Lead and compounds (as Pb)
45	Lindane	45 - Lindane
21	Mercury and compounds (as H	21 - Mercury and compounds (as Hg)
01	Methane (CH4)	01 - Methane (CH4)
46	Mirex	46 - Mirex
68	Naphthalene	68 - Naphthalene
22	Nickel and compounds (as Ni)	22 - Nickel and compounds (as Ni)
08	Nitrogen oxides (NOx/NO2)	08 - Nitrogen oxides (NOx/NO2)
05	Nitrous oxide (N2O)	05 - Nitrous oxide (N2O)
07	Non-methane volatile organic	07 - Non-methane volatile organic compounds (NMVOC)
64	Nonylphenol and Nonylphenol	64 - Nonylphenol and Nonylphenol ethoxylates (NP/NPEs)
87	Octylphenols and Octylphenol	87 - Octylphenols and Octylphenol ethoxylates
69	Organotin compounds (as tota	69 - Organotin compounds (as total Sn)
86	Particulate matter (PM10)	86 - Particulate matter (PM10)
47	PCDD + PCDF (dioxins + fura	47 - PCDD + PCDF (dioxins + furans)(as Teq)
48	Pentachlorobenzene	48 - Pentachlorobenzene
49	Pentachlorophenol (PCP)	49 - Pentachlorophenol (PCP)
09	Perfluorocarbons (PFCs)	09 - Perfluorocarbons (PFCs)
71	Phenols (as total C)	71 - Phenols (as total C)
50	Polychlorinated biphenyls (PC	50 - Polychlorinated biphenyls (PCBs)
72	Polycyclic aromatic hydrocarb	72 - Polycyclic aromatic hydrocarbons (PAHs)
51	Simazine	51 - Simazine
10	Sulphur hexafluoride (SF6)	10 - Sulphur hexafluoride (SF6)
11	Sulphur oxides (SOx/SO2)	11 - Sulphur oxides (SOx/SO2)
52	Tetrachloroethylene (PER)	52 - Tetrachloroethylene (PER)
53	Tetrachloromethane (TCM)	53 - Tetrachloromethane (TCM)
73	Toluene	73 - Toluene
12	Total nitrogen	12 - Total nitrogen

76	Total organic carbon (TOC) (a	76 - Total organic carbon (TOC) (as total C or COD/3)
13	Total phosphorus	13 - Total phosphorus
59	Toxaphene	59 - Toxaphene
74	Tributyltin and compounds	74 - Tributyltin and compounds
54	Trichlorobenzenes (TCBs)(all	54 - Trichlorobenzenes (TCBs)(all isomers)
57	Trichloroethylene	57 - Trichloroethylene
58	Trichloromethane	58 - Trichloromethane
77	Trifluralin	77 - Trifluralin
75	Triphenyltin and compounds	75 - Triphenyltin and compounds
60	Vinyl chloride	60 - Vinyl chloride
78	Xylenes	78 - Xylenes
24	Zinc and compounds (as Zn)	24 - Zinc and compounds (as Zn)

Licensed (Non-PRTR) Pollutants

Emission Type : Air

Pollutant_Number	Pollutant_Name	Pollutant_Lookup
201	1,2 trichloroethylene	201 - 1,2 trichloroethyle
241	2-Chloroethanol	241 - 2-Chloroethanol
202	2-methyoxyethanol	202 - 2-methyoxyethan
301	Acetate	301 - Acetate
203	Acetic acid	203 - Acetic acid
361	Acrylates	361 - Acrylates
369	Alkyl Phenol Ethoxyla	369 - Alkyl Phenol Ethoxylates
355	Aluminium	355 - Aluminium
205	Antimony (as Sb)	205 - Antimony (as Sb)
206	Benzene & toluene &	206 - Benzene & toluen
243	cis-1,2-dichloroethene	243 - cis-1,2-dichloroeth
207	Class B organics	207 - Class B organics
356	Cobalt	356 - Cobalt
208	Condenseable volatil	208 - Condenseable vo
310	Dimethylester	310 - Dimethylester
209	Dimethylformamide	209 - Dimethylformamid
245	Dimethylsulphate	245 - Dimethylsulphate
210	Dust	210 - Dust
211	Epichlorohydrin	211 - Epichlorohydrin
212	Formaldehyde	212 - Formaldehyde
315	Formaldehyde	315 - Formaldehyde
213	Formic acid	213 - Formic acid
316	Hydrazine	316 - Hydrazine
214	Hydrogen bromide	214 - Hydrogen bromide
317	Hydrogen peroxide	317 - Hydrogen peroxide
215	Hydrogen sulphide	215 - Hydrogen sulphide
318	Hydrogen sulphide	318 - Hydrogen sulphide
216	Indicator Microorganis	216 - Indicator Microorganisms
319	Inorganic acids	319 - Inorganic acids
217	Iodinated compounds	217 - Iodinated compounds
357	Iron	357 - Iron
218	Isocyanate	218 - Isocyanate
320	Magnesium	320 - Magnesium

Air Lookup	
From Row	4
To Row	86
Start Cell	3
Water Lookup	
From Row	89
To Row	165
Start Cell	88
Offsite Xfers Lookup	
From Row	168
To Row	243
Start Cell	167
Land Lookup	
From Row	246
To Row	246
Start Cell	245

321	Manganese (as Mn)	321 - Manganese (as Mn)
219	MDI	219 - MDI
322	MDI as NCO group	322 - MDI as NCO group
220	Mercaptans	220 - Mercaptans
323	Methanol	323 - Methanol
367	Methyl Methacrylate	367 - Methyl Methacrylate
368	Molybdenum	368 - Molybdenum
325	Monochloramine	325 - Monochloramine
326	n-hexene	326 - n-hexene
221	Nitric acid (HNO3)	221 - Nitric acid (HNO3)
330	Organic solvents	330 - Organic solvents
222	Organic substances w	222 - Organic substances with photochemical ozone potential
331	Organohalogens	331 - Organohalogens
223	Ozone	223 - Ozone
333	Permethrin	333 - Permethrin
334	Pesticides	334 - Pesticides
337	Pharmaceutical active	337 - Pharmaceutical actives
338	Potassium	338 - Potassium
339	Preventol WB	339 - Preventol WB
370	Selenium	370 - Selenium
340	Semi-volatiles	340 - Semi-volatiles
354	Silver	354 - Silver
341	Sodium	341 - Sodium
342	Streptomycin	342 - Streptomycin
353	Sulphides	353 - Sulphides
239	Sulphuric Acid	239 - Sulphuric Acid
344	TA luft carcinogenic s	344 - TA luft carcinogenic substance class 3
224	TA Luft carcinogenic s	224 - TA Luft carcinogenic substances Class 1
225	TA Luft carcinogenic s	225 - TA Luft carcinogenic substances Class 2
226	TA Luft carcinogenic s	226 - TA Luft carcinogenic substances Class 3
227	TA Luft inorganic dust	227 - TA Luft inorganic dust particles class 1
228	TA Luft inorganic dust	228 - TA Luft inorganic dust particles class 2
229	TA Luft inorganic dust	229 - TA Luft inorganic dust particles class 3
230	TA Luft organic substa	230 - TA Luft organic substances class 1
231	TA Luft organic substa	231 - TA Luft organic substances class 2
232	TA Luft organic substa	232 - TA Luft organic substances class 3

371	Tellurium	371 - Tellurium
233	Thallium compounds	233 - Thallium compounds
358	Tin	358 - Tin
234	Toluene di-isocyanate	234 - Toluene di-isocyanate
235	Total acids	235 - Total acids
345	Total acids	345 - Total acids
242	Total Aldehydes (as C	242 - Total Aldehydes (as C)
347	Total heavy metals	347 - Total heavy metals
351	Total Organic Carbon	351 - Total Organic Carbon (as C)
352	Total Organic Carbon	352 - Total Organic Carbon (as Toluene)
244	Total Particulates	244 - Total Particulates
350	Undenatured botulinu	350 - Undenatured botulinum toxin
236	Vanadium (as V)	236 - Vanadium (as V)
237	Volatile organic comp	237 - Volatile organic compounds (as TOC)

Emission Type : Water

Pollutant_Number	Pollutant_Name	Pollutant_Lookup
301	Acetate	301 - Acetate
203	Acetic acid	203 - Acetic acid
361	Acrylates	361 - Acrylates
369	Alkyl Phenol Ethoxyla	369 - Alkyl Phenol Ethoxylates
355	Aluminium	355 - Aluminium
204	Amines	204 - Amines
238	Ammonia (as N)	238 - Ammonia (as N)
205	Antimony (as Sb)	205 - Antimony (as Sb)
373	Barium	373 - Barium
206	Benzene & toluene &	206 - Benzene & toluene & xylene (combined)
302	Biocides	302 - Biocides
303	BOD	303 - BOD
374	Boron	374 - Boron
304	Bromide	304 - Bromide
305	Calcium	305 - Calcium
243	cis-1,2-dichloroethene	243 - cis-1,2-dichloroethene
356	Cobalt	356 - Cobalt
306	COD	306 - COD
208	Condenseable volatile	208 - Condenseable volatile organic compounds
308	Detergents (as MBAS	308 - Detergents (as MBAS)

309	Diesel range organics	309 - Diesel range organics
310	Dimethylester	310 - Dimethylester
245	Dimethylsulphate	245 - Dimethylsulphate
211	Epichlorohydrin	211 - Epichlorohydrin
314	Fats, Oils and Grease	314 - Fats, Oils and Greases
212	Formaldehyde	212 - Formaldehyde
315	Formaldehyde	315 - Formaldehyde
213	Formic acid	213 - Formic acid
316	Hydrazine	316 - Hydrazine
366	Hydrocarbons	366 - Hydrocarbons
214	Hydrogen bromide	214 - Hydrogen bromide
317	Hydrogen peroxide	317 - Hydrogen peroxide
318	Hydrogen sulphide	318 - Hydrogen sulphide
319	Inorganic acids	319 - Inorganic acids
357	Iron	357 - Iron
362	Kjeldahl Nitrogen	362 - Kjeldahl Nitrogen
320	Magnesium	320 - Magnesium
321	Manganese (as Mn)	321 - Manganese (as Mn)
322	MDI as NCO group	322 - MDI as NCO group
323	Methanol	323 - Methanol
367	Methyl Methacrylate	367 - Methyl Methacrylate
324	Mineral oils	324 - Mineral oils
368	Molybdenum	368 - Molybdenum
325	Monochloramine	325 - Monochloramine
326	n-hexene	326 - n-hexene
327	Nitrate (as N)	327 - Nitrate (as N)
372	Nitrite (as N)	372 - Nitrite (as N)
328	Non-purgeable organi	328 - Non-purgeable organic compounds
329	Octafluropentanol	329 - Octafluropentanol
330	Organic solvents	330 - Organic solvents
331	Organohalogens	331 - Organohalogens
332	Ortho-phosphate (as I	332 - Ortho-phosphate (as PO4)
333	Permethrin	333 - Permethrin
334	Pesticides	334 - Pesticides
335	Petrol range organics	335 - Petrol range organics
337	Pharmaceutical active	337 - Pharmaceutical actives

