Bohernabreena Landfill

Environmental Risk Assessment (Appendices)

November 2019





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Bohernabreena Landfill

Environmental Risk Assessment

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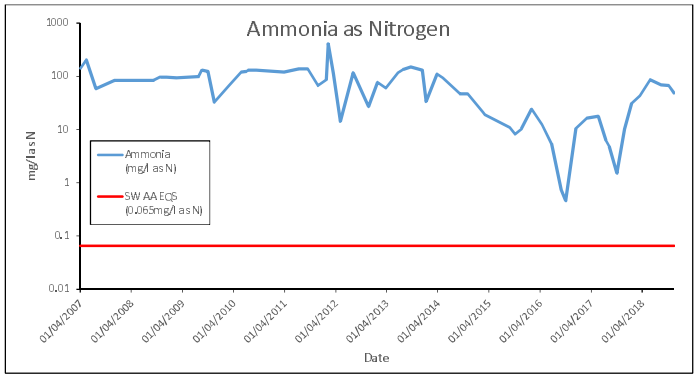
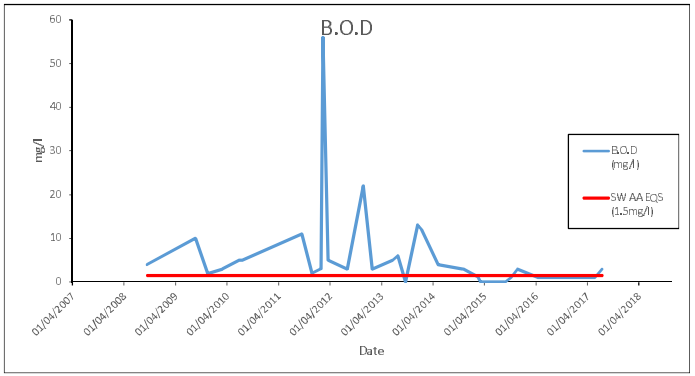
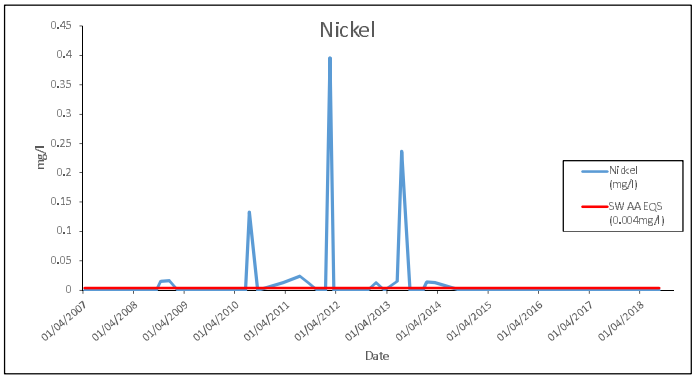
APPENDIX A

SDCC BOHERNABREENA LEACHATE DATA

Sampled Date	Date	Ammonia (mg/l as N)	SW AA EQS (2009 & 2015) (mg/l as N)	B.O.D (mg/l)	B.O.D (with assumptions)	SW AA EQS (2009 & 2015) (mg/l)	Nickel (mg/l)	Nickel (with assumptions)	SW AA EQS (2009 & 2015) (mg/l)
04/04/2007 10:00	04/04/2007	141.2	0.065			1.5	< 0.012	0	0.004
15/05/2007 10:30	15/05/2007	204.27	0.065			1.5			0.004
24/07/2007 10:45	24/07/2007	58.17	0.065			1.5	< 0.012	0	0.004
04/12/2007 11:30	04/12/2007	83.9	0.065			1.5			0.004
14/04/2008 10:15	14/04/2008		0.065			1.5	< 0.012	0	0.004
21/07/2008 11:10	21/07/2008		0.065			1.5	0.032		0.004
11/09/2008 09:45	11/09/2008	83.35	0.065	4	4	1.5	< 0.012	0	0.004
28/10/2008 09:40	28/10/2008	96.29	0.065			1.5	0.015	0.015	0.004
12/12/2008 09:30	12/12/2008	95.88	0.065			1.5	0.016	0.016	0.004
19/02/2009 12:10	19/02/2009	92.2	0.065			1.5	< 0.012	0	0.004
29/07/2009 10:00	29/07/2009	98.81	0.065			1.5			0.004
19/08/2009 11:15	19/08/2009	129.9	0.065	10	10	1.5	< 0.012	0	0.004
28/09/2009 10:35	28/09/2009	124.4	0.065			1.5	< 0.012	0	0.004
13/11/2009 10:20	13/11/2009	32.92	0.065	2	2	1.5	< 0.012	0	0.004
26/02/2010 10:20	26/02/2010	67.86	0.065	3	3	1.5	< 0.012	0	0.004
26/05/2010 12:05	26/05/2010	118.19	0.065			1.5	< 0.012	0	0.004
30/06/2010 12:00	30/06/2010	122.67	0.065	5	5	1.5	<0.012	0	0.004
16/07/2010 09:35	16/07/2010	130.54	0.065	5	5	1.5	0.133	0.133	0.004
13/09/2010 10:45	13/09/2010	129.36	0.065			1.5	< 0.012	0	0.004
28/03/2011 11:50	28/03/2011	120.52	0.065			1.5	0.013	0.013	0.004
12/07/2011 11:15	12/07/2011	137.06	0.065			1.5	0.024	0.024	0.004
14/09/2011 10:20	14/09/2011	137.84	0.065	11	11	1.5	0.012	0.012	0.004
24/11/2011 10:55	24/11/2011	66.58	0.065	2	2	1.5	< 0.012	0	0.004
25/01/2012 11:45	25/01/2012	86.46	0.065	3	3	1.5	< 0.012	0	0.004
09/02/2012 09:05	09/02/2012	411.29	0.065	56	56	1.5	0.396	0.396	0.004
15/03/2012 11:00	15/03/2012	112.17	0.065	5	5	1.5	< 0.012	0	0.004
02/05/2012 11:30	02/05/2012	14.37	0.065			1.5	< 0.012	0	0.004
02/08/2012 10:35	02/08/2012	117.96	0.065	3	3	1.5	< 0.012	0	0.004
23/11/2012 10:50	23/11/2012	27.04	0.065	22	22	1.5	< 0.012	0	0.004
23/01/2013 11:35	23/01/2013	77.59	0.065	3	3	1.5	0.013	0.013	0.004
25/03/2013 12:00	25/03/2013	59.23	0.065			1.5	< 0.012	0	0.004
21/06/2013 09:45	21/06/2013	116.36	0.065	5	5	1.5	0.015	0.015	0.004
26/07/2013 10:50	26/07/2013	134.24	0.065	6	6	1.5	0.236	0.236	0.004
19/09/2013 09:25	19/09/2013	149.62	0.065	<1	0	1.5	< 0.012	0	0.004
12/12/2013 11:20	12/12/2013	129.73	0.065	13	13	1.5	< 0.012	0	0.004
09/01/2014 09:45	09/01/2014	33.24	0.065	12	12	1.5	0.014	0.014	0.004
24/03/2014 11:40	24/03/2014	109.43	0.065			1.5	0.013	0.013	0.004
08/05/2014 10:55	08/05/2014	93.74	0.065	4	4	1.5			0.004
08/09/2014 11:55	08/09/2014	47.03	0.065			1.5	< 0.012	0	0.004
31/10/2014 10:00	31/10/2014	46.47	0.065	3	3	1.5	< 0.012	0	0.004
18/02/2015 09:25	18/02/2015	21.18	0.065	1	1	1.5	< 0.012	0	0.004
06/03/2015 12:00	06/03/2015	18.73	0.065	<1	0	1.5	< 0.012	0	0.004
28/08/2015 11:15	28/08/2015	10.85	0.065	<1	0	1.5	< 0.012	0	0.004
07/10/2015 12:20	07/10/2015	8.09	0.065	1	1	1.5	< 0.012	0	0.004
20/11/2015 11:45	20/11/2015	10.18	0.065	3	3	1.5	< 0.012	0	0.004
02/02/2016 10:30	02/02/2016	24.15	0.065			1.5	< 0.012	0	0.004
13/04/2016 10:50	13/04/2016	12.29	0.065	1	1	1.5	< 0.012	0	0.004
23/06/2016 11:20	23/06/2016	5.38	0.065	1	1	1.5	< 0.012	0	0.004
29/08/2016 11:15	29/08/2016	0.73	0.065			1.5	< 0.012	0	0.004
03/10/2016 11:30	03/10/2016	0.46	0.065			1.5	< 0.012	0	0.004
12/12/2016 10:40	12/12/2016	10.45	0.065			1.5	< 0.012	0	0.004
27/02/2017 09:50	27/02/2017	16.31	0.065			1.5	< 0.012	0	0.004
24/05/2017 11:40	24/05/2017	17.61	0.065	1	1	1.5	< 0.012	0	0.004
14/07/2017 10:00	14/07/2017	6.19	0.065	3	3	1.5			0.004
08/08/2017 11:55	08/08/2017	4.77	0.065			1.5	< 0.012	0	0.004
03/10/2017 12:00	03/10/2017	1.53	0.065			1.5	< 0.012	0	0.004
28/11/2017 11:10	28/11/2017	10.3	0.065			1.5	< 0.012	0	0.004
16/01/2018 11:10	16/01/2018	30.45	0.065			1.5	< 0.012	0	0.004
15/03/2018 11:35	15/03/2018	42.73	0.065	5	5	1.5	< 0.012	0	0.004
29/05/2018 09:40	29/05/2018	86.62	0.065			1.5	< 0.012	0	0.004
13/08/2018 10:55	13/08/2018	69.2	0.065			1.5	< 0.012	0	0.004
09/10/2018 11:00	09/10/2018	67.37	0.065			1.5			0.004
16/11/2018 09:10	16/11/2018	47.42	0.065			1.5			0.004







APPENDIX B

FRIARSTOWN LANDFILL ENVIRONMENTAL REPORTS

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ENVIRONMENTAL ASSESSMENT OF THE QUALITY OF GROUNDWATERS AT THE FRIARSTOWN LANDFILL SITE AT BOHERNABREENA, CO. DUBLIN.

For the Attention of: Mr. Joseph Bockarie
South Dublin County Council
Town Hall,
Tallaght,
Dublin 24

Prepared by: Mr. Jason Smyth
Environmental Scientist

Reviewed by: Mr. Peter Coogan
Environmental Team Leader

Report No: ECS5038

Monitoring Date: 06th December 2014

Reporting Date: March 2014

Executive Summary

At the request of South Dublin County Council, Anua Environmental was commissioned to perform sampling and analysis of groundwater's and leachate at the Friarstown Landfill. The site was subsequently visited by Anua Environmental Scientists on the 06th of December 2014 and groundwater samples were returned to the laboratory for subsequent analysis.

Groundwater results are compared to the *"European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No.9 of 2010)"* Groundwater Threshold Values (GTV's) and alternatively to the EPA Interim Guideline Values (IGV's) as detailed in the EPA report *"Towards setting Guideline Values for the Protection of Groundwater in Ireland"* where limits are not specified for certain parameters in S.I. No.9 of 2010 Regulations.

Groundwater sample were obtained from three boreholes (MW–10A MW–12R and MW–14RB) at the Friarstown Landfill during this monitoring event. In general, the readings at each location are similar to those levels observed in previous monitoring events (see trended graphs in Appendix 1).

MW–10A is located at the south western end of the Friarstown Landfill site. In keeping with previous trends, this monitoring well was found to exceed the IGV limits and/or European Communities Environmental Objectives (Groundwater) Regulations, 2010 for Conductivity (1,265µS/cm) and Potassium (20mg/l). Historical trended data displays exceedences of GTV and IGV levels in previous monitoring events. The Manganese concentration has decreased (866µg/l→<2µg/l) since the previous monitoring event and is now below IGV limit of 50µg/l. All remaining parameters were within their respective limit values.

MW–12R is located at the eastern side of landfill, beside Friarstown House. Chloride (45µg/l) and Arsenic (8µg/l) were both found to be above their respective IGV limit. A number of parameters have seen their concentration increase since the last monitoring event in June 2013 these include Iron (<0.1mg/l→1.1mg/l), Manganese (3868µg/l→9929µg/l) and Potassium (4.9µg/l→6.8µg/l) and were all found to be above their respective IGV limits. This represents an increase since the previous monitoring event of June 2013. Ammonia (0.8mg/l→0.52mg/l) has seen a decrease in concentration since the previous monitoring event of June 2013 however the result was still found to be above its GTV limit of 0.136mg/l and IGV limit of 0.12mg/l. All remaining parameters were within their respective limit values.

MW–14RB is located in a field north of the landfill site. Nitrite (0.32mg/l) was found to be above its GTV limit of 0.11mg/l and IGV limit of 0.03mg/l. This represents an increase since the previous monitoring event of November 2013 (<0.03mg/l). Manganese (<2µg/l → 60µg/l) concentration increased since the last monitoring event and was found to be above its IGV limits of 50g/l. All remaining parameters were within their respective limit values.

Respectively Submitted,

Mr. Jason Smyth
Environmental Scientist

Mr. Peter Coogan
Environmental Team Leader

1.0 INTRODUCTION

At the request of South Dublin County Council, Anua Environmental was commissioned to perform sampling and analysis of groundwaters and Leachate at the Friarstown Landfill. The site was subsequently visited by an Anua Environmental Scientist on the 6th of December 2014 and groundwater samples were returned to the laboratory for subsequent analysis.

This report details the groundwater sampling that was carried out, including the sampling and analytical methods used. In addition, a commentary on the results obtained is included.

A total of nineteen groundwater monitoring boreholes are located at the Friarstown Landfill site. Nine of these were required to be monitored. During this monitoring event (December 2014) a total of three groundwater samples were extracted as the remainder boreholes were dry, blocked or contained insufficient volume

2.0 METHODOLOGY

2.1 Groundwater Sampling

Samples of Groundwater were extracted in accordance with the following standards;

TABLE 2.1 SAMPLING PROCEDURE AND GUIDANCE

ISO Standard	Description
ISO 5667–1–2006	*Guidance on the design of sampling programmes and sampling techniques*
ISO 5667–3–2012	*Guidance on sample preservation and handling*
ISO 5667–14–1998	*Guidance on quality assurance of environmental sampling & handling*
ISO 5667–11–2009	*Guidance on sampling groundwater's*

Sampling was conducted in strict accordance with Anua Environmental recognised Standard Operations Procedures (SOP) TS–W–01. All samples were returned to the laboratory, and stored between 1–8°C.

2.2 Sampling Locations

TABLE 2.2: LOCATION OF GROUNDWATER MONITORING BOREHOLES	
Borehole ID	**Location**
MW–6RA	North western end of landfill
MW–6RB	North western end of landfill
MW–8B	Western side of the landfill, beside the River Dodder
MW–8A	Western side of the landfill, beside the River Dodder
MW–9	Western side of main landfill body
MW–9R	Western side of main landfill body
MW–10C	South western end of main landfill body
MW–10B	South western end of main landfill body
MW–10A	South western end of main landfill body
MW–11	Southern end of main landfill body
MW–11R	Southern end of main landfill body
MW–12	Eastern side of landfill, beside Friarstown House
MW–12R	Eastern side of landfill, beside Friarstown House
MW–13	Beside the landfill gas electricity station
MW–13R	Beside the landfill gas electricity station
MW–14	Northern end of the landfill
MW–14RA	Northern end of the landfill
MW–14RB	Northern end of the landfill
LGW4R	Main landfill body

3.0 RESULTS

The results of the investigation carried out by Anua Environmental are presented as follows:

Table 3.1 Weather Data from Met Eireann – Casement
Table 3.2: Results of field measurements taken at each groundwater monitoring borehole.
Table 3.3: Results of chemical analysis of groundwater samples.
Table 3.4: Results of metal scan of groundwater samples.

TABLE 3.1: WEATHER DATA FROM MET EIREANN – CASEMENT

Date	Rainfall (mm)	Max Temp. (^{0}C)	Min Temp. (^{0}C)
02/12/2014	0	6.4	-0.3
03/12/2014	0	6.5	-0.8
04/12/2014	0.6	7.0	1.4
05/12/2014	0.3	5	1.3
06/12/2014	0.1	9.6	1.8
	Total 1.0	***Average 6.9***	***Average 0.68***

TABLE 3.2: RESULTS OF FIELD MEASUREMENTS TAKEN AT EACH GROUNDWATER MONITORING BOREHOLE

Borehole ID	Depth (m)	Static Water Level (m)	Volume Evacuated(l)	Temperature (^{o}C)	Conductivity (µS/cm)
MW–10A	13.98	10.04	15	9.1	1142
MW–10B	15.57	15.55	Dry	-	-
MW –11	3.95	3.95	Dry	-	-
MW –11R	12.44	-	Dry	-	-
MW –12	3.18	318	Dry	-	-
MW –12R	8.47	5.86	112	11.0	563
MW –13	3.23	2.63	Dry	-	-
MW –13R	22.0	-	Dry	-	-
MW–14RB	8.17	4.12	12	10.4	532

3.1 Groundwater Results

TABLE 3.3: RESULTS OF CHEMICAL ANALYSIS OF GROUNDWATER SAMPLES					
Parameter	***IGV*** *Note2*	***GTV*** *Note1*	**MW–10A**	**MW–12R**	**MW–14RB**
pH (units)	***≥ 6.5 ≤ 9.5***	***6.5–9.5***	8.2	7.2	7.5
Temperature (°C)	***25***	**–**	9.1	11.0	10.4
Odour	**–**	**–**	None	Faint	Faint
Visual	**–**	**–**	Pale Yellow, Some SS	Clear, High SS	Brown, Some SS
Conductivity (µS/cm)	***1,000***	***800–1,875***	**1265**	721	643
Ammonia as N (mg/l)	***0.12****	***0.05–0.136****	<0.02	**0.52**	<0.02
BOD (mg/l)	**–**	**–**	<2	<2	<2
COD (mg/l)	**–**	**–**	<10	23	<10
TOC (mg/l)	***No abnormal change***	**–**	11	8.5	<5
Chloride (mg/l)	***30***	***24 – 187.5***	30	**45**	19
Nitrate as N (mg/l)	***5.65****	***8.47****	<0.04	<0.04	3
Nitrite (mg/l)	***0.03****	***0.11****	<0.03	<0.3	**0.32**
TON (mg/l)	***No abnormal change***	**–**	1.7	<0.2	3.1
Sulphate (mg/l)	***200***	***187.5***	7.1	3.9	12
Total Alkalinity (mg/l) $CaCO_3$	***No abnormal change***	**–**	632	237	308
Total Dissolved Solids (mg/l)	***1,000***	**–**	770	420	394

Notes:

Note 1: Guide Values refers to EPA Guideline Values for the Protection of Groundwater in Ireland, IGV = Interim Guideline Value. Note these standards are presented for guideline purposes only, therefore, due care should be exercised in cross–referencing these standards with the groundwater results obtained

Note 2: GTV = Groundwater Threshold Values refers to "*European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010*)". "Threshold Values" have been established for pollutants that are causing a risk to groundwater bodies. Exceedance of a relevant threshold value at a representative monitoring point triggers further investigation to confirm whether the criteria for poor groundwater chemical status are being met.

*: Converted GTV for Ammonia as N mg/l, Nitrate as N mg/l and Nitrite as N mg/l.

< Indicates less than the laboratory detection limit

Results highlighted in bold represent results in exceedence of their respective limits

TABLE 3.4: RESULTS OF METAL ANALYSIS OF GROUNDWATER SAMPLES					
Parameter	***IGV*** [Note1]	***GTV*** [Not2]	**MW–10A**	**MW–12R**	**MW–14RB**
Sodium (mg/l)	***150***	***150***	13	37	4.6
Magnesium (mg/l)	***50***	**–**	4.6	11	4
Potassium (mg/l)	***5***	**–**	**20**	**6.8**	0.6
Calcium (mg/l)	***200***	**–**	60	119	164
Chromium (µg/l)	***30***	***37.5***	<2	<2	<2
Nickel (µg/l)	***20***	***15***	<2	6	2
Copper (µg/l)	***30***	***1,500***	<2	<2	<2
Zinc (µg/l)	***100***	***100***	16	33	25
Cadmium (µg/l)	***5***	***3.75***	<2	<2	<2
Lead (µg/l)	***10***	***18.75***	<2	<2	<2
Mercury (µg/l)	***1.0***	***0.75***	<1	<1	<1
Boron (µg/l)	***1,000***	***750***	12	<2	19
Arsenic (µg/l)	***10***	***7.5***	<2	**8**	5
Silver (µg/l)	**–**	**–**	<2	<2	<2
Aluminium (µg/l)	***200***	***150***	3	14	7
Berylium (µg/l)	**–**	**–**	<2	<2	<2
Barium (µg/l)	***100***	**–**	10	<2	18
Cobalt (µg/l)	**–**	**–**	<2	3	<2
Antimony (µg/l)	**–**	**–**	<2	<2	<2
Selenium (µg/l)	**–**	**–**	<2	<2	<2
Tin (µg/l)	**–**	**–**	<2	<2	<2
Iron (mg/l)	***0.2***	**–**	<0.1	**1.1**	<0.1
Cyanide (mg/l)	***10***	***37.5***	<0.01	<0.01	<0.01
Manganese (µg/l)	***50***	**–**	2	**9929**	**60**

Notes:
Note 1: Guide Values refers to EPA Guideline Values for the Protection of Groundwater in Ireland, IGV = Interim Guideline Value. Note these standards are presented for guideline purposes only, therefore, due care should be exercised in cross–referencing these standards with the groundwater results obtained

Note 2: GTV = Groundwater Threshold Values refers to "*European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010*)". "Threshold Values" have been established for pollutants that are causing a risk to groundwater bodies. Exceedance of a relevant threshold value at a representative monitoring point triggers further investigation to confirm whether the criteria for poor groundwater chemical status are being met.

<: Indicates less than the laboratory detection limit.

Results highlighted in bold represent results in exceedence of their respective limits.

4.0 DISCUSSION

Three groundwater samples were extracted at the Friarstown landfill site at boreholes MW–10A, MW-12R and MW–14RB. The remaining wells were unable to be sampled as they were dry, blocked or contained insufficient volume, as shown in Table 4.2.

The parameters analysed are compared to the *"European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No.9 of 2010) Groundwater Threshold Values (GTV's)"* and alternatively to the EPA "Interim Guideline Values (IGV's) as detailed in the EPA report *"Towards setting Guideline Values for the Protection of Groundwater in Ireland"* where limits are not specified for certain parameters in S.I. No.9 of 2010 regulations.

MW–10A is located at the south western end of the Friarstown Landfill site. In keeping with previous trends, this monitoring well was found to exceed the IGV limits and/or European Communities Environmental Objectives (Groundwater) Regulations, 2010 for parameters as follows:

Conductivity → 1,265µS/cm above the IGV of 1000 µS/cm however below the GTV of 1875µS/cm. Potassium (20mg/l) above its guideline limit of 5mg/l.

Historical trended data displays exceedences of GTV and IGV levels in previous monitoring events (see Appendix 1) for most of the fore mentioned parameters. A number of parameters have seen their concentration decrease since the last monitoring event:

- Ammonia (47mg/l→<0.02mg/l),
- Chloride (49mg/l→30mg/l),
- Sulphate (31mg/l→7.1mg/l),
- Manganese (866µg/l→2µg/l),
- Calcium (237mg/l→60mg/l),
- Nickel (45µg/l→<2 µg/l),
- Barium (406µg/l→10 µg/l)
- Iron (0.49mg/l→<0.1mg/l).

All remaining parameters were within their respective limit values.

MW–12R is located at the eastern side of landfill, beside Friarstown House.
Ammonia (0.8mg/l→0.52mg/l) has seen a decrease in concentration since the previous monitoring event of June 2013, however the result was still found to be above its GTV limit of 0.136mg/l.
Chloride (45mg/l) was found to be above its IGV limit of 30mg/l however below the GTV limit of 187.5µg/l.
Arsenic (8µg/l) was found to be above its GTV limit of 7.5µg/l however below the IGV limit of 10µg/l.
Manganese (3868µg/l→9929µg/l) above the limit of 50µg/l and is the highest concentration detected at this borehole to date.

A number of parameters have seen their concentration increase since the last monitoring event in June 2013:

- Iron (<0.1mg/l→1.1mg/l) above the limit of 0.2mg/l,
- Potassium (4.9µg/l→6.8µg/l) above the limit of 5 mg/l,

All remaining parameters were within their respective limit values.

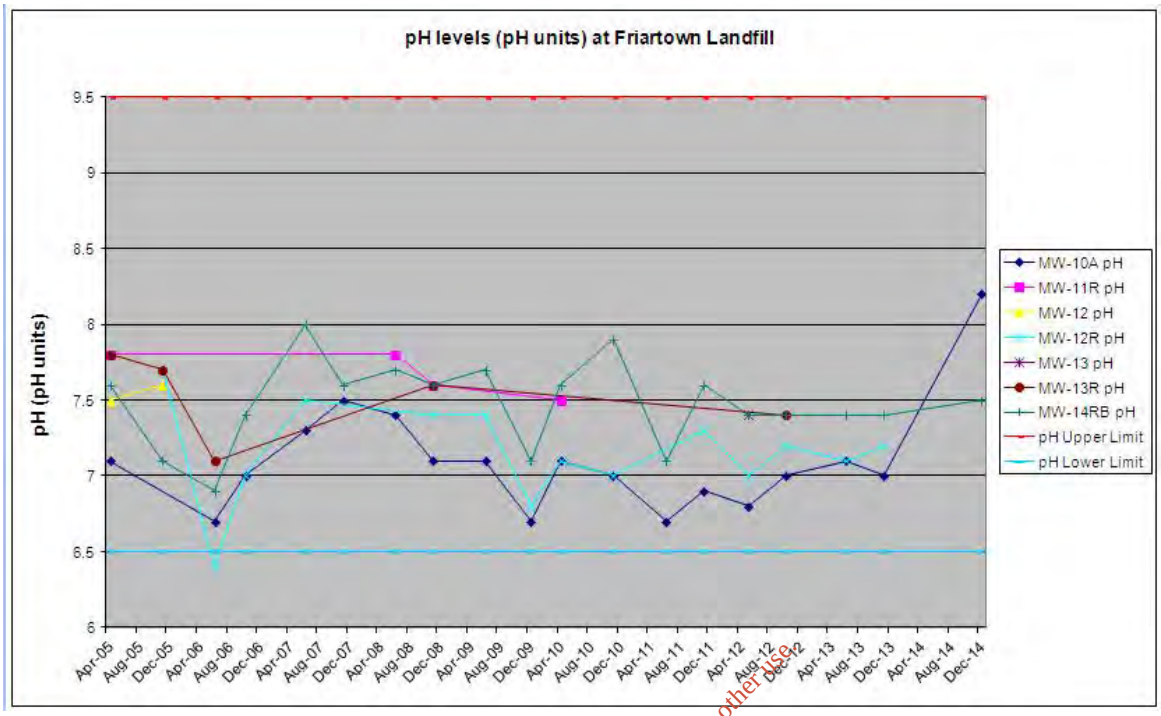
MW–14RB is located in a field north of the landfill site.
Nitrite (0.32mg/l) was found to be above its GTV limit of 0.11mg/l and IGV limit of 0.03mg/l. This represents an increase since the previous monitoring event of November 2013 (<0.03mg/l).

