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TECHNICAL REPORT

MODELLING OF BASELINE PCDD/F INTAKE AND PREDICTED IMPACT OF EMISSIONS FROM THE PROPOSED POOLBEG WASTE TO ENERGY PLANT ON PCDD/F INTAKE

FOR

Elsam

Report prepared by: **Dr Fergal Callaghan**
Our reference: FC/06/3018SR01_rev_1
Date: 24 May 2006

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EXECUTIVE SUMMARY

Soil sampling and ambient air monitoring data, and published data for Irish food, was used to establish a baseline for PCDD/F for a theoretical Maximum At Risk Individual (MARI) and a TARI (Typical At Risk Individual) in the Poolbeg area. The MARI was assumed to live at the point of maximum PCDD/F deposition from the proposed development and to be a person who obtained their vegetables from a 100m diameter site, upon which the maximum deposition flux impacted and who may be exposed to PCDD/F emissions from the WTE from inhalation, dermal contact with soil, ingestion of soil and ingestion of vegetables . It was assumed that the MARI spent 24 hours per day, 7 days per week on the site, and spent 16 hours per day outside.

The TARI was assumed to be a typical urban dweller who does not grow vegetables but relies on shops and supermarkets, supplying food grown outside the area, and therefore is only potentially exposed to PCDD/F emissions from the WTE facility through inhalation, ingestion of soil and dermal contact with soil.

The baseline PCDD/F intake for the MARI and TARI was modelled following US EPA Methodology and using the Dutch Government Approved Model RISC Human 3.2 (May 2005). The PCDD/F emissions under maximum operating conditions (assuming the WTE facility operated continuously at the process emission limits set by the Incineration Directive 2000/67/EC) were then used to model the increase in soil concentrations of PCDD/F over the operating life of the facility. The modelled soil and air values were then added to the existing background values for PCDD/F and input to the RISC HUMAN Model.

The model predicted that the PCDD/F intake for both the MARI and the TARI, even with the WTE operating at maximum licensed emission rates, was very low and was still significantly less than recommended guideline values for PCDD/F intake.

An accident scenario, where the WTE facility was assumed to operate for 48 hours at 10 ng/m^3 PCDD/F was also modelled to assess potential impacts on the MARI and the TARI.

The modelling predicted that the accident scenario led to PCDD/F intake levels that were still well below the recommended guideline values for PCDD/F intake.

It was therefore concluded that the proposed WTE facility will have no significant impact on PCDD/F intake for even the theoretical MARI or TARI.

CONTENTS

1.0 INTRODUCTION

AWN Consulting was instructed by Elsam to undertake a mathematical modelling study to assess the potential impact of PCDD/F emissions from the proposed waste to energy (WTE) facility at Poolbeg.

2.0 MODELLING PHILOSOPHY

It was proposed to model the impact of the emissions following the methodology described by the US EPA for hazardous waste facilities [1].

The modelling philosophy was as follows:

Develop a (Conceptual Site Model) CSM to assess the potential dietary intake of PCDD/F for the theoretical Maximum at Risk Individual (MARI) and the Typical At Risk Individual (TARI);

Select most appropriate background soil PCDD/F concentration;

Model PCDD/F intake using background concentrations in soil;

Obtain data on deposition rates for PCDD/F from proposed WTE facility;

Model impact of deposition rates on soil concentrations of PCDD/F over 30 year operating life of facility;

Model increase in ambient air concentrations;

Model impact of WTE facility-related PCDD/F deposition rates and increased ambient air concentrations on dietary intake of PCDD/F for the MARI and TARI.

Model impact of accident at WTE facility and the related PCDD/F deposition rates and increased ambient air concentrations on dietary intake of PCDD/F for the MARI and TARI.

3.0 CONCEPTUAL SITE MODEL: MAXIMUM AT RISK INDIVIDUAL AND TYPICAL AT RISK INDIVIDUAL

3.1 Conceptual Site Model

The Conceptual Site Model (CSM) was developed as follows, using the methodology presented in the relevant US EPA Modelling Guidance [1].

Background concentrations of PCDD/F are transferred to a human receptor by the following pathways;

- Inhalation indoor air
- Inhalation outdoor air
- Ingestion of soil
- Dermal contact with soil
- Inhalation of soil dust
- Ingestion of drinking water
- Dermal contact with shower water
- Inhalation of water vapour in the shower
- Ingestion of meat (this pathway was eliminated as the area of land in question is not agricultural and PCDD/F exposure from known levels in Irish produce was used to model this component of PCDD/F intake)
- Ingestion of milk and dairy products (this pathway was eliminated as the area of land in question is not agricultural and PCDD/F exposure from known levels in Irish produce was used to model this component of PCDD/F intake)
- Ingestion of vegetables
- Ingestion of surface water

- Ingestion of suspended matter in water
- Dermal contact with surface water

The CSM assumes all PCDD/F is deposited on the ground and is available for uptake, apart from the fractions which are removed through volatilisation, surface water run off, erosion and degradation. These elements are calculated for each of the 17 PCDD/F congeners.

The CSM then assumes the remainder of the PCDD/F deposited is available for uptake through the pathways listed above.

The group of 17 PCDD/F congeners vary widely in molecular weight and chemical characteristics and behave quite differently with respect to the fraction which absorbs to soil, dissolves in water or is present in the vapour phase. It is therefore not valid to model the PCDD/F concentrations as a total I-TEQ as 2,3,7,8 PCDD/F value or to only model the chemical characteristics of PCDD/F intake as 2,3,7,8 PCDD/F and each congener must therefore be modelled separately.

3.2 The Maximum At Risk Individual (MARI)

In order to conduct a conservative assessment of the potential impact of PCDD/F emissions on a theoretical individual, a number of assumptions, which are listed in this Section of the report, were made for the MARI (these assumptions are based on the MARI as used by the US EPA for hazardous waste facility assessment) [1].

The methodology for selection of the MARI also follows the UK recommended methodology "Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes, HMIP/CPR2/41/1/181, London 1996". This document recommends that all likely pathways for dioxin and furan intake in a human be considered and the impact of the dioxin and furan deposition rate on soil dioxin and furan concentrations and subsequently food dioxin and furan concentrations, be examined.

The UK methodology uses the concept of the Hypothetically Maximum Exposed Individual (HMEI), in which the individual is assumed to live in the area of predicted maximum impact from the WTE facility and whose food intake is also assumed to be from this area (worst case scenario), this is the MARI concept.

The assumptions made were as follows:

- The MARI lives at the point where the highest deposition rate, for emissions from the proposed WTE facility occurs.

- The MARI is an individual, who spends 16 hours per day, 7 days per week, 50 weeks per year outside in the field where the deposition occurs;

- The MARI spends 6 years as a child and 60 years as an adult living on the site;

- The MARI only eats vegetables grown on this soil (milk and meat are obtained off site as the environment in question is an urban environment and cattle raising is not practised in this area)

3.3 The Typical At Risk Individual (TARI)

The following assumptions made for the TARI:

- The TARI lives at the point where the highest deposition rate, for emissions from the proposed WTE facility occurs.

- The TARI is an individual, who spends 16 hours per day, 7 days per week, 50 weeks per year outside in the area where the deposition occurs;

- The TARI spends 6 years as a child and 60 years as an adult living on the site;

- The TARI does not eat any food produced in the area in which they live.

4.0 SOIL BACKGROUND CONCENTRATIONS

AWN Consulting Ltd previously carried out a programme of background soil sampling and monitoring (ref FC/03/2008SR01).

The results of this survey and the location of the monitoring points are summarised in Tables 4.1 - 4.3.

AWN Sampling Point	Sampling Point Location	Position	Sampling Date
A	Sean Moore Park	53^0 20.169' N 006^0 12.923' W	5th November 2003
B	Irishtown Nature Park	53^0 20.161' N 006^0 11.757' W	6th November 2003
C	Ringsend Park	53^0 20.520' N 006^0 13.258' W	3rd November 2003
D	Sandymount (grassed area along the sea front)	53^0 19.584' N 006^0 12.456' W	7th November 2003
E	Clontarf (grassed area along the sea front)	53^0 21.476' N 006^0 11.605' W	29th October 2003
F	Bull Island Nature Reserve	53^0 21.962' N 006^0 09.223' W	31st October 2003

Table 4.1 Location of AWN Sampling Points

Sampling Point	Sampling Point Location
A	SW of site, peak area from dispersion model
B	Adjacent and to the South of site, peak area from dispersion model
C	West of site, closest residential community
D	SW of site, residential community (downwind of NE winds)
E	North of site, residential community
F	NE of site (downwind of SW winds)

Table 4.2 Rationale for choosing AWN sampling locations

Sample	Site Location	PCDD/F (ng/kg) [1]
A	Sean Moore Park	10
B	Irishtown Nature Park	5.7
C	Ringsend Park	3.2
D	Sandymount Promenade	23
E	Clontarf Promenade	3.9
F	Bull Island Nature Reserve	0.54

Table 4.3 Analysis results

1 NATO/CCMS I TEQ (Toxic Equivalent) (2,3,7,8 – tetrachloro dibenzo-p-dioxin)

The highest PCDD/F value recorded (NATO CCMS TEQ OF 23 ng/kg)was for the sample from the road side location at Sandymount, Sample D from the soil monitoring report. However, this is a road side location and is subject to localised PCDD/F emission sources such as traffic fumes and hence would not be a realistic background soil concentration for the MARI.

The next highest PCDD/F value, recorded for Sean Moore Park, which was also at the point of maximum ground level concentration as predicted using the US EPA approved ISC modelling software package (and as presented elsewhere in this EIS). This source is not close to significant traffic emissions and therefore is not likely to be significantly affected by the PCDD/F component of such emissions, unlike the Sandymount sample.

It was therefore decided that the soil concentration for the background on the site inhabited by the MARI and the TARI would consist of a soil PCDD/F contribution of 9.5 ng/kg WHO TEQ. The ambient air concentrations used were those measured by AWN (and presented elsewhere in the EIS Document) in Winter 2004 which are considerably higher than those measured in Summer 2003 and hence it was felt that the use of these figures was suitably conservative.

5.0 BASELINE MODELLING OF INTAKE OF PCDD/F

5.1 Model Selection and Set up

The RISC Human Model Version 3.2 (May 2005) package was chosen to model intake of PCDD/F. The model was developed by the Dutch National Institute of Public Health and Environmental Protection (RIVM)., on behalf of the Dutch Ministry for Spatial Planning, Housing and the Environment and has been used to model the Dutch Soil standards for protection of human health [2].

The model consists of series of equations which allow each of the pathways listed in Section 3.1 to be modelled mathematically. The principal model variables used to calculate total exposure are presented as Attachment A.

The equations used to calculate each variable are presented in Attachment B.