338	Potassium	338 - Potassium
339	Preventol WB	339 - Preventol WB
370	Selenium	370 - Selenium
340	Semi-volatiles	340 - Semi-volatiles
354	Silver	354 - Silver
341	Sodium	341 - Sodium
342	Streptomycin	342 - Streptomycin
343	Sulphate	343 - Sulphate
353	Sulphides	353 - Sulphides
364	Sulphites (as SO3)	364 - Sulphites (as SO3)
240	Suspended Solids	240 - Suspended Solids
371	Tellurium	371 - Tellurium
358	Tin	358 - Tin
345	Total acids	345 - Total acids
363	Total Dissolved Solids	363 - Total Dissolved Solids
347	Total heavy metals	347 - Total heavy metals
351	Total Organic Carbon	351 - Total Organic Carbon (as C)
352	Total Organic Carbon	352 - Total Organic Carbon (as Toluene)
348	Total petroleum hydrc	348 - Total petroleum hydrocarbons
350	Undenatured botulinu	350 - Undenatured botulinum toxin
237	Volatile organic comp	237 - Volatile organic compounds (as TOC)

Emission Type : Offsite Transfers

Pollutant_Number	Pollutant_Name	Pollutant_Lookup
301	Acetate	301 - Acetate
203	Acetic acid	203 - Acetic acid
361	Acrylates	361 - Acrylates
369	Alkyl Phenol Ethoxyla	369 - Alkyl Phenol Ethoxylates
355	Aluminium	355 - Aluminium
204	Amines	204 - Amines
238	Ammonia (as N)	238 - Ammonia (as N)
205	Antimony (as Sb)	205 - Antimony (as Sb)
373	Barium	373 - Barium
206	Benzene & toluene &	206 - Benzene & toluene & xylene (combined)
302	Biocides	302 - Biocides
303	BOD	303 - BOD
374	Boron	374 - Boron

304	Bromide	304 - Bromide
305	Calcium	305 - Calcium
356	Cobalt	356 - Cobalt
306	COD	306 - COD
208	Condenseable volatile	208 - Condenseable volatile organic compounds
308	Detergents (as MBAS	308 - Detergents (as MBAS)
309	Diesel range organics	309 - Diesel range organics
310	Dimethylester	310 - Dimethylester
245	Dimethylsulphate	245 - Dimethylsulphate
211	Epichlorohydrin	211 - Epichlorohydrin
314	Fats, Oils and Grease	314 - Fats, Oils and Greases
212	Formaldehyde	212 - Formaldehyde
315	Formaldehyde	315 - Formaldehyde
213	Formic acid	213 - Formic acid
316	Hydrazine	316 - Hydrazine
366	Hydrocarbons	366 - Hydrocarbons
214	Hydrogen bromide	214 - Hydrogen bromide
317	Hydrogen peroxide	317 - Hydrogen peroxide
318	Hydrogen sulphide	318 - Hydrogen sulphide
319	Inorganic acids	319 - Inorganic acids
357	Iron	357 - Iron
362	Kjeldahl Nitrogen	362 - Kjeldahl Nitrogen
320	Magnesium	320 - Magnesium
321	Manganese (as Mn)	321 - Manganese (as Mn)
322	MDI as NCO group	322 - MDI as NCO group
323	Methanol	323 - Methanol
367	Methyl Methacrylate	367 - Methyl Methacrylate
324	Mineral oils	324 - Mineral oils
368	Molybdenum	368 - Molybdenum
325	Monochloramine	325 - Monochloramine
326	n-hexene	326 - n-hexene
327	Nitrate (as N)	327 - Nitrate (as N)
372	Nitrite (as N)	372 - Nitrite (as N)
328	Non-purgeable organi	328 - Non-purgeable organic compounds
329	Octafluropentanol	329 - Octafluropentanol
330	Organic solvents	330 - Organic solvents

331	Organohalogens	331 - Organohalogens
332	Ortho-phosphate (as I	332 - Ortho-phosphate (as PO4)
333	Permethrin	333 - Permethrin
334	Pesticides	334 - Pesticides
335	Petrol range organics	335 - Petrol range organics
337	Pharmaceutical active	337 - Pharmaceutical actives
338	Potassium	338 - Potassium
339	Preventol WB	339 - Preventol WB
370	Selenium	370 - Selenium
340	Semi-volatiles	340 - Semi-volatiles
354	Silver	354 - Silver
341	Sodium	341 - Sodium
342	Streptomycin	342 - Streptomycin
343	Sulphate	343 - Sulphate
353	Sulphides	353 - Sulphides
364	Sulphites (as SO3)	364 - Sulphites (as SO3)
240	Suspended Solids	240 - Suspended Solids
371	Tellurium	371 - Tellurium
358	Tin	358 - Tin
345	Total acids	345 - Total acids
363	Total Dissolved Solids	363 - Total Dissolved Solids
347	Total heavy metals	347 - Total heavy metals
351	Total Organic Carbon	351 - Total Organic Carbon (as C)
352	Total Organic Carbon	352 - Total Organic Carbon (as Toluene)
348	Total petroleum hydrc	348 - Total petroleum hydrocarbons
350	Undenatured botulinu	350 - Undenatured botulinum toxin
237	Volatile organic comp	237 - Volatile organic compounds (as TOC)

Emission Type : Land

Pollutant_Number	Pollutant_Name	Pollutant_Lookup

GroupCode	Description	2
01	WASTE RESULTING FROM EXPLORATION, MINING, QUARRYING, AND PHYSICAL AND CHEMICAL TREATMENT OF MINERALS	21
02	WASTES FROM AGRICULTURE, HORTICULTURE, AQUACULTURE, FORESTRY, HUNTING AND FISHING, FOOD PREPARATION AND PROCESSING	23
03	WASTES FROM WOOD PROCESSING AND THE PRODUCTION OF PANELS AND FURNITURE, PULP, PAPER AND CARDBOARD	133
04	WASTES FROM THE LEATHER, FUR AND TEXTILE INDUSTRIES	135
05	WASTES FROM PETROLEUM REFINING, NATURAL GAS PURIFICATION AND PYROLYTIC TREATMENT OF COAL	973
06	WASTES FROM INORGANIC CHEMICAL PROCESSES	2
07	WASTES FROM ORGANIC CHEMICAL PROCESSES	21
08	WASTES FORM THE MANUFACTURE, FORMULATION, SUPPLY AND USE (MFSU) OF COATINGS (PAINTS, VARNISHES AND VITREOUS ENAMELS,) ADHESIVES, SEALANTS AND PRINTING INKS	
09	WASTES FROM THE PHOTOGRAPHIC INDUSTRY	
10	WASTES FROM THERMAL PROCESSES	
11	WASTES FROM CHEMICAL SURFACE TREATMENT AND COATING OF METALS AND OTHER MATERIALS; NON-FERROUS HYDRO-METALLURGY	
12	WASTES FROM SHAPING AND PHYSICAL AND MECHANICAL SURFACE TREATMENT OF METALS AND PLASTICS	
13	OIL WASTES AND WASTES OF LIQUID FUELS (except edible oils, and those in chapters 05, 12 and 19)	
14	WASTE ORGANIC SOLVENTS, REFRIGERANTS AND PROPELLANTS (except 07 and 08)	
15	WASTE PACKAGING; ABSORBENTS, WIPING CLOTHS, FILTER MATERIALS AND PROTECTIVE CLOTHING NOT OTHERWISE SPECIFIED	
16	WASTES NOT OTHERWISE SPECIFIED IN THE LIST	
17	CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)	
18	WASTES FROM HUMAN OR ANIMAL HEALTH CARE AND/OR RELATED RESEARCH (except kitchen and restaurant wastes not arising from immediate RESEARCH (except kitchen and restaurant wastes not arising from immediate health care)	
19	WASTES FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTE WATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE	
20	MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS	

GroupCode	SubGroupCode	Description
01	01	wastes from mineral excavation
01	03	wastes from physical and chemical processing of metalliferous minerals
01	04	wastes from physical and chemical processing of non-metalliferous minerals
01	05	drilling muds and other drilling wastes
02	01	wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing
02	02	wastes from the preparation and processing of meat, fish and other foods of animal origin
02	03	wastes from fruit, vegetables, cereals, edible oils, cocoa, coffee, tea and tabacco preparation and processing; conserve production; yeast and yeast extract production, molasses preparation and fermentation
02	04	wastes from sugar processing
02	05	wastes from the dairy products industry
02	06	wastes from the baking and confectionery industry
02	07	wastes from the production of alcoholic and non-alcoholic beverages (except coffee, tea and cocoa)
03	01	wastes from wood processing and the production of panels and furniture
03	02	wastes from wood preservation
03	03	wastes from pulp, paper and cardboard production and processing
04	01	wastes from the leather and fur industry
04	02	wastes from the textile industry
05	01	wastes from petroleum refining
05	06	waste from the pyrolytic treatment of coal
05	07	waste from natural gas purification and transportation
06	01	wastes from the manufacture, formulation, supply and use (MFSU) of acids
06	02	wastes from the MFSU of bases
06	03	wastes from the MFSU of salts and their solutions and metallic oxides
06	04	metal-containing wastes other than those mentioned in 06 03
06	05	sludges from on-site effluent treatment
06	06	wastes from the MFSU of sulphur chemicals, sulphur chemical processes and desulphurisation processes
06	07	wastes from the MFSU of halogens and halogen chemical processes
06	08	wastes from the MFSU of silicon and silicon derivatives
06	09	wastes from the MFSU of phosphorus chemicals and phosphorous chemical processes
06	10	wastes from the MFSU of nitrogen chemicals, nitrogen chemical processes and fertiliser manufacture
06	11	wastes from the manufacture of inorganic pigments and opacificiers
06	13	wastes from inorganic chemical processes not otherwise specified
07	01	wastes from the manufacture, formulation, supply and use (MFSU) of basic organic chemicals
07	02	wastes from the MFSU of plastics, synthetic rubber and man-made fibres
07	03	wastes from the MFSU of organic dyes and pigments (except 06 11)
07	04	wastes from the MFSU of organic plant protection products (except 02 01 08 and 02 01 09), wood preserving agents (except 03 02) and other biocides
07	05	wastes from the MFSU of pharmaceuticals