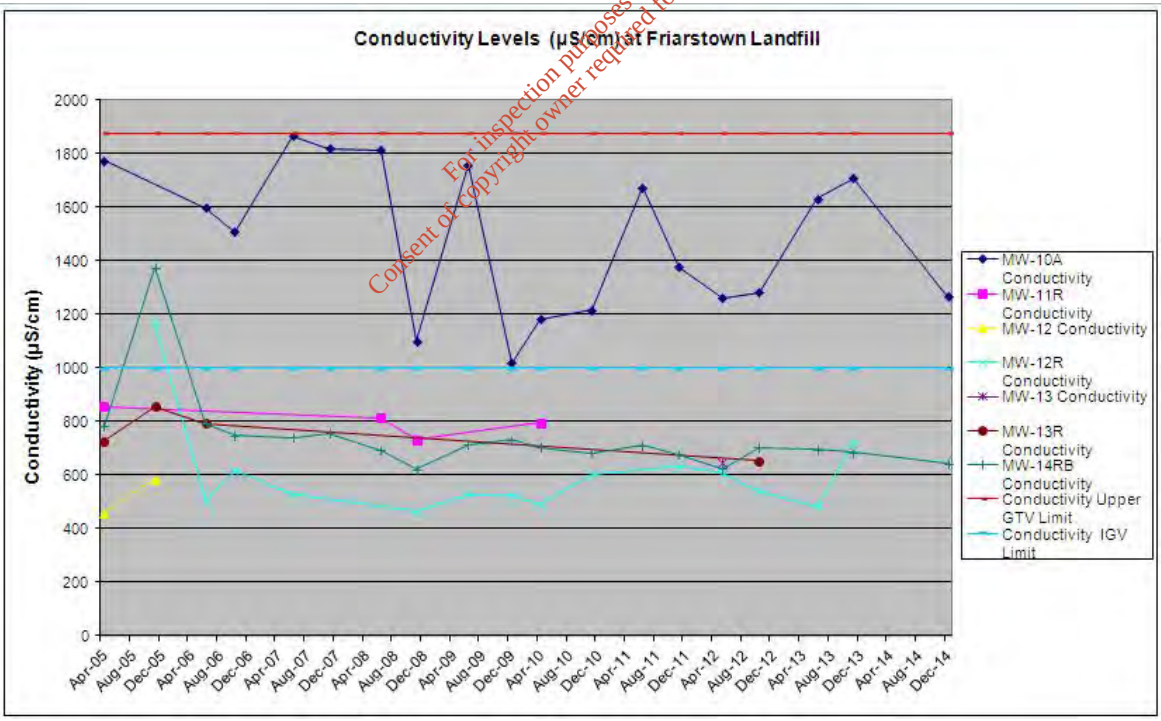
Manganese (<2µg/l → 60µg/l) concentration increased since the last monitoring event in November 2013 and was found to be above its IGV limits of 50g/l.
Arsenic (18µg/l→5µg/l) has seen a decrease in concentration and now below its GTV limit of 7.5µg/l and IGV limit of 10µg/l.

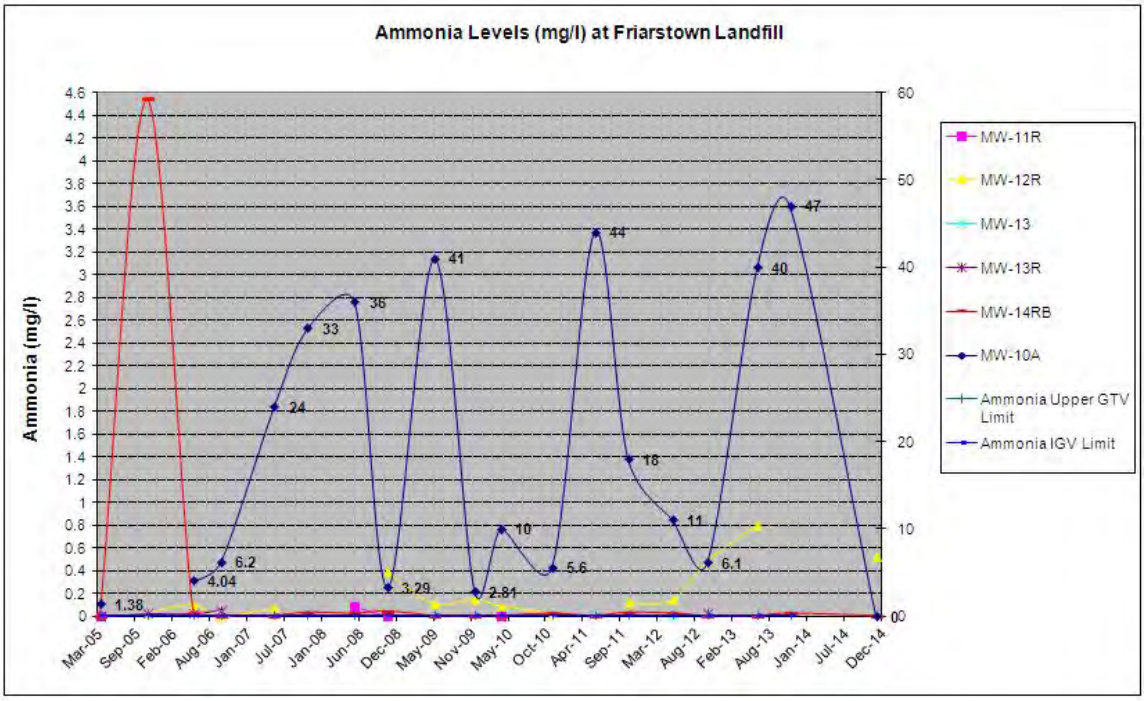
All remaining parameters were within their respective limit values.