The values selected for the model variables and the justification for selecting these values is presented as Attachment C.

The model data base contains many of the necessary chemical parameters such as the octanol-water coefficient, Henry's coefficient and the water solubility, which are necessary to model the behaviour of substances in soil and water environments. Where these parameters were not available from the model database, The Handbook of Physical Chemistry [3] and Appendices A – J of the US EPA Human Health and Ecological Risk Assessment Report [1] were used.

5.2 Model Results

The Model Output Reports for the MARI and the TARI for PCDD/F for each intake pathway, are presented as Attachment D. The modelled WHO TEQ intake value for the MARI, in pg/kg body weight/day, is presented in Table 5.1 and for the TARI, is presented in Table 5.2.

The model predicted a baseline PCDD/F intake for the MARI of 1.4 pg/kg body weight/day using the WHO TEF values and a baseline intake for the TARI of 0.0849 pg/kg body weight/day using the WHO TEF values . Both values are much less than the EC TWI (Tolerable Weekly Intake) of 14 pg WHO-TEQ/kg body weight/wk (from Update to "Opinion of the Scientific Committee on the Risk Assessment of Dioxins and Dioxin-like PCBs in Food 22/11/2000", adopted 30th May 2001 (SCF/CS/CNTMDIOXIN/ 20 Final))

PCDD Congeners	pg/kg/d
	WHO TEQ
2,3,7,8-TCDD	1.66E-01
1,2,3,7,8-PeCDD	7.26E-01
1,2,3,4,7,8-HxCDD	3.28E-02
1,2,3,6,7,8-HxCDD	1.21E-01
1,2,3,7,8,9-HxCDD	7.01E-02
1,2,3,4,6,7,8-HpCDD	7.52E-02
OCDD	1.08E-02
PCDF Congeners	0.00E+00
2,3,7,8-TCDF	7.70E-03
1,2,3,7,8-PeCDF	4.89E-03
2,3,4,7,8-PeCDF	8.50E-02
1,2,3,4,7,8-HxCDF	3.60E-02
1,2,3,6,7,8-HxCDF	1.97E-02
1,2,3,7,8,9-HxCDF	9.90E-03
2,3,4,6,7,8-HxCDF	9.38E-03
1,2,3,4,6,7,8-HpCDF	1.64E-02
1,2,3,4,7,8,9-HpCDF	1.40E-02
OCDF	1.81E-03
WHO TEF	**1.40668**

Table 5.1 Modelled baseline PCDD/F intake for MARI– using WHO TEF

PCDD Congeners	pg/kg/d
	WHO TEQ
2,3,7,8-TCDD	2.65E-03
1,2,3,7,8-PeCDD	5.28E-03
1,2,3,4,7,8-HxCDD	1.43E-03
1,2,3,6,7,8-HxCDD	1.47E-03
1,2,3,7,8,9-HxCDD	1.69E-03
1,2,3,4,6,7,8-HpCDD	3.48E-03
OCDD	2.90E-04
PCDF Congeners	
2,3,7,8-TCDF	3.10E-03
1,2,3,7,8-PeCDF	1.18E-03
2,3,4,7,8-PeCDF	4.53E-02
1,2,3,4,7,8-HxCDF	5.52E-03
1,2,3,6,7,8-HxCDF	3.89E-03
1,2,3,7,8,9-HxCDF	4.02E-03
2,3,4,6,7,8-HxCDF	2.09E-03
1,2,3,4,6,7,8-HpCDF	3.24E-03
1,2,3,4,7,8,9-HpCDF	3.01E-04
OCDF	3.45E-05
WHO TEF	**0.08492**

Table 5.2 Modelled baseline PCDD/F intake for TARI– using WHO TEF

It is interesting to note the significant PCDD/F contribution associated with the additional PCDD/F intake from vegetables grown and consumed by the MARI.

However, in order to determine a PCDD/F total contribution for the MARI and TARI, it is necessary to include PCDD/F exposure from meat and milk, based on milk sourced in the Dublin area and meat sourced in Ireland. The input values for this calculation (for meat, milk, and vegetables) are given in Attachment C. The calculation procedure and calculated values are shown in Tables 5.3 and 5.4

MARI						
		PCDD/F	**PCDD/F**	**PCDD/F**	**Adult**	**PCDD/F**
	kg/day	**ng/kg**	**ng/day**	**pg/day**	**Body Wt**	**pg/kg/day**
Meat	0.157	0.067	0.010	10.458	60	0.17
Milk	0.238	0.022	0.005	5.232	60	0.09
Sum						0.26

***Table 5.*3** Calculated PCDD/F from off-site Meat and Milk Intake for MARI

TARI						
		PCDD/F	**PCDD/F**	**PCDD/F**	**Adult**	**PCDD/F**
	kg/day	**ng/kg**	**ng/day**	**pg/day**	**Body Wt**	**pg/kg/day**
Meat	0.157	0.067	0.010	10.458	60	0.17
Milk	0.238	0.022	0.005	5.236	60	0.09
Leafy Veg	0.118	0.012	0.001	1.416	61	0.02
Tuber Veg	0.225	0.017	0.004	3.825	62	0.06
Sum						0.35

Table 5.4 Calculated PCDD/F from off-site Meat, Milk and Vegetable Intake for TARI (vegetable data from German Data, from Task 4, Annex 1 of EU Dioxin Inventory, published by the EU and Compiled by AEA,1999)

The predicted MARI and TARI baselines, for the modelled site related PCDD/F dose from exposure to PCDD/F in the area and for the PCDD/F dose from food sources are shown in Table 5.5.

	A	**B**	**C**	**D**
	pg/kg/d	**pg/kg/d**	**%**	**%**
MARI	0.26	1.4066	16	84
TARI	0.35	0.0849	80	20

***Table 5.*5** Calculated total MARI and TARI Baselines and percentage of PCDD/F from outside area

Where:

A = Food sourced outside area pg/kg bw/day

B = PCDD/F intake from area pg/kg bw/day

C = % PCDD/F from outside area

D = % PCDD/F contribution from area

It is of interest to note that the strongly conservative modelling assumptions used to generate the MARI intake figures lead to a relatively high baseline dose for the MARI, when compared with the more realistic TARI, where the baseline dose from the area is shown to be quite low.

However, even the TARI is somewhat conservative, as it is assumed that the receptor in question spends all of their time (for 16 hours per day) in the environment where the soil value used in the modelling study was measured.

6.0 MAXIMUM DEPOSITION RATE OF PCDD/F FROM WTE EMISSIONS AND CALCULATION OF PREDICTED SOIL AND AIR CONCENTRATIONS

Air emissions from the proposed WTE facility were modelled by AWN Consulting and are presented in the Air Chapter of this EIS. Emissions were modelled using the ISCST3 dispersion model which is the USEPA's regulatory model used to assess pollutant concentrations associated with industrial sources. Emissions were assessed assuming the unrealistically worst case scenario that the plant operated continuously under the maximum emission limits of EU Directive 2000/76/EC.

The annual deposition rate under maximum operating conditions for each of the 17 PCDD/F congeners is shown in Table 6.1 (which is considered to be an extremely conservative modelling assumption as it assumes the plant operates at maximum capacity throughout the year).

Congener	Total flux
	ng/m2/yr
2,3,7,8-TCDD	0.03791
1,2,3,7,8-PeCDD	0.18560
1,2,3,6,7,8-HxCDD	0.06570
1,2,3,4,7,8-HcCDD	0.13249
1,2,3,7,8,9-HxCDD	0.15956
1,2,3,4,6,7,8-HpCDD	0.11678
OCDD	0.01787
2,3,7,8-TCDF	0.13198
1,2,3,7,8-PeCDF	0.01621
2,3,4,7,8-PeCDF	0.44050
1,2,3,4,7,8-HxCDF	0.26981
1,2,3,6,7,8 HxCDF	0.08940
2,3,4,6,7,8-HpCDF	0.01807
1,2,3,7,8,9-HxCDF	0.30027
1,2,3,4,6,7,8-HpCDF	0.04953
1,2,3,4,7,8,9-HpCDF	0.01513
OCDF	0.00668

Table 6.1 Predicted annual average PCDD/F flux at WTE facility (facility assumed to be operating continuously at maximum operating conditions)

	max	max	predicted	predicted	Baseline	Baseline +
	gaseous conc	particle conc	air conc.	air conc	air conc	predicted
	fg/m3	fg/m3	fg/m3	ug/m3	ug/m3	ug/m3
2,3,7,8-TCDD	0.012443503	0.040598457	0.053042	5.3042E-11	1.69E-09	1.74E-09
1,2,3,7,8-PeCDD	0.007959351	0.198759133	0.2067185	2.06718E-10	6.77E-09	6.98E-09
1,2,3,4,7,8-HxCDD	0.000559896	0.070358963	0.0709189	7.09189E-11	3.16E-08	3.17E-08
1,2,3,6,7,8-HxCDD	0.001129111	0.141889053	0.1430182	1.43018E-10	6.21E-09	6.35E-09
1,2,3,7,8,9-HxCDD	0.001359754	0.17087274	0.1722325	1.72232E-10	2.88E-08	2.90E-08
1,2,3,4,6,7,8-HpCDD	0.000247314	0.125066278	0.1253136	1.25314E-10	2.43E-07	2.43E-07
OCDD	9.44515E-06	0.019134298	0.0191437	1.91437E-11	3.95E-07	3.95E-07
2,3,7,8-TCDF	0.046488626	0.141337902	0.1878265	1.87827E-10	2.48E-08	2.50E-08
1,2,3,7,8-PeCDF	0.001550524	0.017360423	0.0189109	1.89109E-11	2.54E-08	2.54E-08
2,3,4,7,8-PeCDF	0.023984302	0.471739462	0.4957238	4.95724E-10	2.14E-07	2.14E-07
1,2,3,4,7,8-HxCDF	0.005226144	0.288942251	0.2941684	2.94168E-10	8.46E-08	8.49E-08
1,2,3,6,7,8-HxCDF	0.001731694	0.095741639	0.0974733	9.74733E-11	7.33E-08	7.34E-08
1,2,3,7,8,9-HxCDF	0.000212345	0.019347999	0.0195603	1.95603E-11	1.02E-07	1.02E-07
2,3,4,6,7,8-HxCDF	0.003529159	0.321562611	0.3250918	3.25092E-10	3.27E-08	3.30E-08
1,2,3,4,6,7,8-HpCDF	0.000262997	0.053038865	0.0533019	5.33019E-11	4.34E-07	4.34E-07
1,2,3,4,7,8,9-HpCDF	4.16822E-05	0.016204575	0.0162463	1.62463E-11	5.36E-08	5.36E-08
OCDF	3.53101E-06	0.007153231	0.0071568	7.15676E-12	2.43E-07	2.43E-07

Table 6.2 Predicted airborne concentrations of PCDD/F (including background) – annual average under maximum operating conditions

The deposition flux data from Table 6.1 was used to predict the average soil concentration over the exposure duration period, by applying the model used by the US EPA for Assessment of Hazardous Waste Facilities [1].