07	06	wastes from the MFSU of fats, grease, soaps, detergents, disinfectants and cosmetics
07	07	wastes from the MFSU of fine chemicals and chemical products not otherwise specified
08	01	wastes from MFSU and removal of paint and varnish
08	02	wastes from MFSU of other coatings (including ceramic materials)
08	03	wastes from MFSU of printing inks
08	04	wastes from MFSU of adhesives and sealants (including waterproofing products)
08	05	wastes not otherwise specified in 08
09	01	wastes for the photographic industry
10	01	wastes from power stations and other combustion plants (except 19)
10	02	wastes from the iron and steel industry
10	03	wastes from aluminium thermal metallurgy
10	04	wastes from lead thermal metallurgy
10	05	wastes from zinc thermal metallurgy
10	06	wastes from copper thermal metallurgy
10	07	wastes from silver, gold and platinum thermal metalurgy
10	08	wastes from other non-ferous thermal metallurgy
10	09	wastes from casting of ferrous pieces
10	10	wastes from casting of non-ferrous pieces
10	11	wastes from manufacture of glass and glass products
10	12	wastes from manufacture of ceramic goods, bricks, tiles and construction products
10	13	wastes from manufacture of cement, lime and plaster and articles and products made from them
10	14	waste from crematoria
11	01	wastes from chemical surface treatment and coating of metals and other materials (for example galvanic processes, zinc coating processes, pickling processes, etching, phosphating, alkaline degreasing, anodising)
11	02	waste from non-ferrous hydrometallurgical processes
11	03	sludges and solids from tempering processes
11	05	wastes from hot galvanising processes
12	01	wastes from shaping and physical and mechanical surface treatment of metals and plastics
12	03	wastes from water and steam degreasing processes (except 11)
13	01	waste hydraulic oils
13	02	waste engine, gear and lubricating oils
13	03	waste insulating and heat transmission oils
13	04	bilge oils
13	05	oil/water separator contents
13	07	wastes of liquid fuels
13	08	oil wastes not otherwise specified
14	06	waste organic solvents, refrigerants and foam/aerosol propellants
15	01	packaging (including separately collected municipal packaging waste)
15	02	absorbents, filter materials, wiping cloths and protective clothing
16	01	end-of-life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance (except 13, 14, 16 06 and 16 08)
16	02	wastes from electrical and electronic equipment
16	03	off-specification batches and unused products
16	04	waste explosives
16	05	gases in pressure containers and discarded chemicals
16	06	batteries and accumulators
16	07	wastes from transport tank, storage tank and barrel cleaning (except 05 and 13)
16	08	spent catalysts
16	09	oxidising substances
16	10	aqueous liquid wastes destined for off-site treatment
16	11	waste linings and refractories
17	01	concrete, bricks, tiles and ceramics
17	02	wood, glass and plastic
17	03	bituminous mixtures, coal tar and tarred products
17	04	metals (including their alloys)
17	05	soil (including excavated soil from contaminated sites), stones and dredging spoil
17	06	insulation materials and asbestos-containing construction materials
17	08	gypsum-based construction material
17	09	other construction and demolition waste
18	01	wastes from natal care, diagnosis, treatment or prevention of disease in humans

18	02	wastes from research, diagnosis, treatment or prevention of disease involving animals
19	01	wastes from incineration or pyrolysis of waste
19	02	wastes from physico/chemical treatments of waste (including dechromatation, decyanidation, neutralisation)
19	03	stabilised/solidified wastes (19)
19	04	vitrified waste and wastes from vitrification
19	05	wastes from aerobic treatment of solid wastes
19	06	wastes from anaerobic treatment of waste
19	07	landfill leachate
19	08	wastes from waste water treatment plants not otherwise specified
19	09	wastes from the preparation of water intended for human consumption or water for industrial use
19	10	wastes from shredding of metal-containing wastes
19	11	wastes from oil regeneration
19	12	wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified
19	13	wastes from soil and groundwater remediation
20	01	separately collected fractions (except 15 01)
20	02	garden and park wastes (including cemetery waste)
20	03	other municipal wastes

GroupCode	SubGroupCode	WasteCode	Description	Hazardous
01	01	01	wastes from mineral metalliferous excavation	No
01	01	02	wastes from mineral non-metalliferous excavation	No
01	03	04	acid-generating tailings from processing of sulphide ore	Yes
01	03	05	other tailings containing dangerous substances	Yes
01	03	06	tailings other than those mentioned in 01 03 04 and 01 03 05	No
01	03	07	other wastes containing dangerous substances from physical and chemical processing of metalliferous	Yes
01	03	08	dusty and powdery wastes other than those mentioned in 01 03 07	No
01	03	09	red mud from alumina production other than the wastes mentioned in 01 03 07	No
01	03	99	wastes not otherwise specified	No
01	04	07	waste containing dangerous substances from physical and chemical processing of nonmetalliferous mi	Yes
01	04	08	waste gravel and crushed rocks other than those mentioned in 01 04 07	No
01	04	09	waste sand and clays	No
01	04	10	dusty and powdery wastes other than those mentioned in 01 04 07	No
01	04	11	wastes from potash and rock salt processing other than those mentioned in 01 04 07	No
01	04	12	tailings and other wastes from washing and cleaning of minerals other than those mentioned in 01 04 (	No
01	04	13	waste from stone cutting and sawing other than those mentioned in 01 04 07	No
01	04	99	waste not otherwise specified	No
01	05	04	freshwater drilling muds and wastes	No
01	05	05	oil-containing drilling muds and wastes	Yes
01	05	06	drilling muds and other drilling wastes containing dangerous substances	Yes
01	05	07	barite-containing drilling muds and wastes other than those mentioned in 01 05 05 and 0105 06	No
01	05	08	chloride-containing drilling muds and wastes other than those mentioned in 01 05 05 and 01 05 06	No
01	05	99	wastes not otherwise specified	No
02	01	01	sludges from washing and cleaning	No
02	01	02	animal-tissue waste	No
02	01	03	plant-tissue waste	No
02	01	04	waste plastics (except packaging)	No
02	01	06	animal faeces, urine and manure (including spoiled straw), effluent, collected separately and treated of	No
02	01	07	waste from forestry	No
02	01	08	agrochemical waste containing dangerous substances	Yes
02	01	09	agrochemical waste other than those mentioned in 02 01 08	No
02	01	10	waste metal	No
02	01	99	wastes not otherwise specified	No
02	02	01	sludges from washing and cleaning	No
02	02	02	animal-tissue waste	No
02	02	03	materials unsuitable for consumption or processing	No
02	02	04	sludges from on-site effluent treatment	No
02	02	99	waste not otherwise specified	No
02	03	01	sludges from washing, cleaning, peeling, centrifuging and separation	No
02	03	02	waste from preserving agents	No

02	03	03	wastes from solvent extraction	No
02	03	04	materials unsuitable for consumption or processing	No
02	03	05	sludges from on-site effluent treatment	No
02	03	99	wastes not otherwise specified	No
02	04	01	soil from cleaning and washing beet	No
02	04	02	off-specification calcium carbonate	No
02	04	03	sludges from on-site effluent treatment	No
02	04	99	wastes not otherwise specified	No
02	05	01	materials unsuitable for consumption or processing	No
02	05	02	sludges from on-site effluent treatment	No
02	05	99	wastes not otherwise specified	No
02	06	01	materials unsuitable for consumption or processing	No
02	06	02	wastes from preserving agents	No
02	06	03	sludges from on-site effluent treatment	No
02	06	99	waste not otherwise specified	No
02	07	01	wastes from washing, cleaning and mechanical reduction of raw materials	No
02	07	02	wastes from spirits distillation	No
02	07	03	wastes from chemical treatment	No
02	07	04	materials unsuitable for consumption or processing	No
02	07	05	sludges from on-site effluent treatment	No
02	07	99	waste not otherwise specified	No
03	01	01	waste bark and cork	No
03	01	04	sawdust, shavings, cuttings, wood, particle board and veneer containing dangerous substances	Yes
03	01	05	sawdust, shavings, cuttings, wood, particle board and veneer other than those mentioned in 03 01 04	No
03	01	99	wastes not otherwise specified	No
03	02	01	non-halogenated organic wood preservatives	Yes
03	02	02	organochlorinated wood preservatives	Yes
03	02	03	organometallic wood preservatives	Yes
03	02	04	inorganic wood preservatives	Yes
03	02	05	other wood preservatives containing dangerous substances	Yes
03	02	99	wood preservatives not otherwise specified	No
03	03	01	waste bark and wood	No
03	03	02	green liquor sludge (from recovery of cooking liquor)	No
03	03	05	de-inking sludges from paper recycling	No
03	03	07	mechanically separated rejects from pulping of waste paper and cardboard	No
03	03	08	wastes from sorting of paper and cardboard destined for recycling	No
03	03	09	lime mud waste	No
03	03	10	fibre rejects, fibre-, filler- and coating-sludges from mechanical separation	No
03	03	11	sludges from on-site effluent treatment other than those mentioned in 03 03 10	No
03	03	99	wastes not otherwise specified	No
04	01	01	fleshings and lime split wastes	No
04	01	02	liming waste	No
04	01	03	degreasing wastes containing solvents without a liquid phase	Yes
04	01	04	tanning liquor containing chromium	No
04	01	05	tanning liquor free of chromium	No
04	01	06	sludges, in particular from on-site effluent treatment containing chromium	No
04	01	07	sludges , in particular from on-site effluent treatment free of chromium	No
04	01	08	waste tanned leather (blue sheetings, shavings, cuttings, buffing dust) containing chromium	No
04	01	09	wastes from dressing and finishing	No
04	01	99	wastes not otherwise specified	No
04	02	09	wastes from composite materials (impregnated textile, elastomer, plastomer)	No
04	02	10	organic matter from natural products (for example grease, wax)	No
04	02	14	wastes from finishing containing organic solvents	Yes
04	02	15	wastes from finishing other than those mentioned in 04 02 14	No
04	02	16	dyestuffs and pigments containing dangerous substances	Yes
04	02	17	dyestuffs and pigments other than those mentioned in 04 02 16	No
04	02	19	sludges from on-site effluent treatment containing dangerous substances	Yes
04	02	20	sludges from on-site effluent treatment other than those mentioned in 04 02 19	No

04	02	21	wastes from unprocessed textile fibres	No
04	02	22	wastes from processed textile fibres	No
04	02	99	wastes not otherwise specified	No
05	01	02	desalter sludges	Yes
05	01	03	tank bottom sludges	Yes
05	01	04	acid alkyl sludges	Yes
05	01	05	oil spills	Yes
05	01	06	oily sludges from maintenance operations of the plant or equipment	Yes
05	01	07	acid tars	Yes
05	01	08	other tars	Yes
05	01	09	sludges from on-site effluent treatment containing dangerous substances	Yes
05	01	10	sludges from on-site effluent treatment other than those mentioned in 05 01 09	No
05	01	11	wastes from cleaning of fuels with bases	Yes
05	01	12	oil containing acids	Yes
05	01	13	boiler feedwater sludges	No
05	01	14	wastes from cooling columns	No
05	01	15	spent filter clays	Yes
05	01	16	sulphur-containing wastes from petroleum desulphurisation	No
05	01	17	bitumen	No
05	01	99	wastes not otherwise specified	No
05	06	01	acid tars	Yes
05	06	03	other tars	Yes
05	06	04	waste from cooling columns	No
05	06	99	wastes not otherwise specified	No
05	07	01	wastes containing mercury	Yes
05	07	02	wastes containing sulphur	No
05	07	99	wastes not otherwise specified	No
06	01	01	sulphuric acid and sulphurous acid	Yes
06	01	02	hydrochloric acid	Yes
06	01	03	hydrochloric acid	Yes
06	01	04	phosphoric and phosphorous acid	Yes
06	01	05	nitric acid and nitrous acid	Yes
06	01	06	other acids	Yes
06	01	99	wastes not otherwise specified	No
06	02	01	calcium hydroxide	Yes
06	02	03	ammonium hydroxide	Yes
06	02	04	sodium and potassium hydroxide	Yes
06	02	05	other bases	Yes
06	02	99	wastes not otherwise specified	No
06	03	11	solid salts and solutions containing cyanides	Yes
06	03	13	solid salts and solutions containing heavy metals	Yes
06	03	14	solid salts and solution other than those mentioned in 06 03 11 and 06 03 13	No
06	03	15	metallic oxides containing heavy metals	Yes
06	03	16	metallic oxides other than those mentioned in 06 03 15	No
06	03	99	wastes not otherwise specified	No
06	04	03	wastes containing arsenic	Yes
06	04	04	wastes containing mercury	Yes
06	04	05	wastes containing other heavy metals	Yes
06	04	99	wastes not otherwise specified	No
06	05	02	sludges from on-site effluent treatment containing dangerous solutions	Yes
06	05	03	sludges from onsite effluent treatment other than those mentioned in 06 05 02	No
06	06	02	wastes containing dangerous sulphides	Yes
06	06	03	wastes containing sulphides other than those mentioned in 06 06 02	No
06	06	99	wastes not otherwise specified	No
06	07	01	wastes containing asbestos from electrolysis	Yes
06	07	02	activated carbon from chlorine production	Yes
06	07	03	barium sulphate sludge containing mercury	Yes
06	07	04	solutions and acids, for example contact acid	Yes