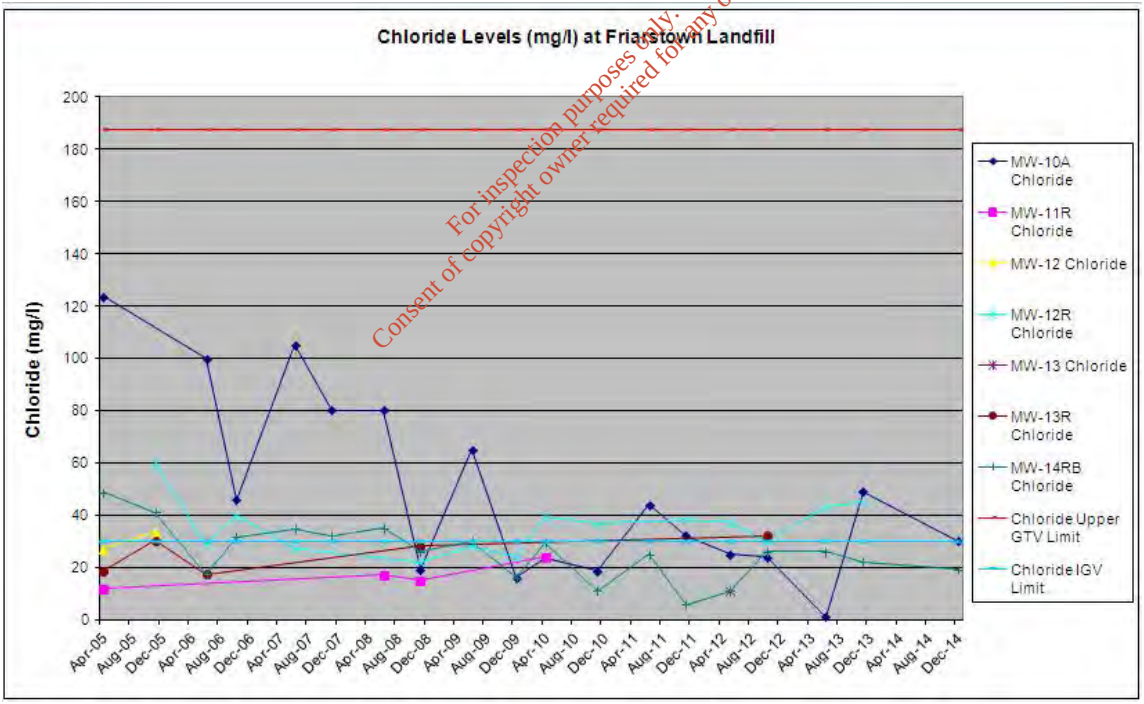
Appendix 1

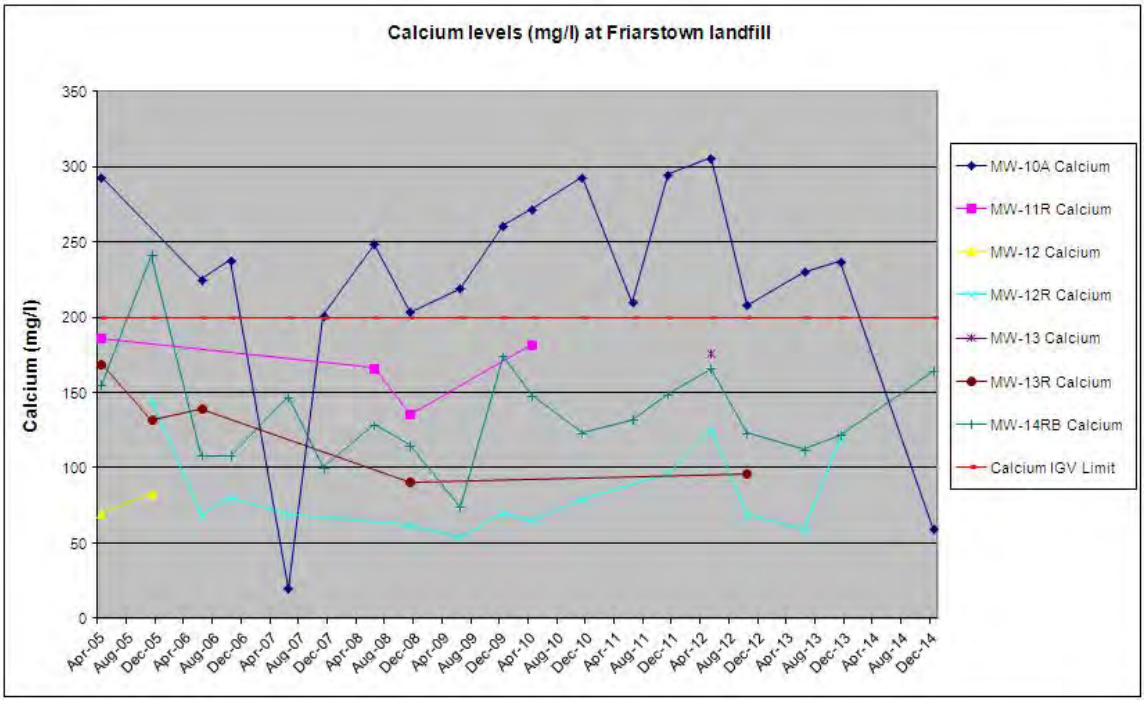
Trended Graphs

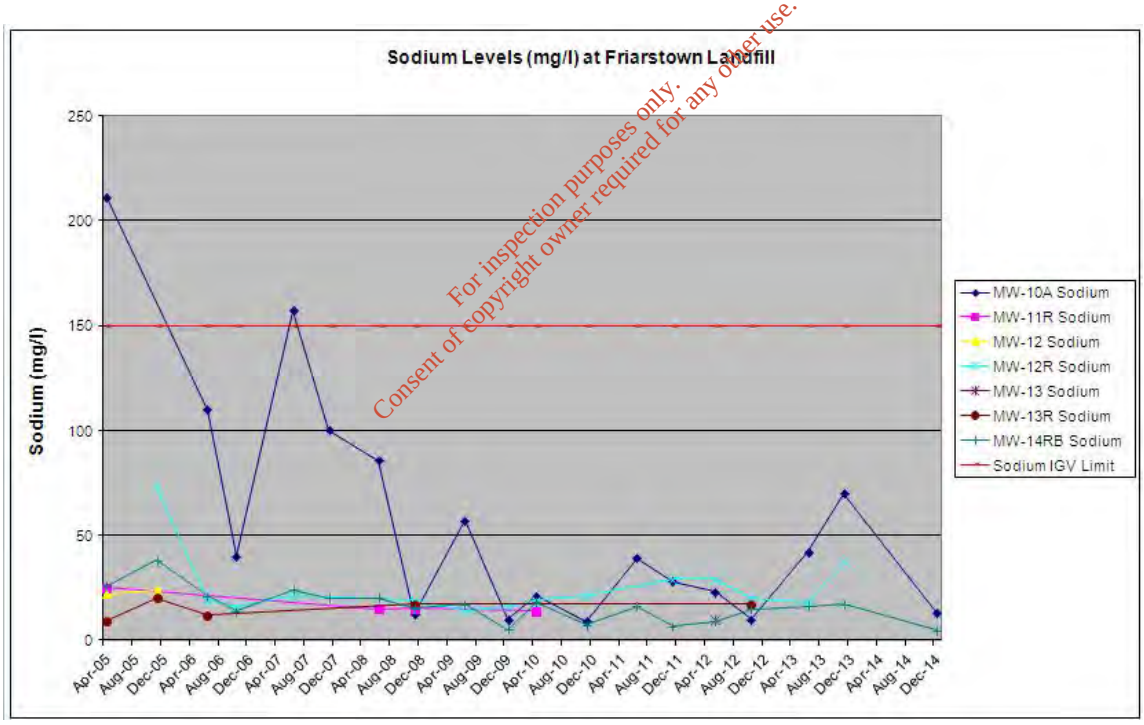


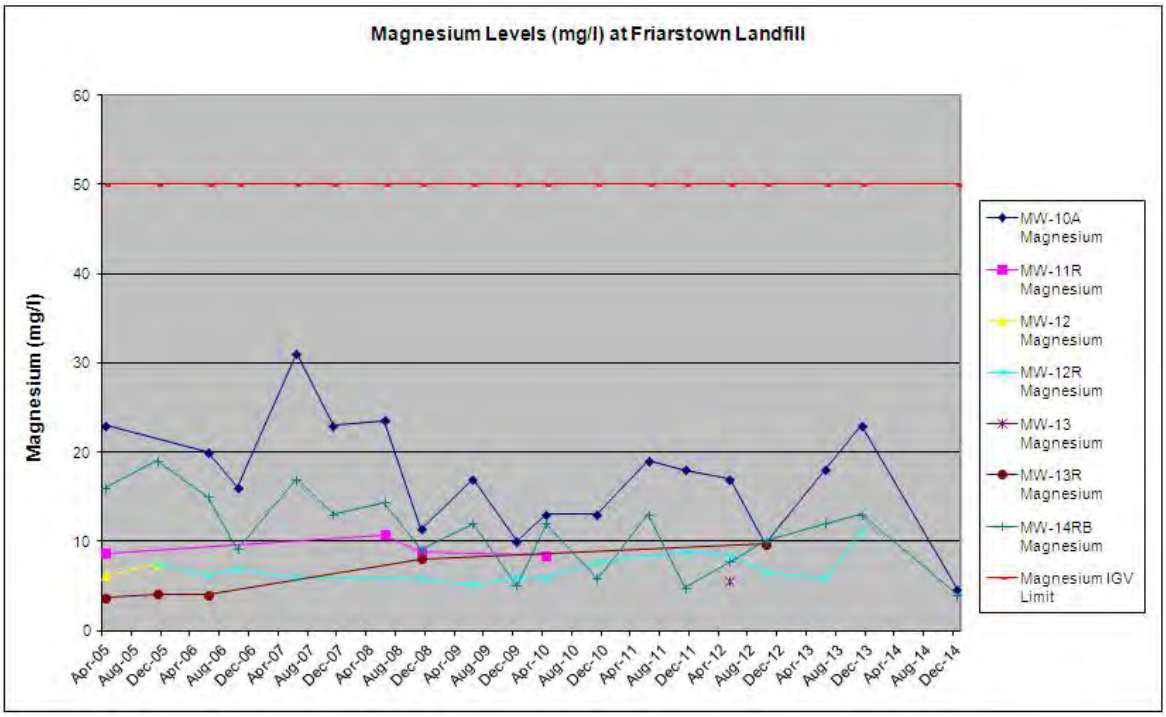


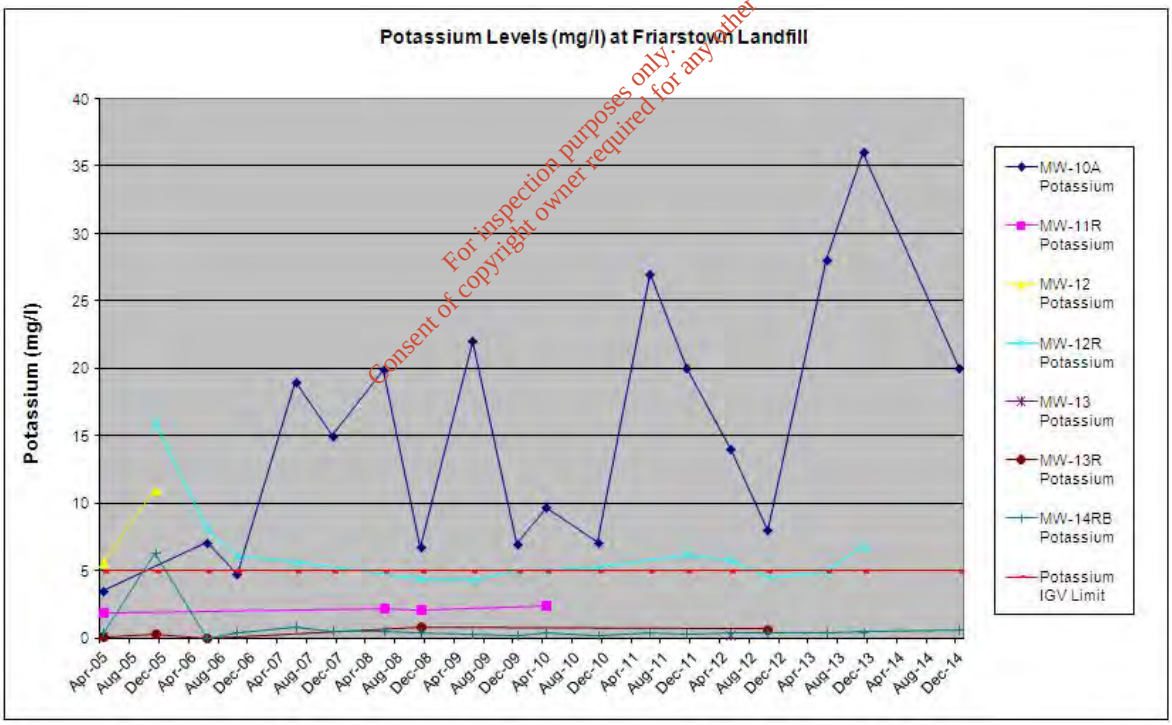


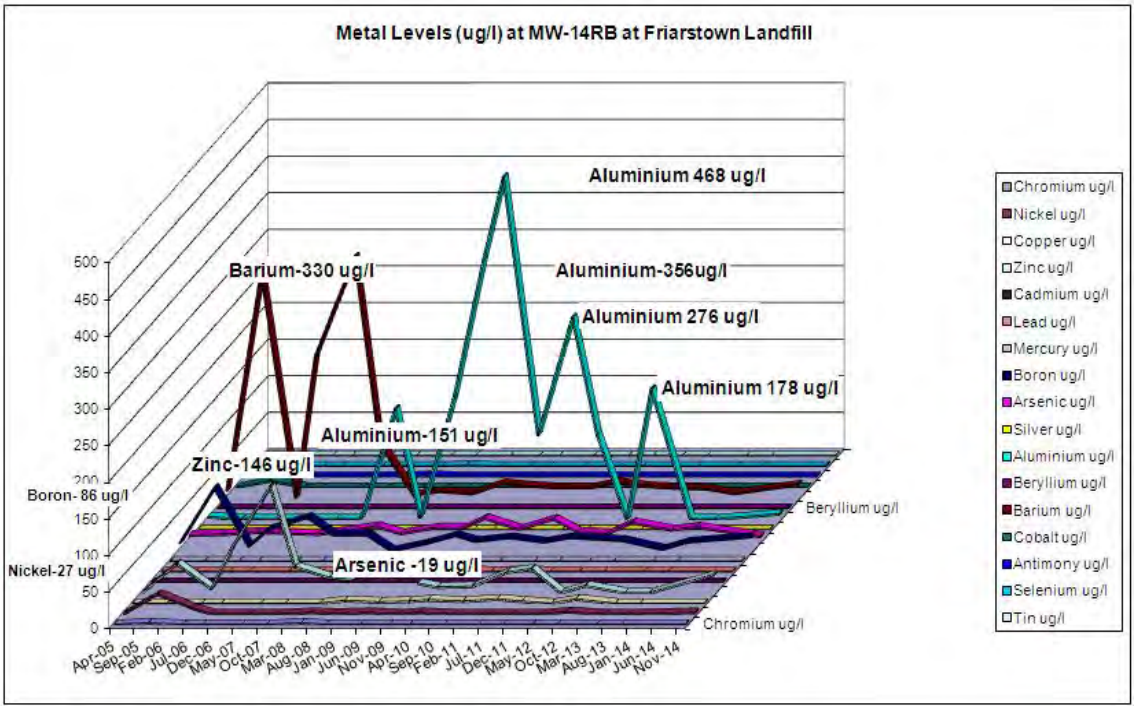


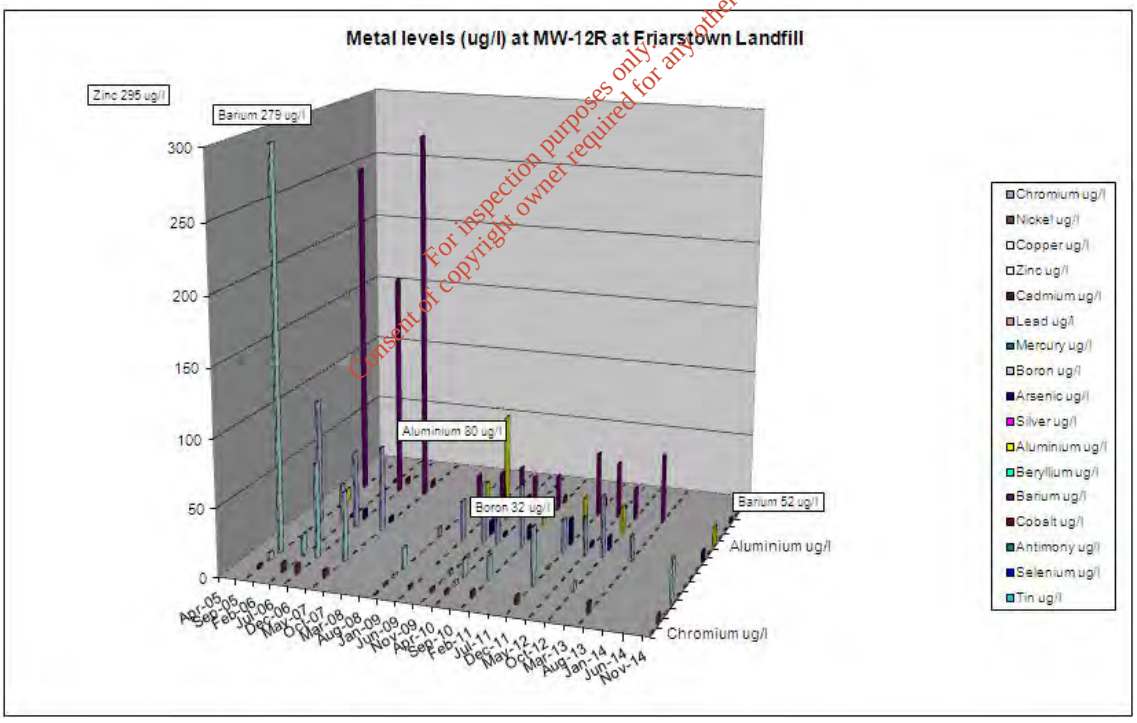


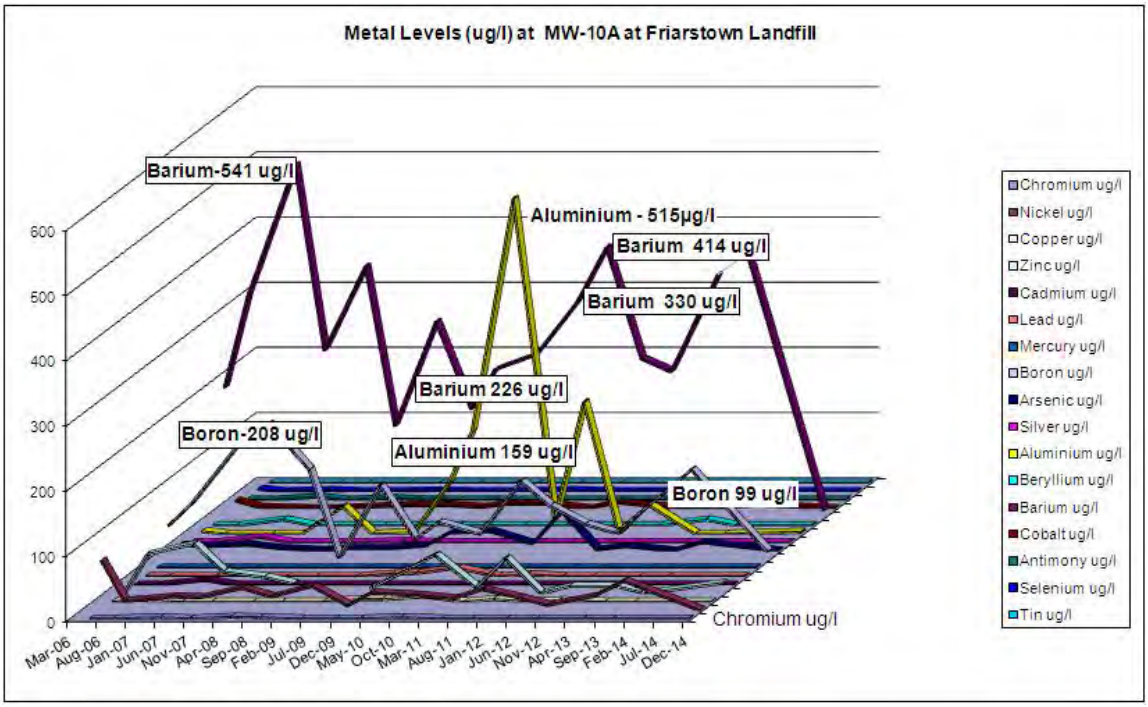






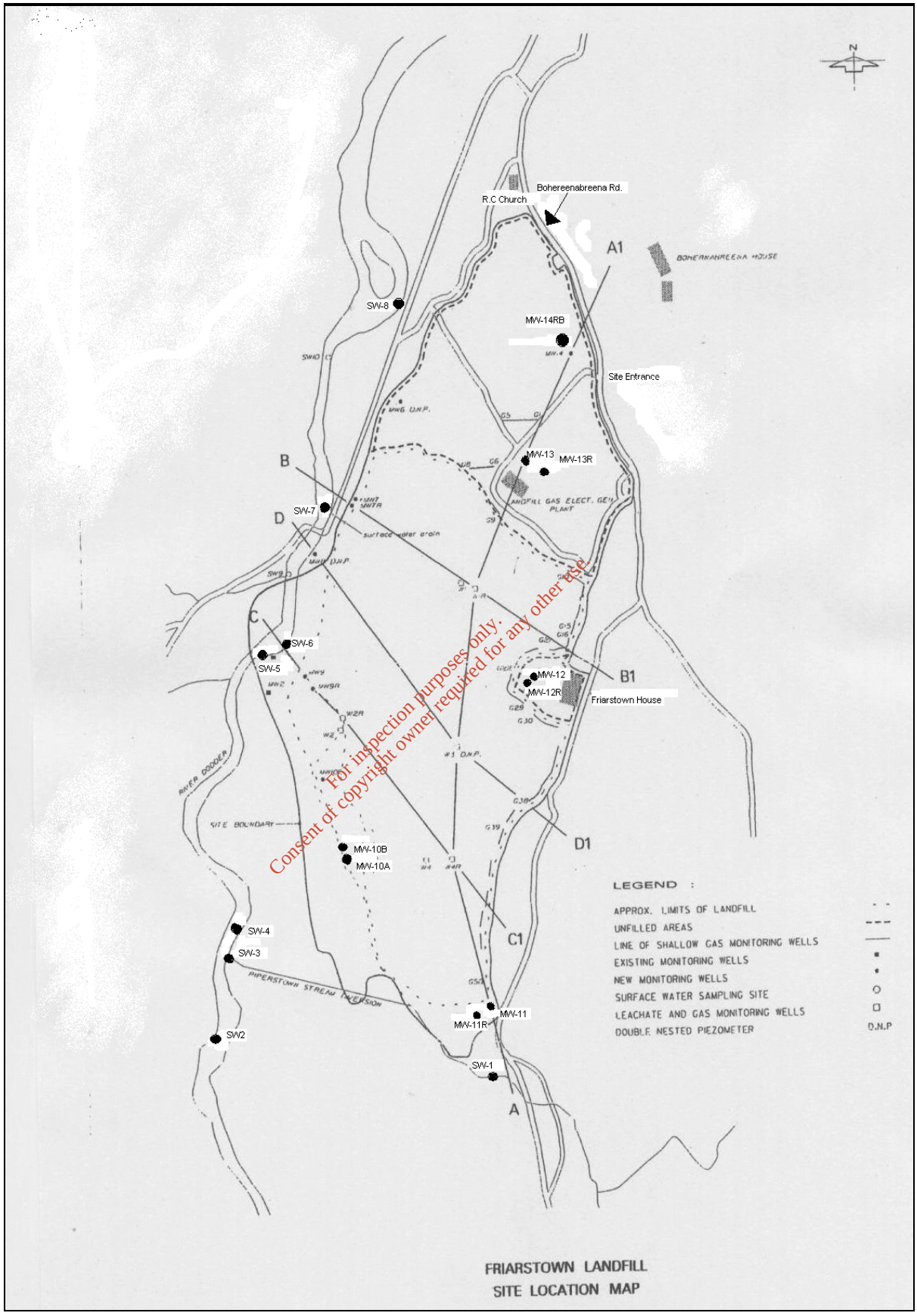






Appendix 2

Monitoring Location Map



APPENDIX 3

Analytical Methods

Lab Accreditation

Chain of Custody

Chemical Analysis

CHEMICAL ANALYSIS OF SAMPLES			
Parameter	**Limit of Detection/ Range**	**Method**	**Accredited**
Visual Inspection	–	On–Site Visual Determination	X
Odour	–	On–Site Sensory Determination	X
pH (pH units)	0.1 – 14	G/05	✓ INAB
Temperature (°C)	0 -50	*In–Situ* Calibrated Thermometer	X
Dissolved Oxygen (mg/l)	0.1 - 20	*In–Situ* Calibrated DO meter / Thermometer	
Ammonia–N (mg/l)	<0.02	G/67	✓ INAB
Sulphate (mg/l)	<0.5	G/39	✓ INAB
Total Dissolved Solids (TDS) (mg/l)	50 mg/l dried residue	G/18.	✓
BOD (mg/l)	<2	G/04	✓ INAB
COD (mg/l)	<10	G/03:	✓ INAB
Conductivity (µS/cm)	0.1 - 1999 µS/cm	G/06	✓ INAB
Calcium, Iron, Magnesium,Potassium, Sodium (mg/l)	<0.1	G/57	X
Chloride (mg/l)	<0.5	G/39	✓ INAB
Nitrate–N (mg/l)	<0.04	G/39	✓ INAB
Nitrite–N (mg/l)	<0.03		
TON as N (mg/l)	<0.2 mg/l	G/67:	X
TOC (mg/l)	<5	G94:	✓ INAB
Alkalinity (mg/l $CaCO_2$)	<50	G/69:	✓ INAB
Boron–Dissolved (µg/l)	<2	ICP–MS	X
Mercury (µg/l)	<1		
Cyanide (Free) (mg/l)	<0.01	G/63	X
Dissolved Metals (µg/l)	<2	G/57	✓ INAB

Notes:

ASTM – American Society for Testing and Materials, Annual Book of ASTM Standards 1997.

APHA – American Public Health Association, Standard Methods for the Examination of Water and Wastewaters, 21st Edition, 2005.

G/ – ANUA Environmental Analytical Laboratory Standard Operating Procedures Manual.

✓ – INAB Accredited Test Method – INAB Registration Reference No. 083T.

X – Non Accredited Test Method

ACCREDITED QUALITY SYSTEM

ISO 17025 Accreditation

ANUA Environmental analytical laboratory is accredited to ISO 17025 by the National Accreditation Board (INAB). ISO 17025 accreditation ensures that the laboratory operates a quality system with technically competent staff. The laboratory has accreditation since 1997 and it is the policy of the laboratory to achieve and maintain a high standard of quality consistent with client's requirements in all aspects of the work carried out within the laboratory.

Interlaboratory Proficiency Schemes

To ensure the accuracy of the analytical testing the laboratory participates in several external proficiency schemes. The ongoing competence of the laboratory and its staff is assessed by participation in various inter–laboratory proficiency testing schemes, such as LGC Aquacheck scheme and the EPA Intercalibration programme organised for environmental laboratories throughout Ireland. ANUA Environmental Analytical Laboratory is listed on the EPA's register of Quality Controlled Laboratories

Controlled Chain of Custody

As part of the Quality System in place in Anua Environmental, measures are taken to ensure controlled chain of custody. An outline of the chain of custody is given overleaf.

CONTROLLED CHAIN OF CUSTODY

SITE		TRANSPORT		LABORATORY
Sampling and packaging of all samples were carried out by ANUA Environmental Technical Team:	Transport Document Form	Transport to laboratory by ANUA Environmental Team.	Sample Reception Form	Receiving of samples at ANUA Environmental Laboratory complex by: Laboratory Manager (Secure laboratory complex access to authorised personnel only)
Mr. Jason Smyth	→		→	↓
				Storage of all samples for 1 month period after report issue.
				↓
				Supervised Disposal

Environmental Assessment of the Quality of Surface Waters at the Friarstown Landfill Site at Boherbnabreena, Co. Dublin .

For the Attention of:
Mr. Brian Harkin
South Dublin County Council
Town Hall
Tallaght
Dublin 24

Prepared by:
Mr. Ronan Connolly
Environmental Scientist

Reviewed By:
Ms. Linda Lenihan
Environmental Scientist

Report No: ECS3585-SW
Monitoring Date: November 2010
Reporting Date: January 2011

Executive Summary

At the request of South Dublin County Council, Bord na Móna Technical Services was commissioned to perform sampling and analysis of surface waters at the Friarstown Landfill. The site was subsequently visited by Bord na Móna Environmental Scientists on the 18th of November 2010 and surface water samples were returned to the laboratory for subsequent analysis.

Results obtained were compared to the limit values set out in the European Communities (Quality of Salmonid Waters) Regulations 1988 (S.I. No 293 of 1988).

All results obtained for the parameters referenced with respect to European Communities (Quality of Salmonoid Waters) Regulations 1988 (S.I. No 293 of 1988) are below their respective limit values.

No significant difference was noted between the upstream and downstream water quality with respect to the landfill site, which suggests that the landfill is having no significant impact on the water quality.

Respectively Submitted

Mr. Ronan Connolly	Ms. Linda Lenihan
Environmental Scientist	Environmental Scientist

CONTENTS

1.0 INTRODUCTION

At the request of South Dublin County Council, Bord na Móna Technical Services was commissioned to perform sampling and analysis of surface waters at the Friarstown Landfill. The site was subsequently visited by Bord na Móna Environmental Scientists on the 18th of November 2010 and surface water samples were returned to the laboratory for subsequent analysis

This report details the sampling methodologies, procedures followed and results obtained.

2.0 METHODOLOGY

2.1 Sampling Locations

TABLE 2.1: LOCATION OF SURFACE WATER SAMPLING STATIONS	
Sample Point	**Location**
SW-1	Located upstream of the landfill at the entry point of the Piperstown stream onto the site (south of the site).
SW-2	Located approx 50m upstream of the SW-3 location.
SW-3	SW-3 is taken from the diverted Piperstown Stream at the point where it enters the River Dodder
SW-4	Located approx 50m downstream of SW-3
SW-5	Located beside MW-1 monitoring well
SW-6	Located approx 50m down stream where the groundwater drain flows into the river.
SW-7	Located 20m downstream of the Piperstown Bridge.
SW-8	Furthest point downstream of the Friarstown landfill.

2.2 Surface Water Sampling

Grab samples of surface water were extracted in accordance with the following standards;

ISO Standard	Description
ISO 5667-1-2006	Guidance on the design of sampling programmes and sampling techniques
ISO 5667-3-2004	Guidance on sample preservation and handling
ISO 5667-14-1998	Guidance on quality assurance of environmental sampling & handling
ISO 5667-10-1992	Guidance on sampling wastewaters
ISO 5667-6-2005	Guidance on sampling rivers & streams

Sampling was conducted in strict accordance with Bord na Móna Technical Services recognised Standard Operations Procedures (SOP) TS-W-02. All samples were returned to the laboratory, and stored between 1-8°C.

TABLE 2.2: CHEMICAL AND MICROBIOLOGICAL ANALYSIS OF SAMPLES		
Parameter	**Limit of Detection/Range**	**Method**
pH (pH units)	0.1 – 14	APHA Method 4500 H^+B
Temperature (°C)	-	*In-Situ* Calibrated Thermometer
Ammonia-N (mg/l)	0.02 – 25	G/67
BOD_5 – TCMP (mg/l)	2 – 5000	G/04
COD (mg/l)	10 – 1500	G/03
Conductivity (µS/cm)	0.1 - 1999	G/06
Calcium (mg/l)	<0.1	ICP-MS
Cadmium (µg/l)	<2	ASTM D 5673
Chloride (mg/l)	<0.5	G/39
Chromium (µg/l)	<2	ICP-MS
Copper (µg/l)	<2	ICP-MS
Iron (mg/l)	<0.1	ICP-MS
Lead (µg/l)	<2	ASTM D 5673
Magnesium (mg/l)	<0.1	ICP-MS
Manganese (µg/l)	<2	ICP-MS
Mercury (µg/l)	<1	ASTM D 5673
Nickel (µg/l)	<2	ICP-MS
Nitrate-N (mg/l)	<0.04	G/39
Nitrite-N (mg/l)	<0.03	IC based on ASTM D 4327
Orthophosphate-P (mg/l)	<0.16	G/39
Potassium (mg/l)	<0.1	ICP-MS
Sodium (mg/l)	<0.1	ICP-MS
Sulphate (mg/l)	<0.5	G/39
TOC (mg/l)	0.18	Subcontracted to City Analysts
Boron (µg/l)	<2	ICP-MS
Barium (µg/l)	<2	G/57 ICP-MS
Silver (µg/l)	<2	G/57 ICP-MS
Aluminium (µg/l)	<2	ICP-MS
Beryllium (µg/l)	<2	ICP-MS
Cobalt (µg/l)	<2	G/57 ICP-MS
Antimony (µg/l)	<2	G/57 ICP-MS
Tin (µg/l)	<2	ICP-MS
Selenium (µg/l)	<2	G/57 ICP-MS
Arsenic (µg/l)	<2	G/57 ICP-MS
Zinc (µg/l)	<2	ICP-MS
Total Alkalinity ($CaCO_3$) (mg/l)	0 – 500	G/69
Total Suspended Solids (mg/l)	<5	G/19
Total Phosphorous (mg/l)	<0.05	Digest colourimetric analysis

Note: **ASTM** - American Society for Testing and Materials, Annual Book of ASTM Standards 1997.
APHA - American Public Health Association, Standard Methods for the Examination of Waters and Waste Waters, 20th Edition, 1998.
G/ - INAB Accredited Method, Bord na Móna Environmental & Analytical Services Standard Operating Procedures Manual

3.0 COMMITMENT TO QUALITY

3.1 INAB Accreditation

Bord na Móna Technical Services analytical laboratories is accredited to ISO 17025 by the National Accreditation Board (INAB). ISO 17025 accreditation ensures that the laboratory operates a quality system with technically competent staff. The laboratory has accreditation since 1997 and it is the policy of the laboratory to achieve and maintain a high standard of quality consistent with client's requirements in all aspects of the work carried out within the laboratory.

3.2 Interlaboratory Proficiency Schemes

To ensure the accuracy of the analytical testing the laboratory participates in several external proficiency schemes. The ongoing competence of the laboratory and its staff is assessed by participation in various inter-laboratory proficiency testing schemes, such as LGC Aquacheck scheme and the EPA Intercalibration programme organised for environmental laboratories throughout Ireland. Bord na Móna Environmental Consultancy & Laboratory Services Analytical Laboratory is listed on the EPA's register of Quality Controlled Laboratories.

3.3 Control Chain of Custody

As part of the Quality System in place in Bord na Móna, Environmental Ltd., measures are taken to ensure controlled chain of custody. An outline of the chain of custody is given below.

BORD NA MÓNA

CONTROLLED CHAIN OF CUSTODY

SITE	TRANSPORT	LABORATORY
Sampling and packaging of all samples were carried out by Bord na Móna: Technical Team. Mr. Ronan Connolly	Transport Document Form → Transport to laboratory by Bord na Móna Technical Team.	Sample Reception Form → Receiving of samples at Bord na Móna Environmental Laboratory complex by: Laboratory Manager (Secure laboratory complex access to authorised personnel only) ↓ Storage of all samples for 1 month period after report issue. ↓ Supervised Disposal

4.0 RESULTS

The results of the investigation carried out by Bord na Móna Technical Services are presented as follows:

Table 4.1: Results of field measurements taken at each surface water sampling point.

Table 4.2: Results of chemical analysis of surface water samples.

Table 4.3: Results of metal scan of surface water samples.

4.1 Surface Water Results

TABLE 4.1: RESULTS OF FIELD MEASUREMENTS TAKEN AT EACH SURFACE WATER SAMPLING POINT								
Parameter	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**
Temperature (^{o}C)	8.4	7.6	8.5	7.6	7.6	7.7	7.7	7.8
Dissolved Oxygen (mg/l)	10.96	11.25	11.14	11.29	11.29	11.26	11.37	11.32
Odour / Visual	Clear, few Suspended Solids, no odour	Yellow/ Brown tint, few suspended solids, no odour	Clear, few suspended solids, no odour	Yellow/ Brown tint , few suspended solids, no odour	Yellow/ Brown tint, few suspended solids, no odour	Yellow/ Brown tint, few suspended solids, no odour	Yellow/ Brown tint, no suspended solids, no odour	Yellow/ Brown tint, no suspended solids, no odour

TABLE 4.2: RESULTS OF CHEMICAL ANALYSIS OF SURFACE WATER SAMPLES									
Parameter	**Salmonoid Water Quality Standard** [1]	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**
pH (pH units)	***≥6 ≤9***	8.1	7.6	8.2	7.6	7.6	7.6	7.6	7.6
Conductivity µS/cm @ 25^{0}C	-	300	67	319	88	98	94	94	105
BOD (TCMP) mg/l	***5***	<2	<2	<2	<2	<2	<2	<2	<2
COD mg/l	-	10	21	<10	<10	14	12	21	20
Ammonia as N mg/l (ISE)	***0.8***	<0.02	<0.02	0.04	0.02	<0.02	0.05	0.05	0.06
Suspended Solids mg/l	***25***	<5	<5	<5	<5	<5	<5	<5	<5
Total Alkalinity ($CaC0_3$) mg/l	-	114	<50	111	<50	<50	<50	<50	<50
TOC mg/l		<5	8	<5	8	8	8	8	8
*Chloride mg/l	-	18.39	9.12	17.39	9.9	9.68	8.57	9.72	10.24
Sulphate mg/l	-	8.78	2.63	9.39	3	3.56	3.46	3.33	3.75
*Nitrate as N mg/l	-	1.55	0.2	1.5	0.28	0.34	0.28	0.31	0.37
*Nitrite mg/l	***0.015***	<0.03	<0.03	0.26	<0.03	0.06	0.17	0.07	0.11
Total Phosphorus	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Note 1: Water Quality Standard= 1988 Statutory Instrument No. 293, European Communities (Quality of Salmonoid Waters) Regulations 1988

* Non INAB accredited test method

TABLE 4.3: RESULTS OF METAL SCAN OF SURFACE WATERS									
Parameter	***Surface Water Quality Standard*** [1]	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**
Sodium mg/l	-	8.3	3.9	8.5	4.8	4.5	4.6	4.4	4.8
Magnesium mg/l	-	2.8	0.9	3.1	1.3	1.3	1.1	1.3	1.5
Potassium mg/l	-	0.9	0.4	1	0.6	0.5	0.5	0.5	0.6
Calcium mg/l	-	44	5.9	46	8	10	10	9.6	13
Chromium µg/l	-	<2	<2	<2	<2	<2	<2	<2	<2
Mercury µg/l	-	<1	<1	<1	<1	<1	<1	<1	<1
Boron µg/l	-	10	<2	11	4	4	11	3	5
Nickel µg/l	-	<2	<2	<2	<2	<2	<2	<2	<2
Copper µg/l	-	2	2	2	<2	<2	<2	<2	<2
Zinc µg/l	-	4	5	23	36	24	<2	33	28
Cadmium µg/l	-	<2	<2	<2	<2	<2	<2	<2	<2
Lead µg/l	-	<2	<2	<2	<2	<2	<2	<2	<2
Silver µg/l	-	<2	<2	<2	<2	<2	<2	<2	<2
Aluminium µg/l	-	51	158	47	164	174	170	175	174
Berylium µg/l	-	<2	<2	<2	<2	<2	<2	<2	2
Barium µg/l	-	11	4	20	13	10	4	11	8
Cobalt µg/l	-	<2	<2	<2	<2	<2	<2	<2	<2
Antimony µg/l	-	<2	<2	<2	<2	<2	<2	<2	<2
Manganese µg/l	-	9	30	16	32	28	29	28	28
Tin µg/l	-	<2	<2	<2	2	<2	<2	<2	<2
Selenium µg/l	-	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic µg/l	-	<2	2	<2	2	2	2	2	2
Iron mg/l	-	1.1	0.2	0.2	0.3	0.2	0.2	0.2	0.2

Note 1: Water Quality Standard= 1988 Statutory Instrument No. 293, European Communities (Quality of Salmonid Waters) Regulations 1988

5.0 DISCUSSION

Tables 4.1–4.3 present the results of physical and chemical determinations of the eight surface water samples (SW-1, SW-2, SW-3, SW-4, SW-5, SW-6, SW-7 and SW-8) from the receiving watercourses located within the vicinity of the Friarstown Landfill site.

The results for the parameters obtained are referenced to the European Communities (Quality of Salmonid Waters) Regulations 1988 (S.I. No 293 of 1988) and were found to be below their respective limit values.

Both SW-1 (located upstream of the landfill at the entry point of the Piperstown stream onto the site (south of the site)) and SW-3 (taken from the diverted Piperstown Stream at the point where it enters the River Dodder) recorded conductivity levels of 300µS/cm and 319µS/cm respectively. These two points were found to have a higher conductivity than the six other remaining locations which ranged from 67µS/cm at SW-2 to 105µS/cm at SW-8. These findings are in keeping with previous trends (see Bord Na Mona Environmental Reports ECS3316, ECS3480 & ECS3584).

BOD levels were found to be below the limit of detection (<2mg/l) at each of the eight surface water monitoring locations. This is in keeping with the previous monitoring report of April 2010. Levels of COD have remained steady ranging from <10 mg/l at SW-3, and SW-4 to 21 mg/l at SW-7 and SW-2.

The levels of Suspended Solids were found to be below the limit outlined for the Salmonid Water Regulations for all monitoring locations.

Total alkalinity, Chloride and Sulphate levels were highest at monitoring locations SW-1 (114 mg/l, 18.39 mg/l and 8.78 mg/l) (located upstream of the landfill at the entry point of the Piperstown stream onto the site (south of the site)) and SW-3 (111 mg/l, 17.39 mg/l and 9.39 mg/l) (taken from the diverted Piperstown Stream at the point where it enters the River Dodder)). The levels of the fore mentioned parameters remain in keeping with previous trends displaying minor fluctuations at each of the remaining monitoring locations.

Undetectable amounts of Total Phosphorus were recorded at the eight monitoring locations. This is in keeping with the previous monitoring in April 2009. Ammonia levels displayed minor fluctuations across the eight monitoring locations from the previous monitoring event remaining below the limit value as stated in the European Communities (Quality of Salmonid Waters) Regulations 1988. Nitrate concentrations ranged between 0.2mg/l at SW-2 to 1.55 mg/l at SW-1.

Nitrite was detected at elevated levels at five of the eight surface water monitoring locations at levels ranging from 0.06 mg/l at SW-5 to 0.26 mg/l at SW-3. The remaining results were below the detection limit of <0.03mg/l.

Mercury, Cadmium, Chromium, Lead, Silver, Cobalt, Antimony, and Selenium were not detected at any of the eight monitoring locations.

Undetectable or trace amounts of Arsenic, Copper, Tin, Beryllium and Nickel were detected at all monitoring locations. The levels are consistent with previous Bord na Móna monitoring events.

Levels of Sodium, Magnesium and Potassium recorded display minor fluctuations in concentration at all the 8 monitoring locations compared to the previous monitoring event. The levels of Calcium decreased across each location during this monitoring event returning to levels similar to previous trends (see Appendix1).

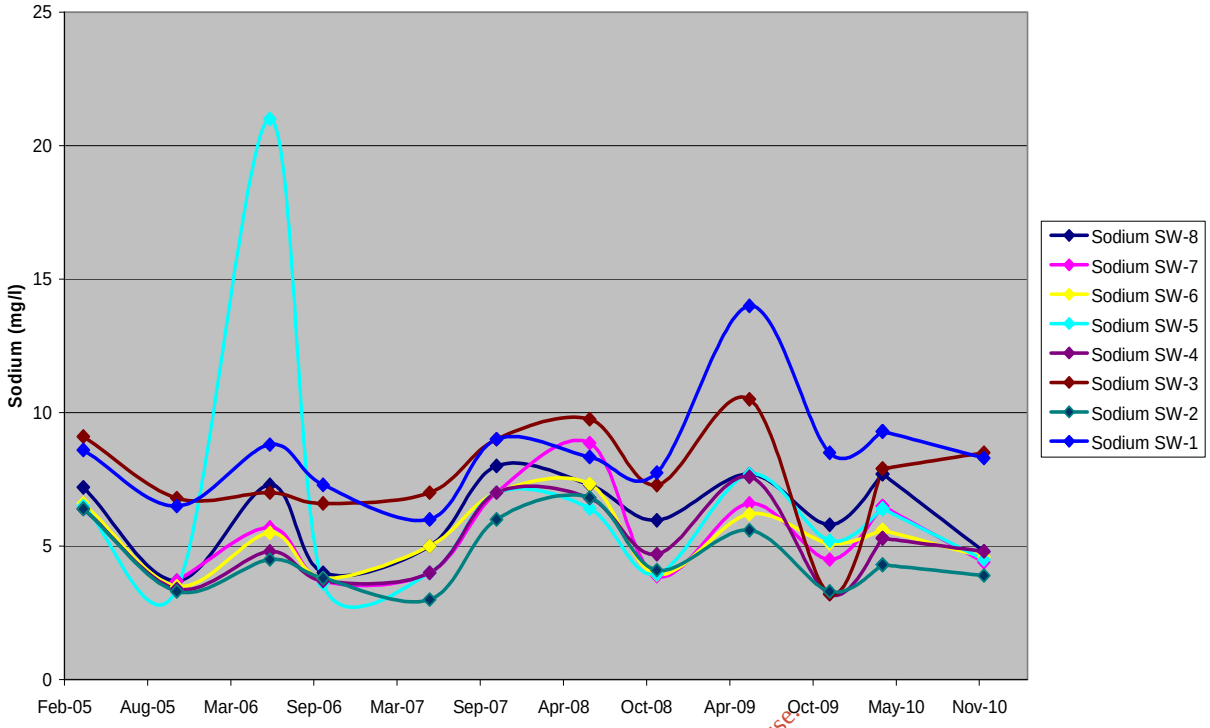
Manganese levels range from 9µg/l at SW-1 to 30µg/l at SW2 and displayed slight fluctuations in concentrations since the previous monitoring event in April 2010.

Concentrations of Aluminium remained lowest at SW-3 (47 µg/l) and SW1 (51µg/l).Aluminium concentrations displayed fluctuations of varying degrees across each of the remaining monitoring locations.