The model enables increases in soil concentrations due to aerial deposition of PCDD/F to be calculated, over a set time period and includes for natural processes such as volatilisation and sediment removal by surface water run-off, which reduce PCDD/F concentrations in soil.

The model equation to predict the increase in soil concentration of PCDD/F, resulting from aerial deposition is:

$$Sc_1 = \frac{Ds}{ks \ (Tc - T_1)} \left[\left(Tc + \frac{\exp(-ks \ Tc)}{ks} \right) - \left(T_1 + \frac{\exp(-ks \ T_1)}{ks} \right) \right] for\ 0 < T_1 < Tc$$

Equation terms are defined in Attachment E.

Ks, the soil loss constant due to all processes, is calculated using the following equation;

$$ks = ksl + kse + ksr + ksg + ksv$$

Equation terms and the equations used to calculate each of the “Ks terms”, are defined in Attachment F and definitions of terms used in equations to calculate Ks are given in Attachment G.

Ds, the PCDD/F deposition term, expressed in terms of mg/kg/yr, is calculated as per Attachment H.

A radius of 50m was used to calculate the Ds values used in the modelling study. This assumes that the deposition occurs over a 100m diameter area, inside which the MARI spends all their time.

Tc, the time period over which the emissions occur, has been set at 30 years, as it has been assumed that the facility will have a 30 year operational lifetime.

The calculation of predicted soil concentration over the exposure period is presented as Attachment I.

7.0 MODELLING OF IMPACT OF WTE EMISSIONS ON PCDD/F INTAKE

The predicted ambient air concentrations and predicted soil concentrations were used to model the impact of WTE Emissions on PCDD/F intake for the MARI.

7.1 Normal Operation of WTE facility

The predicted increase in soil and air concentrations is given in Table 7.1.

	Background	Sc	Sc	Background + Sc	Background + Sc	Predicted Air conc
	ng/kg	mg/kg	ng/kg	ng/kg	mg/kg	ug/m3
2,3,7,8-TCDD	0.690	5.44879E-09	5.45E-03	0.695	6.95E-07	1.74E-09
1,2,3,7,8-PeCDD	0.980	1.30663E-07	1.31E-01	1.111	1.11E-06	6.98E-09
1,2,3,6,7,8-HxCDD	4.200	1.87636E-07	1.88E-01	4.388	4.39E-06	6.35E-09
1,2,3,4,7,8-HcCDD	1.100	8.00299E-08	8.00E-02	1.180	1.18E-06	3.17E-08
1,2,3,7,8,9-HxCDD	2.400	1.12286E-07	1.12E-01	2.512	2.51E-06	2.90E-08
1,2,3,4,6,7,8-HpCDD	88.000	1.66158E-07	1.66E-01	88.166	8.82E-05	2.43E-07
OCDD	930.000	2.5405E-08	2.54E-02	930.025	9.30E-04	3.95E-07
2,3,7,8-TCDF	7.500	2.69666E-08	2.70E-02	7.527	7.53E-06	2.50E-08
1,2,3,7,8-PeCDF	5.000	7.86238E-09	7.86E-03	5.008	5.01E-06	2.54E-08
2,3,4,7,8-PeCDF	5.400	2.65648E-07	2.66E-01	5.666	5.67E-06	2.14E-07
1,2,3,4,7,8-HxCDF	8.700	1.70817E-07	1.71E-01	8.871	8.87E-06	8.49E-08
1,2,3,6,7,8 HxCDF	4.500	8.57827E-08	8.58E-02	4.586	4.59E-06	7.34E-08
2,3,4,6,7,8-HpCDF	3.200	2.31892E-07	2.32E-01	3.432	3.43E-06	3.30E-08
1,2,3,7,8,9-HxCDF	1.700	1.39526E-08	1.40E-02	1.714	1.71E-06	1.02E-07
1,2,3,4,6,7,8-HpCDF	58.000	3.35853E-08	3.36E-02	58.034	5.80E-05	4.34E-07
1,2,3,4,7,8,9-HpCDF	3.900	1.02634E-08	1.03E-02	3.910	3.91E-06	5.36E-08
OCDF	87.000	9.46815E-09	9.47E-03	87.009	8.70E-05	2.43E-07

Table 7.1 Predicted increase in soil concentrations over the lifetime of the facility and predicted increase in ambient air concentrations (facility assumed to be operating at maximum licensed emission rates over 30 year period)

The intake modelling methodology was as for the baseline intake modelling.

The Model output, for each of the 17 PCDD/F congeners and for mercury for each intake pathway is presented as Attachment J. The modelled PCDD/F WHO TEQ intake value for the impact of WTE Emissions on PCDD/F intake for the MARI and the TARI, in pg/kg body weight/day, are presented in Tables 7.2 and 7.3.

PCDD Congeners	**mg/kg/d**	**WHO**	**mg/kg/d**	**pg/kg/d**
	PCDD/F	**TEQ**	**WHO TEQ**	**WHO TEQ**
2,3,7,8-TCDD	1.68E-10	1	1.68E-10	1.68E-01
1,2,3,7,8-PeCDD	8.15E-10	1	8.15E-10	8.15E-01
1,2,3,4,7,8-HxCDD	3.51E-10	0.1	3.51E-11	3.51E-02
1,2,3,6,7,8-HxCDD	1.27E-09	0.1	1.27E-10	1.27E-01
1,2,3,7,8,9-HxCDD	7.33E-10	0.1	7.33E-11	7.33E-02
1,2,3,4,6,7,8-HpCDD	7.54E-09	0.01	7.54E-11	7.54E-02
OCDD	1.08E-07	0.0001	1.08E-11	1.08E-02
PCDF Congeners				0.00E+00
2,3,7,8-TCDF	7.75E-11	0.1	7.75E-12	7.75E-03
1,2,3,7,8-PeCDF	9.80E-11	0.05	4.90E-12	4.90E-03
2,3,4,7,8-PeCDF	1.75E-10	0.5	8.75E-11	8.75E-02
1,2,3,4,7,8-HxCDF	3.67E-10	0.1	3.67E-11	3.67E-02
1,2,3,6,7,8-HxCDF	2.01E-10	0.1	2.01E-11	2.01E-02
1,2,3,7,8,9-HxCDF	1.01E-10	0.1	1.01E-11	1.01E-02
2,3,4,6,7,8-HxCDF	9.98E-11	0.1	9.98E-12	9.98E-03
1,2,3,4,6,7,8-HpCDF	1.64E-09	0.01	1.64E-11	1.64E-02
1,2,3,4,7,8,9-HpCDF	2.00E-11	0.01	2.00E-13	2.00E-04
OCDF	1.81E-08	0.0001	1.81E-12	1.81E-03
			1.50E-09	**1.50004**

Table 7.2 Modelled WTE + baseline PCDD/F intake for MARI

PCDD Congeners	**mg/kg/d**	**WHO**	**mg/kg/d**	**pg/kg/d**
	PCDD/F	**TEQ**	**WHO TEQ**	**WHO TEQ**
2,3,7,8-TCDD	2.68E-12	1	2.68E-12	2.68E-03
1,2,3,7,8-PeCDD	5.71E-12	1	5.71E-12	5.71E-03
1,2,3,4,7,8-HxCDD	1.45E-11	0.1	1.45E-12	1.45E-03
1,2,3,6,7,8-HxCDD	1.53E-11	0.1	1.53E-12	1.53E-03
1,2,3,7,8,9-HxCDD	1.76E-11	0.1	1.76E-12	1.76E-03
1,2,3,4,6,7,8-HpCDD	3.48E-10	0.01	3.48E-12	3.48E-03
OCDD	2.92E-09	0.0001	2.92E-13	2.92E-04
PCDF Congeners				0.00E+00
2,3,7,8-TCDF	3.12E-11	0.1	3.12E-12	3.12E-03
1,2,3,7,8-PeCDF	2.38E-11	0.05	1.19E-12	1.19E-03
2,3,4,7,8-PeCDF	9.13E-11	0.5	4.57E-11	4.57E-02
1,2,3,4,7,8-HxCDF	5.60E-11	0.1	5.60E-12	5.60E-03
1,2,3,6,7,8-HxCDF	3.92E-11	0.1	3.92E-12	3.92E-03
1,2,3,7,8,9-HxCDF	4.06E-11	0.1	4.06E-12	4.06E-03
2,3,4,6,7,8-HxCDF	2.17E-11	0.1	2.17E-12	2.17E-03
1,2,3,4,6,7,8-HpCDF	3.24E-10	0.01	3.24E-12	3.24E-03
1,2,3,4,7,8,9-HpCDF	1.86E-11	0.01	1.86E-13	1.86E-04
OCDF	3.45E-10	0.0001	3.45E-14	3.45E-05
			8.61E-11	**0.08607**

Table 7.3 Modelled WTE + baseline PCDD/F intake for TARI

The increase in PCDD/F dose associated with the WTE facility, for both the MARI and TARI, is shown in Table 7.4.

	Baseline	Inc. Dose	Predicted Dose	% increase	Predicted Dose
	pg/kg/d	pg/kg/d	pg/kg/d		pg/kg/wk
MARI	1.4066	0.0938	1.5004	6.67	10.5028
TARI	0.0849	0.00117	0.08607	1.38	0.60249

Table 7.4 Increase in PCDD/F dose associated with WTE facility

The baseline PCDD/F dose, from food sourced outside area of the WTE facility and within area, is shown in Table 7.5 to allow for comparison with the predicted PCDD/F dose when the WTE facility is operational, which is shown in Table 7.6

	A	B	C	D	E	F
	pg/kg/d	pg/kg/d	%	%	pg/kg/d	pg/kg/wk
MARI	0.26	1.4066	16	84	1.67	11.7
TARI	0.35	0.0849	80	20	0.4314	3.0196

Table 7.5 Baseline PCDD/F dose from within and outside site

	A	B	C	D	E	F
	pg/kg/d	pg/kg/d	%	%	pg/kg/d	pg/kg/wk
MARI	0.26	1.5004	15	85	1.76	12.3
TARI	0.35	0.08607	80	20	0.4325	3.0278

Table 7.6 Predicted PCDD/F dose when WTE plant operational

Where:

A = Food sourced outside area pg/kg bw/day

B = PCDD/F intake from area pg/kg bw/day

C = % PCDD/F from food from outside area pg/kg bw/day

D = % PCDD/F contribution from area pg/kg bw/day

E= Combined Dose pg/kg bw/day

F= Combined Dose pg/kg bw/day

It can be seen that the increase in PCDD/F dose, for both the MARI and TARI, is very low, and both MARI and TARI PCDD/F intake is still well below the recommended value of 14 pg/kg bw/week.