06	07	99	wastes not otherwise specified	No
06	08	02	waste containing dangerous silicones	Yes
06	08	99	wastes not otherwise specified	No
06	09	02	phosphorus slag	No
06	09	03	calcium-based reaction wastes containing or contaminated with dangerous substances	Yes
06	09	04	calcuim-based reaction wastes other than those mentioned in 06 09 03	No
06	09	99	wastes not otherwise specified	No
06	10	02	wastes containing dangerous substances	Yes
06	10	99	wastes not otherwise specified	No
06	11	01	calcium-based reaction wastes from titanium dioxide production	No
06	11	99	wastes not otherwise specified	No
06	13	01	inorganic plant protection products, wood-preserving agents and other biocides	Yes
06	13	02	spent activated carbon (except 06 07 02)	Yes
06	13	03	carbon black	No
06	13	04	wastes from asbestos processing	Yes
06	13	05	soot	Yes
06	13	99	wastes not otherwise specified	No
07	01	01	aqueous washing liquids and mother liquors	Yes
07	01	03	organic halogenated solvents, washing liquids and mother liquors	Yes
07	01	04	other organic solvents, washing liquids and mother liquors	Yes
07	01	07	halogenated still bottoms and reaction residues	Yes
07	01	08	other still bottoms and reaction residues	Yes
07	01	09	halogenated filter cakes and spent absorbents	Yes
07	01	10	other filter cakes and spent absorbents	Yes
07	01	11	sludges from on-site effluent treatment containing dangerous substances	Yes
07	01	12	sludges from on-site effluent treatment other than those mentioned in 07 01 11	No
07	01	99	wastes not otherwise specified	No
07	02	01	aqueous washing liquids and mother liquors	Yes
07	02	03	organic halogenated solvents, washing liquids and mother liquors	Yes
07	02	04	other organic solvents, washing liquids and mother liquors	Yes
07	02	07	halogenated still bottoms and reaction residues	Yes
07	02	08	other still bottoms and reaction residues	Yes
07	02	09	halogenated filter cakes and spent absorbents	Yes
07	02	10	other filter cakes and spent absorbents	Yes
07	02	11	sludges from on-site effluent treatment containing dangerous substances	Yes
07	02	12	sludges from on-site effluent treatment other than those mentioned in 07 02 11	No
07	02	13	waste plastic	No
07	02	14	wastes from additives containing dangerous substances	Yes
07	02	15	wastes from additives other than those mentioned in 07 02 14	No
07	02	16	waste containing dangerous silicones	Yes
07	02	17	waste containing silicones other than those mentioned in 07 02 16	No
07	02	99	wastes not otherwise specified	No
07	03	01	aqueous washing liquids and mother liquors	Yes
07	03	03	organic halogenated solvents, washing liquids and mother liquors	Yes
07	03	04	other organic solvents, washing liquids and mother liquors	Yes
07	03	07	halogenated still bottoms and reaction residues	Yes
07	03	08	other still bottoms and reaction residues	Yes
07	03	09	halogenated filter cakes and spent absorbents	Yes
07	03	10	other filter cakes and spent absorbents	Yes
07	03	11	sludges from on-site effluent treatment containing dangerous substances	Yes
07	03	12	sludges from on-site effluent treatment other than those mentioned in 07 03 11	No
07	03	99	wastes not otherwise specified	No
07	04	01	aqueous washing liquids and mother liquors	Yes
07	04	03	organic halogenated solvents, washing liquids and mother liquors	Yes
07	04	04	other organic solvents, washing liquids and mother liquids	Yes
07	04	07	halogenated still bottoms and reaction residues	Yes
07	04	08	other still bottoms and reaction residues	Yes
07	04	09	halogenated filter cakes and spent absorbents	Yes

07	04	10	other filter cakes and spent absorbents	Yes
07	04	11	sludges from on-site effluent treatment containing dangerous substances	Yes
07	04	12	sludges from on-site effluent treatment other than those mentioned in 07 04 11	No
07	04	13	solid wastes containing dangerous substances	Yes
07	04	99	wastes not otherwise specified	No
07	05	01	aqueous washing liquids and mother liquors	Yes
07	05	03	organic halogenated solvents, washing liquids and mother liquors	Yes
07	05	04	other organic solvents, washing liquids and mother liquors	Yes
07	05	07	halogenated still bottoms and reaction residues	Yes
07	05	08	other still bottoms and reaction residues	Yes
07	05	09	halogenated filter cakes and spent absorbents	Yes
07	05	10	other filter cakes and spent absorbents	Yes
07	05	11	sludges from on-site effluent treatment containing dangerous substances	Yes
07	05	12	sludges from on-site effluent treatment other than those mentioned in 07 05 11	No
07	05	13	solid wastes containing dangerous substances	Yes
07	05	14	solid wastes other than those mentioned in 07 05 13	No
07	05	99	wastes not otherwise specified	No
07	06	01	aqueous washing liquids and mother liquors	Yes
07	06	03	organic halogenated solvents, washing liquids and mother liquors	Yes
07	06	04	other organic solvents, washing liquids and mother liquors	Yes
07	06	07	halogenated still bottoms and reaction residues	Yes
07	06	08	other sill bottoms and reaction residues	Yes
07	06	09	halogenated filter cakes and spent absorbents	Yes
07	06	10	other filter cakes and spent absorbents	Yes
07	06	11	sludges from on-site effluent treatment containing dangerous substances	Yes
07	06	12	sludges from on-site effluent treatment other than those mentioned in 07 06 11	No
07	06	99	wastes not otherwise specified	No
07	07	01	aqueous washing liquids and mother liquors	Yes
07	07	03	organic halogenated solvents, washing liquids and mother liquors	Yes
07	07	04	other organic solvents, washing liquids and mother liquors	Yes
07	07	07	halogenated still bottoms and reaction residues	Yes
07	07	08	other still bottoms and reaction residues	Yes
07	07	09	halogenated filter cakes and spent absorbents	Yes
07	07	10	other filter cakes and spent sbsorbents	Yes
07	07	11	sludges from on-site effluent treatment containing dangerous substances	Yes
07	07	12	sludges from on-site effluent treatment other than those mentioned in 07 07 11	No
07	07	99	wastes not otherwise specified	No
08	01	11	waste paint and varnish containing organic solvents or other dangerous substances	Yes
08	01	12	waste paint and varnish other than those mentioned in 08 01 11	No
08	01	13	sludges from paint or varnish containing organic solvents or other dangerous substances	Yes
08	01	14	sludges from paint or varnish other than those mentioned in 08 01 13	No
08	01	15	aqueous sludges containing paint or varnish containing organic solvents or other dangerous substance	Yes
08	01	16	aqueous sludges containing paint or varnish other than those mentioned in 08 01 15	No
08	01	17	wastes from paint or varnish removal containing organic solvents or other dangerous substances	Yes
08	01	18	wastes from paint or varnish removal other than those mentioned in 08 01 17	No
08	01	19	aqueous suspensions containing paint or varnish containing organic solvents or other dangerous subs	Yes
08	01	20	aqueous suspensions containing paint or varnish other than those mentioned in 08 01 19	No
08	01	21	waste paint or varnish remover	Yes
08	01	99	wastes not otherwise specified	No
08	02	01	waste coating powders	No
08	02	02	aqueous sludges containing ceramic materials	No
08	02	03	aqueous suspensions containing ceramic materials	No
08	02	99	wastes not otherwise specified	No
08	03	07	aqueous sludges containing ink	No
08	03	08	aqueous liquid waste containing ink	No
08	03	12	waste ink containing dangerous substances	Yes
08	03	13	waste ink other than those mentioned in 08 03 12	No
08	03	14	ink sludges containing dangerous substances	Yes

08	03	15	ink sludges other than those mentioned in 08 03 14	No
08	03	16	waste etching solutions	Yes
08	03	17	waste printing toner containing dangerous substances	Yes
08	03	18	waste printing toner other than those mentioned in 08 03 17	No
08	03	19	disperse oil	Yes
08	03	99	wastes not otherwise specified	No
08	04	09	waste adhesives and sealants containing organic solvents or other dangerous substances	Yes
08	04	10	waste adhesives and sealants other than those mentioned in 08 04 09	No
08	04	11	adhesive and sealant sludges containing organic solvents or other dangerous substances	Yes
08	04	12	adhesive and sealant sludges other than those mentioned in 08 04 11	No
08	04	13	aqueous sludges containing adhesives or sealants containing organic solvents or other dangerous sub	Yes
08	04	14	aqueous sludges containing adhesives or sealants other than those mentioned in 08 04 13	No
08	04	15	aqueous liquid waste containing adhesives or sealants containing organic solvents or other dangerous	Yes
08	04	16	aqueous liquid waste containing adhesives or sealants other than those mentioned in 08 04 15	No
08	04	17	rosin oil	Yes
08	04	99	wastes not otherwise specified	No
08	05	01	waste isocyanates	Yes
09	01	01	water-based developer and activator solutions	Yes
09	01	02	water-based offset plate developer solutions	Yes
09	01	03	solvent-based developer solutions	Yes
09	01	04	fixed solutions	Yes
09	01	05	bleach solutions and bleach fixer solutions	Yes
09	01	06	wastes containing silver from on-site treatment of photographic wastes	Yes
09	01	07	photographic film and paper containing silver or silver compounds	No
09	01	08	photographic film and paper free of silver or silver compounds	No
09	01	10	single-use cameras without batteries	No
09	01	11	single-use cameras containing batteries included in 16 06 01, 16 06 02 or 16 06 03	Yes
09	01	12	single-use cameras containing batteries other than those mentioned in 09 01 11	No
09	01	13	aqueous liquid waste from on-site reclamation of silver other than those mentioned in 09 01 06	Yes
09	01	99	wastes not otherwise specified	No
10	01	01	bottom ash, slag and boiler dust (excluding boiler dust mentioned in 10 01 04)	No
10	01	02	coal fly ash	No
10	01	03	fly ash from peat and untreated wood	No
10	01	04	oil fly ash and boiler dust	Yes
10	01	05	calcium-based reaction wastes from flue-gas desulphurisation in solid form	No
10	01	07	calcium-based reaction wastes from flue-gas desulphurisation in sludge form	No
10	01	09	sulphuric acid	Yes
10	01	13	fly ash from emulsified hydrocarbons used as fuel	Yes
10	01	14	bottom ash, slag and boiler dust from co-incineration containing dangerous substances	Yes
10	01	15	bottom ash, slag and boiler dust from co-incineration other than those mentioned in 10 01 14	No
10	01	16	fly ash from co-incineration containing dangerous substances	Yes
10	01	17	fly ash from co-incineration other than those mentioned in 10 01 16	No
10	01	18	wastes from gas cleaning containing dangerous substances	Yes
10	01	19	wastes from gas cleaning other than those mentioned in 10 01 05, 10 01 07 and 10 01 18	No
10	01	20	sludges from on-site effluent treatment containing dangerous substances	Yes
10	01	21	sluges from on-site effluent treatment other than those mentioned in 10 01 20	No
10	01	22	aqueous sludges from boiler cleansing containing dangerous substances	Yes
10	01	23	aqueous sludges from boiler cleansing other than those mentioned in 10 01 22	No
10	01	24	sands from fluidised beds	No
10	01	25	wastes from fuel storage and preparation of coal-fired power plants	No
10	01	26	wastes from cooling-water treatment	No
10	01	99	wastes not otherwise specified	No
10	02	01	wastes from the processing of slag	No
10	02	02	unprocessed slag	No
10	02	07	solid wastes from gas treatment containing dangerous substances	Yes
10	02	08	solid wastes from gas treatment other than those mentioned in 10 02 07	No
10	02	10	mill scales	No
10	02	11	wastes from cooling-water treatment containing oil	Yes