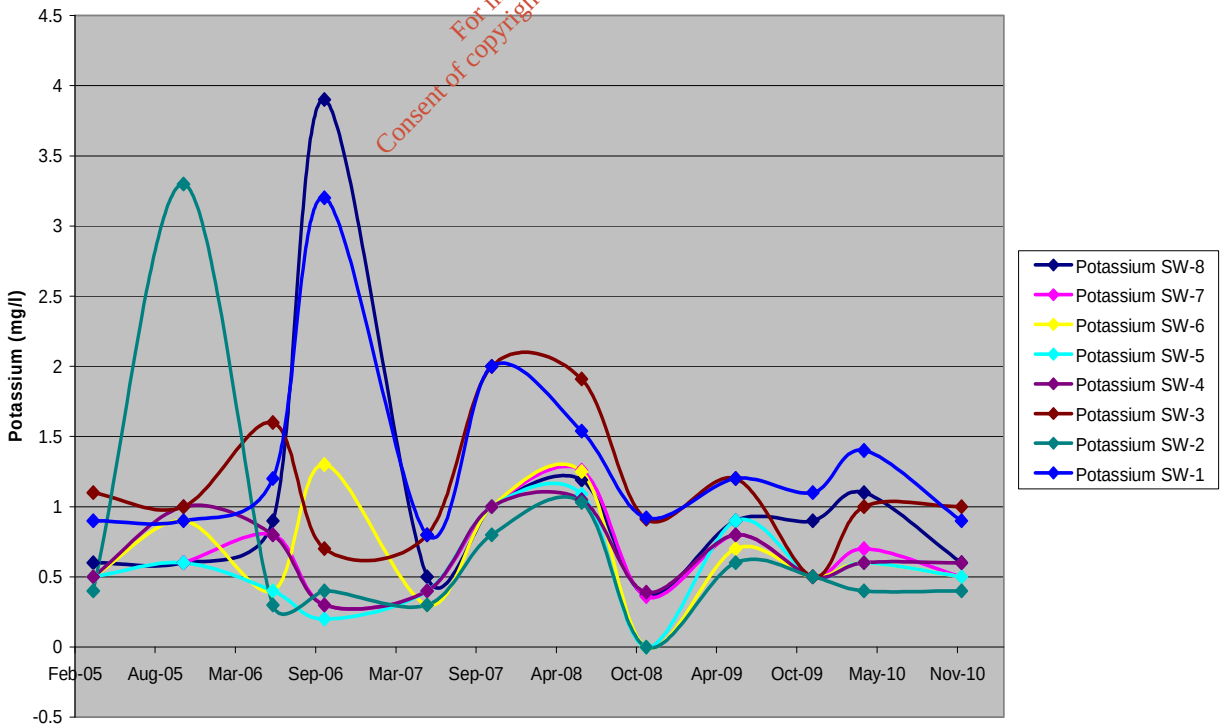
APPENDIX 1

TRENDED GRAPHS

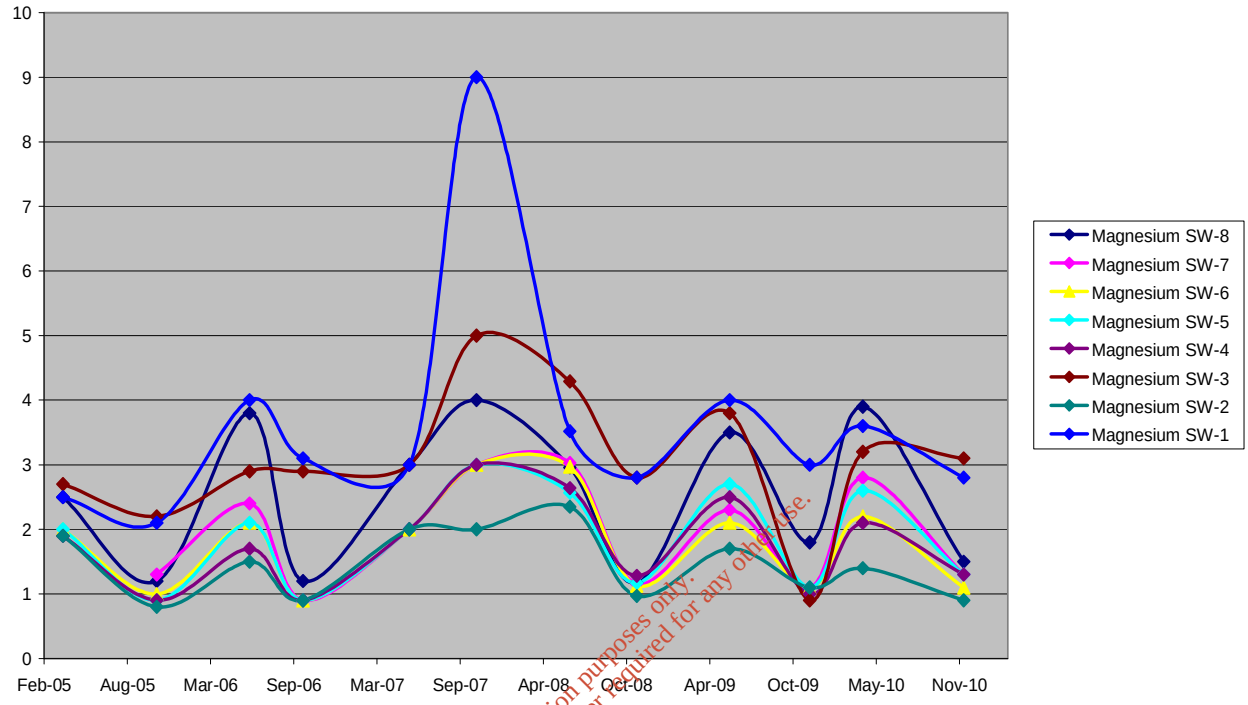
Sodium levels at surface water monitoring locations at Friarstown Landfill



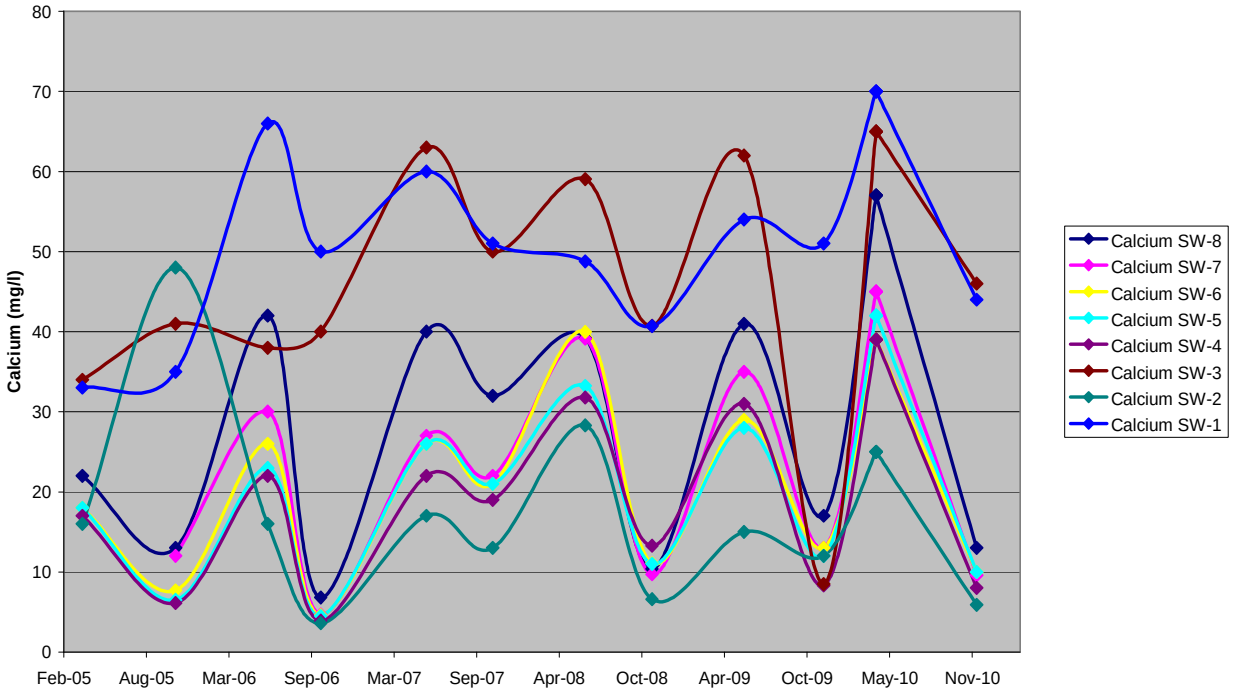
Potassium levels (mg/l) at surface water monitoring locations at Friarstown Landfill



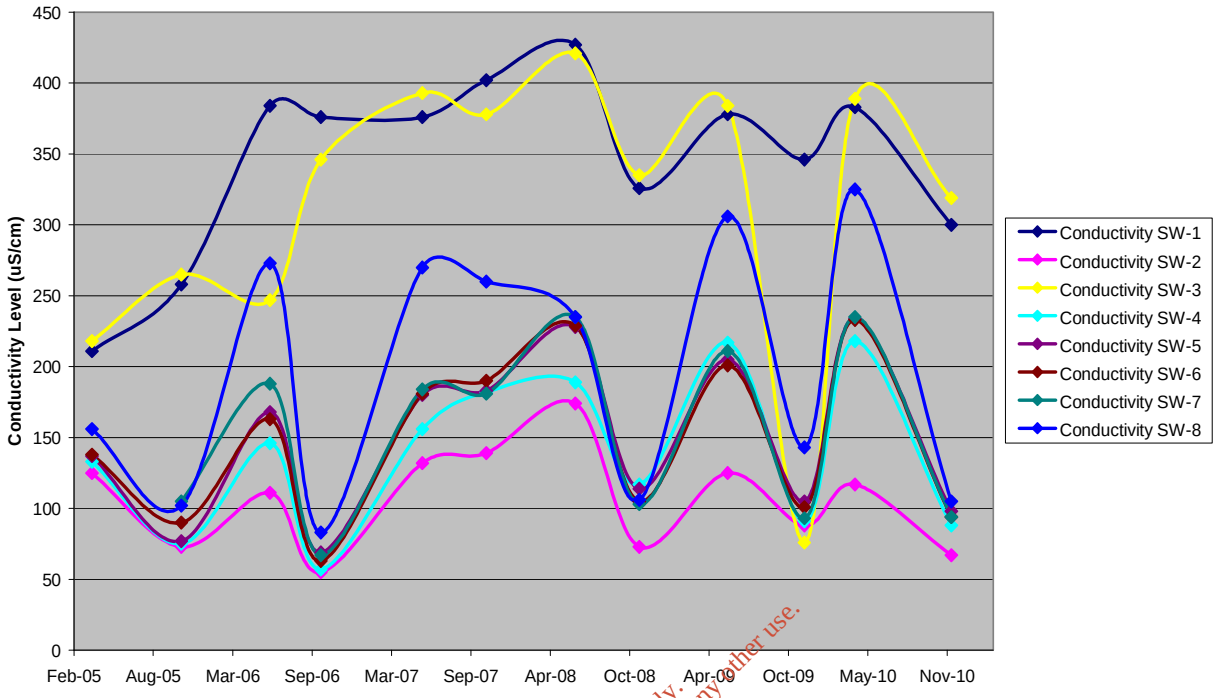
Magnesium Levels (mg/l) at surface water monitoring locations



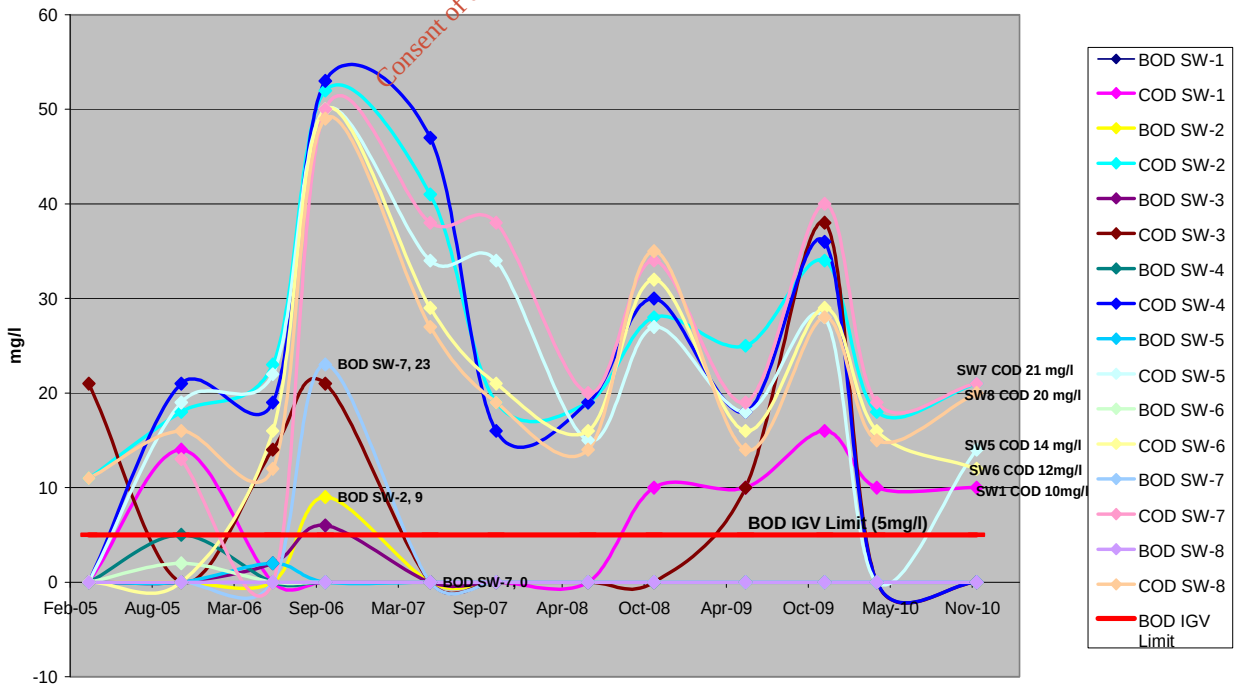
Calcium levels (mg/l) at surface water monitoring locations at Friarstown Landfill



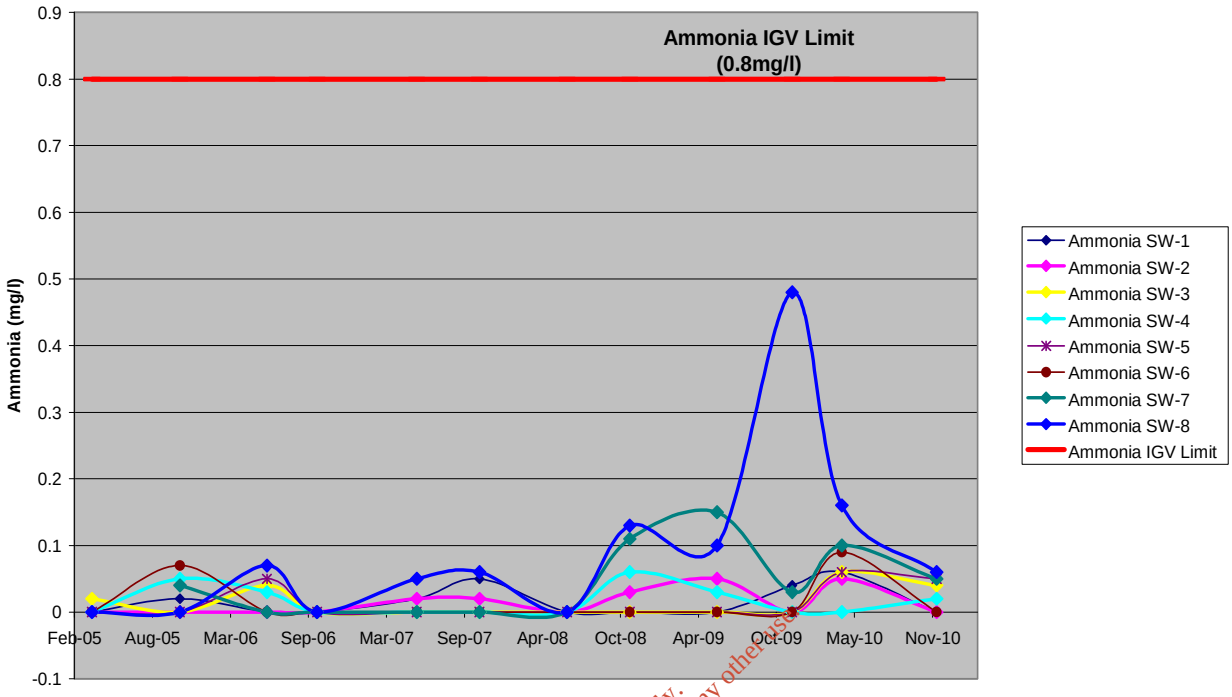
Conductivity levels (uS/cm) at surface water monitoring locations at Friarstown Landfill



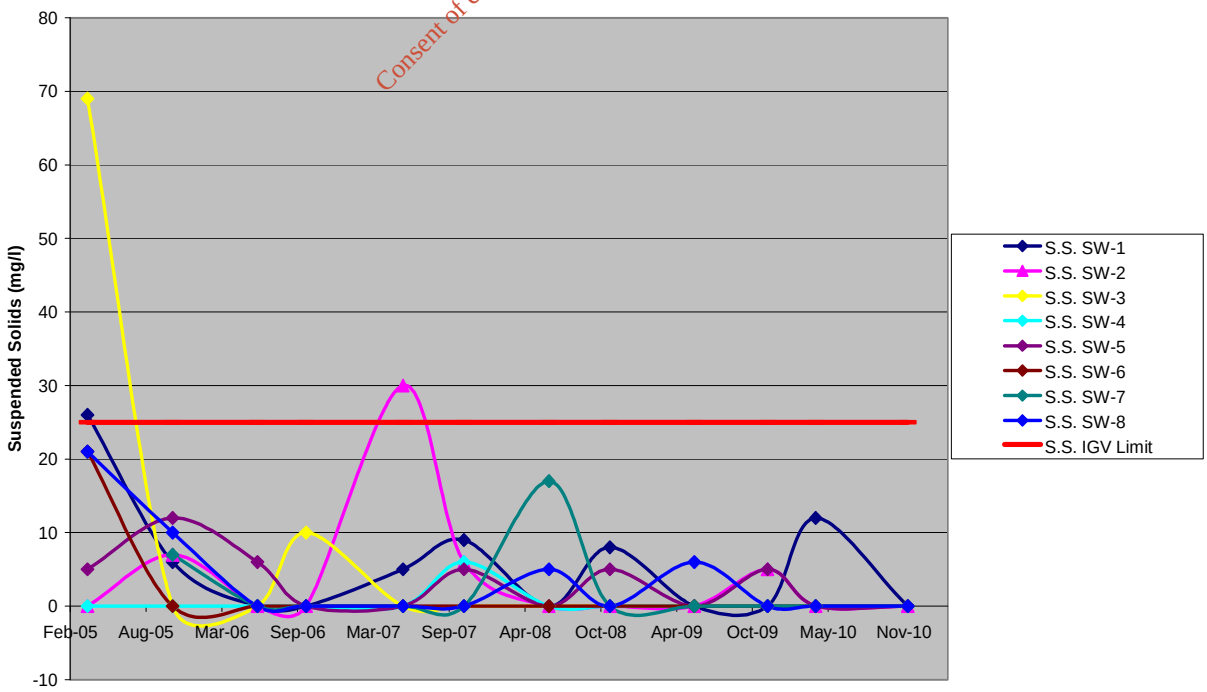
COD and BOD levels (mg/l) at surface water monitoring locations at Friarstown Landfill



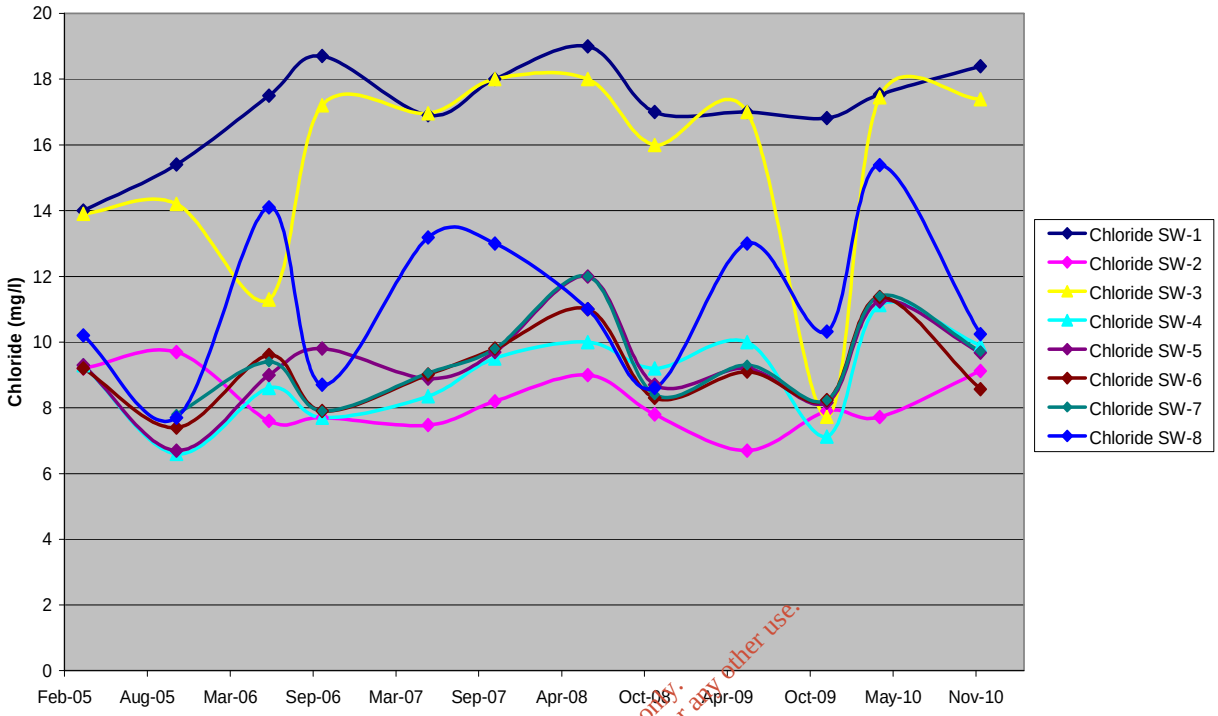
Ammonia Levels (mg/l) at surface water monitoring locations at Friartown Landfill



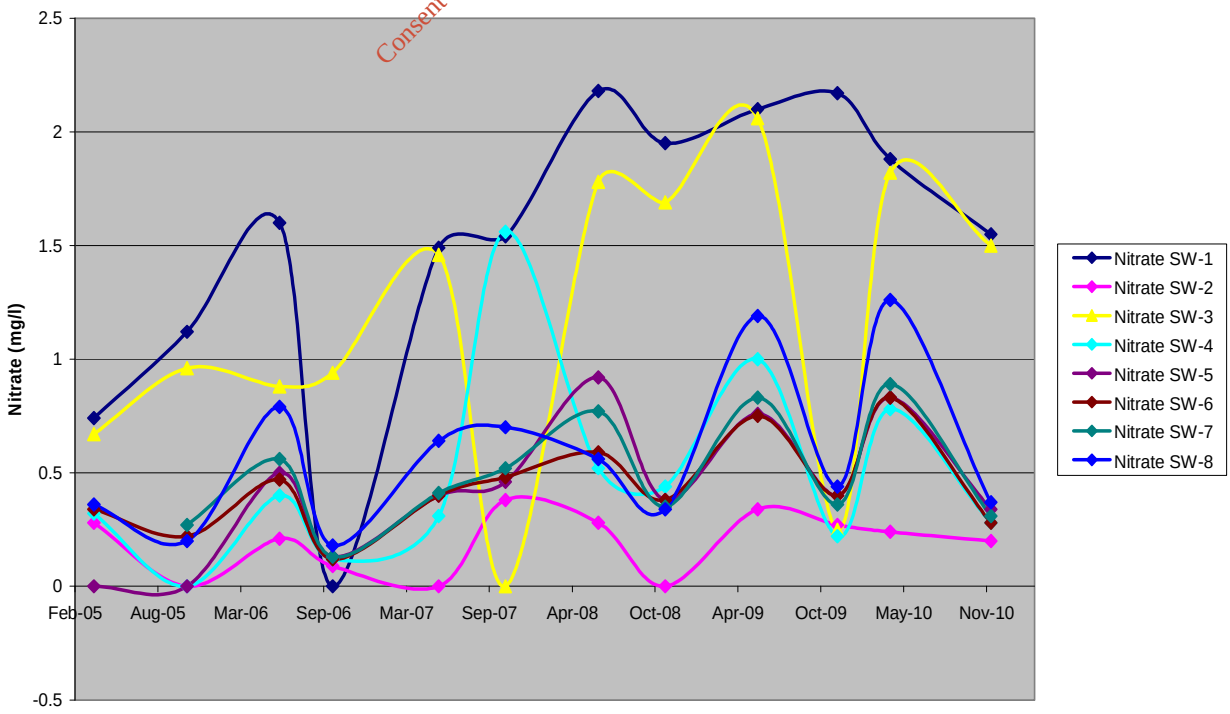
Suspended Solids levels (mg/l) at surface water monitoring locations at Friarstown Landfill



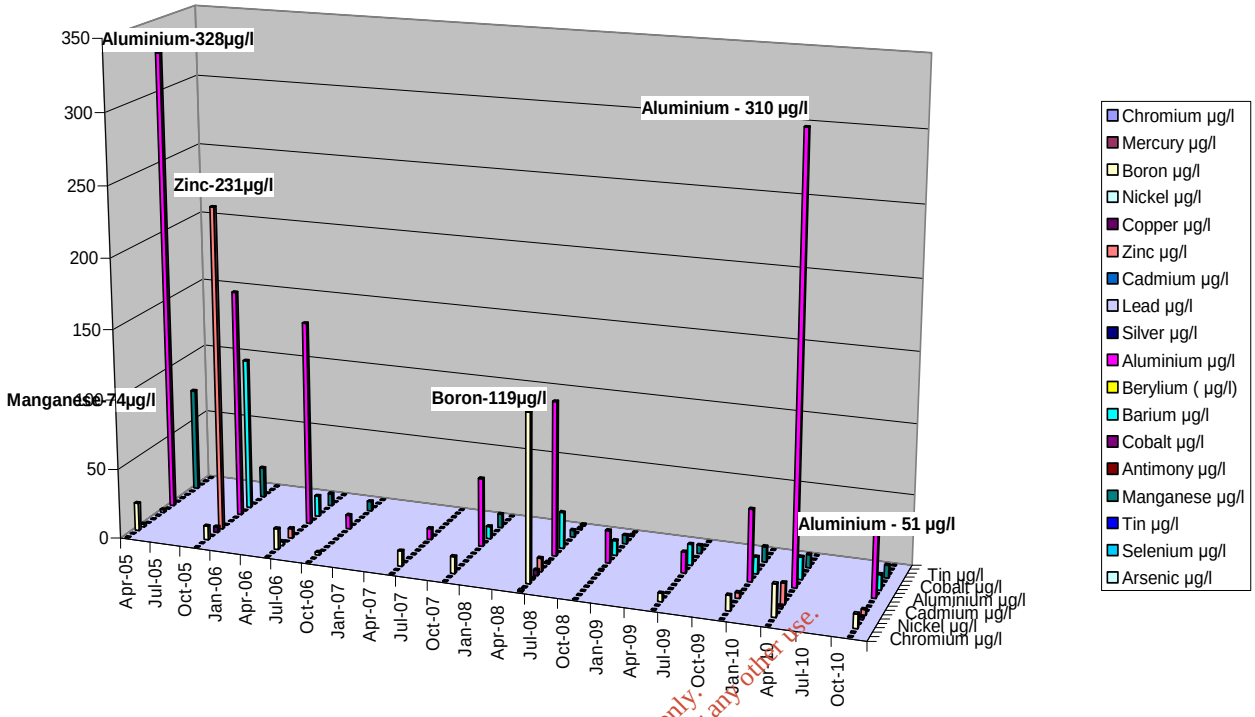
Chloride levels (mg/l) at surface water monitoring locations at Friarstown Landfill