7.2 Modelling of Accident Scenario at WTE facility

It was also considered prudent to model the impact of a credible accident scenario, on PCDD/F intake, this was accomplished as follows.

It was assumed that the facility operated at 10 ng/m^3 PCDD/F I-TEQ for 48 hours and the impact of this event was assessed, in terms of PCDD/F intake, in pg/kg bw/day.

The results of this exercise are presented in Tables 7.7 and 7.8.

PCDD Congeners	mg/kg/d	WHO	mg/kg/d	pg/kg/d
	PCDD/F	TEQ	WHO TEQ	WHO TEQ
2,3,7,8-TCDD	1.68E-10	1	1.68E-10	1.68E-01
1,2,3,7,8-PeCDD	8.59E-10	1	8.59E-10	8.59E-01
1,2,3,4,7,8-HxCDD	3.60E-10	0.1	3.60E-11	3.60E-02
1,2,3,6,7,8-HxCDD	1.29E-09	0.1	1.29E-10	1.29E-01
1,2,3,7,8,9-HxCDD	7.48E-10	0.1	7.48E-11	7.48E-02
1,2,3,4,6,7,8-HpCDD	7.54E-09	0.01	7.54E-11	7.54E-02
OCDD	1.08E-07	0.0001	1.08E-11	1.08E-02
PCDF Congeners				0.00E+00
2,3,7,8-TCDF	7.76E-11	0.1	7.76E-12	7.76E-03
1,2,3,7,8-PeCDF	9.81E-11	0.05	4.91E-12	4.91E-03
2,3,4,7,8-PeCDF	1.77E-10	0.5	8.85E-11	8.85E-02
1,2,3,4,7,8-HxCDF	3.70E-10	0.1	3.70E-11	3.70E-02
1,2,3,6,7,8-HxCDF	2.02E-10	0.1	2.02E-11	2.02E-02
1,2,3,7,8,9-HxCDF	1.01E-10	0.1	1.01E-11	1.01E-02
2,3,4,6,7,8-HxCDF	1.02E-10	0.1	1.02E-11	1.02E-02
1,2,3,4,6,7,8-HpCDF	1.64E-09	0.01	1.64E-11	1.64E-02
1,2,3,4,7,8,9-HpCDF	2.00E-11	0.01	2.00E-13	2.00E-04
OCDF	1.81E-08	0.0001	1.81E-12	1.81E-03
			1.55E-09	**1.55008**

Table 7.7 Modelled WTE Accident + baseline PCDD/F intake for MARI

PCDD Congeners	mg/kg/d	WHO	mg/kg/d	pg/kg/d
	PCDD/F	TEQ	WHO TEQ	WHO TEQ
2,3,7,8-TCDD	2.72E-12	1	2.72E-12	2.72E-03
1,2,3,7,8-PeCDD	5.93E-12	1	5.93E-12	5.93E-03
1,2,3,4,7,8-HxCDD	1.46E-11	0.1	1.46E-12	1.46E-03
1,2,3,6,7,8-HxCDD	1.56E-11	0.1	1.56E-12	1.56E-03
1,2,3,7,8,9-HxCDD	1.78E-11	0.1	1.78E-12	1.78E-03
1,2,3,4,6,7,8-HpCDD	3.48E-10	0.01	3.48E-12	3.48E-03
OCDD	2.92E-09	0.0001	2.92E-13	2.92E-04
PCDF Congeners				0.00E+00
2,3,7,8-TCDF	3.13E-11	0.1	3.13E-12	3.13E-03
1,2,3,7,8-PeCDF	2.38E-11	0.05	1.19E-12	1.19E-03
2,3,4,7,8-PeCDF	9.20E-11	0.5	4.60E-11	4.60E-02
1,2,3,4,7,8-HxCDF	5.63E-11	0.1	5.63E-12	5.63E-03
1,2,3,6,7,8-HxCDF	3.93E-11	0.1	3.93E-12	3.93E-03
1,2,3,7,8,9-HxCDF	4.06E-11	0.1	4.06E-12	4.06E-03
2,3,4,6,7,8-HxCDF	2.21E-11	0.1	2.21E-12	2.21E-03
1,2,3,4,6,7,8-HpCDF	3.24E-10	0.01	3.24E-12	3.24E-03
1,2,3,4,7,8,9-HpCDF	1.87E-11	0.01	1.87E-13	1.87E-04
OCDF	3.45E-10	0.0001	3.45E-14	3.45E-05
			8.68E-11	**0.08683**

Table 7.8 Modelled WTE Accident + baseline PCDD/F intake for TARI

A comparison with the predicted PCDD/F intake under normal operating conditions and the % increase in PCDD/F dose resulting from an accident are shown in Table 7.9.

	Normal Operation	**Increase**	**Accident Scenario**	**% increase**
	Predicted Dose	**in Dose**	**Predicted Dose**	
	pg/kg/d	**pg/kg/d**	**pg/kg/d**	
MARI	1.5004	0.04968	1.55008	3.31
TARI	0.08607	0.00076	0.08683	0.88

Table 7.9 Comparison with predicted PCDD/F intake and percentage increase

It can be seen from Table 7.9 that the accident scenario described above is predicted to lead to an increase in PCDD/F dose for the MARI of 3.3% and of 0.88% for the TARI.

Again, these dose levels are insignificant when compared with EU weekly intake guideline values.

8.0 CONCLUSIONS

It was concluded that the predicted impact of the emissions from the proposed WTE facility, for both maximum operating conditions and an accident scenario, on the MARI and the TARI is not significant.

The predicted PCDD/F intake for the MARI and the TARI was modelled to be well below the EC TWI of 14 pg/kg body weight/wk.

9.0 REFERENCES

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3. Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals, Volume II, Polynuclear Aromatic Hydrocarbons, Polychlorinated Dioxins and Dibenzofurans, Mackay, D., Ying Shiu, W. and Chimg Ma, K., Lewis Publishers, Ann Arbor, Tokyo and London, 1995.

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TECHNICAL REPORT

UPDATE OF SOIL PCB MONITORING PROGRAM FOR PROPOSED POOLBEG WASTE TO ENERGY FACILITY

FOR

Elsam Dublin Waste to Energy Ltd

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

AWN Consulting Ltd was instructed by Elsam Dublin Waste to Energy Ltd. to undertake the additional soil sampling at Sean Moore Park and Clontarf Promenade. This was as a result of recommendations in a report dated 2003 which indicated baseline PCDD/F-like PCBs were somewhat elevated at sampling locations in Sean Moore Park and Clontarf Promenade, when compared with other locations around Dublin Bay.

2.0 SAMPLING SITES

The sampling programme was conducted during the months of March and April, 2006 by AWN Consulting Ltd. The sampling programme was designed to establish the exact location of the elevated PCDD/F-like PCB concentrations at both sampling locations. 5 separate areas at each location were sampled.

3.0 SAMPLING METHODOLOGY

The original sampling areas at both Clontarf Promenade and Sean Moore Park were divided into 4 separate rectangular areas to isolate the exact location of the elevated PCDD/F-like PCB concentrations. An additional sample was taken at each location in an area that was not sampled previously in order to determine the background concentration at an alternative part of the same sampling location.

Samples were thoroughly mixed in a clean plastic basin and then a 1 kg aliquot extracted from the mixed sample. The 1 kg sample was placed in an amber glass jar (supplied by Scientific Analysis Laboratories Ltd. in the U.K. an analytical laboratory used by AWN Consulting Ltd.).

5.0 RESULTS

At Clontarf Promenade locations 2-5 recorded a value of 0.02 µg/kg or less for the 8 mono-ortho PCBs and <0.01 µg/kg for the 4 non-ortho PCBs, whereas the sample taken at Location 1 had higher PCB concentrations of 0.46 µg/kg (8 mono –ortho), <0.01 µg/kg (4 non-ortho). It can be concluded that Location 1 has the highest concentrations of PCBs for the sampling area. This indicates that the high concentration measured during the previous event is confined to location 1.

At Sean Moore Park there was a varied concentration of PCDD/F-like PCBs at each location. Values for the 8 mono-ortho PCBs ranged from a low of 0.71 µg/kg at location 5 to a high of 2.45 µg/kg at location 3. For the 4 non-ortho PCBs, concentrations varied from a low of 0.01 µg/kg at location 1 to a high of 0.04 µg/kg at location 3. It can be concluded that Location 3 has the highest concentrations of PCBs for the sampling area.

In comparison with the results from the sampling events undertaken in 2003, results were significantly lower. This is most evident for Pentachloro, BZ#118, where a concentration of 4.4µg/kg was recorded at Clontarf Promenade in 2003 but a maximum of only 0.03µg/kg was recorded during the current monitoring programme. At Sean Moore Park the concentration of Pentachloro, BZ#118 was 0.51µg/kg in 2003 whereas the maximum concentration in 2006 was 1.3 µg/kg at location 3.

Pentachloro, BZ#126 is the most important of the 12 PCDD/F-like PCBs because it has a high WHO-TEF value of 0.1. It is one of the major congeners contributing to the total WHO toxicity equivalent. Results of the sampling programme show that Pentachloro, BZ#126 levels were below the limit of detection (0.01µg/kg) for all locations in Clontarf and locations 1, 4 and 5 in Sean Moore Park. Locations 2 and 3 in Sean Moore Park had Pentachloro, BZ#126 levels of 0.01µg/kg.

6.0 DISSUSSION OF RECENT STUDIES

There are a number of sources of these PCBs in the environment. Combustion sources are believed to be the main source of PCB 126, 169 and 189. Soils and sediments which have been contaminated in the past may release low concentrations back into the atmosphere over extended periods of time, therefore areas where industrial activities have taken place in the past, are likely to contain concentrations of PCDD/F-like PCBs.

Studies in Belgium showed the presence of PCDD/F-like PCB concentrations in scrap yards, metal yards and shredder plants. This led to the investigation of the contribution of PCDD/F and PCDD/F-like PCBs to diffuse emission sources, showing the importance of such sources at particular plants, mainly in the non-ferrous metal and scrap metal industries. Results from a recent soil sampling programme in Germany indicated that there were higher levels of PCCD/F-like PCB concentrations in the upper soil layer (0-10cm) than in deeper layers (0-30cm), indicating that the major source is atmospheric deposition.

Very little research has been done in Ireland in relation to the levels of PCDD/F-like PCBs in the Irish Environment. Studies by the Irish EPA and the Food Safety Authority of Ireland have investigated levels of dioxins, furans, PCBs and PBDEs in Irish Food and have found these levels to be low; however there is no direct reference to the levels of PCDD/F-like dioxins in Irish soils. No Irish guidance is currently available for PCB contamination in soils.