10	02	12	waste from cooling-water treatment other than those mentioned in 10 02 11	No
10	02	13	sludges and filter cakes from gas treatment containing dangerous substances	Yes
10	02	14	sludges and filter cakes from gas treatment other than those mentioned in 10 02 13	No
10	02	15	other sludges and filter cakes	No
10	02	99	wastes not otherwise specified	No
10	03	02	anode scraps	No
10	03	04	primary production slags	Yes
10	03	05	waste alumina	No
10	03	08	salt slags from secondary production	Yes
10	03	09	black drosses from secondary production	Yes
10	03	15	skimmings that are flammable or emit, upon contact with water, flammable gases in dangerous quantiti	Yes
10	03	16	skimming other than those mentioned in 10 03 15	No
10	03	17	tar-containing wastes from anode manufacture	Yes
10	03	18	carbon-containing waste from anode manufacture other than those mentioned in 10 03 17	No
10	03	19	flue-gas dust containing dangerous substances	Yes
10	03	20	flue-gas dust other than those mentioned in 10 03 19	No
10	03	21	other particulates and dust (including ball-mill dust) containing dangerous substances	Yes
10	03	22	other particulates and dust (including ball-mill dust) other than those mentioned in 10 03 21	No
10	03	23	solid wastes from gas treatment containing dangerous substances	Yes
10	03	24	solid wastes from gas treatment other than those mentioned in 10 03 23	No
10	03	25	sludges and filter cakes from gas treatment containing dangerous substances	Yes
10	03	26	sludges and filter cakes from gas treatment other than those mentioned in 10 03 25	No
10	03	27	wastes from cooling-water treatment containing oil	Yes
10	03	28	wastes from cooling-water treatment other than those mentioned in 10 03 27	No
10	03	29	waste from treatment of salt slags and black drosses containing dangerous substances	Yes
10	03	30	wastes from treatment of salt slags and black drosses other than those mentioned in 10 03 29	No
10	03	99	wastes not otherwise specified	No
10	04	01	slags from primary and secondary production	Yes
10	04	02	dross and skimmings from primary and secondary production	Yes
10	04	03	calcium arsenate	Yes
10	04	04	flue-gas dust	Yes
10	04	05	other particulates and dust	Yes
10	04	06	solid wastes from gas treatment	Yes
10	04	07	sludges and filter cakes from gas treatment	Yes
10	04	09	wastes from cooling-water treatment containing oil	Yes
10	04	10	waste from cooling-water treatment other than those mentioned in 10 04 09	No
10	04	99	wastes not otherwise specified	No
10	05	01	slags from primary and secondary production	No
10	05	03	flue-gas dust	Yes
10	05	04	other particulates and dust	No
10	05	05	solid waste from gas treatment	Yes
10	05	06	sludges and filter cakes from gas treatment	Yes
10	05	08	wastes from cooling-water treatment containing oil	Yes
10	05	09	wastes from cooling-water treatment other than those mentioned in 10 05 08	No
10	05	10	dross and skimmings that are flammable or emit, upon contact with water, flammable gases in dangerc	Yes
10	05	11	dross and skimmings other than those mentioned in 10 05 10	No
10	05	99	wastes not otherwise specified	No
10	06	01	slags from primary and secondary production	No
10	06	02	dross and skimmings from primary and secondary production	No
10	06	03	flue-gas dust	Yes
10	06	04	other particulates and dust	No
10	06	06	solid wastes from gas treatment	Yes
10	06	07	sludges and filter cakes from has treatment	Yes
10	06	09	wastes from cooling-water treatment containing oil	Yes
10	06	10	waste from cooling-water treatment other than those mentioned in 10 06 09	No
10	06	99	wastes not otherwise specified	No
10	07	01	slags from primary and secondary production	No
10	07	02	dross and skimmings from primary and secondary production	No

10	07	03	solid wastes from gas treatment	No
10	07	04	other particultes and dust	No
10	07	05	sludges and filter cakes from gas treatment	No
10	07	07	wastes from cooling-water treatment containing oil	Yes
10	07	08	wastes from cooling-water treatment other than those mentioned in 10 07 07	No
10	07	99	wastes not otherwise specified	No
10	08	04	particulates and dust	No
10	08	08	salt slag from primary and secondary production	Yes
10	08	09	other slags	No
10	08	10	dross and skimming that are flammable or emit, upon the contact with water, flammable gases in dang	Yes
10	08	11	dross and skimmings other than those mentioned in 10 08 10	No
10	08	12	tar-containing waste from anode manufacture	Yes
10	08	13	carbon-containing wastes from anode manufacture other than those mentioned in 10 08 12	No
10	08	14	anode scrap	No
10	08	15	flue-gas dust containing dangerous substances	Yes
10	08	16	flue-gas dust other than those mentioned in 10 08 15	No
10	08	17	sludges and filter cakes from flue-gas treatment containing dangerous substances	Yes
10	08	18	sludges and filter cakes from flue-gas treatment other than those mentioned in 10 08 17	No
10	08	19	wastes from cooling-water treatment containing oil	Yes
10	08	20	wastes from cooling-water treatment other than those mentioned in 10 08 19	No
10	08	99	wastes not otherwise specified	No
10	09	03	furnace slag	No
10	09	05	casting cores and moulds which have not undergone pouring containing dangerous substances	Yes
10	09	06	casting cores and moulds which have not undergone pouring other than those mentioned in 10 09 05	No
10	09	07	casting cores and moulds which have undergone pouring containing dangerous substances	Yes
10	09	08	casting cores and moulds have undergone pouring other than those mentioned in 10 09 07	No
10	09	09	flue-gas dust containing dangerous substances	Yes
10	09	10	flue-gas dust other than those mentioned in 10 09 09	No
10	09	11	other particulates containing dangerous substances	Yes
10	09	12	other particulates other than those mentioned in 10 09 11	No
10	09	13	waste binders containing dangerous substances	Yes
10	09	14	waste binders other than those mentioned in 10 09 13	No
10	09	15	waste crack-indicating agent containing dangerous substances	Yes
10	09	16	waste crack-indicating agent other than those mentioned in 10 09 15	No
10	09	99	wastes not otherwise specified	No
10	10	03	furnace slag	No
10	10	05	casting cores and moulds which have not undergone pouring, containing dangerous substances	Yes
10	10	06	casting cores and moulds which have not undergone pouring, other than those mentioned in 10 10 05	No
10	10	07	casting cores and moulds which have undergone pouring, containing dangerous substances	Yes
10	10	08	casting cores and moulds which have undergone pouring, other than those mentioned in 10 10 07	No
10	10	09	flue-gas dust containing dangerous substances	Yes
10	10	10	flue-gas dust other than those mentioned in 10 10 09	No
10	10	11	other particulates containing dangerous substances	Yes
10	10	12	other particulates other than those mentioned in 10 10 11	No
10	10	13	waste binders containing dangerous substances	Yes
10	10	14	waste binders other than those mentioned in 10 10 13	No
10	10	15	waste crack-indicating agent containing dangerous substances	Yes
10	10	16	waste crack-indicating agent other than those mentioned in 10 10 15	No
10	10	99	wastes not otherwise specified	No
10	11	03	waste glass-based fibrous materials	No
10	11	05	particulates and dust	No
10	11	09	waste preparation mixture before thermal processing, containing dangerous substances	Yes
10	11	10	waste preparation mixture before thermal processing, other than those mentioned in 10 11 9	No
10	11	11	waste glass in small particles and glass powder containing heavy metals (for example from cathode ra	Yes
10	11	12	waste glass other than those mentioned in 10 11 11	No
10	11	13	glass-polishing and -grinding sludge containing dangerous substances	Yes
10	11	14	glass-polishing and -grinding sludge other than those mentioned in 10 11 13	No
10	11	15	solid wastes from flue-gas treatment containing dangerous substances	Yes