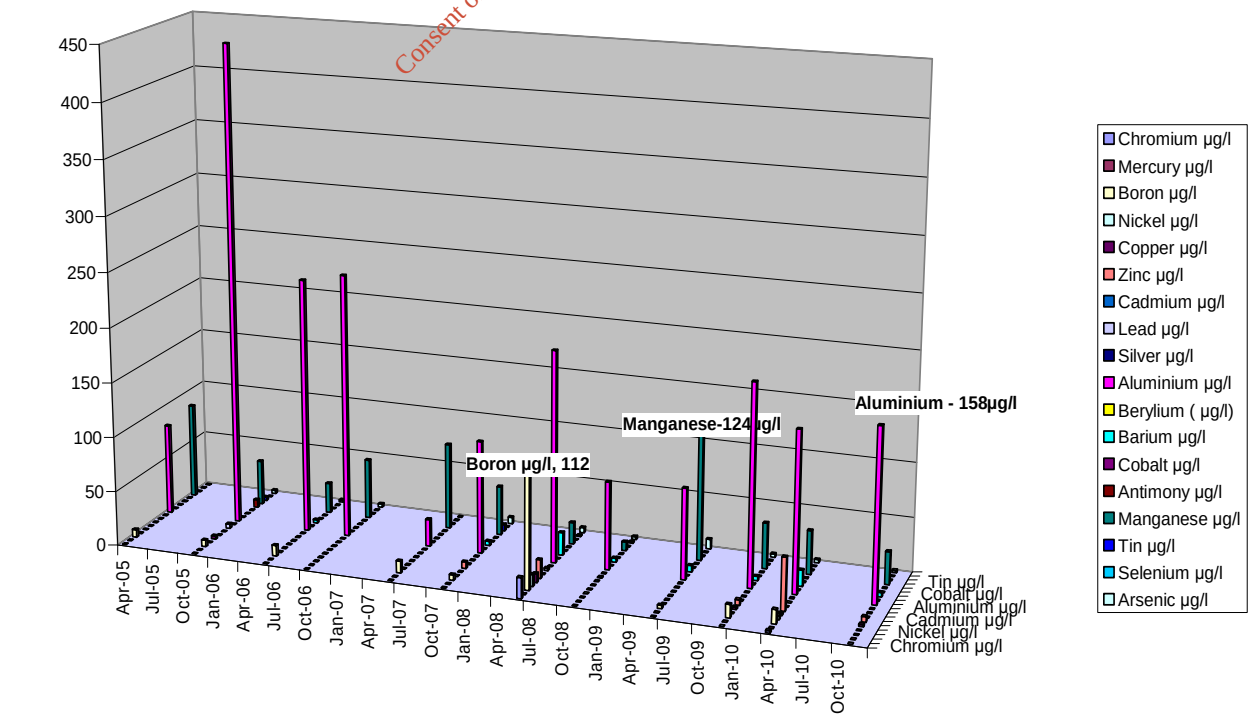
Nitrate levels (mg/l) at surface water monitoring locations at Friarstown Landfill



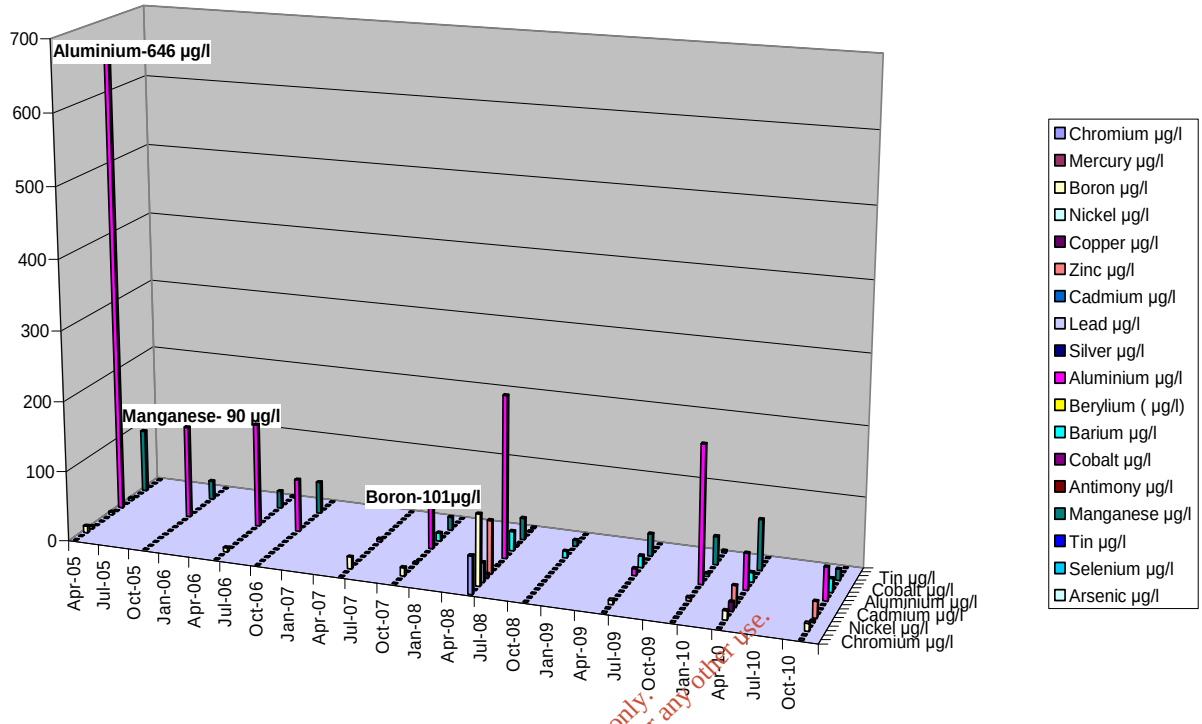
Metal levels (µg/l) at monitoring location SW-1 at Friarstown Landfill



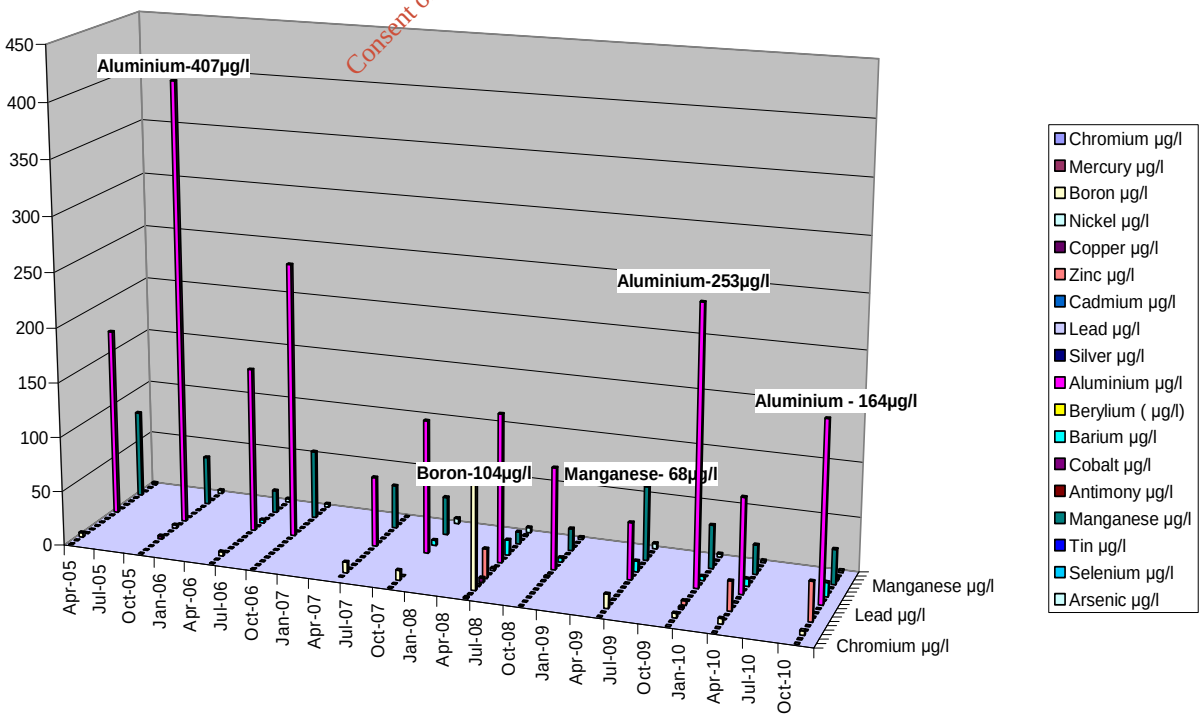
Metal levels (µg/l) at monitoring location SW-2 at Friarstown Landfill



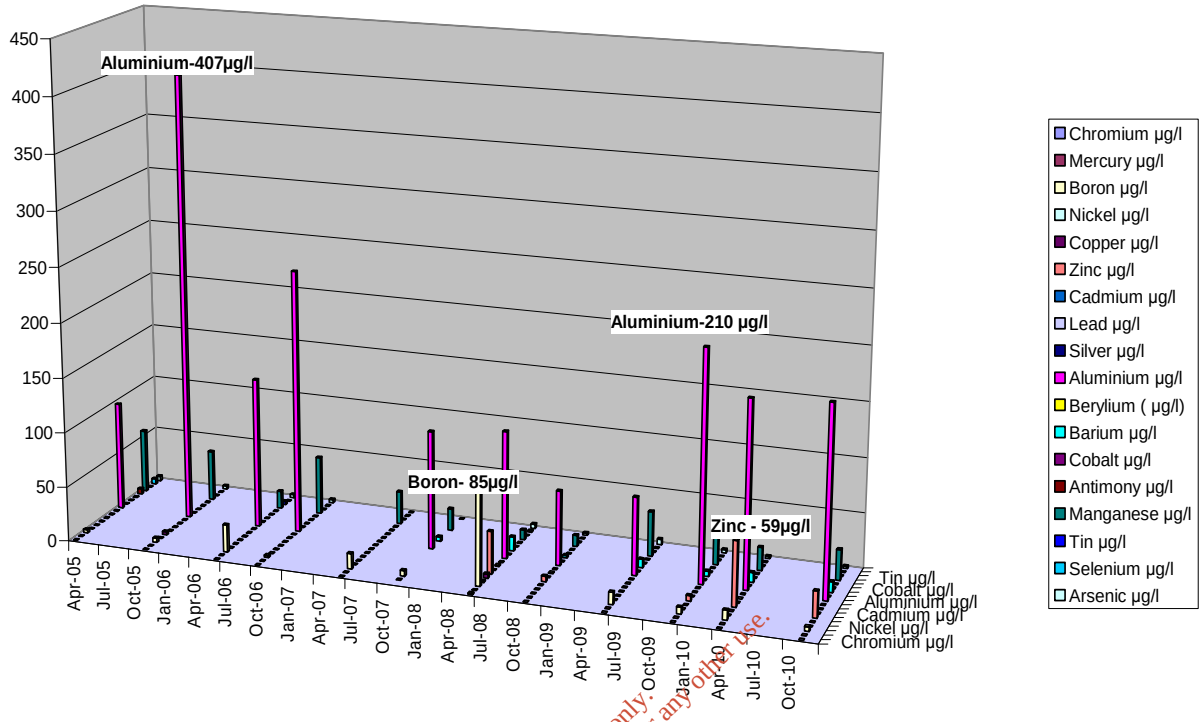
Metal levels (µg/l) at monitoring location SW-3 at Friarstown Landfill



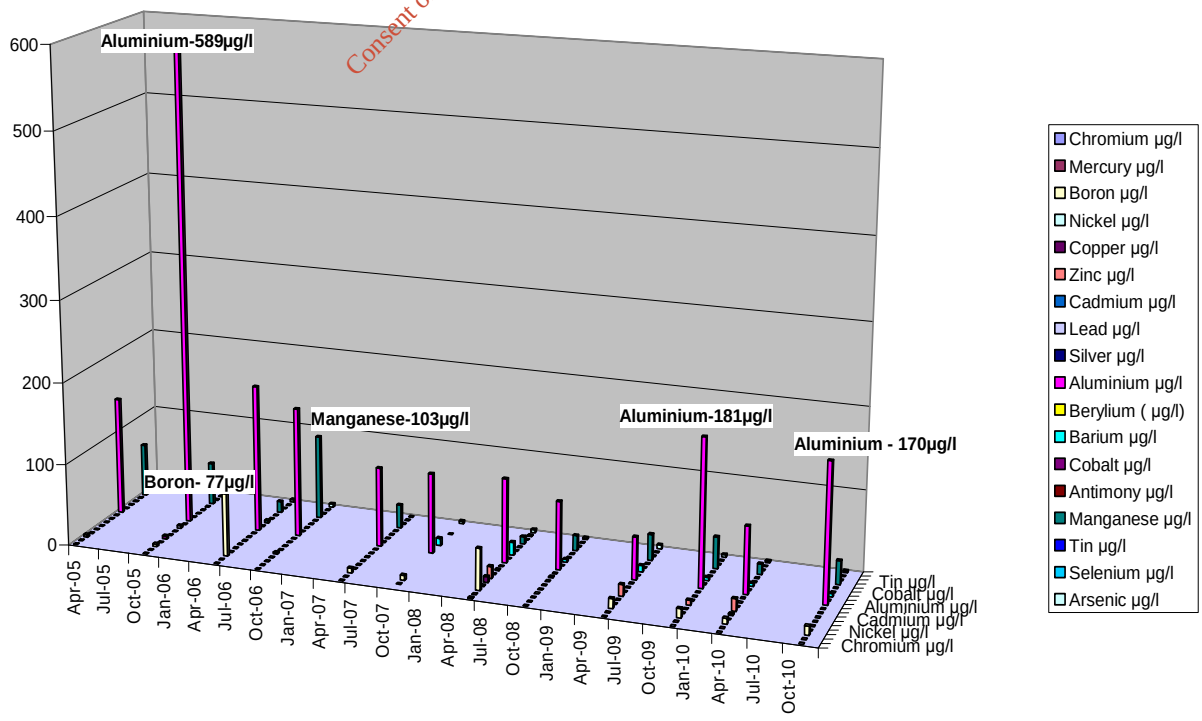
Metal levels (µg/l) at monitoring location SW-4 at Friarstown Landfill



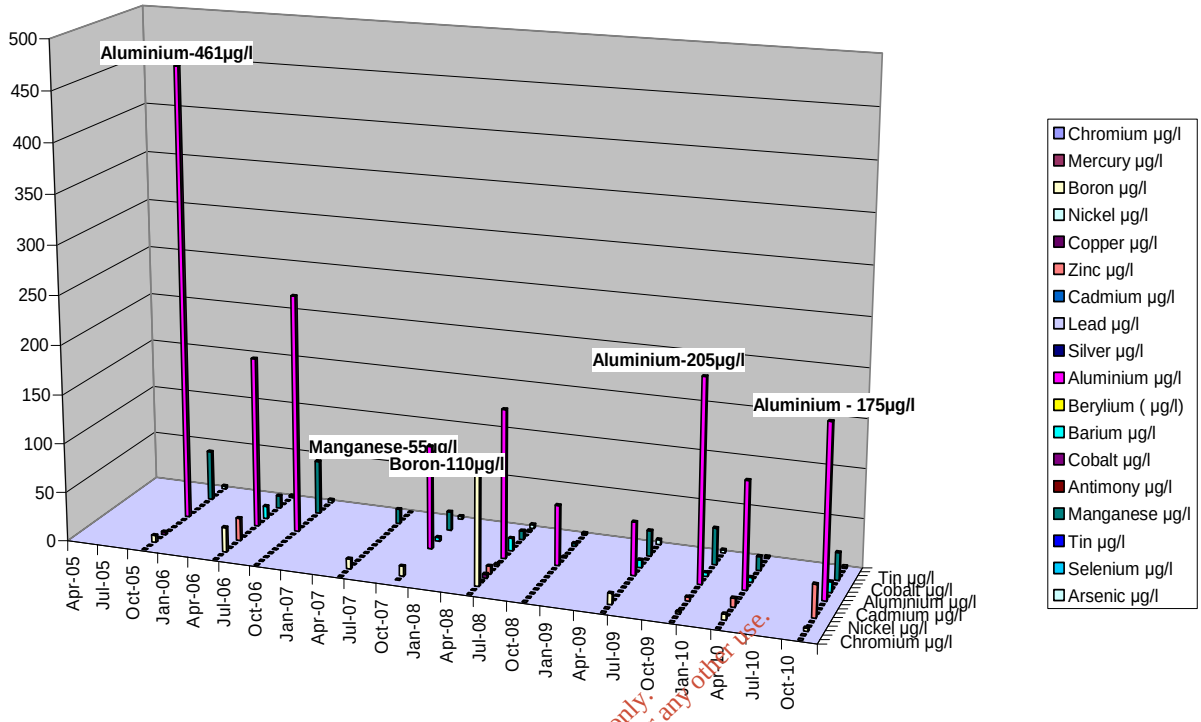
Metal levels (µg/l) at monitoring location SW-5 at Friarstown Landfill



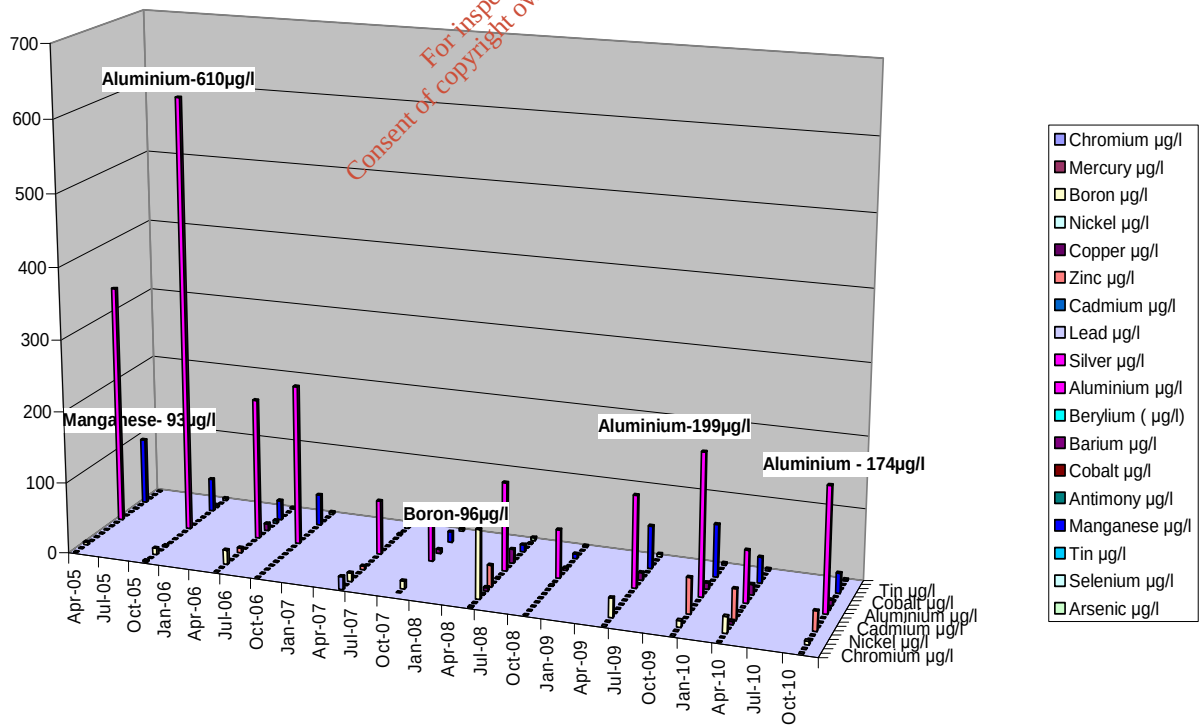
Metal levels (µg/l) at monitoring location SW-6 at Friarstown Landfill



Metal levels (µg/l) at monitoring location SW-7 at Friarstown Landfill

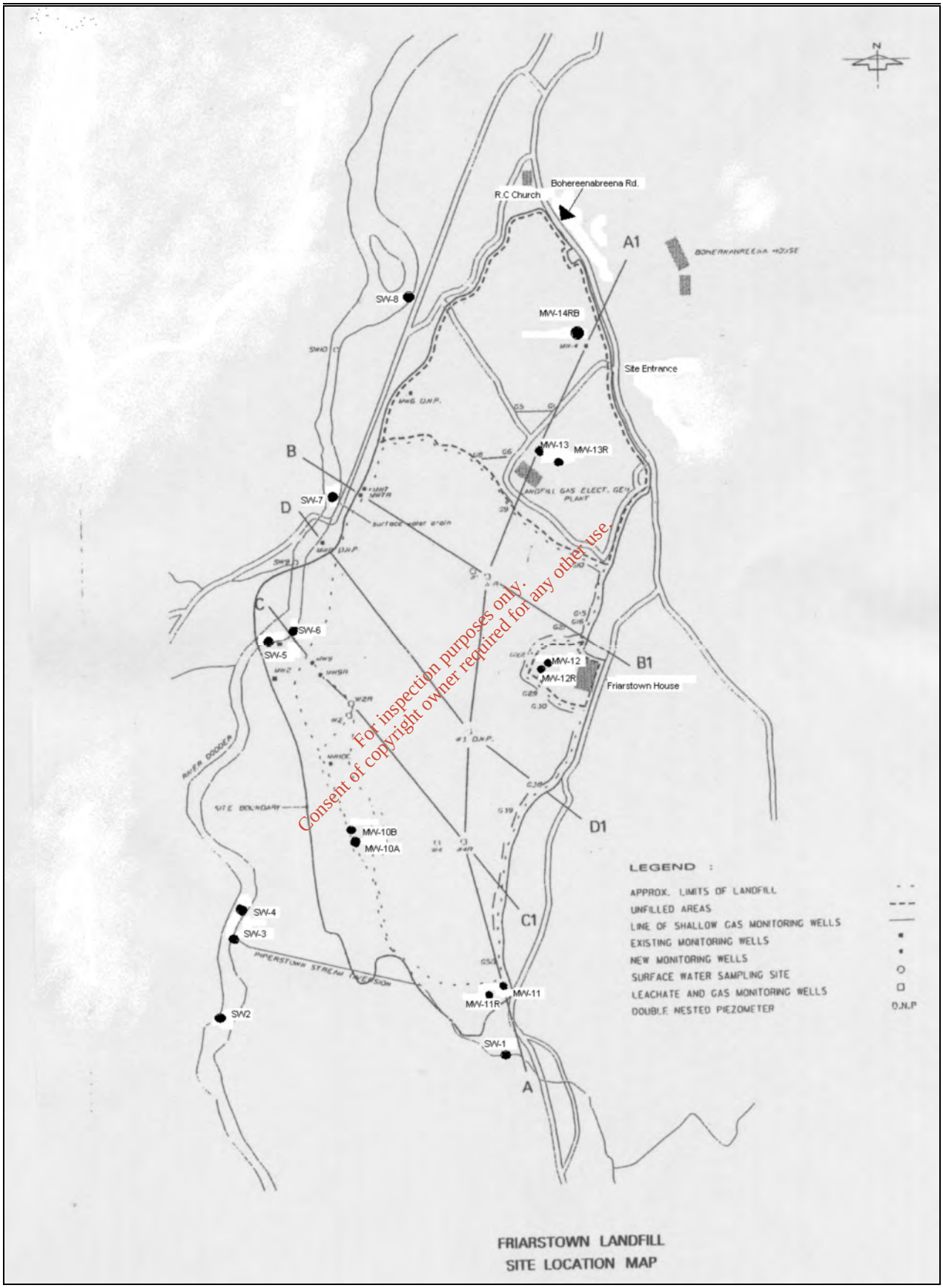


Metal levels (µg/l) at monitoring location SW-8 at Friarstown Landfill



APPENDIX 2

MONITORING LOCATION MAP



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ENVIRONMENTAL ASSESSMENT OF THE QUALITY OF SURFACE WATERS AT THE FRIARSTOWN LANDFILL SITE AT BOHERNABREENA, CO. DUBLIN .

For the Attention of: Mr. Joseph Bockarie
South Dublin County Council
Town Hall,
Tallaght,
Dublin 24

Prepared by: Mr. Jason Smyth
Environmental Scientist

Reviewed by: Mr. Peter Coogan
Environmental Team Leader

Report No: ECS5038

Monitoring Date: 06th December 2014

Reporting Date: March 2015

Bord na Móna Environmental Ltd T/A Anua Registered Office:
Main Street, Newbridge, Co Kildare, Ireland. Registered No: 303312, VAT No: IE6323313B

Executive Summary

At the request of South Dublin County Council, Anua Environmental was commissioned to perform sampling and analysis of surface waters at the Friarstown Landfill. The site was subsequently visited by Anua Environmental Scientists on the 06th December 2014 and surface water samples were returned to the laboratory for subsequent analysis.

Results obtained were compared to their respective limits set out under (a) the *"European Communities Quality of Surface Water Intended for the Abstraction of Drinking Water Regulations, 1989",* (b) the *"European Communities Environmental Objectives (Surface Waters) Regulations, 2009"* and (c) the *"European Communities (Quality of Salmonid Waters) Regulations, 1988".*

The following exceedance were noted

SW-1 Conductivity 1231μS/cm
BOD 8mg/l
COD 89mg/l
Suspended Solids 292mg/l

Ammonia exceeded the guideline limit at all locations with the exception of SW-1 ranging from 0.09mg/l to 0.33mg/l.
Additionally Nitrite exceeded its respective guideline limit of 0.05mg/l at SW-2 (0.19mg/l), SW-3 (32mg/l), SW-4 (0.1mg/l), SW-5 (0.18mg/l) and SW-7 (0.16mg/l).

No significant difference was noted between the upstream and downstream water quality with respect to the landfill site, which suggests that the landfill is having no significant impact on the water quality.

Respectively Submitted,

Mr. Jason Smyth
Environmental Scientist

Mr. Peter Coogan
Environmental Team Leader

1.0 INTRODUCTION

At the request of South Dublin County Council, Anua Environmental was commissioned to perform sampling and analysis of surface waters at the Friarstown Landfill. The site was subsequently visited by Anua Environmental staff on the 6th December 2014 and surface water samples were returned to the laboratory for subsequent analysis.