7.0 CONCLUSIONS

Further sampling was undertaken at Sean Moore Park and Clontarf Promenade to determine if a source of PCB contamination is present on the surface, or if the measured value is representative of the maximum concentrations present. Results have shown that there are low levels of PCDD/F-like PCBs at both sites however the levels are elevated in some locations at each site more than others. Sean Moore Park location 3 has elevated levels in comparison to the others. In Clontarf Promenade all locations show the majority of PCDD/F-like PCB levels below the limit of detection, location 1 at Clontarf Promenade has slightly elevated levels in comparison to the others.

Definitions:

PCDD: Polychlorinated dibenzo-*p*-dioxins
PCDF: Polychlorinated dibenxo-*p*-furans
PCB: Polychlorinated Biphenols
PBDE: Polybrominated Diphenylethers

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TABLE OF CONTENTS

1.0 INTRODUCTION

Monitoring undertaken by AWN Consulting in 2003 indicated that baseline PCDD/F-like PCBs were somewhat elevated at sampling locations in Sean Moore Park and Clontarf Promenade, when compared with other locations around Dublin Bay.

The report recommended the following:

“It would be prudent to carry out additional soil sampling at Sean Moore Park to determine if a source of PCB contamination is present on the surface, or if the measured value is representative of the maximum concentrations present. Similarly, the PCB concentration recorded at Clontarf was also elevated when compared with the other samples measured and it would be prudent to conduct further sampling at this location also”.

AWN Consulting Ltd was instructed by Elsam Dublin Waste to Energy Ltd. to undertake the additional sampling; this incorporated the following scope of work:

- Surface soil sampling,
- Laboratory analyses for PCDD/F-like PCBs
- Reporting including an interpretation and significance assessment,

2.0 LOCATION OF SAMPLING SITES

The details of the soil sampling locations are described in Table 2.1. The sampling programme was conducted during the months of March and April, 2006 by AWN Consulting Ltd.

Table 2.1 – Soil Sampling Locations

Location No.	*Sampling Point Location*	*Position (Grid Ref.)*	*Sample Date*
A	Sean Moore Park	53^0 20.169' N 006^0 12.923' W	3rd April 2006
B	Clontarf (grassed area along the sea front)	53^0 21.476' N 006^0 11.605' W	30th March 2006

The sampling programme was designed to establish the exact location of the elevated PCDD/F-like PCB concentrations at both sampling locations. 5 separate areas at each location were sampled.

3.0 SAMPLING METHODOLOGY

The aim of the sampling programme at each site was to establish baseline topsoil PCDD/F-like PCB concentrations for each particular sampling location and to try to isolate the previously measured elevated concentrations.

US EPA guidance, as presented in the US EPA EISOPQAM, was followed in the selection and design of the sampling methodology[1]. The EISOPQAM Areal Composite Methodology was selected as the method most applicable for determining background soil concentrations for an area[2]. This method ensures the sample collected is representative of an area. Briefly, the methodology consists of taking a number of samples in an identical manner and of an identical size and then combining these samples to form a composite sample, which is then thoroughly mixed. A sample of this composite material is then sent for analysis.

The original sampling areas at both Clontarf Promenade and Sean Moore Park were divided into 4 separate rectangular areas to isolate the exact location of the elevated PCDD/F-like PCB concentrations. An additional sample was taken at each location in an area that was not sampled previously in order to determine the background concentration at an alternative part of the same sampling location.

3.1 Sampling Depth

The investigation was designed to measure background contaminant concentrations in surface soils, which has been defined by EISOPQAM as soils between the ground surface and up to 6 - 12 inches (15 – 30 cm) below the ground surface [3]. Other authors, such as Hendriks *et al* [4] have taken samples of cores, which are 0 – 5 cm thick, whereas the team that has been working for many years on assessing the impact of the Seveso accident near Milan, Italy, has used samples of 7 cm thickness[5].

As the aim of this study was to assess the impact of surface deposition of contaminants, it was felt that the depth used by the Seveso study team (who were studying airborne deposition and were among the first teams to actively study the impact of dioxin deposition on soil concentrations) was the most appropriate. Therefore, soil samples of 7 cm thickness (from the surface to 7 cm below the surface) were taken.

3.2 Sampling Pattern

The sampling on each site was carried out in a “W” Pattern or a series of “W” patterns (where the site area was confined). Following the EPA EISOPQAM sampling methodology, samples were taken at 10 m centres.

The field records for each sampling site can be seen in Appendix 3. The layout of the sampling grid at each sampling location can be seen from the plates in Appendix 4.

3.3 Sample acquisition and Handling

The field records note that between 15 - 20 soil samples were taken at 10 m intervals, using a 2 cm diameter corer extended to a depth of 7 cm, at the sampling sites, with the sample number and sampling interval being determined by the area available for sampling.

Samples were thoroughly mixed in a clean plastic basin and then a 1 kg aliquot extracted from the mixed sample. The 1 kg sample was placed in an amber glass jar (supplied by Scientific Analysis Laboratories Ltd. in the U.K. an analytical laboratory used by AWN Consulting Ltd.). All soil samples were labelled samples A-F, and the analysis required for each sample was listed on a Sampling and Chain of Custody Record.

The samples were collected in one batch by Indn City Express, on 3rd April 2006, and couriered overnight to Scientific Analysis Laboratories Ltd. in the U.K., for analysis.

3.4 Analysis suite

Scientific Analysis Laboratories Ltd. (SAL) are a UKAS 1549 Group accredited laboratory and were instructed to undertake the analysis of PCDD/F-like PCBs (WHO 12) by AWN Consulting Ltd. SAL holds UKAS accreditation for these tests.

4.0 RESULTS OF LABORATORY ANALYSES

The analysis results for PCDD/F-like PCBs at Clontarf Promenade and Sean Moore Park are shown in Tables 4.1 and 4.2. See Appendix 2 for the sampling locations 1-5.

Table 4.1 PCDD/F-like PCBs – Clontarf Promenade

Determinand	Method	Units	Sampling Locations				
Ortho PCB's [1]			1	2	3	4	5
Pentachloro, BZ#105	GC/MS	µg/kg	0.11	0.02	<0.01	0.02	<0.01
Pentachloro, BZ#114	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Pentachloro, BZ#118	GC/MS	µg/kg	0.21	0.03	0.02	0.03	0.02
Pentachloro, BZ#123	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Hexachloro, BZ#156	GC/MS	µg/kg	0.08	0.01	<0.01	<0.01	<0.01
Hexachloro, BZ#157	GC/MS	µg/kg	0.02	<0.01	<0.01	<0.01	<0.01
Hexachloro, BZ#167	GC/MS	µg/kg	0.04	0.02	<0.01	<0.01	<0.01
Hepachloro, BZ#189	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Non Ortho PCB's							
Tetrachloro, BZ#81	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Tetrachloro, BZ#77	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Pentachloro, BZ#126	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Hexachloro, BZ#169	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01

1. Limit of Detection is 0.01 µg/kg unless otherwise stated

Table 4.2 PCDD/F-like PCBs – Sean Moore Park

Determinand	Method	Units	Sampling Locations				
Ortho PCB's [1]			1	2	3	4	5
Pentachloro, BZ#105	GC/MS	µg/kg	0.25	0.26	0.72	0.11	0.2
Pentachloro, BZ#114	GC/MS	µg/kg	0.03	0.03	0.07	<0.01	0.02
Pentachloro, BZ#118	GC/MS	µg/kg	0.45	0.54	1.3	0.21	0.39
Pentachloro, BZ#123	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Hexachloro, BZ#156	GC/MS	µg/kg	0.08	0.09	0.15	0.04	0.06
Hexachloro, BZ#157	GC/MS	µg/kg	0.02	0.03	0.05	<0.01	0.02
Hexachloro, BZ#167	GC/MS	µg/kg	0.07	0.06	0.16	0.02	0.04
Hepachloro, BZ#189	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Non Ortho PCB's							
Tetrachloro, BZ#81	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
Tetrachloro, BZ#77	GC/MS	µg/kg	0.01	0.03	0.03	0.02	0.03
Pentachloro, BZ#126	GC/MS	µg/kg	<0.01	0.01	0.01	<0.01	0.01
Hexachloro, BZ#169	GC/MS	µg/kg	<0.01	<0.01	<0.01	<0.01	<0.01

1. Limit of Detection is 0.01 µg/kg unless otherwise stated

5.0 RESULTS

7.1 Analysis of measured PCDD/F-like PCBs.

7.1.1 Clontarf Promenade

It can be seen from Table 4.1 that Locations 2-5 recorded a value of 0.02 µg/kg or less for the 8 mono-ortho PCBs and <0.01 µg/kg for the 4 non-ortho PCBs, whereas the sample taken at Location 1 had higher PCB concentrations of 0.46 µg/kg (8 mono –ortho) and <0.01 µg/kg (4 non-ortho).

See Figure 5.1 for a graphical representation of the results. It can be concluded that Location 1 had the highest concentrations of PCBs for the sampling area. This indicates that the high concentration measured during the previous event is confined to location 1.

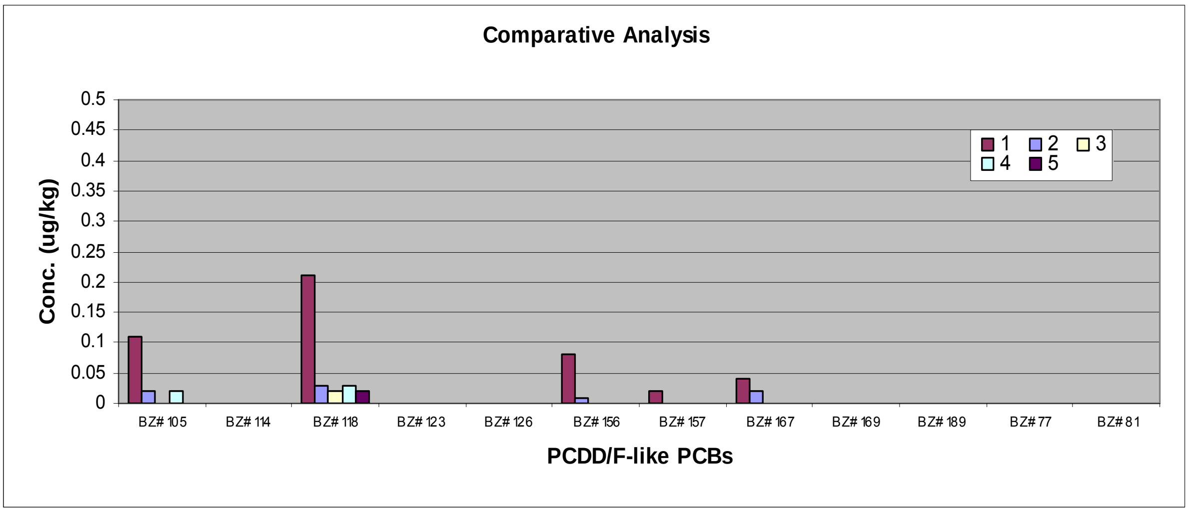

Figure 5.1 Comparative Analysis: PCDD/F-like PCBs – Clontarf Promenade

7.1.2 Sean Moore Park

It can be seen that from Table 4.2 that there was a varied concentration of PCDD/F-like PCBs at each location. Values for the 8 mono-ortho PCBs ranged from a low of 0.71 µg/kg at location 5 to a high of 2.45 µg/kg at location 3. For the 4 non-ortho PCBs, concentrations varied from a low of 0.01 µg/kg at location 1 to a high of 0.04 µg/kg at location 3. It can be concluded that Location 3 had the highest concentrations of PCBs for the sampling area. See Figure 5.1 for a graphical representation of the results.