10	11	16	solid wastes from flue-gas treatment other than those mentioned in 10 11 15	No
10	11	17	sludges and filter cakes from flue-gas treatment containing dangerous substances	Yes
10	11	18	sludges and filter cakes from flue-gas treatment other than those mentioned in 10 11 17	No
10	11	19	solid wastes from on-site effluent treatment containing dangerous substances	Yes
10	11	20	solid wastes from on-site effluent treatment other than those mentioned in 10 11 19	No
10	11	99	wastes not otherwise specified	No
10	12	01	waste preparation mixture before thermal processing	No
10	12	03	particulates and dust	No
10	12	05	sludges and filter cakes from gas treatment	No
10	12	06	discarded moulds	No
10	12	08	waste ceramics, bricks, tiles and construction products (after thermal processing)	No
10	12	09	solid wastes from gas treatment containing dangerous substances	Yes
10	12	10	solid wastes from gas treatment other than those mentioned in 10 12 09	No
10	12	11	wastes from glazing containing heavy metals	Yes
10	12	12	wastes from glazing other than those mentioned in 10 12 11	No
10	12	13	sludge from on-site effluent treatment	No
10	12	99	wastes not otherwise specified	No
10	13	01	waste preparation mixture before thermal processing	No
10	13	04	wastes from calcination and hydration of lime	No
10	13	06	particulates and dust (except 10 13 12 and 10 13 13)	No
10	13	07	sludges and filter cakes from gas treatment	No
10	13	09	wastes from asbestos-cement manufacture containing asbestos	Yes
10	13	10	wastes from asbestos-cement manufacture other than those mentioned in 10 13 09	No
10	13	11	wastes from cement-based composite materials other than those mentioned in 10 13 09 and 10 13 10	No
10	13	12	solid wastes from gas treatment containing dangerous substances	Yes
10	13	13	solid wastes from gas treatment other than those mentioned in 10 13 12	No
10	13	14	waste concrete and concrete sludge	No
10	13	99	wastes not otherwise specified	No
10	14	01	waste from gas cleaning containing mercury	Yes
11	01	05	pickling acids	Yes
11	01	06	acids not otherwise specified	Yes
11	01	07	pickling bases	Yes
11	01	08	phosphatising sludges	Yes
11	01	09	sludges and filter cakes containing dangerous substances	Yes
11	01	10	sludges and filter cakes other than those mentioned in 11 01 09	No
11	01	11	aqueous rinsing liquids containing dangerous substances	Yes
11	01	12	aqueous rinsing liquids other than those mentioned in 11 01 11	No
11	01	13	degreasing wastes containing dangerous substances	Yes
11	01	14	degreasing wastes other than those mentioned in 11 01 13	No
11	01	15	eluate and sludges from membrane systems or ion exchange systems containing dangerous substanc	Yes
11	01	16	saturated or spent ion exchange resins	Yes
11	01	98	other wastes containing dangerous substances	Yes
11	01	99	wastes not otherwise specified	No
11	02	02	sludges from zinc hydrometallurgy (including jarosite, goethite)	Yes
11	02	03	wastes from the production of anodes for aqueous electrolytical processes	No
11	02	05	wastes from copper hydrometallurgical processes containing dangerous substances	Yes
11	02	06	wastes from copper hydrometallurgical processes other than those mentioned in 11 02 05	No
11	02	07	other wastes containing dangerous substances	Yes
11	02	99	wastes not otherwise specified	No
11	03	01	waste containing cyanide	Yes
11	03	02	other wastes	Yes
11	05	01	hard zinc	No
11	05	02	zinc ash	No
11	05	03	solid wastes from gas treatment	Yes
11	05	04	spent flux	Yes
11	05	99	wastes not otherwise specified	No
12	01	01	ferrous metal filings and turnings	No
12	01	02	ferrous metal dust and particles	No

12	01	03	non-ferrous metal filings and turnings	No
12	01	04	non-ferrous metal dust and particles	No
12	01	05	plastics shavings and turnings	No
12	01	06	mineral-based machining oils containing halogens (except emulsions and solutions)	Yes
12	01	07	mineral-based machining oils free of halogens (except emulsions and solutions)	Yes
12	01	08	machining emulsions and solutions containing halogens	Yes
12	01	09	machining emulsions and solutions free of halogens	Yes
12	01	10	synthetic machining oils	Yes
12	01	12	spent waxes and fats	Yes
12	01	13	welding wastes	No
12	01	14	machining sludges containing dangerous substances	Yes
12	01	15	machining sludges other than those mentioned in 12 01 14	No
12	01	16	waste blasting material containing dangerous substances	Yes
12	01	17	waste blasting material other than those mentioned in 12 01 16	No
12	01	18	metal sludge (grinding, honing and lapping sludge) containing oil	Yes
12	01	19	readily biodegradable machining oil	Yes
12	01	20	spent grinding bodies and grinding materials containing dangerous substances	Yes
12	01	21	spent grinding bodies and grinding materials other than those mentioned in 12 01 20	No
12	01	99	wastes not otherwise specified	No
12	03	01	aqueous washing liquids	Yes
12	03	02	steam degreasing wastes	Yes
13	01	01	hydraulic oils, containing PCBs (15)	Yes
13	01	04	chlorinated emulsions	Yes
13	01	05	non-chlorinated emulsions	Yes
13	01	09	mineral-based chlorinated hydraulic oils	Yes
13	01	10	mineral-based non-chlorinated hydraulic oils	Yes
13	01	11	synthetic hydraulic oils	Yes
13	01	12	readily biodegradable hydraulic oils	Yes
13	01	13	other hydraulic oils	Yes
13	02	04	mineral-based chlorinated engine, gear and lubricating oils	Yes
13	02	05	mineral-based non-chlorinated engine, gear and lubricating oils	Yes
13	02	06	synthetic engine, gear and lubricating oils	Yes
13	02	07	readily biodegradable engine, gear and lubricating oils	Yes
13	02	08	other engine, gear and lubricating oils	Yes
13	03	01	insulating or heat transmission oils containing PCBs	Yes
13	03	06	mineral-based chlorinated insulating and heat transmission oils other than those mentioned in 13 03 01	Yes
13	03	07	mineral-based non-chlorinated insulating and heat transmission oils	Yes
13	03	08	synthetic insulating and heat transmission oils	Yes
13	03	09	readily biodegradable insulating and heat transmission oils	Yes
13	03	10	other insulating and heat transmission oils	Yes
13	04	01	bilge oils from inland navigation	Yes
13	04	02	bilge oils from jetty sewers	Yes
13	04	03	bilge oils from other navigation	Yes
13	05	01	solids from grit chambers and oil/water separators	Yes
13	05	02	sludges from oil/water separators	Yes
13	05	03	interceptor sludges	Yes
13	05	06	oil from oil/water separators	Yes
13	05	07	oily water from oil/water separators	Yes
13	05	08	mixtures of wastes from grit chambers and oil/water separators	Yes
13	07	01	fuel oil and diesel	Yes
13	07	02	petrol	Yes
13	07	03	other fuels (including mixtures)	Yes
13	08	01	desalter sludges or emulsions	Yes
13	08	02	other emulsions	Yes
13	08	99	wastes not otherwise specified	Yes
14	06	01	chlorofluorocarbons, HCFC, HFC	Yes
14	06	02	other halogenated solvents and solvent mixtures	Yes
14	06	03	other solvents and solvent mixtures	Yes

14	06	04	sludges or solid wastes containing halogenated solvents	Yes
14	06	05	sludges or solid wastes containing other solvents	Yes
15	01	01	paper and cardboard packaging	No
15	01	02	plastic packaging	No
15	01	03	wooden packaging	No
15	01	04	metallic packaging	No
15	01	05	composite packaging	No
15	01	06	mixed packaging	No
15	01	07	glass packaging	No
15	01	09	textile packaging	No
15	01	10	packaging containing residues of or contaminated by dangerous substances	Yes
15	01	11	metallic packaging containing a dangerous solid porous matrix (for example asbestos), including empty	Yes
15	02	02	absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothin	Yes
15	02	03	absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 (	No
16	01	03	end-of-life tyres	No
16	01	04	end-of-life vehicles	Yes
16	01	06	end-of-life vehicles, containing neither liquids nor other hazardous components	No
16	01	07	oil filters	Yes
16	01	08	components containing mercury	Yes
16	01	09	components containing PCBs	Yes
16	01	10	explosive components (for example air bags)	Yes
16	01	11	brake pads containing asbestos	Yes
16	01	12	brake pads other than those mentioned in 16 01 11	No
16	01	13	brake fluids	Yes
16	01	14	antifreeze fluids containing dangerous substances	Yes
16	01	15	antifreeze fluids other than those mentioned in 16 01 14	No
16	01	16	tanks for liquefied gas	No
16	01	17	ferrous metal	No
16	01	18	non-ferrous metal	No
16	01	19	plastic	No
16	01	20	glass	No
16	01	21	hazardous components other than those mentioned in 16 01 07 to 16 01 11 and 16 01 13 and 16 01 1	Yes
16	01	22	components not otherwise specified	No
16	01	99	wastes not otherwise specified	No
16	02	09	transformers and capacitors containing PCBs	Yes
16	02	10	discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09	Yes
16	02	11	discarded equipment containing chlorofluorocarbons, HCFC, HFC	Yes
16	02	12	discarded equipment containing free asbestos	Yes
16	02	13	discarded equipment containing hazardous components (16) other than those mentioned in 16 02 09 t	Yes
16	02	14	discarded equipment other than those mentioned in 16 02 09 to 16 02 13	No
16	02	15	hazardous components removed from discarded equipment	Yes
16	02	16	components removed from discarded equipment other than those mentioned in 16 02 15	No
16	03	03	inorganic wastes containing dangerous substances	Yes
16	03	04	inorganic wastes other than those mentioned in 16 03 03	No
16	03	05	organic wastes containing dangerous substances	Yes
16	03	06	organic wastes other than those mentioned in 16 03 05	No
16	04	01	waste ammunition	Yes
16	04	02	fireworks wastes	Yes
16	04	03	other waste explosives	Yes
16	05	04	gases in pressure containers (including halons) containing dangerous substances	Yes
16	05	05	gases in pressure containers other than those mentioned in 16 05 04	No
16	05	06	laboratory chemicals, consisting of or containing dangerous substances, including mixtures of laborato	Yes
16	05	07	discarded inorganic chemicals consisting of or containing dangerous substances	Yes
16	05	08	discarded organic chemicals consisting of or containing dangerous substances	Yes
16	05	09	discarded chemicals other than those mentioned in 16 05 06, 16 05 07 or 16 05 08	No
16	06	01	lead batteries	Yes
16	06	02	Ni-Cd batteries	Yes
16	06	03	mercury-containing batteries	Yes

16	06	04	alkaline batteries (except 16 06 03)	No
16	06	05	other batteries and accumulators	No
16	06	06	separately collected electrolyte from batteries and accumulators	Yes
16	07	08	wastes containing oil	Yes
16	07	09	wastes containing other dangerous substances	Yes
16	07	99	wastes not otherwise specified	No
16	08	01	spent catalysts containing gold, silver, rhenium, rhodium, palladium, iridium or platinum (except 16 08 (	No
16	08	02	spent catalysts containing dangerous transition metals (17) or dangerous transition metal compounds	Yes
16	08	03	spent catalysts containing transition metals or transition metal compounds not otherwise specified	No
16	08	04	spent fluid catalytic cracking catalysts (except 16 08 07)	No
16	08	05	spent catalysts containing phosphoric acid	Yes
16	08	06	spent liquids used as catalysts	Yes
16	08	07	spent catalysts contaminated with dangerous substances	Yes
16	09	01	permanganates, for example potassium permanganate	Yes
16	09	02	chromates, for example potassium chromate, potassium or sodium dichromate	Yes
16	09	03	peroxides, for example hydrogen peroxide	Yes
16	09	04	oxidising substances, not otherwise specified	Yes
16	10	01	aqueous liquid wastes containing dangerous substances	Yes
16	10	02	aqueous liquid wastes other than those mentioned in 16 10 01	No
16	10	03	aqueous concentrates containing dangerous substances	Yes
16	10	04	aqueous concentrates other than those mentioned in 16 10 03	No
16	11	01	carbon-based linings and refractories from metallurgical processes containing dangerous substances	Yes
16	11	02	carbon-based linings and refractories fronm metallurgical processes other than those mentioned in 16	No
16	11	03	other linings and refractories from metallurgical processes containing dangerous substances	Yes
16	11	04	other linings and refractories from metallurgical processes other than those mentioned in 16 11 03	No
16	11	05	linings and refractories from non-metallurgical processes containing dangerous substances	Yes
16	11	06	linings and refractories from non-metallurgical processes other than those mentioned in 16 11 05	No
17	01	01	concrete	No
17	01	02	bricks	No
17	01	03	tiles and ceramics	No
17	01	06	mixtures of, or separate fractions of concrete, bricks, tiles and ceramics containing dangerous substan	Yes
17	01	07	mixture of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	No
17	02	01	wood	No
17	02	02	glass	No
17	02	03	plastic	No
17	02	04	glass, plastic and wood containing or contaminated with dangerous substances	Yes
17	03	01	bituminous mixtures containing coal tar	Yes
17	03	02	bituminous mixtures containing other than those mentioned in 17 03 01	No
17	03	03	coal tar and tarred products	Yes
17	04	01	copper, bronze, brass	No
17	04	02	aluminium	No
17	04	03	lead	No
17	04	04	zinc	No
17	04	05	iron and steel	No
17	04	06	tin	No
17	04	07	mixed metals	No
17	04	09	metal waste contaminated with dangerous substances	Yes
17	04	10	cables containing oil, coal tar and other dangerous substances	Yes
17	04	11	cables other than those mentioned in 17 04 10	No
17	05	03	soil and stones containing dangerous substances	Yes
17	05	04	soil and stones other than those mentioned in 17 05 03	No
17	05	05	dredging spoil containing dangerous substances	Yes
17	05	06	dredging spoil other than those mentioned 17 05 05	No
17	05	07	track ballast containing dangerous substances	Yes
17	05	08	track ballast other than those mentioned in 17 05 07	No
17	06	01	insulation materials containing asbestos	Yes
17	06	03	other insulation materials consisting of or containing dangerous substances	Yes
17	06	04	insulation materials other than those mentioned in 17 06 01 and 17 06 03	No

