APPENDIX 14
SOIL AND HERBAGE MONITORING

Volume 3 of 3

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14.1 Introduction

In order to determine the potential impacts of the proposed development on soil and herbage in the vicinity through atmospheric emissions from the stack or soil contamination through spillages, a comprehensive soil and herbage analysis was undertaken in June and July 2001 within a 5km area surrounding the proposed plant site. Sampling was carried out over a 2-day period in June 2001 at 26 sampling locations, five of which were located on the proposed development site. A systematic sampling pattern was employed for selecting soil and herbage sampling locations with grid pattern and spacing dependant on distance from site as per ISO 10381 Part 5 Version 6 – *Guidance on the procedures for the investigation of urban and industrial sites with regard to soil contamination.* This sampling procedure was used in order to ensure complete and unbiased coverage of the surveyed area. However, because of the requirement to collect both soil and plants at each sampling point, and the necessity to avoid buildings, roads, powerlines etc, it was not always possible to adhere to a rigid compass-based grid pattern.

Baseline concentrations from a wide range of chemical parameters (heavy metals, cations and anions) were analysed from a total of 26 sampling locations for both soil and herbage samples. I m core samples were taken at the proposed development site at 5 sampling locations for VOC's, Dioxins/Furans, pesticides PAH's and PCB's respectively. Each soil core sample was logged with regard tu lithological profile. Sampling locations are outlined in Table 14.1 and Fig 14.1. Samples were analysed for the suite of parameters outlined in Table 14.2. Any future monitoring requirements can be referenced against these baseline environmental monitoring results. While atmospheric emission monitoring data indicates that no significant deposition will occur as a result of the development, baseline monitoring provides an environmental datum against which any future monitoring regime can be compared.

14.2 Sampling Methodology

Soil materials were sampled as per BS DD 175 1988 (1992) *Code of Practice for the identification of potentially contaminated land and its investigation* and as per the UK HMIP protocol. For all sampling locations the following information was collected

- Identification of the area by OS reference (8 figure)
- Photographs and details of sampling site to ensure future samples can taken from the same location.

- Details on land use and use of herbicides/ pesticides to judge whether the use of chlorinated pesticide/herbicide usage may have lead to significant inputs of dioxins in the soil.

- Details on soil characteristics based on archaeological soil recording charts (ref http:www.artacorn.com/soil.html), (Figure 14.2) were recorded for each sampling site including hardness, soil type and any details of color or possible contamination

- All plant samples, including weeds and arable crops, were inspected visually for evidence of pest disease, aerial pollution and nutritional imbalance.

Obtaining the Samples

- All samples were taken on land whii was not subject to swage sludge spreading or within 10 stack heights of any other combustion source. All sample sites were at least 10m away from overhangin cables to preven sample contamination from heavy metals

- Where the sample grid located potential sample sites in arable land. this site was discounted and an alternative site locate as the mixing caused by ploughing will dilute any input of pollutants

- Using a soil corer five sub samples were taken from a one meter square area at depths of up to 0.3m. The top 10cms of the sample containing roots was discounted and core samples from approximately 10-20cms were taken from each point of a W shape using a soil corer.

- Core samples with an approximate weight of 200g were taken from each point ofthe W and the five sub-samples were combined to make one composite. This was wrapped in heavy duty polyethylene bags and sent to laboratory for analysis.

- Five sub-samples of surface vegetation were taken in a similar manner using stainless steel scissors, taking care not to cross contaminate the samples with soil material.

- Visual examination of the plant foliage was also carried out since chemical analysis of the foliage for aerial pollutants is not always conclusive. Pollutants are rapidly absorbed within other compounds and the individual elements of the pollutant e.g. nitrogen and sulphur are usually already present within the plant in large concentrations. Table 14.3 outlines typical symptoms of air pollution injury an vegetation. Samples were inspected for symptoms of air pollution injury, specifically by sulphur dioxide, hydrogen chloride and nitrogen oxides.

Sample Site Selection

Sample sites were located on a grid basis as outlined in Fig 14.1. The grid was based on the following specifications to ensure all areas which may be impacted upon by the proposed development were included in the sampling area.