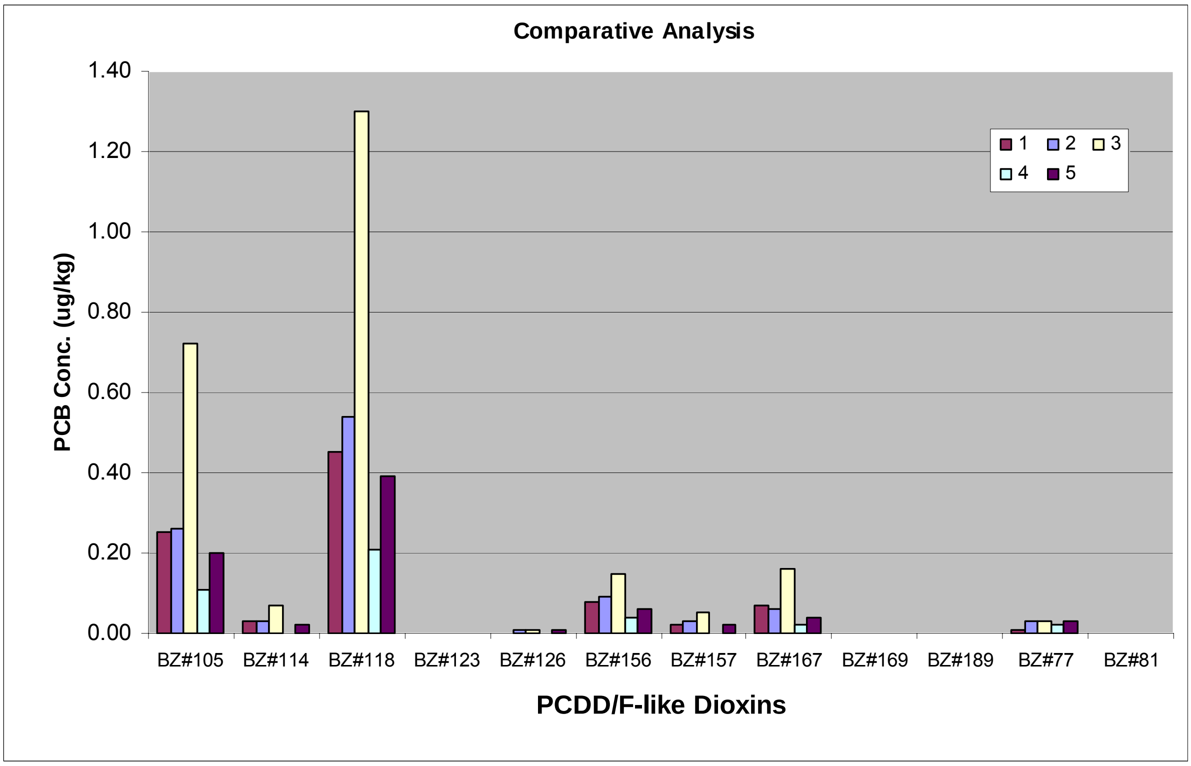

Figure 5.2 Comparative Analysis: PCDD/F-like PCBs – Sean Moore Park

7.2 Comparison of measured PCDD/F-like PCBs with data from previous sampling event

Table 5.2 shows the results of the PCDD/F-like PCB soil sampling that took place in November 2003 at Clontarf promenade and Sean Moore Park.

Table 5.1 PCDD/F-like PCBs – Clontarf Promenade & Sean Moore Park, November 2003

Determinand *Ortho PCB's* [1]	*Method*	*Units*	*Clontarf Promenade*	*Sean Moore Park*
Pentachloro, BZ#105	GC/MS	µg/kg	1.9	0.27
Pentachloro, BZ#114	GC/MS	µg/kg	0.09	<0.05
Pentachloro, BZ#118	GC/MS	µg/kg	4.4	0.51
Pentachloro, BZ#123	GC/MS	µg/kg	<0.05	<0.05
Hexachloro, BZ#156	GC/MS	µg/kg	0.62	0.08
Hexachloro, BZ#157	GC/MS	µg/kg	0.17	<0.05
Hexachloro, BZ#167	GC/MS	µg/kg	0.27	<0.05
Hepachloro, BZ#189	GC/MS	µg/kg	<0.05	<0.05
Non Ortho PCB's				
Tetrachloro, BZ#81	GC/MS	µg/kg	<0.05	<0.05
Tetrachloro, BZ#77	GC/MS	µg/kg	0.14	<0.05
Pentachloro, BZ#126	GC/MS	µg/kg	<0.05	<0.05
Hexachloro, BZ#169	GC/MS	µg/kg	<0.05	<0.05

It can be seen from Table 5.1 that the results were significantly higher that the results recorded in Table 4.1. This is most evident for Pentachloro, BZ#118, where a concentration of 4.4µg/kg was recorded at Clontarf Promenade in 2003 but only reached a maximum of

0.03µg/kg at the recent monitoring event. At Sean Moore Park the concentration of Pentachloro, BZ#118 was 0.51µg/kg in 2003 whereas the maximum concentration in 2006 was 1.3 µg/kg at location 3. The comparison between the 2003 levels and the 2006 levels can be seen in Figure 5.3.

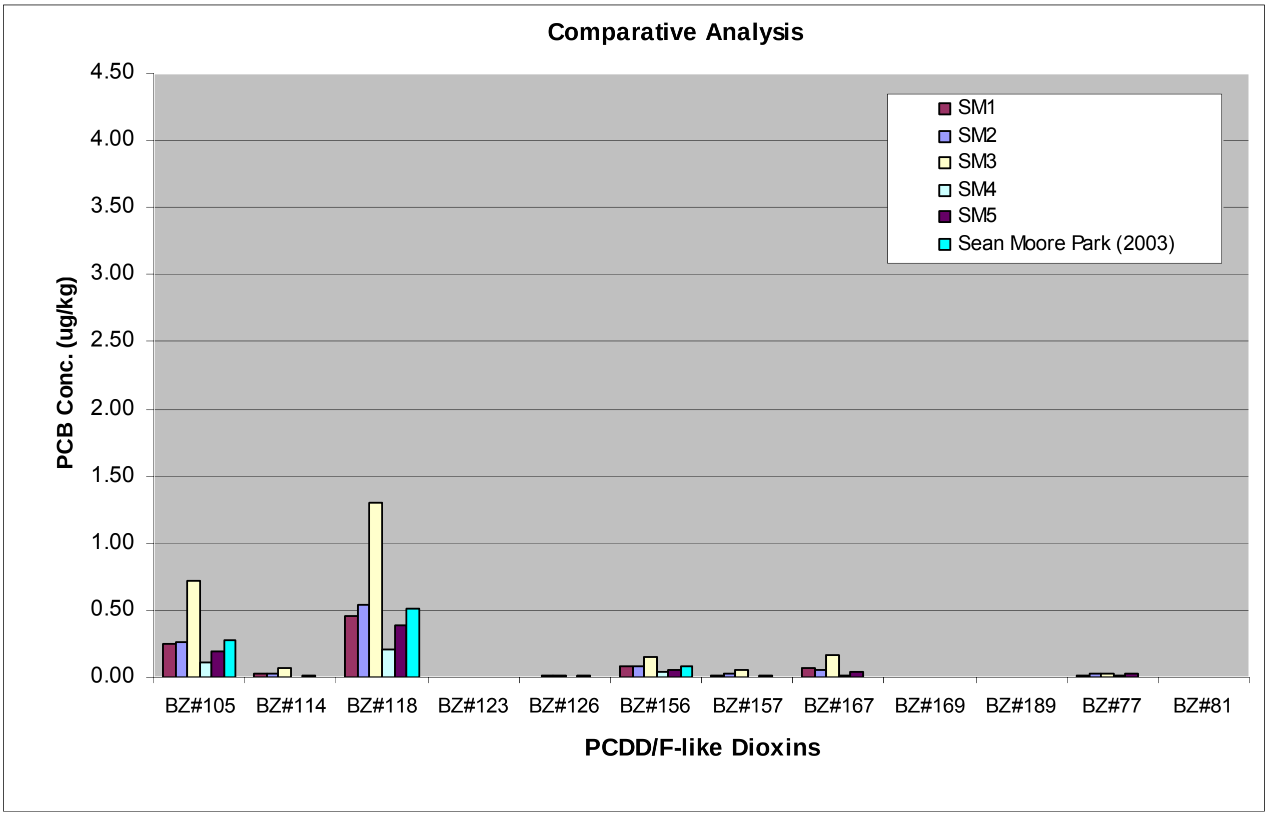

Figure 5.3 ***Comparative Analysis: PCDD/F-like PCBs – 2003 Monitoring Event & 2006 Monitoring Event(Sean Moore Park)***