17	06	05	construction materials containing asbestos (18)	Yes
17	08	01	gypsum-based construction materials contaminated with dangerous substances	Yes
17	08	02	gypsum-based construction materials other than those mentioned in 17 08 01	No
17	09	01	construction and demolition wastes containing mercury	Yes
17	09	02	construction and demolition wastes containing pcb (for example pcb-containing sealants, pcb-containir	Yes
17	09	03	other construction and demolition wastes (including mixed wastes) containing dangerous substances	Yes
17	09	04	mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09	No
18	01	01	sharps (except 18 01 03)	No
18	01	02	body parts and organs including blood bags and blood preserves (except 18 01 03)	No
18	01	03	wastes whose collection and disposal is subject to special requirements in order to prevent infection	Yes
18	01	04	wastes whose collection and disposal is not subject to special requirements in order to prevent infectio	No
18	01	06	chemicals consisting of or containing dangerous substances	Yes
18	01	07	chemicals other than those mentioned in 18 01 06	No
18	01	08	cytotoxic and cytostatic medicines	Yes
18	01	09	medicines other than those mentioned in 18 01 08	No
18	01	10	amalgam waste from dental care	Yes
18	02	01	sharps except (18 02 02)	No
18	02	02	wastes whose collection and disposal is subject to special requirements in order to prevent infection	Yes
18	02	03	wastes whose collection and disposal is not subject to special requirements in order to prevent infectio	No
18	02	05	chemicals consisting of or containing dangerous substances	Yes
18	02	06	chemicals other than those mentioned in 18 02 05	No
18	02	07	cytotoxic and cytostatic medicines	Yes
18	02	08	medicines other than those mentioned in 18 02 07	No
19	01	02	ferrous materials removed from bottom ash	No
19	01	05	filter cake from gas treatment	Yes
19	01	06	aqueous liquid wastes from gas treatment and other aqueous liquid wastes	Yes
19	01	07	solid wastes from gas treatment	Yes
19	01	10	spent activated carbon from flue-gas treatment	Yes
19	01	11	bottom ash and slag containing dangerous substances	Yes
19	01	12	bottom ash and slag other than those mentioned in 19 01 11	No
19	01	13	fly ash containing dangerous substances	Yes
19	01	14	fly ash other than those mentioned in 19 01 13	No
19	01	15	boiler dust containing dangerous substances	Yes
19	01	16	boiler dust other than those mentioned in 19 01 15	No
19	01	17	pyrolysis wastes containing dangerous substances	Yes
19	01	18	pyrolysis wastes other than those mentioned in 19 01 17	No
19	01	19	sands from fluidised beds	No
19	01	99	wastes not otherwise specified	No
19	02	03	premixed wastes composed only of non-hazardous wastes	No
19	02	04	premixed wastes composed of at least one hazardous waste	Yes
19	02	05	sludges from physico/chemical treatment containing dangerous substances	Yes
19	02	06	sludges from physico/chemical treatment other than those mentioned in 19 02 05	No
19	02	07	oil and concentrates from separation	Yes
19	02	08	liquid combustible wastes containing dangerous substances	Yes
19	02	09	solid combustible wastes containing dangerous substances	Yes
19	02	10	combustible wastes other than those mentioned in 19 02 08 and 19 02 09	No
19	02	11	other wastes containing dangerous substances	Yes
19	02	99	wastes not otherwise specified	No
19	03	04	wastes marked as hazardous, partly (20) stabilised	Yes
19	03	05	stabilised wastes other than those mentioned in 19 03 04	No
19	03	06	wastes marked as hazardous, solidified	Yes
19	03	07	solidified wastes other than those mentioned in 19 03 06	No
19	04	01	vitrified waste	No
19	04	02	fly ash and other flue-gas treatment wastes	Yes
19	04	03	non-vitrified solid phase	Yes
19	04	04	aqueous liquid wastes from vitrified waste tempering	No
19	05	01	non-composted fraction of municipal and similar wastes	No
19	05	02	non-composted fraction of animal and vegetable waste	No

19	05	03	off-specification compost	No
19	05	99	wastes not otherwise specified	No
19	06	03	liquor from anaerobic treatment of municipal waste	No
19	06	04	digestate from anaerobic treatment of municipal waste	No
19	06	05	liquor from anaerobic treatment of animal and vegetable waste	No
19	06	06	digestate from anaerobic treatment of animal and vegetable waste	No
19	06	99	wastes not otherwise specified	No
19	07	02	landfill leachate containing dangerous substances	Yes
19	07	03	landfill leachate other than those mentioned in 19 07 02	No
19	08	01	screenings	No
19	08	02	waste from desanding	No
19	08	05	sludges from treatment of urban waste water	No
19	08	06	saturated or spent ion exchange resins	Yes
19	08	07	solutions and sludges from regeneration of ion exchangers	Yes
19	08	08	membrane system waste containing heavy metals	Yes
19	08	09	grease and oil mixture from oil/water separation containing only edible oil and fats	No
19	08	10	grease and oil mixture from oil/water separation other than those mentioned in 19 08 09	Yes
19	08	11	sludges containing dangerous substances from biological treatment of industrial waste water	Yes
19	08	12	sludges from biological treatment of industrial waste water other than those mentioned in 19 08 11	No
19	08	13	sludges containing dangerous substances from other treatment of industrial waste water	Yes
19	08	14	sludges from other treatment of industrial waste water other than those mentioned in 19 08 13	No
19	08	99	wastes not otherwise specified	No
19	09	01	solid waste from primary filtration and screenings	No
19	09	02	sludges from water clarification	No
19	09	03	sludges from decarbonation	No
19	09	04	spent activated carbon	No
19	09	05	saturated or spent ion exchange resins	No
19	09	06	solutions and sludges from regeneration of ion exchangers	No
19	09	99	wastes not otherwise specified	No
19	10	01	iron and steel waste	No
19	10	02	non-ferrous waste	No
19	10	03	fluff-light fraction and dust containing dangerous substances	Yes
19	10	04	fluff-light fraction and dust other than those mentioned in 19 10 03	No
19	10	05	other fractions containing dangerous substances	Yes
19	10	06	other fractions other than those mentioned in 19 10 05	No
19	11	01	spent filter clays	Yes
19	11	02	acid tars	Yes
19	11	03	aqueous liquid wastes	Yes
19	11	04	wastes from cleaning of fuel with bases	Yes
19	11	05	sludges from on-site effluent treatment containing dangerous substances	Yes
19	11	06	sludges from on-site effluent treatment other than those mentioned in 19 11 05	No
19	11	07	wastes from flue-gas cleaning	Yes
19	11	99	wastes not otherwise specified	No
19	12	01	paper and cardboard	No
19	12	02	ferrous metal	No
19	12	03	non-ferrous metal	No
19	12	04	plastic and rubber	No
19	12	05	glass	No
19	12	06	wood containing dangerous substances	Yes
19	12	07	wood other than that mentioned in 19 12 06	No
19	12	08	textiles	No
19	12	09	minerals (for example sand, stones)	No
19	12	10	combustible waste (refuse derived fuel)	No
19	12	11	other wastes (including mixtures of materials) from mechanical treatment of waste containing dangerou	Yes
19	12	12	other wastes (including mixtures of materials) from mechanical treatment of wastes other than those m	No
19	13	01	solid wastes from soil remediation containing dangerous substances	Yes
19	13	02	solid wastes from soil remediation other than those mentioned in 19 13 01	No
19	13	03	sludges from soil remediation containing dangerous substances	Yes

19	13	04	sludges from soil remediation other than those mentioned in 19 13 03	No
19	13	05	sludges from groundwater remediation containing dangerous substances	Yes
19	13	06	sludges from groundwater remediation other than those mentioned in 19 13 05	No
19	13	07	aqueous liquid wastes and aqueous concentrates from groundwater remediation containing dangerous	Yes
19	13	08	aqueous liquid wastes and aqueous concentrates from groundwater remediation other than those men	No
20	01	01	paper and cardboard	No
20	01	02	glass	No
20	01	08	biodegradable kitchen and canteen waste	No
20	01	10	clothes	No
20	01	11	textiles	No
20	01	13	solvents	Yes
20	01	14	acids	Yes
20	01	15	alkalines	Yes
20	01	17	photochemicals	Yes
20	01	19	pesticides	Yes
20	01	21	fluorescent tubes and other mercury-containing waste	Yes
20	01	23	discarded equipment containing chlorofluorocarbons	Yes
20	01	25	edible oil and fat	No
20	01	26	oil and fat other than those mentioned in 20 01 25	Yes
20	01	27	paint, inks, adhesives and resins containing dangerous substances	Yes
20	01	28	paint, inks, adhesives and resins other than those mentioned in 20 01 27	No
20	01	29	detergents containing dangerous substances	Yes
20	01	30	detergents other than those mentioned in 20 01 29	No
20	01	31	cytotoxic and cytostatic medicines	Yes
20	01	32	medicines other than those mentioned in 20 01 31	No
20	01	33	batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accu	Yes
20	01	34	batteries and accumulators other than those mentioned in 20 01 33	No
20	01	35	discarded electrical and electronic equipment other than those mentioned in 20 01 21 and and 20 01 2	Yes
20	01	36	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20	No
20	01	37	wood containing dangerous substances	Yes
20	01	38	wood other than that mentioned in 20 01 37	No
20	01	39	plastics	No
20	01	40	metals	No
20	01	41	wastes from chimney sweeping	No
20	01	99	other fractions not otherwise specified	No
20	02	01	biodegradable waste	No
20	02	02	soil and stones	No
20	02	03	other non-biodegradable wastes	No
20	03	01	mixed municipal waste	No
20	03	02	waste from markets	No
20	03	03	street-cleaning residues	No
20	03	04	septic tank sludge	No
20	03	06	waste from sewage cleaning	No
20	03	07	bulky waste	No
20	03	99	municipal wastes not otherwise specified	No