This report details the sampling methodologies, procedures followed and results obtained.

2.0 METHODOLOGY

2.1 Surface Water Sampling

Grab samples of surface water were extracted in accordance with the following standards;

TABLE 2.1 SAMPLING PROCEDURE AND GUIDANCE	
ISO Standard	**Description**
ISO 5667–1–2006	Guidance on the design of sampling programmes and sampling techniques
ISO 5667–3–2012	Guidance on sample preservation and handling
ISO 5667–14–1998	Guidance on quality assurance of environmental sampling & handling
ISO 5667–6–2005	Guidance on sampling rivers & streams

Sampling was conducted in strict accordance with Anua Environmental recognised Standard Operations Procedures (SOP) TS–W–02. All samples were returned to the laboratory, and stored between 1–8°C.

2.2 Sampling Locations

TABLE 2.2: LOCATION OF SURFACE WATER SAMPLING STATIONS	
Sample Point	**Location**
SW–1	Located upstream of the landfill at the entry point of the Piperstown stream onto the site (south of the site).
SW–2	Located approx 50m upstream of the SW–3 location.
SW–3	SW–3 is taken from the diverted Piperstown Stream at the point where it enters the River Dodder
SW–4	Located approx 50m downstream of SW–3
SW–5	Located beside MW–1 monitoring well
SW–6	Located approx 50m downstream from where the groundwater drain flows into the river.
SW–7	Located 20m downstream of the Piperstown Bridge.
SW–8	Furthest point downstream of the Friarstown landfill.

3.0 RESULTS

The results of the investigation carried out by Anua Environmental are presented as follows:

Table 3.1 Weather Data from Met Éireann – Casement

Table 3.2: Results of field measurements taken at each surface water sampling point

Table 3.3: Results of chemical analysis of surface water samples.

Table 3.4: Results of metal scan of surface water samples.

3.1 Weather Data

TABLE 3.1: WEATHER DATA FROM MET ÉIREANN – CASEMENT			
Date	**Rainfall (mm)**	**Max Temp. (^{0}C)**	**Min Temp. (^{0}C)**
02/12/2014	0	6.4	-0.3
03/12/2014	0	6.5	-0.8
04/12/2014	0.6	7.0	1.4
05/12/2014	0.3	5	1.3
06/12/2014	0.1	9.6	1.8
	Total 1.0	***Average 6.9***	***Average 0.68***

3.2 Surface water Results

TABLE 3.2: FIELD MEASUREMENTS TAKEN AT SURFACE WATER SAMPLING POINTS								
Parameter	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**
Temperature (^{o}C)	6.6	6.9	6.5	6.4	6.2	6.3	6.4	6.5
Dissolved Oxygen (mg/l)	12.62	13.53	13.61	13.39	13.51	13.38	13.23	13.26
Odour / Visual	Clear, No SS, No Odour	Clear, No SS, No Odour	Clear, No SS, No Odour	Pale Yellow, No SS, No Odour	Clear, No SS, No Odour	Clear, No SS, No Odour	Clear, No SS, No Odour	Pale Yellow, No SS, No Odour

TABLE 3.3: RESULTS OF CHEMICAL ANALYSIS OF SURFACE WATER SAMPLES									
Parameter	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**	**Water Quality Standard**
pH (pH units)	6.7	8.0	8.0	8.0	8.0	8.0	8.0	8.0	**6.0 – 9.0** Note 2
Conductivity µS/cm@25^{0}C	**1231**	200.2	245.1	208.1	198.1	228.1	249.6	252.3	**1000 µS/cm** Note 1
BOD mg/l	**8**	<2	<2	<2	<2	<2	<2	<2	**High Status: ≤ 2.2 mg/l Good Status: ≤2.6 mg/l** Note 2
COD mg/l	**89**	16	22	24	13	17	14	12	**40 mg/l** Note 3
Ammonia as N mg/l	<0.02	**0.12**	**0.09**	**0.29**	**0.09**	**0.1**	**0.33**	**0.32**	**High Status: ≤0.04 mg/l Good Status ≤0.065mg/l** Note 2
Suspended Solids mg/l	**292**	<5	<5	<5	<5	<5	7	<5	**25 mg/l** Note 3
Total Alkalinity ($CaC0_3$) mg/l	627	82	82	84	76	78	81	99	–
TOC mg/l	11	7	7	7	7	7.3	6.8	6.7	–
Chloride mg/l	20	11	11	11	11	19	13	12	**250 mg/l** Note 1
Sulphate mg/l	8.3	6	6	6.1	5.9	6	7.3	7.1	**200 mg/l** Note 1
Nitrate as N mg/l	<0.04	0.49	0.34	0.63	0.46	0.69	0.72	0.9	**50 mg/l** Note 1
Nitrite as N mg/l	<0.03	**0.19**	**0.32**	**0.1**	**0.18**	<0.03	**0.16**	<0.03	**0.05mg/l** Note 3
Total Phosphorus mg/l	0.36	<0.05	0.05	<0.05	0.05	<0.05	<0.05	0.07	–

Notes:

Note 1: *Water Quality Standard = Water Quality Standards set in the European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989. Limit values for A2 waters are shown.*

Note 2*: European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009).*

Note3*: European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293 of 1988).*

< Indicates less than the laboratory detection limit

TABLE 3.4: RESULTS OF METAL ANALYSIS OF SURFACE WATERS									
Parameter	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**	**Water Quality Standard**
Sodium mg/l	10	6.9	7	8.4	7.9	8.8	8	9.7	–
Magnesium mg/l	3.9	2.6	2.6	3	2.8	3.1	3.6	4.1	–
Potassium mg/l	1.4	0.8	1.3	1	0.8	11	1	1.1	–
Calcium mg/l	60	28	30	35	30	34	35	46	–
Chromium µg/l	<2	<2	<2	<2	2	<2	<2	<2	**3.4 µg/l** Note 2
Mercury µg/l	<1	<1	<1	<1	<1	<1	<1	**3**	**1µg/l** Note 1
Boron µg/l	7	6	6	6	5	5	9	8	**200 µg/l** Note 1
Nickel µg/l	<2	<2	<2	<2	<2	<2	<2	<2	–
Copper µg/l	<2	<2	<2	<2	<2	<2	<2	<2	**5µg/l** Note 2
Zinc µg/l	10	<2	2	<2	<2	<2	<2	44	**50 µg/l** Note 2
Cadmium µg/l	<2	<2	<2	<2	<2	<2	<2	<2	**5µg/l** Note 1
Lead µg/l	<2	<2	<2	<2	<2	<2	<2	<2	**50 µg/l** Note 1
Silver µg/l	<2	<2	<2	<2	<2	<2	<2	<2	–
Aluminium µg/l	<2	42	85	82	82	91	40	80	–
Berylium µg/l	<2	<2	<2	<2	<2	<2	<2	<2	–
Barium µg/l	10	4	8	2	<2	2	4	12	**1000µg/l** Note 1
Cobalt µg/l	<2	<2	<2	<2	<2	<2	<2	<2	–
Antimony µg/l	<2	<2	<2	<2	<2	<2	<2	<2	–
Manganese µg/l	5	34	35	40	36	41	47	48	**300 µg/l** Note 1
Tin µg/l	<2	<2	9	<2	<2	<2	3	<2	–
Selenium µg/l	<2	<2	<2	<2	<2	3	<2	<2	**10 µg/l** Note 1
Arsenic µg/l	<2	2	2	2	2	<2	2	3	**25 µg/l** Note 2
Iron mg/l	0.1	0.2	0.4	0.3	0.3	0.3	0.3	0.3	**2 mg/l** Note 1

Notes:

Note 1: *Water Quality Standard = Water Quality Standards set in the European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989. Limit values for A2 waters are shown.*

Note 2*: European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009).*

Note3*: European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293 of 1988).*

< Indicates less than the laboratory detection limit

4.0 DISCUSSION

Tables 3.2 – 3.4 present the results of physical and chemical determinations of the eight surface water samples (SW–1, SW–2, SW–3, SW–4, SW–5, SW–6, SW–7 and SW–8) from the receiving watercourses located within the vicinity of the Friarstown Landfill site.

The results for the parameters obtained are referenced to their respective limits set out under (a) the *"European Communities Quality of Surface Water Intended for the Abstraction of Drinking Water Regulations, 1989",* (b) *the "European Communities Environmental Objectives (Surface Waters) Regulations, 2009"* and (c) the *"European Communities (Quality of Salmonid Waters) Regulations, 1988".*

SW–1 (located upstream of the landfill at the entry point of the Piperstown stream onto the site south of the site) recorded conductivity levels of 1,231µS/cm which is an significant increase on all the previous results obtained for SW-1 with the highest recorded conductivity of 449µS/cm from June 2011. This point was found to have the highest conductivity with the remaining surface water locations ranging from 198.1µS/cm at SW–5 to 252.3µS/cm at SW–8. These findings are in keeping with previous trends apart from result for SW-1 (see trends attached in Appendix 1).

BOD result for SW-1 (8mg/l) was above the European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. No. 272 of 2009) for good status of surface water body (<2.6mg/l). BOD levels were found to be below the limit of detection (<2 mg/l) for seven of the eight surface water monitoring locations.

The levels of Suspended Solids were found to be below the limit outlined for the Salmonid Water Regulations at six of the eight monitoring points; SW-1(<5mg/l→292mg/l) and SW-7(<5mg/l→7mg/l) recorded an increase in Suspended solids when compared to previous results and in the case of SW-1 is now above the limit outlined for the Salmonid Water Regulations (25 mg/l). Suspended Solids results were undetected (<5 mg/l) at the remaining monitoring locations.

Levels of COD have remained within naturally varying trended levels as displayed in *Appendix I.* COD levels recorded during this monitoring event ranged from 12 mg/l at SW–8 to 89 mg/l at SW–1. Results for SW-1 (89mg/l) have increased since the previous monitoring event and are now above the above the *"European Communities Quality of Surface Water Intended for the Abstraction of Drinking Water Regulations, 1989"* limit, (40mg/l).

Ammonia levels ranged from <0.02 to 0.33 mg/l across the eight monitoring locations, with just one location SW-1 which is within the *"good status"* limit value as stated in the *"European Communities Environmental Objectives (Surface Waters) Regulations, 2009"*. The remaining locations above the *"good status"* limit value.

Total Alkalinity, Chloride, Sulphate and Nitrate levels were highest at monitoring locations SW–1 (627 mg/l, 20 mg/l, 8.3 mg/l and 1 mg/l, respectively) (located upstream of the landfill at the entry point of the Piperstown stream onto the site (south of the site)). The levels of the

mentioned parameters remain in keeping with previous trends displaying minor fluctuations at each of the remaining monitoring locations.

Undetectable levels of Total Phosphorus were recorded at six of the monitoring locations. Total Phosphorus was present at the following locations, SW-3 (<0.05 0.13mg/l) and SW-5 (<0.05 1.3mg/l) both increasing since previous monitoring event

Nitrite was recorded as below the detection limit of <0.03 mg/l at monitoring locations SW-1, SW-6 and SW-8. Nitrite results at SW-2(0.19mg/l), SW-3 (0.32mg/l), SW-4 (0.10mg/l), SW-5 (0.18mg/l) and SW-7 (0.16mg/l) have increased since the previous monitoring event and are now above the outlined limit by "*European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293 of 1988)"* (0.05mg/l).

Chromium, Cadmium, Lead, Silver, Beryllium, Cobalt, Nickel, Antimony and Copper were not detected at any of the eight monitoring locations. Zinc was found to be slightly elevated at SW-1 (10μg/l) and SW-8 (44μg/l) but remains below the limit value of 50μg/l. Mercury was found to be slightly elevated at SW-8 (3μg/l) which is above the limit set out in "*Water Quality Standard = Water Quality Standards set in the European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989. Limit values for A2 waters are shown"* (<1μg/l).

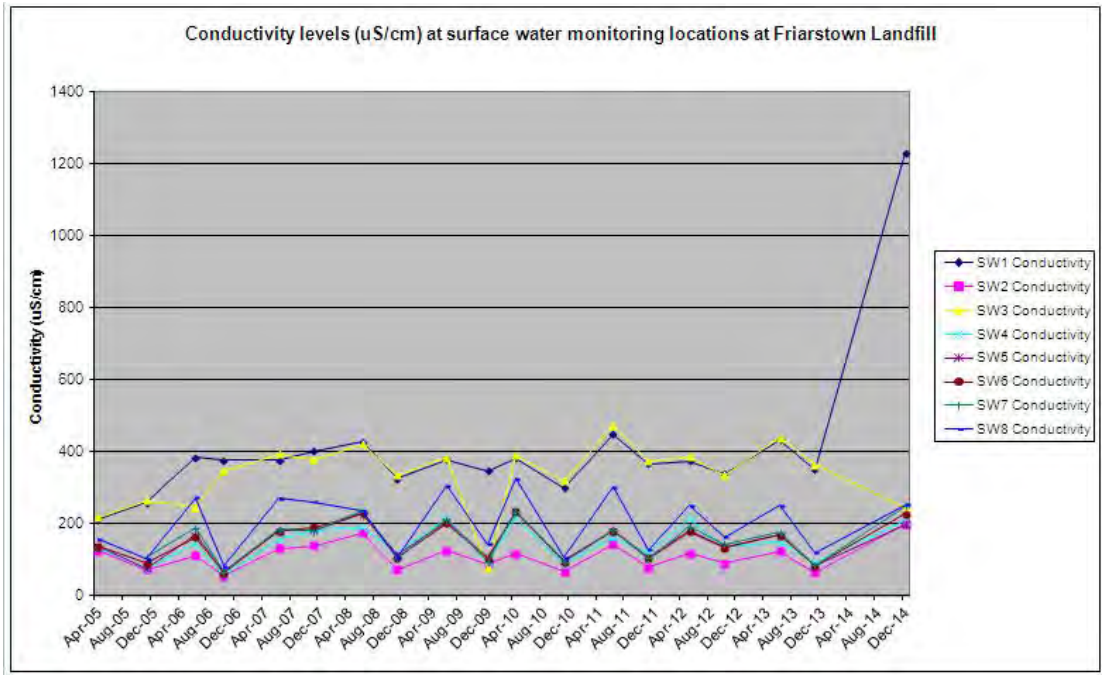
amounts of Arsenic was detected across the monitoring locations with the exception of SW-1 and SW-6 (<1μg/l). Remaining levels are consistent with previous monitoring events.

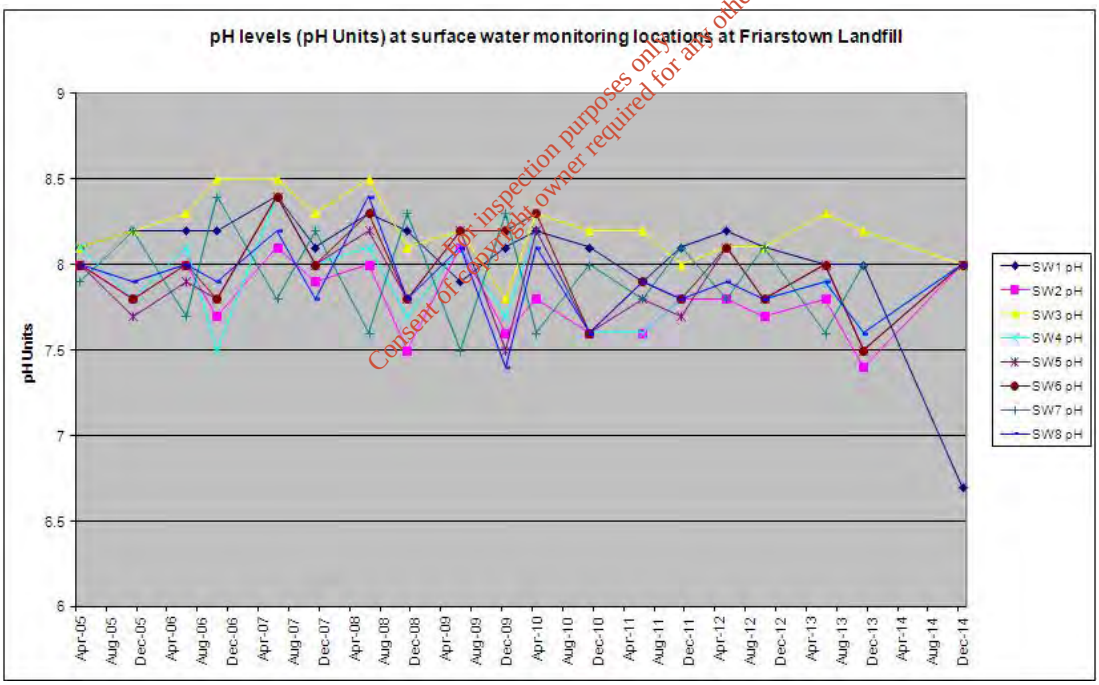
Recorded levels of Manganese Sodium, Magnesium and Potassium display minor fluctuations in concentrations at all monitoring locations compared to the previous monitoring event (see *Appendix1).*

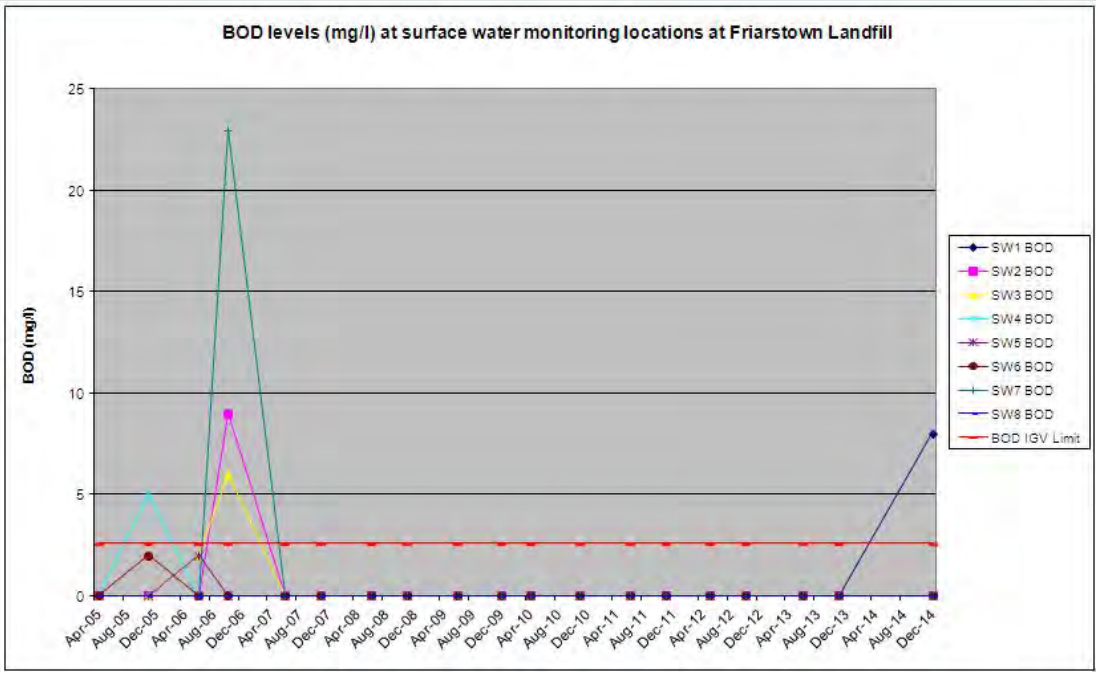
Aluminium concentrations displayed a reduction of concentration across all of the monitoring locations compared to previous trends, the highest level detected was at SW-6 (91μg/l).