- Site and site boundary - 6 sampling locations 5 on site and one at 0.1km
- 0.50 km from site boundary- 8 sampling locations N,S,E,W and at each grid corner
- 1km from site boundary - 4 sampling locations at each grid corner
- 3.0km from site boundary - 4 sampling locations at each grid corner
- 5.0km from site boundary - 4 sampling locations at each grid corner

Where the sample grid site proved unsuitable (e.g. due to land usage, construction or other activities) the nearest most appropriate sample point was used as a substituted and the grid co-ordinates referenced.

All samples were stored in cooler boxes and returned to the laboratory within 24 hours of sampling.

Table 14.1 Outlines locations, vegetation characteristics and general description of soil and herbage sampling.

Site Ref	Distance/ Direction from Proposed Plant Site boundaries	OS Grid Reference	General description of Land Use	Vegetation Characteristics	Soil Character -istics	Soil Profile at Depth Range 0-1m
S1	On site Boundary SSW	263833 344028	Rough Grazing. Unmanaged. No evidence of fertiliser or pesticide use, has been landspread with poultry litter in field centre	Grass pale, some evidence [redacted] yellowing In [redacted]	Compact clay.	**0-7cm**: firm heavy clay. Overall colour olive brown to dark greyish brown K18 **7-100cm**: mixed very heavy clay-medium sand. Some laminations noted with coarse sand and siltier sand. Some mica noted. Reddish brown in colour K20
S2	On Site Boundary SSE	263865 344010	Rough Grazing. Unmanaged. No evidence of fertiliser or pesticide use	Grass pale, some evidence of yellowing in older leaves Nettles medium green	Soft peaty - sandy soil	**0-5cm**: Root layer Firm. Clay K18 **5-50cm**: Soft topsoil. Clay silty with some mica noted **45-75cm:** Soft K15 **75-100**: Firm coarse sand well sorted. E11 – H14 where iron oxide present
S3	Site Boundary ESE	263972 344124	Rough Grazing. Some evidence of recent fertiliser	Grass pale, some evidence of yellowing in	Soft peaty - sandy soil	ND

O

			spreading in environs. Sample taken at verge	older leaves		
S4	Site Boundary NW	263972 344124	Rough grazing, poor quality, unmanaged. No evidence of fertiliser or pesticide usage	Mildew identified on older foliage of grass weeds	Peaty	**0-10cm**: Root layer heavy clay **10-40cm**: Loose friable medium mixed clay. L18 **40-50cm**: Mixed sandy K20 interspersed with 1cm coarse laminae of clay. Greyish brown to dark greyish brown **50-70cm**: oxidised medium to fine sand and sandy clay. Heavy. E11
S5	On Site NE		Peaty, unmanaged no evidence of recent use	Some pest damage. Mildew on older foliage	Soft waterlogged peaty soil	**0-30cm**: Loose, K18 **30-50cm**: Compact, very heavy clay L20 **50-100cm**: Waterlogged, Very compact well sorted M19. Presence of some humic material
S6	0.2km SW	263757, 343973	Lightly grazed (occasional). Grass dominated	Weed species of grass. Some pest damage		**0-30cm**: Friable humus layer, Mixed M14 **30-60cm**: mixed sandy – clay. Firm K11- J19 **60-100cm**: Very compact clay Mixed sand layer and oxidised clay E11 – K14
S7	0.5km SSE	264108, 343486	Rough grazing. Unimproved grassland possibly fertilised in recent past	Dark green in colour possibility of nitrogen application	Compact heavy day. Lt4 –L18	ND
S8	0.5km SE	264422, 344378	Meadow grassland. Unfertilised	Healthy foliage	Compact heavy clay L19. Mixed	ND
S9	0.5 km E	264622, 344757	Silage. Heavily fertilised. Grass sp dominated	Dark green foliage. Suggestion of nitrogen application	Very compact, heavy clay. L18	ND
S10	0.5km W	263432, 344205	Silage. Fertilised. Grass sp dominated	. Suggestion of nitrogen application	Compact. Mixed clay loam L16	ND
S11	0.5km NW	263297, 344812	Silage. May be fertilised in recent past. Grass dominated.	. Suggestion of nitrogen application. Healthy foliage dark green in colour	Compact, waterlogged, very heavy clay. Mixed. Small quantities	ND