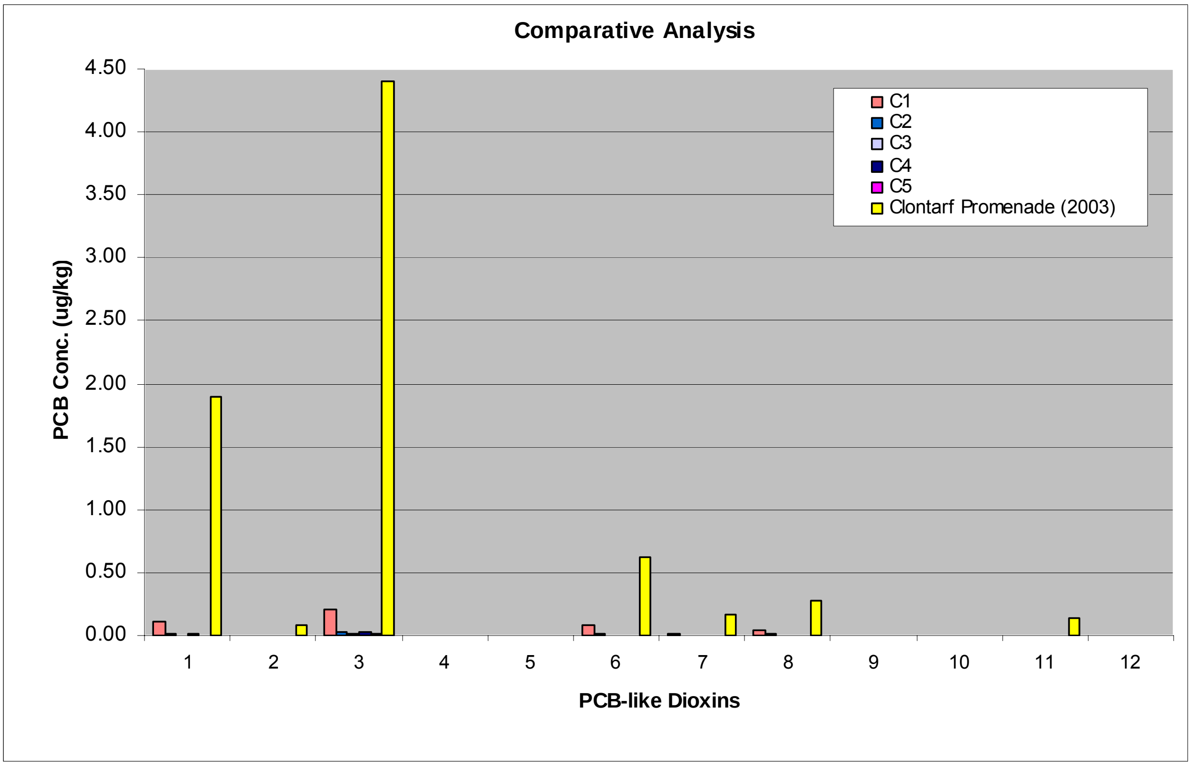

Figure 5.4 Comparative Analysis: PCDD/F-like PCBs – 2003 Monitoring Event & 2006 Monitoring Event (Clontarf Promenade)

Pentachloro, BZ#126 is the most important of the 12 PCDD/F-like PCBs[13] because it has a high WHO-TEF (it has a value of 0.1). It is one of the major congeners contributing to the total WHO toxicity equivalent. Results of the sampling programme show that Pentachloro, BZ#126 levels are below the limit of detection (0.01µg/kg) for all locations in Sean Moore Park and locations 1, 4 and 5 in Sean Moore Park. Locations 2 and 3 have Pentachloro, BZ#126 levels of 0.01µg/kg.

6.0 DISSUSSION OF RECENT STUDIES

There are a number of sources of these PCBs in the environment. Combustion sources (this is combustion of non-PCB materials – that is it is the *de novo* synthesis of PCB) are believed to be the main source of PCB-126, 169 and 189[6,7].

Aroclor, the trade name under which Monsanto Corp. sold commercial PCB formulations (specifically formulations 1221, 1232 and 1242) is likely to be the major source of PCBs 156, 105, 118 and 77 in the environment[6]. Aroclor was used in industry as a heat transfer fluid and in hydraulic lubricants, flame retardants, plasticisers, and as a dielectric fluid in electronic components such as capacitors and transformers[8]. It will be seen that the majority of the PCBs recorded in the current study are in this group (156, 105, 118 and 77), whereas the combustion derived PCBs are generally not represented. Therefore, it can be concluded that the source of the mono-ortho and non-ortho PCBs measured was most likely to be Aroclor related sources.

Research work in the UK and USA has found that PCB-156, 126 and 118 accounts for 70 – 90% of the PCB TEQ burden in human breast milk[9]. This pattern is reflected in the PCB profile of the samples with PCB-156 and 118 being the dominant congeners recorded for the soil samples.

Soils and sediments which have been contaminated in the past may release low concentrations back into the atmosphere over extended periods of time[10], therefore areas where industrial activities have taken place in the past, are likely to contain concentrations of PCDD/F-like PCBs. A study conducted in 1994 measured urban mono-ortho and non-ortho PCB concentrations at a number of locations in the US and Japan and found that concentrations ranged from 0.8 – 9.9 ng/kg I-TEQ[11].

Studies in Belgium showed the presence of PCDD/F-like PCB concentrations in scrap yards, metal yards and shredder plants[12]. This led to the investigation of the contribution of PCDD/F and PCDD/F-like PCBs to diffuse emission sources, showing the importance of such sources at particular plants, mainly in the non-ferrous metal and scrap metal industries.

A monitoring programme was undertaken in 2003 in Germany[13] to assess the levels of PCDD/F-like dioxins in the environment, the results of the soils sampling programme correlated with the ambient air and deposition samples. Results from the soil sampling indicated that there were higher levels of PCCD/F-like PCB concentrations in the upper layer (0-10cm) than in deeper layers (0-30cm), this is a result of the atmospheric deposition.

Very little research has been done in Ireland in relation to the levels of PCDD/F-like PCBs in the Irish Environment. Studies by the EPA and Food Safety Authority of Ireland have investigated levels of dioxins, furans, PCBs and PBDEs in Irish Food[14]; and have found these levels to be low, however there is no direct reference to the levels of PCDD/F-like dioxins in Irish soils. No Irish guidance is currently available for PCB contamination.

8.0 CONCLUSION S

Further sampling was undertaken at Sean Moore Park and Clontarf Promenade to determine if a source of PCB contamination is present on the surface, or if the measured value is representative of the maximum concentrations present. Results have shown that there are low levels of PCDD/F-like PCBs at both sites however the levels are elevated in some locations at each site more than others. In Sean Moore Park location 3 has elevated levels in comparison to the others. In Clontarf Promenade all locations show the majority PCDD/F-like PCB levels below the limit of detection, location 1 has slightly elevated levels in comparison to the others.

REFERENCES

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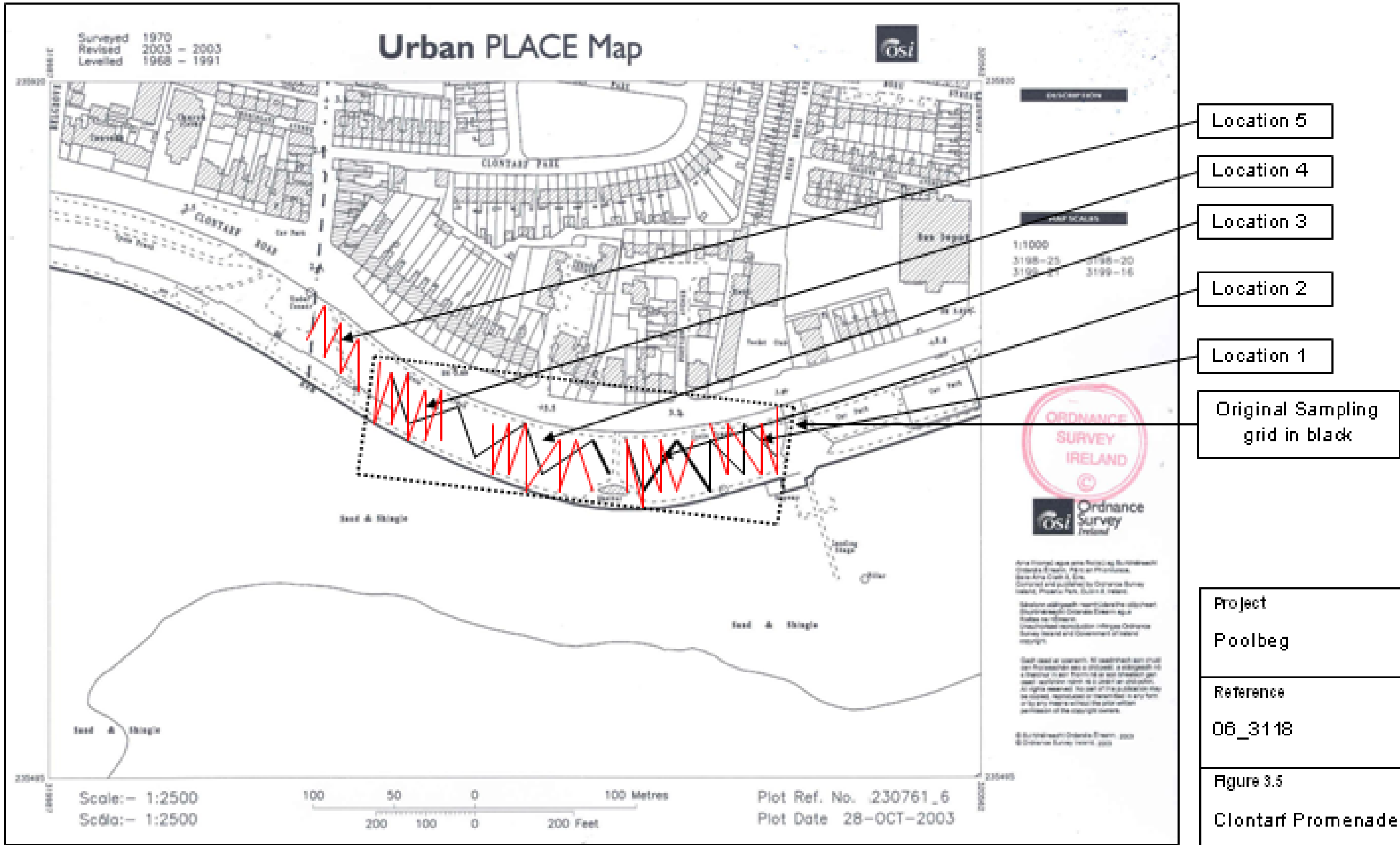
<u>Appendix 1</u>