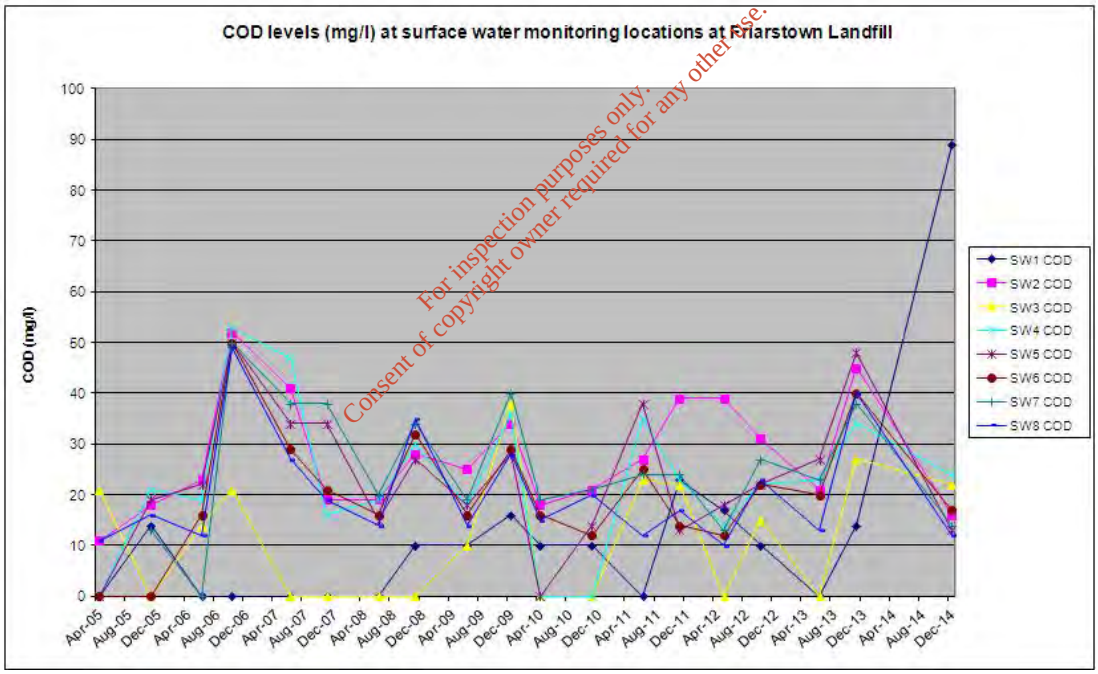
Appendix 1

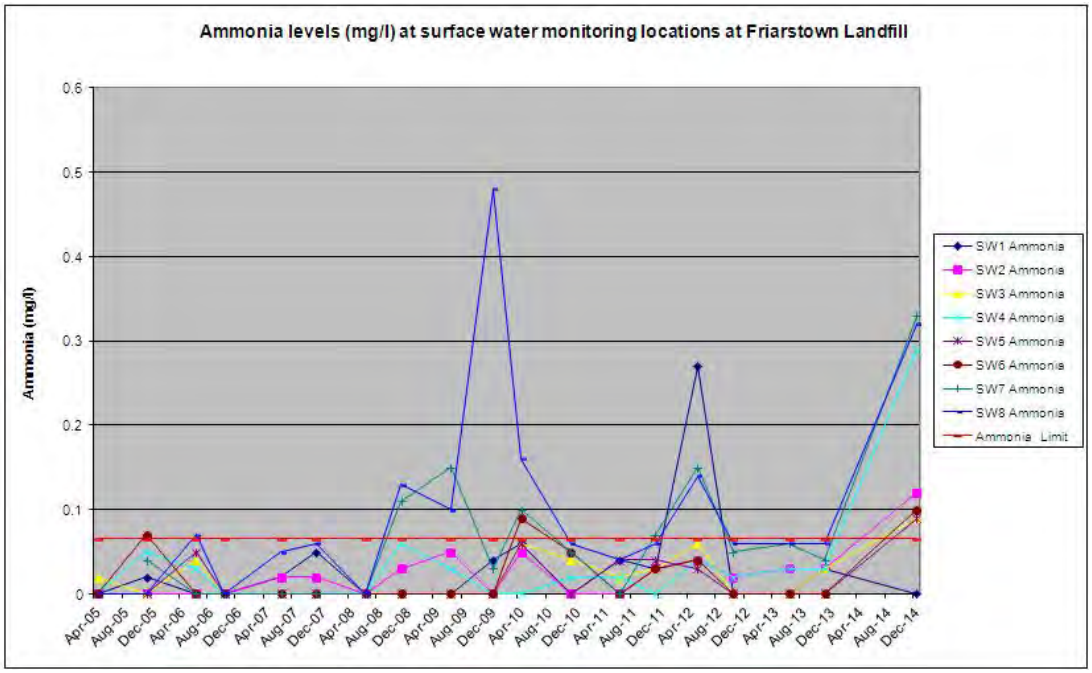
Trended Graphs

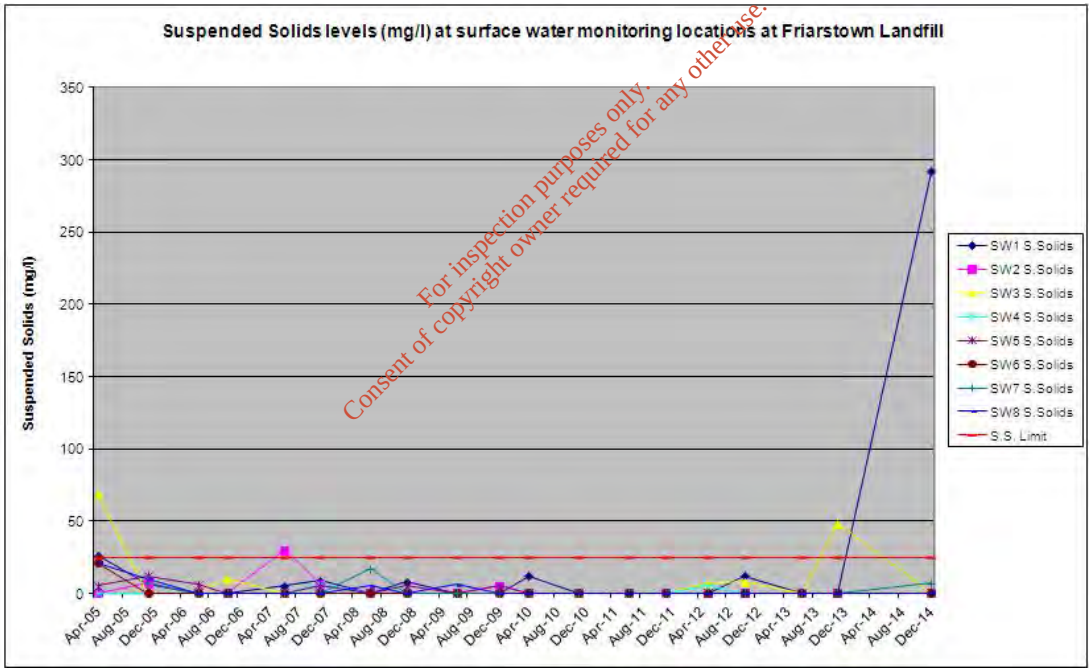


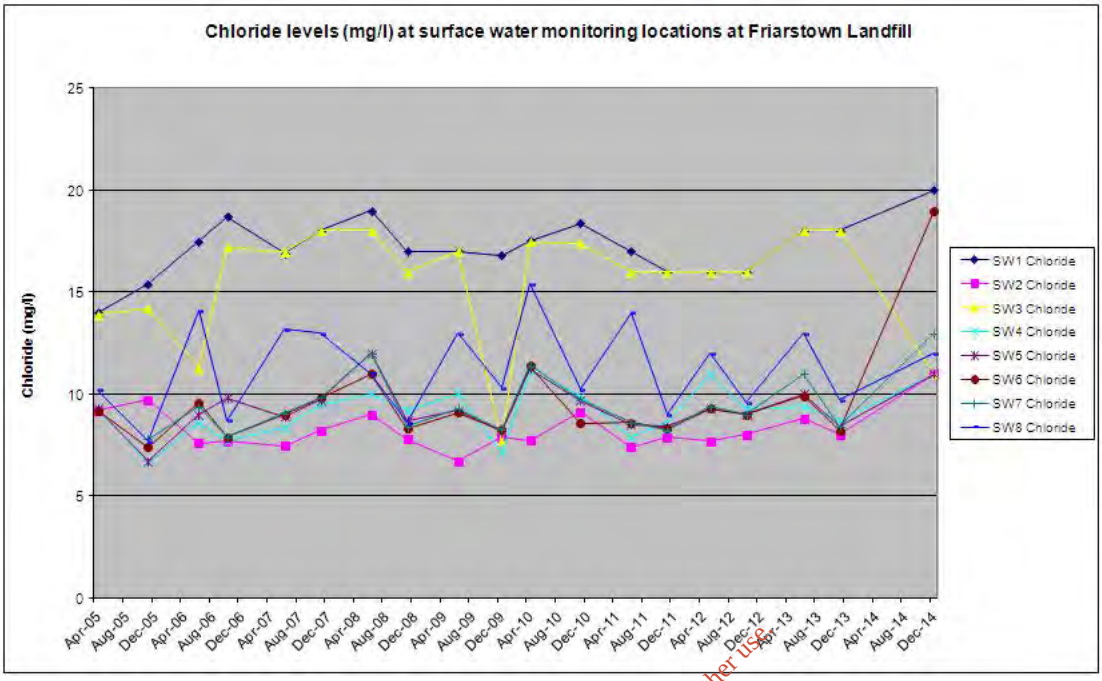


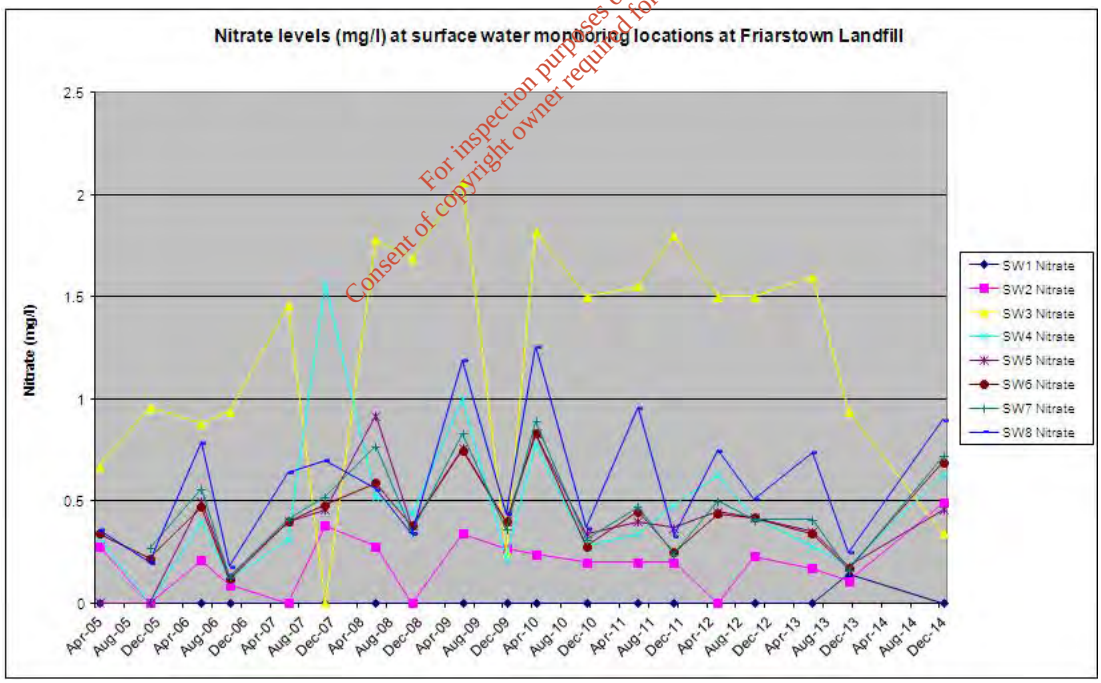


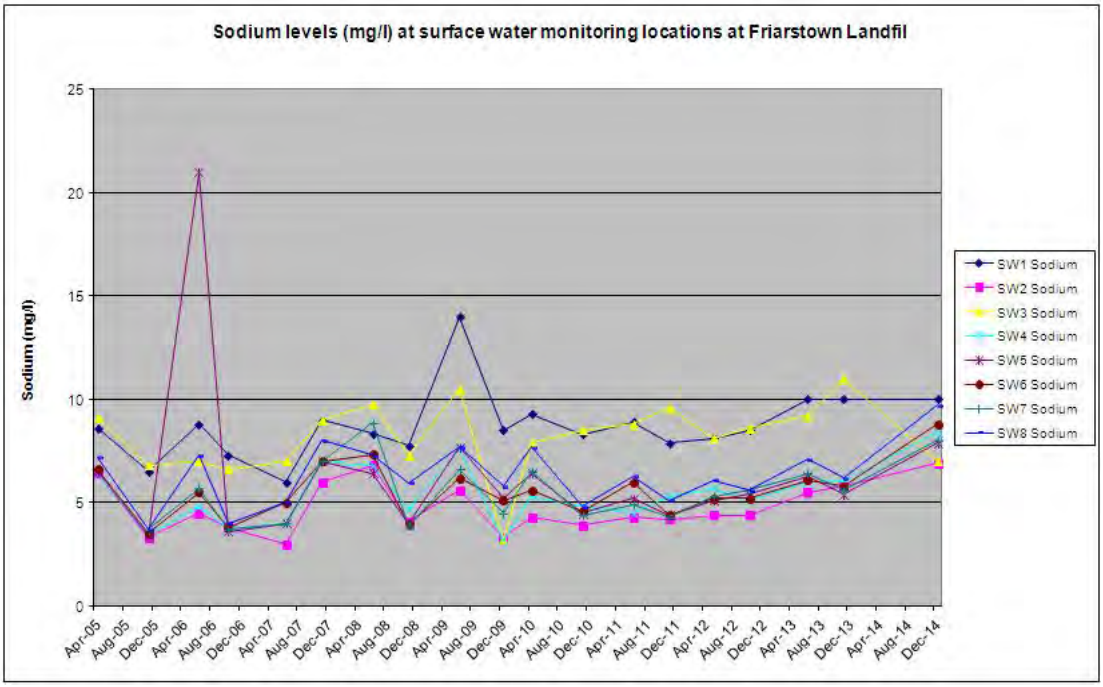


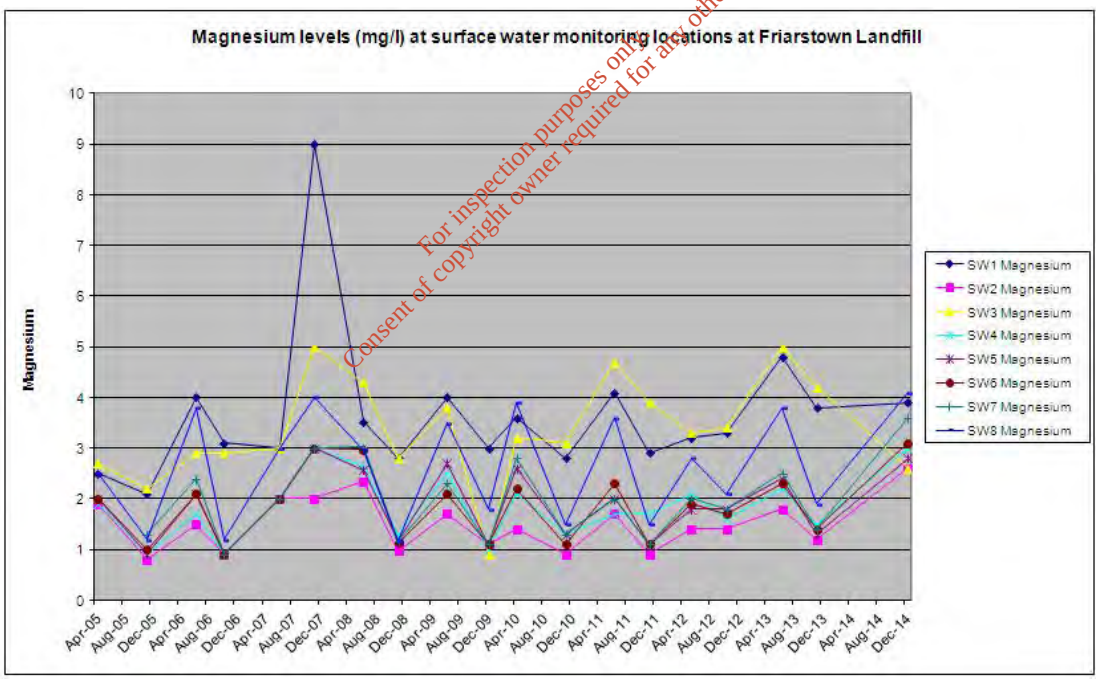


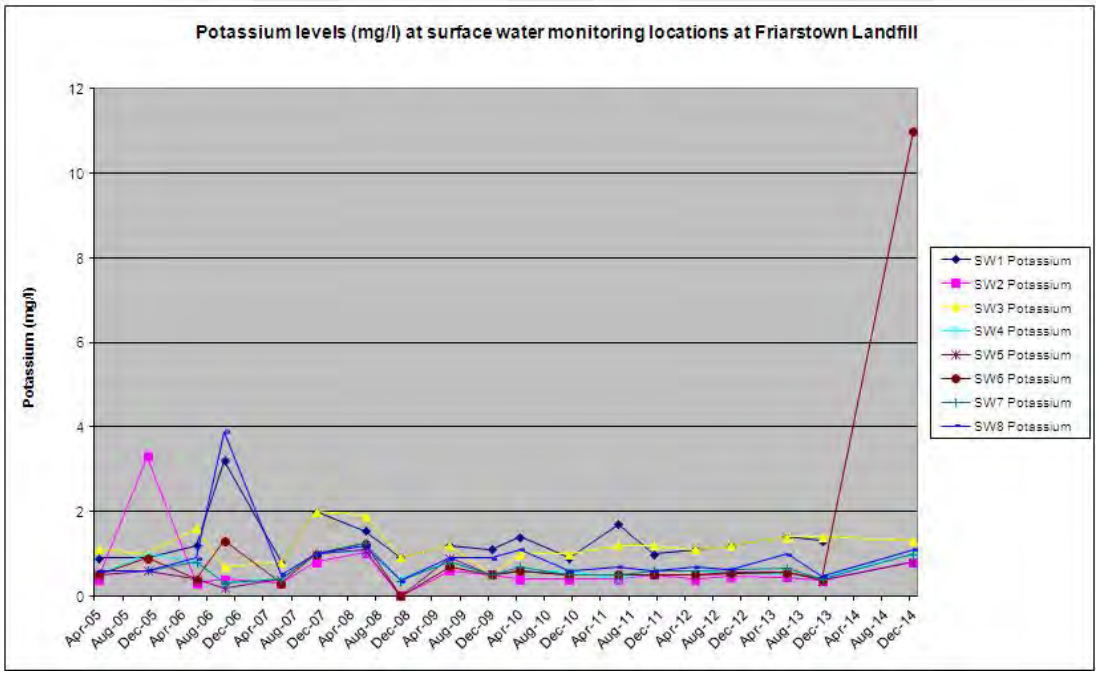


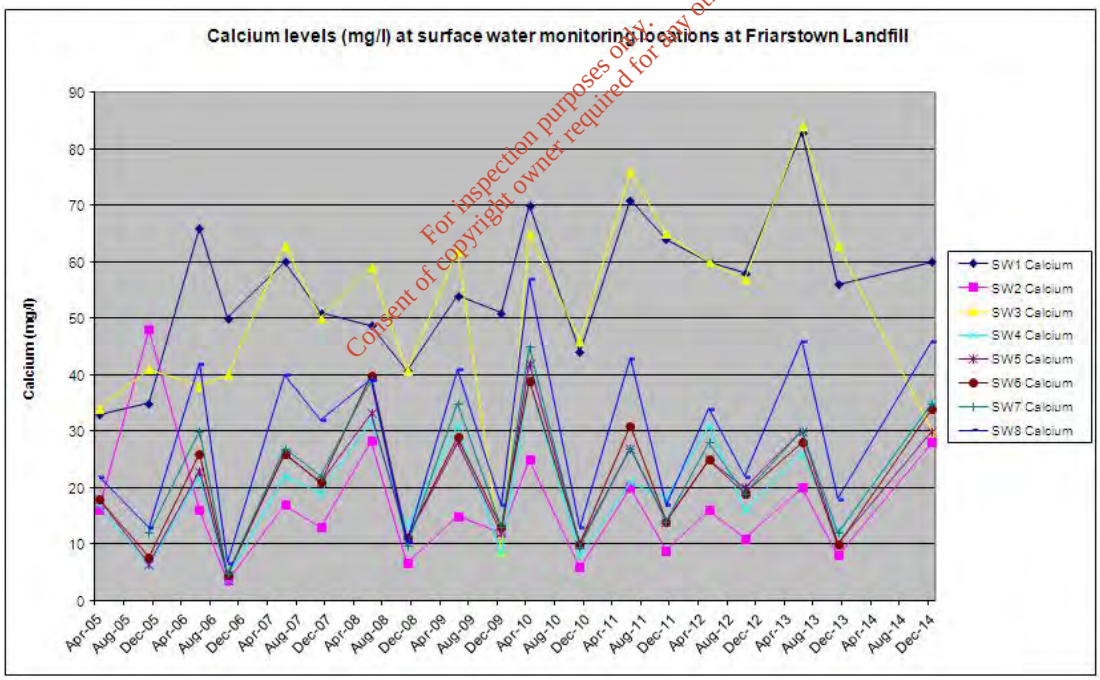


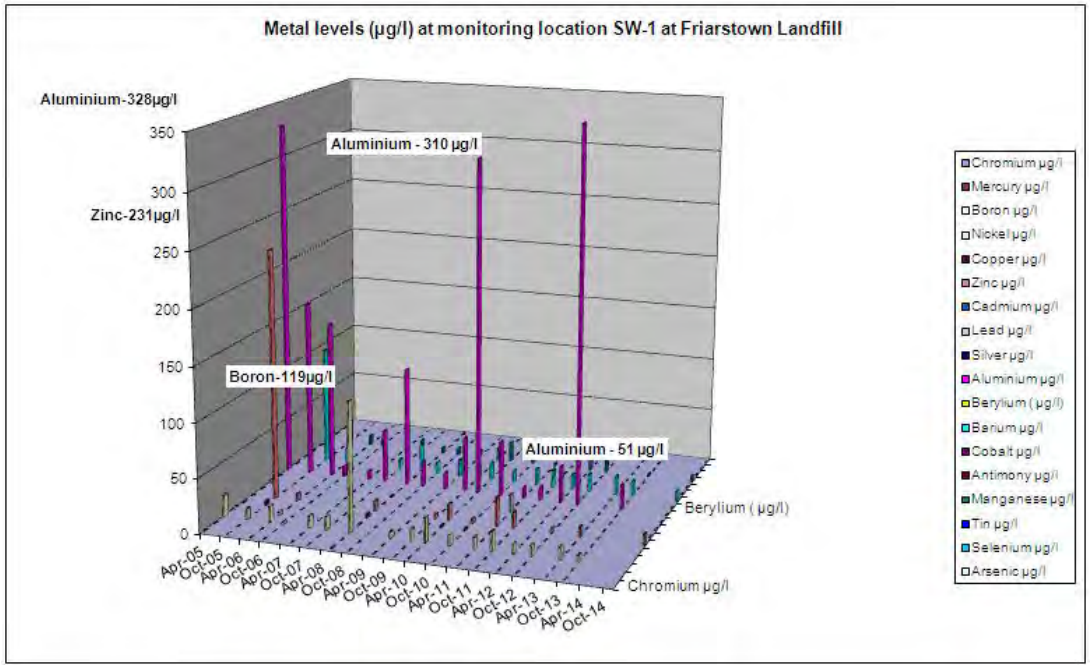


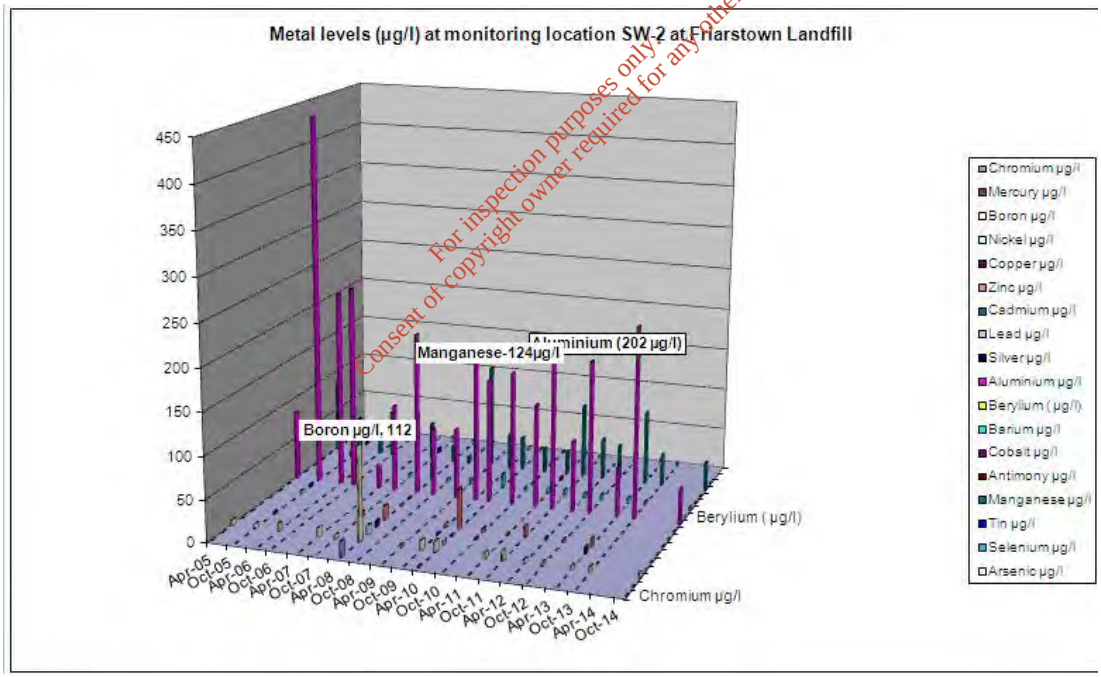


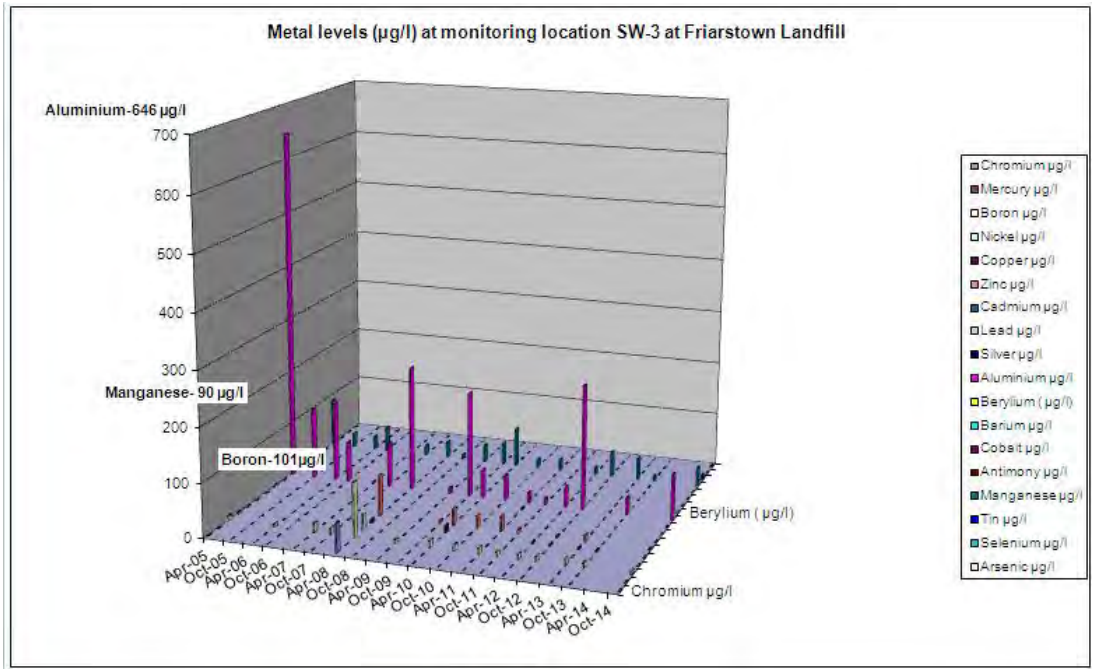


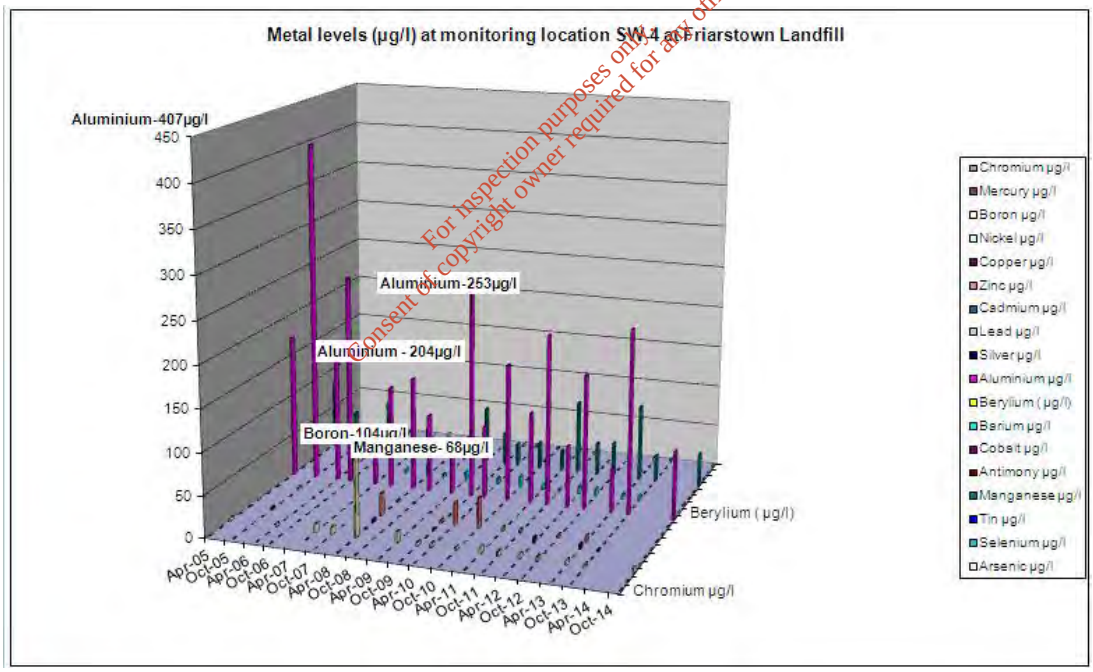


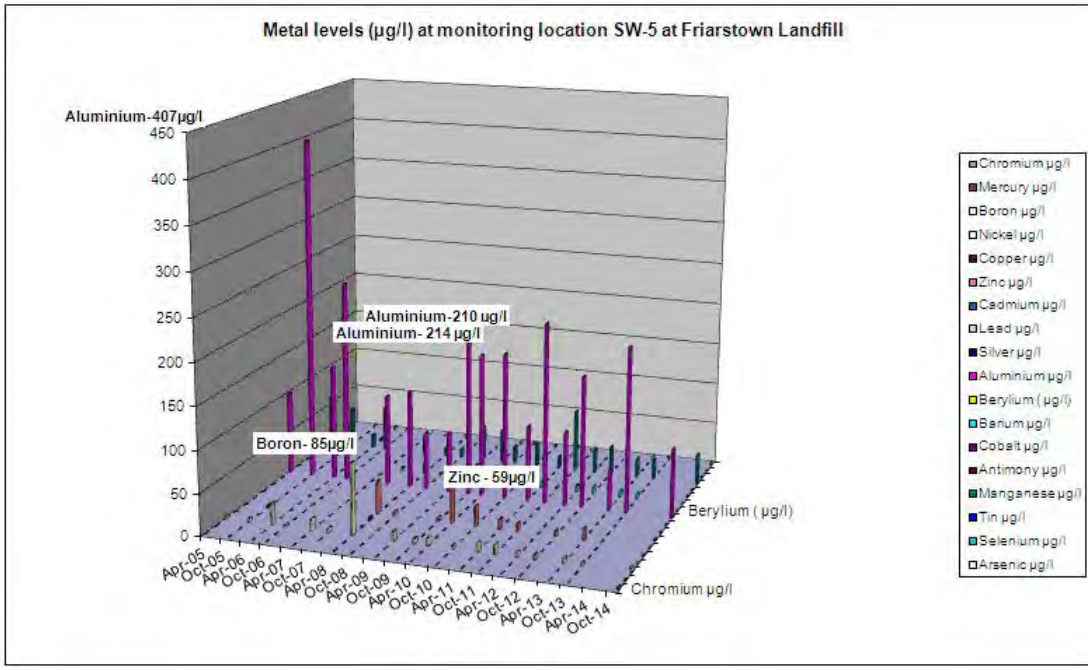


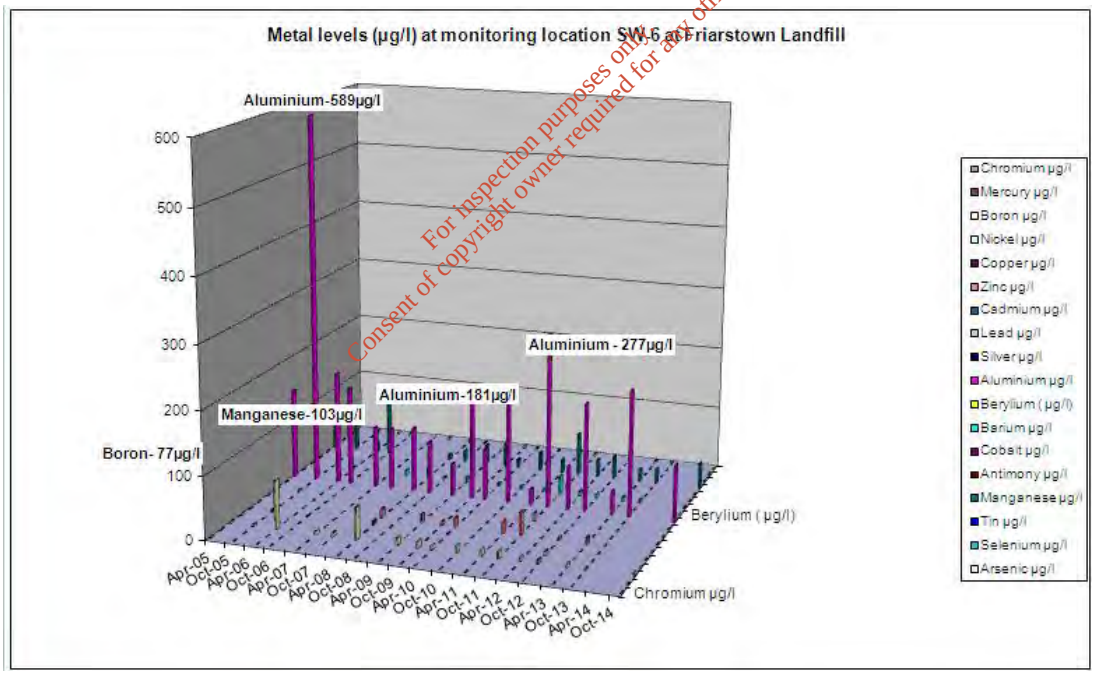


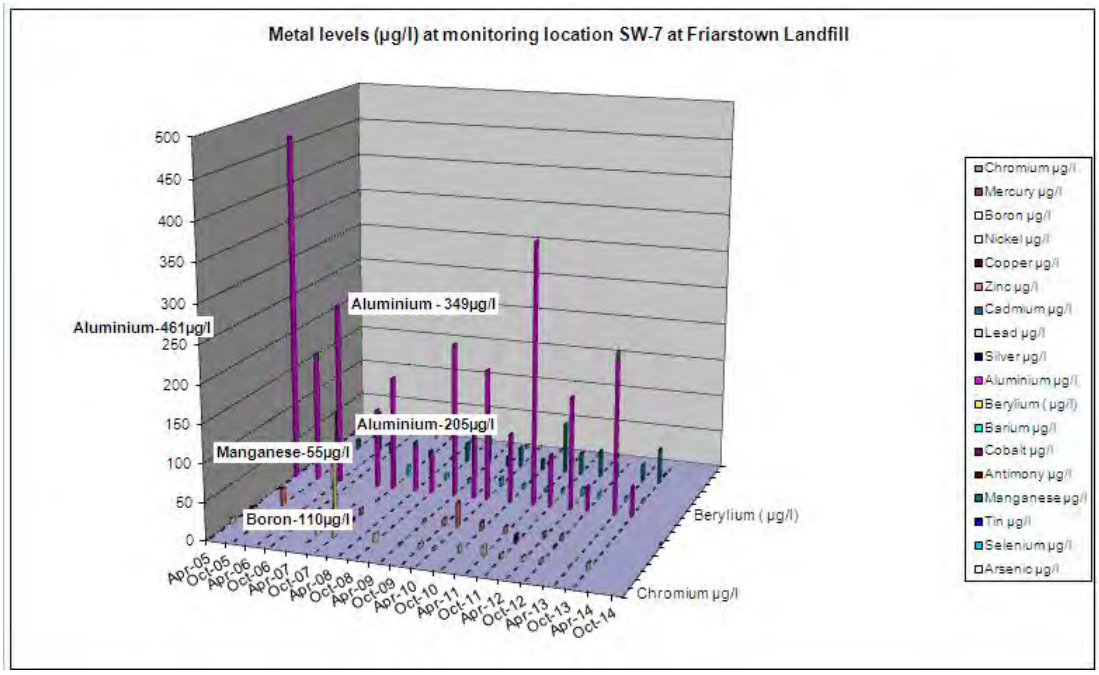


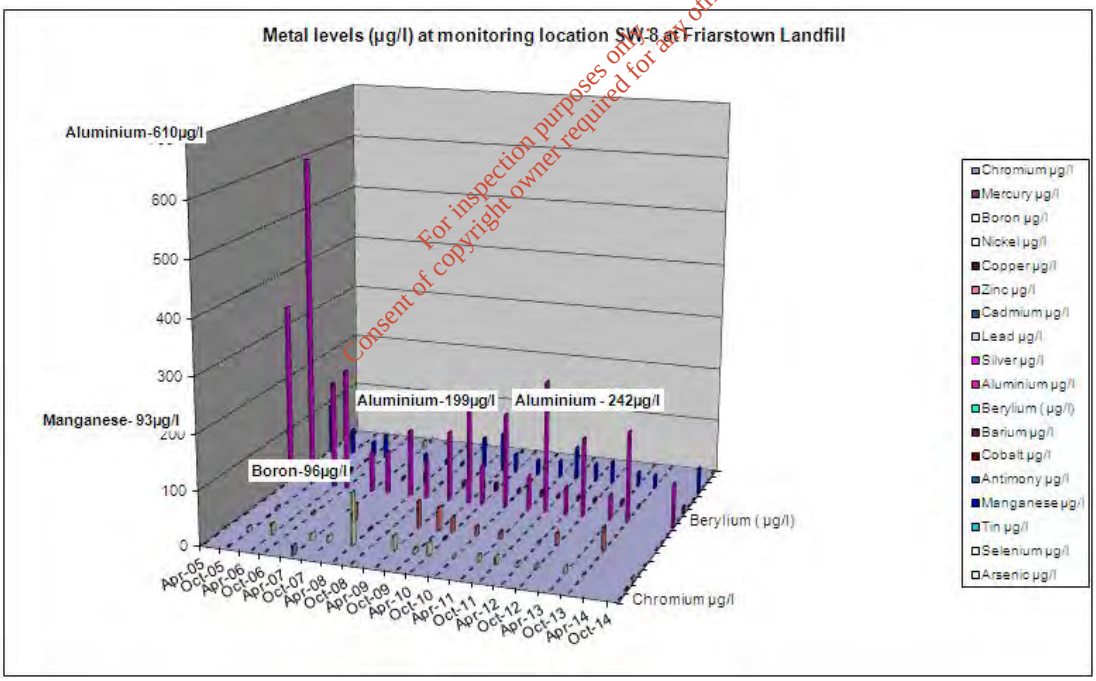






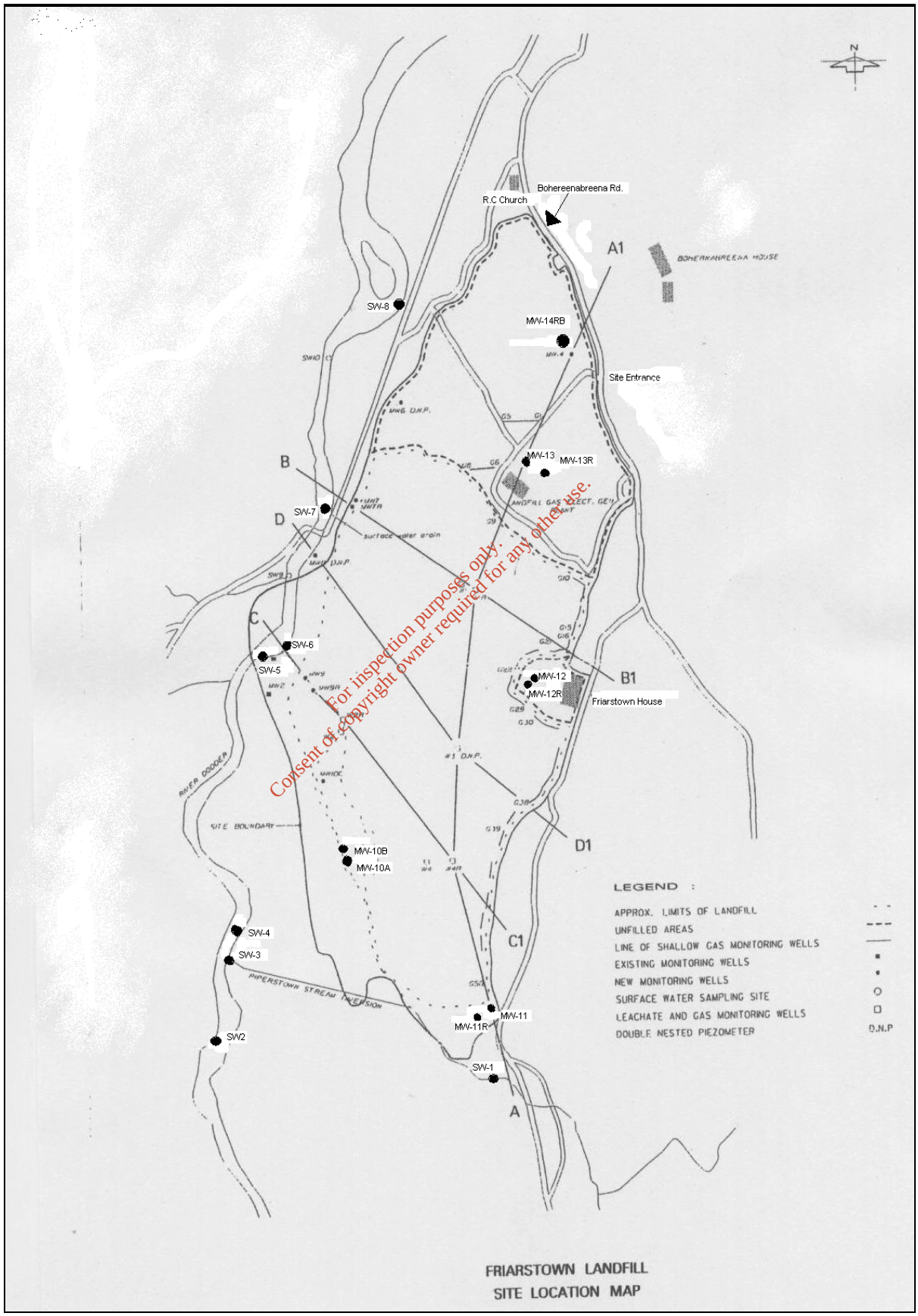






Appendix 2

Monitoring Location Map



APPENDIX 3

Analytical Methods

Lab Accreditation

Chain of Custody

Chemical Analysis

ANALYSIS OF SAMPLES			
Parameter	**Limit of Detection/Range**	**Method**	**Accredited**
pH (pH units)	0.1 – 14	G/05	✓ INAB
Ammonia–N (mg/l)	<0.02	G/67	✓ INAB
BOD (mg/l)	<2	G/04	✓ INAB
COD (mg/l)	<10	G/03	✓ INAB
Conductivity (µS/cm)	0.1 - 1999 µS/cm	G/06	✓ INAB
Aluminium, Antimony, Arsenic, Barium, Beryllium, Cobalt, Cadmium, Chromium, Copper, Lead, Manganese, Nickel, Selenium, Silver, Tin, Zinc (µg/l)	<2	G/112	X
Calcium, Iron, Magnesium, Potassium, Sodium (mg/l)	<0.1		
Mercury (µg/l)	<1	ICP–MS	X
Boron (µg/l)	<2		
Nitrate–N (mg/l)	<0.04	G/39	✓ INAB
Nitrite–N (mg/l)	<0.03		X
Chloride (mg/l)	<0.5		✓ INAB
Sulphate (mg/l)	<0.5		
TOC (mg/l)	<5	G/94.	✓ INAB
Total Alkalinity ($CaCO_3$) (mg/l)	<50	G/69	✓ INAB
Total Suspended Solids (mg/l)	<5	G/19	✓ INAB
Total Phosphorous (mg/l)	<0.05	G/74	✓ INAB

Notes:

ASTM – American Society for Testing and Materials, Annual Book of ASTM Standards 1997.

APHA – American Public Health Association, Standard Methods for the Examination of Water and Wastewaters, 21st Edition, 2005.

G/ – ANUA Environmental Analytical Laboratory Standard Operating Procedures Manual.

✓ – INAB Accredited Test Method – INAB Registration Reference No. 083T.

X – Non Accredited Test Method

ACCREDITED QUALITY SYSTEM

ISO 17025 Accreditation

ANUA Environmental analytical laboratory is accredited to ISO 17025 by the National Accreditation Board (INAB). ISO 17025 accreditation ensures that the laboratory operates a quality system with technically competent staff. The laboratory has accreditation since 1997 and it is the policy of the laboratory to achieve and maintain a high standard of quality consistent with client's requirements in all aspects of the work carried out within the laboratory.

Interlaboratory Proficiency Schemes

To ensure the accuracy of the analytical testing the laboratory participates in several external proficiency schemes. The ongoing competence of the laboratory and its staff is assessed by participation in various inter–laboratory proficiency testing schemes, such as LGC Aquacheck scheme and the EPA Intercalibration programme organised for environmental laboratories throughout Ireland. ANUA Environmental Analytical Laboratory is listed on the EPA's register of Quality Controlled Laboratories

Controlled Chain of Custody

As part of the Quality System in place in Anua Environmental, measures are taken to ensure controlled chain of custody. An outline of the chain of custody is given overleaf.

CONTROLLED CHAIN OF CUSTODY

SITE		TRANSPORT		LABORATORY
Sampling and packaging of all samples were carried out by ANUA Environmental Technical Team:	Transport Document Form	Transport to laboratory by ANUA Environmental Team.	Sample Reception Form	Receiving of samples at ANUA Environmental Laboratory complex by: Laboratory Manager (Secure laboratory complex access to authorised personnel only)
Mr. Eamon Lee	→		→	↓
				Storage of all samples for 1 month period after report issue.
				↓
				Supervised Disposal

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LANDFILL GAS MONITORING AT THE FRIARSTOWN LANDFILL SITE AT BOHERNABREENA, CO. DUBLIN

For the Attention of: Mr. Joseph Bockarie
South Dublin County Council
Town Hall,
Tallaght,
Dublin 24

Prepared by: Mr. Eamonn Le
Environmental Consultant

Reviewed by: Mr. Peter Coogan
Environmental Team Leader

Report Ref: ECS5038

Monitoring Date: 3rd December 2014

Reporting Date: January 2015

Executive Summary

At the request of South Dublin County Council, Anua Environmental was commissioned to carry out a Landfill Gas Survey at the Friarstown Landfill site. The landfill is no longer in-use and has been final capped for many years. The scope of the monitoring event was to monitor Carbon Dioxide, Methane and Oxygen levels generated onsite.

The site was visited by an Environmental Consultant from Anua on the 3rd December 2014, to monitor fifty five (55) landfill gas wells (GW1-55). Readings were obtained from forty eight (48) of the landfill gas wells. The remaining six wells were damaged or non existent. The results obtained are presented in Table 3.1 of this report.

This report is certified as accurate and representative of the sampling and associated analysis carried out.

Respectively Submitted,

Mr. Eamonn Lee
Environmental Consultant

Mr. Peter Coogan
Environmental Team Leader

Table of Contents

1.0 INTRODUCTION

Anua Environmental was commissioned by South Dublin County Council, to carry out a Landfill Gas survey at the Friarstown landfill site. Fifty five (55) boreholes located on-site were utilised to assess Carbon Dioxide, Methane and Oxygen levels from within the boreholes.

This report presents details of the methodology employed for the landfill gas monitoring together with the results obtained.

1.1 Site Location

2.0 METHODOLOGY

2.1 Gas Sampling

A Geothecnical GA5000 Gas Analyser was used for all measurements. The instrument is calibrated on a biannual basis. The calibration protocol involves purging clean air through the instrument in order to remove any residual gases. A certified gas standard is passed through the instrument and readings are adjusted as required.

Prior to sample measurement at each gas monitoring bore, the instrument was flushed with ambient air. A gas measurement was then extracted and the gas concentration recorded once the gas levels stabilised.

The gas analyser measured the following components:

TABLE 2.1: LANDFILL GAS PARAMETERS	
Parameter	**Methodology**
Methane	Infra Red Sensors
Carbon Dioxide	Infra Red Sensors
Oxygen	Infra Red Sensors
Atmospheric Pressure	Barometer

2.2 Landfill Gas Monitoring Checklist

TABLE 2.2: LANDFILL GAS MONITORING FORM	
Site Name:	SDCC Friarstown
Operator:	Eamonn Lee
Date of Survey:	3rd December 2014
Site Address:	Bohernabreena, Co. Dublin.
Site Status:	Non-Operational
Instrument used:	Geotechnical Instruments Biogas 5000