RD_Code	RD_Description	RD_Type
D1	Deposit into or onto land (e.g. landfill etc)	Disposal
D10	Incineration on land	Disposal
D11	Incineration at sea	Disposal
D12	Permanent storage (e.g., emplacement of containers in a mine, etc.)	Disposal
D13	Blending or mixing prior to submission to any of the operations numbered D1 to D12	Disposal
D14	Repackaging prior to submission to any of the operations numbered D1 to D13	Disposal
D15	Storage pending any of the operations numbered D1 to D14 (excluding temporary storage, pending co	Disposal
D2	Land treatment (e.g. biodegradation of liquid or sludgy discards in soils, etc.)	Disposal
D3	Deep injection (e.g. injection of pumpable discards into wells, salt domes or naturally occurring reposit	Disposal
D4	Surface impoundment (e.g. placement of liquid or sludge discards into pits, ponds or lagoons etc.)	Disposal
D5	Specially engineered landfill (e.g. placement into lined discrete cells which are capped and isolated fro	Disposal
D6	Release into a water body except seas/oceans	Disposal
D7	Release into seas/oceans including sea-bed insertion	Disposal
D8	Biological treatment not specified elsewhere in this list which results in final compounds or mixtures wl	Disposal
D9	Physico chemical treatment not specified elsewhere in this list which results in final compounds or mix	Disposal
R1	Use principally as a fuel or other means to generate energy	Recovery
R10	Land treatment resulting in benefit to agriculture or ecological improvement	Recovery
R11	Uses of wastes obtained from any of the operations numbered R1 to R10	Recovery
R12	Exchange of wastes for submission to any of the operations numbered R1 to R11	Recovery
R13	Accumulation of material intended for any operation numbered R1 to R12 (excluding temporary storag	Recovery
R2	Solvent reclamation/regeneration	Recovery
R3	Recycling/reclamation of organic substances which are not used as solvents (including composting an	Recovery
R4	Recycling/reclamation of metals and metal compounds	Recovery
R5	Recycling/reclamation of other inorganic materials	Recovery
R6	Regeneration of acids or bases	Recovery
R7	Recovery of components used for pollution abatement	Recovery
R8	Recovery of components from catalysts	Recovery
R9	Used oil re-refining or other reuses of oil	Recovery

Methods used for determination of releases to air, water, waste water or sewer: Method Identification Codes			
See also the relevant sections of EPA AER Guidance Document and EPA Guidance Note Annex on AER / PRTR Reporting			
For each parameter, where this applies…	Please enter **Method Category (M/C/E)**, **Method Code** and **Method Designation or Description** according to this table.		
Category of Method Used	**M/C/E**	**Method Used**	
		[Method Code]	**Designation or Description**
Measurement methodologies **If you used…**	**Then please enter…**		
Internationally approved measurement standard	**M**	**short designation of the relevant standard (e.g. EN 14385:2004)**	**Leave this cell blank**
Measurement methodology already prescribed by the competent authority in a licence or an operating permit for that facility	**M**	**PER**	**Enter brief description of method you used**
National or regional binding measurement methodology prescribed by legal act for the pollutant and facility concerned	**M**	**NRB**	**Enter brief description of method you used**
Alternative measurement method in accordance with existing CEN/ISO measurement standards	**M**	**ALT**	**Enter brief description of method you used**
Measurement methodology the performance of which is demonstrated by means of certified reference materials and accepted by competent authority	**M**	**CRM**	**Enter brief description of method you used**
Other measurement methodology	**M**	**OTH**	**Enter brief description of method you used**
Calculation methodologies **If you used…**	**Then please enter…**		
Internationally approved calculation method	**C**	**short designation of the method used: ETS, IPCC, UNECE/EMEP**	**Leave this cell blank**
Calculation methodology already prescribed by the competent authority in a licence or an operating permit for that facility	**C**	**PER**	**Enter brief description of method you used**
National or regional binding calculation methodology prescribed by lega act for the pollutant and facility concerned	**C**	**NRB**	**Enter brief description of method you used**
Mass balance method which is accepted by the competent authority	**C**	**MAB**	**Enter brief description of method you used**
European-wide sector specific calculation method	**C**	**SSC**	**Enter brief description of method you used**
Other calculation methodology	**C**	**OTH**	**Enter brief description of method you used**
Estimation methodologies **If you used…**	**Then please enter…**		

A non-standardised estimation procedure	**E**	**ESTIMATE**	**Leave this cell blank, but please ensure that you enter a brief description of method you used for this estimation as a footnote in your paper AER**

"**E**" and **"ESTIMATE"** are used when the releases are determined by best assumptions or expert guesses that are not based on publicly available references or in case of absence of recognised emission estimation methodologies or good practice guidelines.

Completed Example: this example illustrates how the information should be entered for a representative case

Releases to air						
Pollutant		Method			Quantity	
No. Annex II	Name	M/C/E	Method used		T (total) (kg/year)	A (accidental) kg/year
			Code	Designation or description		
1	CH_4	**C**	**NRB**	regional binding measurement methodology using specific gas chromatography	125,000	0
3	CO_2	**C**	**ETS**		244,000,000	0
14	HCFCs	**E**	**ESTIMATE**		1.28	1.28
18	Cd	**M**	**EN 14385:2004**		12.5	0
72	PAH	**M**	**NRB**	**VDI 3873**	122	0

Method Codes
M
C
E

Lookups Configured
Y

Water Types
Freshwater
Seawater
Estuary

Transfer Destination
Within the Country
To Other Countries

Waste Treatment Operation
Recovery
Disposal

Waste Method Used
Weighed
Volume Calculation

Treatment Location
Onsite in Ireland
Offsite in Ireland
Abroad

Yes/No
Yes
No

Country
Afghanistan
Åland Islands
Albania
Algeria
American Samoa
Andorra
Angola
Anguilla
Antarctica
Antigua and Barbuda
Argentina
Armenia
Aruba
Australia
Austria
Azerbaijan
Bahamas
Bahrain
Bangladesh
Barbados
Belarus
Belgium
Belize
Benin

Bermuda
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Bouvet Island
Brazil
British Indian Ocean Territory
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Canada
Cape Verde
Cayman Islands
Central African Republic
Chad
Chile
China
Christmas Island
Cocos (Keeling) Islands
Colombia
Comoros
Congo
Congo the Democratic Republic of the
Cook Islands
Costa Rica
Côte d'Ivoire
Croatia
Cuba
Cyprus
Czech Republic
Denmark
Djibouti
Dominica
Dominican Republic
Ecuador
Egypt
El Salvador
Equatorial Guinea
Eritrea
Estonia
Ethiopia
Falkland Islands (Malvinas)
Faroe Islands
Fiji
Finland
France
French Guiana
French Polynesia
French Southern Territories
Gabon
Gambia

Georgia
Germany
Ghana
Gibraltar
Greece
Greece
Greenland
Grenada
Guadeloupe
Guam
Guatemala
Guernsey
Guinea
Guinea-Bissau
Guyana
Haiti
Heard Island and McDonald Islands
Holy See (Vatican City State)
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Iran Islamic Republic of
Iraq
Ireland
Isle Of Man
Israel
Italy
Jamaica
Japan
Jersey
Jordan
Kazakhstan
Kenya
Kiribati
Korea Democratic People's Republic of
Korea Republic of
Kuwait
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Lesotho
Liberia
Libyan Arab Jamahiriya
Liechtenstein
Lithuania
Luxembourg
Macao
Macedonia the Former Yugoslav Republic of

Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Marshall Islands
Martinique
Mauritania
Mauritius
Mayotte
Mexico
Micronesia Federated States of
Moldova Republic of
Monaco
Mongolia
Montenegro
Montserrat
Morocco
Mozambique
Myanmar
Namibia
Nauru
Nepal
Netherlands
Netherlands Antilles
New Caledonia
New Zealand
Nicaragua
Niger
Nigeria
Niue
Norfolk Island
Northern Mariana Islands
Norway
Oman
Pakistan
Palau
Palestinian Territory Occupied
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Pitcairn
Poland
Portugal
Puerto Rico
Qatar
Reunion
Romania
Russian Federation
Rwanda
Saint Barthélemy
Saint Helena

Saint Kitts and Nevis
Saint Lucia
Saint Martin
Saint Pierre and Miquelon
Saint Vincent and the Grenadines
Samoa
San Marino
Sao Tome and Principe
Saudi Arabia
Senegal
Serbia
Seychelles
Sierra Leone
Singapore
Slovakia
Slovenia
Solomon Islands
Somalia
South Africa
South Georgia and the South Sandwich Islands
Spain
Sri Lanka
Sudan
Suriname
Svalbard and Jan Mayen
Swaziland
Sweden
Switzerland
Syrian Arab Republic
Taiwan Province of China
Tajikistan
Tanzania United Republic of
Thailand
Timor-Leste
Togo
Tokelau
Tonga
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
Turks and Caicos Islands
Tuvalu
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
United States Minor Outlying Islands
Uruguay
Uzbekistan
Vanuatu
Venezuela

Viet Nam
Virgin Islands British
Virgin Islands U.S.
Wallis and Futuna
Western Sahara
Yemen
Zambia
Zimbabwe

Please enter details below then click the OK button

Name of Recoverer / Disposer / Next Destination Facility	KMK Metals Lts
Licence / Permit No. of Recoverer / Disposer / Next Destination Facility	W0133-03
Address of Recoverer / Disposer / Next Destination Facility	
Address 1 / Street name	Cappincur Industrial Estate
Address 2 / Building number	"."
Address 3 / City name	Tullamore
Address 4 / Postcode	Co Offaly
Country	Ireland

Alternatively, please select from previously entered details by clicking on the row below then click OK

Name and License / Permit No.	Address of Recoverer / Disposer / Broker
Cork County Council,W0068-02	Foxhole,".",Youghal,Co Cork,Ireland
Veolia Ltd,W0173-01	Forge Hill,Kinsale Rd,Cork,".",Ireland
greenstar Ltd,W0136-02	Sarsfield Court Industrial Estate,".",Glanmire,Co Cork,Ireland
Mr Binman,W0061-01	Luddenmore,Grange,Kilmallock,Co Limerick,Ireland
MSM Recycling Ltd,W0079-01	Cookstown Industrial Estate,41,Tallaght,Co Dublin,Ireland
Pouladuff Dismantlers Ltd,CK/058	Pouladuff Rd,Togher,Cork,".",Ireland
Green Dragon Recycling Ltd,CK/0	Corbally North,".",Glanmire,Co Cork,Ireland
CTO Environmental Solutions Ltd,	Kinsale Rd Landfill,South City Link Rd,Cork,".",Ireland
KMK Metals Ltd,W0133-03	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland
Enva Ltd,W0184-01	Clonminam Industrial Estate,".",Portlaoise,Co Laois,Ireland
Enva Ltd,W0184-01	Clonminam Industrial Estate,".",Portlaois,Co Laois,Ireland
KMK Metals Ltd,W133-03	Cappincur indistrial Estate,".",Tullamore,Co Offaly,Ireland
KMK Metals Ltd ,W0133-03	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland
KMK Metals Lts,W0133-03	Cappincur Industrial Estate,".",Tullamore,Co Offaly,Ireland