					of sandK19	
S12	0.5km N		Pastureland.	Healthy green colour. Natural senescence on older foliage	Very compact heavy clay K19	ND
S13	3km NE	267124, 346924	Grazed grassland	Medium green healthy	Loam , friable L15	ND
S14	5km NE	268697, 348946	Poor quality grazed grassland. No evidence of fertiliser usage	Some yellowing of leaves	Compact clay loam. L15	ND
S16	5km SE	269703, 339622	Rough grazing. Slurry spread in Winter.	P[redacted] peat	Compact poorly sorted, clay gritty pebbles	ND
S17	5km SW	258827, 327978	Silage. Fertilised	Dark green colour. Suggestion of nitrogen fertilisation	Compact. Very heavy clay, iron oxide rich. K17	ND
S18	3km SW	260870, 341059	Rough grazing	Weed species of grass. Some pest damage	Compact heavy clay. Sorted. Iron oxide rich L17	ND
S19	5km NW	259973, 348189	Poor grazing. No evidence of fertiliser usage	Yellowing of older leaves	Very heavy clay, pliable, sorted. Iron oxide rich L17	ND
S20	1km WNW	265043, 345486	Silage. Fertiliser usage	Dark green colour. Suggestion of nitrogen fertilisation	Compact, heavy clay, interspersed with sandstone . Mixed. K18	NO
S21	1km SSE	264530, 343514	Meadow. Grass sp dominated. No evidence of fertiliser	Healthy colour	Heavy clay. Compact. L18	ND
S22	1km SW	262730, 343038	Waste ground. Unfertilised, poor	Poor quality grassland and	Compact heavy clay	**0-10cm**: Root layer heavy clay **10-30cm**: Loose medium mixed

			soil	weed dominated. Some pest and mildew damage	layered with sand ranging from coarse – fine silt. Overall colour dark brown – red	clay. L18 **30-70cm**: Mixed sandy K20 interspersed with 1cm bands of clay **70-100cm**: sandy clay some fine silt. Heavy. K16
S23	0.5km SW	263886, 344768	Silage. Fertilised.	Dark green colour. Suggestion of nitrogen fertilisation	Silty clay loam. Compact. K14	ND
S24	1km SE	262773, 344746	Waste ground. Unfertilised.	Poor quality. Some sensecence	Compact Very heavy silty clay. L19	NO
S25	3km NW	260805, 347649	Rough grazing. Grass sp dominated.	Weed grass species dominated	Soft heavy clay. Friable. Poorly sorted, peaty sandy layers. K14	NO
S26	3km E	260805, 347649	Silage. Fertilised.	Dark green colour. Suggestion of nitrogen fertilisation	Light friable loamy clay. Firm. Mixed. Humus rich	ND
S27	3km SE	266422, 340438	Hay. No fertiliser	Healthy coloration.	Compact heavy clay. Iron oxide rich. Mixed. K16	ND

ND: Not determined

Soil Profiling

A total of five soil profiles were taken across the site using 1m cores. The sampling locations are indicated in Fig 14.1. Soil profile logs were recorded for evidence of soil contamination. Visual observations of the soil type, were made in the field using archaeological soil recording charts and soils were graded as per Fig 14.2. Figs 14.3 14.1 show a graphical representation of the soil profiles recorded to 1m depths. In general, soils were poor quality clay interspersed with sandy layers ranging from 0.063 – 0.6mm and fine silts. Soils ranged from compact at the upper elevations to loose waterlogged oxidised soils in the lowland areas.

Sampling

samples were analysed for the following parameters:

- Metals
- Volatile Organic Compounds (VOCs)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Polychlorinated Biphenyls (PCBs)
- Pesticides (OPPs; OCPs)
- Dioxins/Furans

14.3 **Results**

Samples were labeled and returned to Alcontrol Geochem accredited Laboratories for analysis following appropriate quality control procedures. Comparison of the analytical results with Dutch Maximum Admissible Concentration (MAC) Guidelines for soil. "S" guidelines being a level below which a soil may be considered uncontaminated and the "I" guideline being a level above which a soil may be considered heavily contaminated. These Dutch Levels have no legal status in Ireland. There is no Irish Legislation that presents a framework for the assessment of soil contamination. However, the EPA are currently preparing a discussion document on Environmental Quality Objectives (EQO's) and Environmental Quality Standards (EQS's) for soils. The EPA is considering setting non-statutory guideline values for soil and groundwater. It is proposed that these values will be derived from existing risk-based generic guideline values adopted in other European countries. The provisions of the Sewage Sludge Directive, which was designated to set provisions for soils that may receive sludge, has been used as threshold or indicator values of soil quality as outlined in Table 14.3

Results were also compared to normal ranges and typical values for heavy metal contents of uncontaminated soil.