Normal Analytical Range:	0 – 100%
Date Next Calibration:	March 2016
Mean Ambient Temp. °C	1°C Met Éireann
Atmospheric Pressure	1019-1029 mbar

3.0 RESULTS

Table 3.1: Landfill Gas Monitoring Results						
Gas Well Number	**Grid Reference** Note 2	**CH_4 (% v/v)**	**CO_2 (% v/v)**	**O_2 (% v/v)**	**CH_4 (% v/v) Trigger Level**	**CO_2 (% v/v) Trigger Level**
GW1	0709376 07024679	0 +/- 0.5	**2.3** +/- 0.5	18.6 +/- 1	1.0	1.5
GW2	0709361 07025684	0 +/- 0.5	0.3 +/- 0.5	20.7 +/- 1	1.0	1.5
GW3	0709338 0724684	0.1 +/- 0.5	1.0 +/- 0.5	19.4 +/- 1	1.0	1.5
GW4	0709317 0724685	0 +/- 0.5	**2.3** +/- 0.5	17.9 +/- 1	1.0	1.5
GW5	0709295 0724695	0 +/- 0.5	0.2 +/- 0.5	20.1 +/- 1	1.0	1.5
GW6	0709271 0724587	0 +/- 0.5	0.5 +/- 0.5	20.1 +/- 1	1.0	1.5
GW7	0709260 0724577	0 +/- 0.5	**2.2** +/- 0.5	13.3 +/- 1	1.0	1.5
GW8	0709243 0724564	0 +/- 0.5	1.1 +/- 0.5	18.8 +/- 1	1.0	1.5
GW9	0709312 0724497	**48.8** +/- 0.5	**33.4** +/- 0.5	0.3 +/- 1	1.0	1.5
GW10	0709444 0724418	0.9 +/- 0.5	**3.5** +/- 0.5	16.4 +/- 1	1.0	1.5
GW11	0709455 0724413	0 +/- 0.5	**3.3** +/- 0.5	13.8 +/- 1	1.0	1.5
GW12	0709461 0724386	**5.9** +/- 0.5	**19.9** +/- 0.5	1.5 +/- 1	1.0	1.5
GW13	Well no longer exists					
GW14	Well no longer exists					
GW15	0709405 0724247	0 +/- 0.5	0.4 +/- 0.5	20.6 +/- 1	1.0	1.5
GW16	0709400 0724232	0 +/- 0.5	**2.2** +/- 0.5	18.3 +/- 1	1.0	1.5
GW17	Well does not exist					
GW18	0709385 0724224	0 +/- 0.5	**3.1** +/- 0.5	18.5 +/- 1	1.0	1.5

Table 3.1: Landfill Gas Monitoring Results Contd.						
Gas Well Number	**Grid Reference** Note 2	**CH_4 (% v/v)**	**CO_2 (% v/v)**	**O_2 (% v/v)**	**CH_4 (% v/v) Trigger Level**	**CO_2 (% v/v) Trigger Level**
GW19	0709365 0724236	0 +/- 0.5	0.8 +/- 0.5	20.2 +/- 1	1.0	1.5
GW20	0709364 0724250	0 +/- 0.5	0.2 +/- 0.5	20.9 +/- 1	1.0	1.5
GW21	Well no longer exists					
GW22	0709301 0724285	0 +/- 0.5	**1.6** +/- 0.5	19.0 +/- 1	1.0	1.5
GW23	0709300 0724247	0 +/- 0.5	**1.5** +/- 0.5	19.1 +/- 1	1.0	1.5
GW24	0709334 0724283	0 +/- 0.5	**1.7** +/- 0.5	20.8 +/- 1	1.0	1.5
GW25	0709313 0724226	0 +/- 0.5	1.3 +/- 0.5	19.9 +/- 1	1.0	1.5
GW26	0709319 0724197	0 +/- 0.5	**2.0** +/- 0.5	19.1 +/- 1	1.0	1.5
GW27	0709338 0724182	0 +/- 0.5	0.4 +/- 0.5	21.0 +/- 1	1.0	1.5
GW28	0709354 0724172	0 +/- 0.5	0.8 +/- 0.5	20.3 +/- 1	1.0	1.5
GW29	0709379 0724119	0 +/- 0.5	**4.6** +/- 0.5	16.2 +/- 1	1.0	1.5
GW30	0709397 0724100	0 +/- 0.5	1.2 +/- 0.5	20.1 +/- 1	1.0	1.5
GW31	0709393 0724085	0 +/- 0.5	**3.2** +/- 0.5	16.2 +/- 1	1.0	1.5
GW32	0709385 0724066	0 +/- 0.5	0.6 +/- 0.5	19.9 +/- 1	1.0	1.5
GW33	0709379 0724049	0 +/- 0.5	**4.2** +/- 0.5	13.5 +/- 1	1.0	1.5
GW34	0709368 0724038	0 +/- 0.5	0.6 +/- 0.5	19.9 +/- 1	1.0	1.5
GW35	0709336 0724011	Well damaged				
GW36	0709321 0724002	0 +/- 0.5	1.0 +/- 0.5	20.4 +/- 1	1.0	1.5
GW37	0709311 0723985	0 +/- 0.5	**5.0** +/- 0.5	17.1 +/- 1	1.0	1.5

Table 3.1: Landfill Gas Monitoring Results Contd.						
Gas Well Number	**Grid Reference** Note 2	**CH_4 (% v/v)**	**CO_2 (% v/v)**	**O_2 (% v/v)**	**CH_4 (% v/v) Trigger Level**	**CO_2 (% v/v) Trigger Level**
GW38	0709303 0723972	No gas-well pipe within concrete pipe-work				
GW39	0709292 0723925	0 +/- 0.5	**3.7** +/- 0.5	18.0 +/- 1	1.0	1.5
GW40	0709280 0723898	0 +/- 0.5	**13.2** +/- 0.5	13.7 +/- 1	1.0	1.5
GW41	0709262 0723881	**4.8** +/- 0.5	**20.4** +/- 0.5	0.6 +/- 1	1.0	1.5
GW42	0709261 0723860	0 +/- 0.5	0.3 +/- 0.5	19.2 +/- 1	1.0	1.5
GW43	0709260 0723844	0 +/- 0.5	0.2 +/- 0.5	21.5 +/- 1	1.0	1.5
GW44	0709262 0723823	0 +/- 0.5	**6.5** +/- 0.5	15.4 +/- 1	1.0	1.5
GW45	0709267 0723801	0 +/- 0.5	0.2 +/- 0.5	20.8 +/- 1	1.0	1.5
GW46	0709280 0723769	0 +/- 0.5	1.3 +/- 0.5	20.5 +/- 1	1.0	1.5
GW47	0709273 0723726	**1.0** +/- 0.5	**8.8** +/- 0.5	3.0 +/- 1	1.0	1.5
GW48	0709273 0723697	0 +/- 0.5	**4.5** +/- 0.5	13.0 +/- 1	1.0	1.5
GW49	0709262 0723678	0 +/- 0.5	**6.6** +/- 0.5	7.8 +/- 1	1.0	1.5
GW50	0709268 0723660	0 +/- 0.5	**8.6** +/- 0.5	7.8 +/- 1	1.0	1.5
GW51	0709418 0724250	0 +/- 0.5	1.0 +/- 0.5	18.9 +/- 1	1.0	1.5
GW52	0709439 0724285	0 +/- 0.5	**1.8** +/- 0.5	16.8 +/- 1	1.0	1.5
GW53	0709430 0724274	0 +/- 0.5	**5.0** +/- 0.5	11.9 +/- 1	1.0	1.5
GW54	Well no longer exists					
GW55	0709309 0724516	0 +/- 0.5	0.3 +/- 0.5	20.5 +/- 1	1.0	1.5

Note 1: Weather data taken from nearest Met-Eireann weather station in Casement Co. Dublin

Note 2: Irish Transverse Mercator (ITM)

4.0 RESULTS

Table 3.1 presents the results of the landfill gas monitoring carried out on the 3rd December 2014 at the Friarstown landfill site.

Methane exceedences

Levels of methane ranged from 0.0 to 48.8 %v/v in the monitoring boreholes GW1 to GW55. The exceedence of the EPA Trigger level of 1%v/v for methane occurred at GW9 (48.8 % v/v), GW12 (5.9 %v/v) GW41 (4.8% v/v) andGW47. Monitoring wells GW9 and GW12 are located beside old buildings close to the current onsite landfill gas generators. Monitoring wells GW41 & GW47 are located in the south eastern corner of the landfills perimeter. Further monitoring will reveal if these exceedances are representative of the methane levels at these monitoring wells.

Carbon Dioxide exceedences

Levels of carbon dioxide ranged from 0 to 33.4% v/v in the monitoring boreholes GW1 to GW55. The exceedence of the EPA Trigger level of 1.5%v/v for carbon dioxide occurred at 27 of the 48 monitoring wells sampled. Table 3.1 displays exceedences of the carbon dioxide trigger level (1.5% v/v) at each of these wells. Further monitoring will reveal if these results are representative of the carbon dioxide levels at each location.

Appendix 1 – Monitoring Locations

Appendix 2 – Calibration Certificate

CERTIFICATION OF CALIBRATION

Geotech

ISSUED BY: GEOTECH LABORATORY
Date Of Calibration: 13-Mar-2014
Certificate Number: G501929_1/12435

UKAS CALIBRATION
No. 4533

Approved by Signatory

Dawn Hemings
Laboratory Inspection

GEOTECHNICAL INSTRUMENTS (UK) LTD
Sovereign House, Queensway, Leamington Spa, Warwickshire, CV31 3JR United Kingdom
Tel: +44 (0) 1926 338111 Fax: +44 (0) 1926 338110
E-mail: service@geotech.co.uk www.geotechuk.com

Customer: ***Commissioning Services Limited***

Deerpark Business Complex
Dublin Road
Carlow
IRELAND

Description: BIOGAS 5000 ***Model:*** BIOGAS 5000
Serial Number: G501929

UKAS Accredited results:

Methane (CH4)		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
50.0	49.4	0.94
15.1	15.1	0.64
5.0	4.9	0.41

Carbon Dioxide (CO2)		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
50.0	50.0	1.1
15.1	14.8	0.70
5.0	4.8	0.43

Oxygen (O2)		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
21.2	21.2	0.31

All concentrations are molar.

CH4, CO2 readings recorded at : 31.8 °C ± 1.5 °C
O2 reading recorded at : 22.2 °C ± 1.5 °C
Barometric Pressure : 1024 mbar ± 3 mbar

Method of Test : The analyser is calibrated in a temperature controlled chamber using reference gases.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.