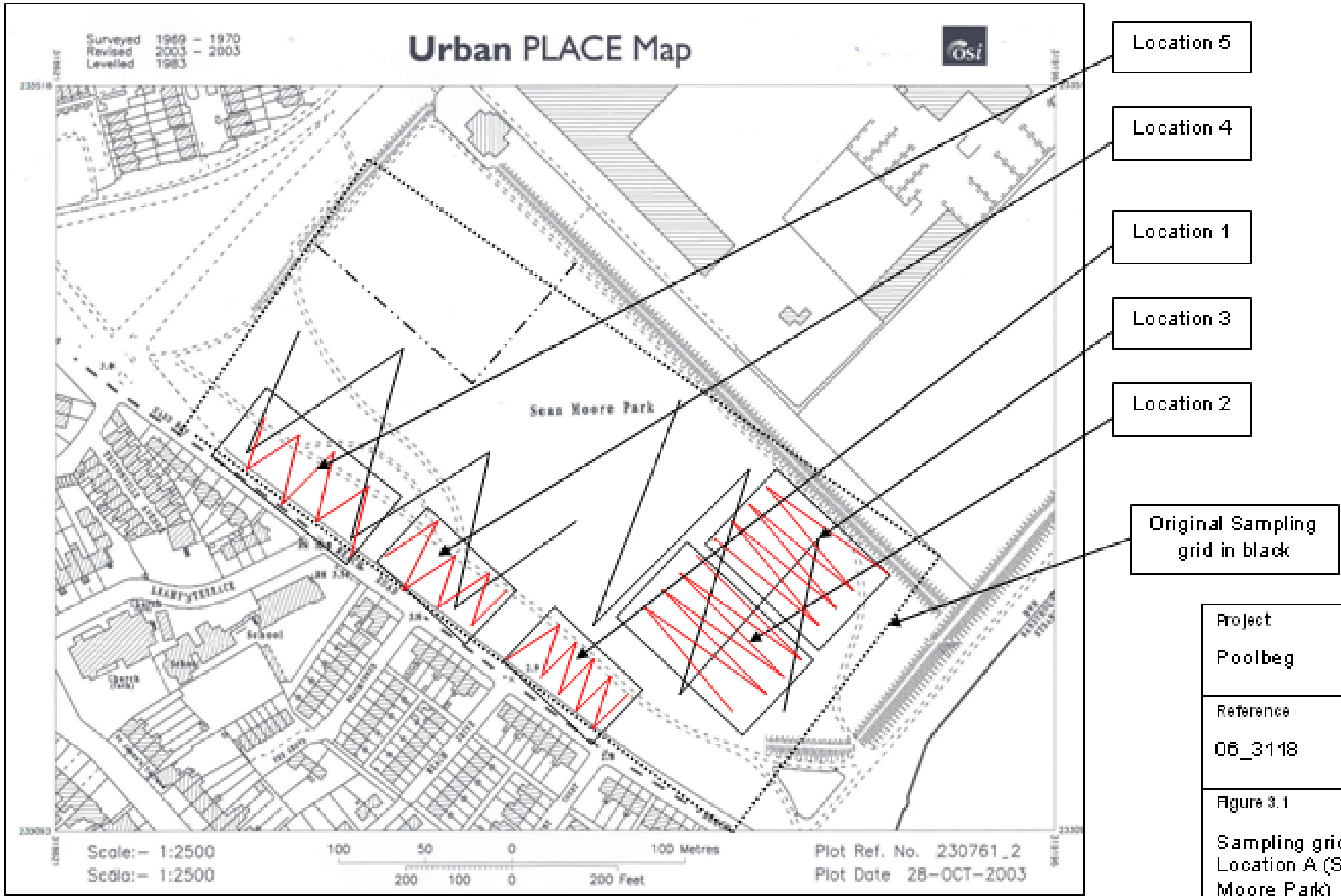
Sampling Locations



Project	Poolbeg
Reference	06_3118
Figure 3.5	Clontarf Promenade Scale 1:2500

awn consulting

The Tecpro Building, Clonshaugh Industrial Estate, Dublin 17. Tel: +353 (0) 1 847 4220 Fax: +353 (0) 1 847 4257



Project

Poolbeg

Reference

06_3118

Figure 3.1

Sampling grid at Location A (Sean Moore Park)

Scale 12500

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<u>Appendix 2</u>

Field Notes

Clontarf Promenade

Location: 1

Sampling conducted by: Heidi Hopper (AWN Consulting)

Sampling area: 1428.16m^2

Transect length: 190m

19 samples taken @ 10m intervals

Project

Poolbeg

Reference

06_3118

awn consulting

The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

Clontarf Promenade

Location: 2

Sampling conducted by: Heidi Hopper (AWN Consulting)

Sampling area: 3840.51m^2

Transect length: 350m

35 samples taken @ 10m intervals

Project

Poolbeg

Reference

06_3118

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The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

Clontarf Promenade

Location: 3

Sampling conducted by: Heidi Hopper (AWN Consulting)

Sampling area: 1829.0m^2

Transect length: 210m

21 samples taken @ 10m intervals

Project

Poolbeg

Reference

06_3118

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Clontarf Promenade

Location: 4

Sampling conducted by: Heidi Hopper (AWN Consulting)

Sampling area: 1590.88m^2

Transect length: 200m

20 samples taken @ 10m intervals

Project

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Reference

06_3118

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Clontarf Promenade

Location: 5

Sampling conducted by: Heidi Hopper (AWN Consulting)

Sampling area: 972m^2

Transect length: 200m

20 samples taken @ 10m intervals

Project

Poolbeg

Reference

06_3118

awn consulting

The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

Sean Moore Park

Location: 1

Sampling conducted by: Brian Tiernan (AWN Consulting)

Sampling area: 582.32m^2

Transect length: 162m

16 samples taken @ 10m intervals

Project

Poolbeg

Reference

06_3118

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The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

Sean Moore Park

Location: 2

Sampling conducted by: Brian Tiernan (AWN Consulting)

Sampling area: 1134.2m^2

Transect length: 194m

19 samples taken @ 10m intervals

Project

Poolbeg

Reference

06_3118

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The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

Sean Moore Park

Location: 3

Sampling conducted by: Brian Tiernan (AWN Consulting)

Sampling area: 11187m^2

Transect length: 184m

18 samples taken @ 10m intervals

Project
Poolbeg
Reference
06_3118

awn consulting

The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

Sean Moore Park

Location: 4

Sampling conducted by: Brian Tiernan (AWN Consulting)

Sampling area: 537m²

Transect length: 158m

15 samples taken @ 10m intervals

Project

Poolbeg

Reference

06_3118

awn consulting

The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

Sean Moore Park

Location: 5

Sampling conducted by: Brian Tiernan (AWN Consulting)

Sampling area: 605m^2

Transect length: 181m

18 samples taken @ 10m intervals

Project

Poolbeg

Reference

06_3118

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The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17. Tel: +353 (0)1 847 4220 Fax: +353 (0)1 847 4257

<u>Appendix 3</u>

Laboratory Analysis Results

Scientific Analysis Laboratories

Report Number:	75290 compiled
Date of Report:	18/04/06
Client:	AWN Consultants, Tecpro Building, Clonshaugh Industrial Estate, Dublin 17.
Client Contact:	Brian Tiernan
Client Job Reference:	06-3118
Date Job Received at SAL:	05/04/06
Date Analysis Started:	06/04/06

The results reported relate to samples received at the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs

Key to symbols used on this report:
W: Analysis was performed at another SAL laboratory
S: Analysis was subcontracted
N: Analysis is not UKAS accredited
U: Analysis is UKAS accredited

Report written by:
Amanda Bailey
Assistant Customer Service Manager

Report checked and authorised by:
Helen Ashpool
Senior Project Manager

UKAS TESTING
1549
Group

Report Number: 75290 compiled

Client Job Reference: 06-3118

				SAL Ref:	75290 001	75290 002	75290 003	75290 004	75290 005	75290 006
				Client Ref:	CLONTARF-1	CLONTARF-2	CLONTARF-3	CLONTARF-4	CLONTARF-5	S.MOORE PARK-1
				Type:	Soil	Soil	Soil	Soil	Soil	Soil
Determinand	**Method**	**Units**	**LOD**	**Symbol**						
Polychlorinated biphenyl BZ#105	GC/MS (HR)	ug/kg	0.01	U	0.11	0.02	<0.01	0.02	<0.01	0.25
Polychlorinated biphenyl BZ#114	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01	<0.01	0.03
Polychlorinated biphenyl BZ#118	GC/MS (HR)	ug/kg	0.01	U	0.21	0.03	0.02	0.03	0.02	0.45
Polychlorinated biphenyl BZ#123	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Polychlorinated biphenyl BZ#126	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Polychlorinated biphenyl BZ#156	GC/MS (HR)	ug/kg	0.01	U	0.08	0.01	<0.01	<0.01	<0.01	0.08
Polychlorinated biphenyl BZ#157	GC/MS (HR)	ug/kg	0.01	U	0.02	<0.01	<0.01	<0.01	<0.01	0.02
Polychlorinated biphenyl BZ#167	GC/MS (HR)	ug/kg	0.01	U	0.04	0.02	<0.01	<0.01	<0.01	0.07
Polychlorinated biphenyl BZ#169	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Polychlorinated biphenyl BZ#189	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Polychlorinated biphenyl BZ#77	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Polychlorinated biphenyl BZ#81	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Organic Carbon	OX/IR	%	0.1	N	4	4.4	3.9	5.9	4.4	5.3
pH	Probe			U	7.5	7.4	7.4	7.6	7.6	7.5

Report Number: 75290 compiled
Client Job Reference: 06-3118

				SAL Ref:	75290 007	75290 008	75290 009	75290 010
				Client Ref:	S.MOORE PARK-2	S.MOORE PARK-3	S.MOORE PARK-4	S.MOORE PARK-5
				Type:	Soil	Soil	Soil	Soil
Determinand	**Method**	**Units**	**LOD**	**Symbol**				
Polychlorinated biphenyl BZ#105	GC/MS (HR)	ug/kg	0.01	U	0.26	0.72	0.11	0.2
Polychlorinated biphenyl BZ#114	GC/MS (HR)	ug/kg	0.01	U	0.03	0.07	<0.01	0.02
Polychlorinated biphenyl BZ#118	GC/MS (HR)	ug/kg	0.01	U	0.54	1.3	0.21	0.39
Polychlorinated biphenyl BZ#123	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01
Polychlorinated biphenyl BZ#126	GC/MS (HR)	ug/kg	0.01	U	0.01	0.01	<0.01	0.01
Polychlorinated biphenyl BZ#156	GC/MS (HR)	ug/kg	0.01	U	0.09	0.15	0.04	0.06
Polychlorinated biphenyl BZ#157	GC/MS (HR)	ug/kg	0.01	U	0.03	0.05	<0.01	0.02
Polychlorinated biphenyl BZ#167	GC/MS (HR)	ug/kg	0.01	U	0.06	0.16	0.02	0.04
Polychlorinated biphenyl BZ#169	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01
Polychlorinated biphenyl BZ#189	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01
Polychlorinated biphenyl BZ#77	GC/MS (HR)	ug/kg	0.01	U	0.03	0.03	0.02	0.03
Polychlorinated biphenyl BZ#81	GC/MS (HR)	ug/kg	0.01	U	<0.01	<0.01	<0.01	<0.01
Total Organic Carbon	OX/IR	%	0.1	N	2.6	5.3	4.5	5.3
pH	Probe			U	7.5	7.5	7.5	7.5