14.3.1 Visual Inspection of Plant Species

Results of visual inspection for aerial pollution damage and pest damage are presented in Tabk 14.1. There was some evidence of pest damage and also evidence of nitrogen application. No symptoms of aerial pollution by sulphur dioxide, hydrogen chloride or nitrogen oxides were noted.

14.3.2 Laboratory Soil and Herbage Analysis

Samples were labeled and returned to Alcontrol Geochem accredited Laboratories for analysis following appropriate quality control procedures Analytical results were compared with guideline values for herbage as prepared by Teagasc and am presented in Table 14.4 and 14.5.

14.3.3 Results – Soil – Dutch S and I Values

14.3.3.1 Heavy Metals

Results am presented in Table 14.5. Copper concentrations In six soil samples exceeded the Dutch "S" Value of 36mg/kg but were within the "I" Value of 190mg/kg. The concentration of lead In ab samples exceeded the Dutch "S" Value of 85mg/kg but were within the 'I' Value of 530mg/kg. No other determinant for which a Dutch "S" Value is given exceeded its respective limit With reference tu the sewage sludge directive, threshold or indicator levels for lead are exceeded in 9 sites (50mg/kg) and for copper at 2 *sites* (50 mg/kg). A total of 42% ofthe soil samples were In breach of one or more ofthe provisions of the Sewage Sludge Directive (EC 1986). The provisions of the Sewage Sludge Directive were designed to set specifications for soils that may receive sludge and is widely used aei indicator values of soil quality.

14.3.3.2 Chlorinated Hydrocarbons

The VOC results are presented in Table 14.8. Analysis was carried out for 62 Volatile organic Compounds as per US EPA 624/8260. None of the soil samples exceeded the relevant Dutch S- Value. Results for Dichloromethane were elevated in three of the soil samples located on site and at a distance of 0.2km from the *site,* In comparison with off site samples. However results am within Dutch I Valuer. The source of this is unclear and there Is no correlating high level found in the associated groundwater. With respect to the remaining VOC's, none exceeded the laboratory detection limit of 1µg/kg.

14.4.3.4 Polynuclear Aromatic Hydrocarbons (PAHs)

16 (EPA List) priority list PAH's were analysed and results presented in Table 14.7 Total values ofthe PAH's quantified ranged from 117 – 306 µg/kg mean values. None ofthe results exceeded the Dutch S Value of 1mg/kg for normal uncontaminated soils. Benz (a) pyrene is often taken as indicative of carcinogenic PAH level. Amounts of this component in Irish soil is low (generally 10 µg/kg –1, Teagasc 1999) Only one soil sample with levels of 17µg/kg had results slightly in exceedence of "typical" soil levels. All results were within Dutch S and I Values.

14.3.3.5 Organochlorine and Organophosphorous Pesticides

A suite of *28* organochlorine and 21 organophosphorous pesticides were analysed from the five soil *samples.* Results are presented In Tables 14.8 and 14.9. No samples were found above the laboratory detection limit of 1µg/kg.

14.3.3.6 Polychlorinated Biphenyls (PCBs)

28 PCB's were analysed and results presented in Table 14.10. PCB's were detected n one soil sample at a level of 4µg/kg. This does not exceed the Dutch S Value of 0.02mg/kg. All other results were at a level of <1µg/kg.

14.3.3.7 Dioxins

Five soil samples were analysed for the seventeen 2,3,7,8 containing chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans.the concentration of total tetra-throughheptachlorinated dioxin and furan homologues were also determined. Results for the targeted 2378 containing contingers and totals for other chlorinated dioxin and furan isomers present in the sample are presented in Table 14.11. The current Toxic Equivalent Factors (TEFs) of the European Community/NATO or I-TEF are used to produce a total dioxin and furan equivalent amount for all contingers.

14.4 Interpretation of Results

The objective of this study was to establish the existing levels of sail nutrients and corresponding plant tissues within a defined area surrounding the proposed plant site. Since soil acts as a long-term reservoir, soil analysis can provide evidence of historical inputs. Soil analysis also provides an indication of possible plant nutritional factors (mineral excesses or deficiencies) that would affect crop growth and nutrient content, thereby contributing to animal health problems. Herbage and fodder (silage and hay) tad as a short-term reservoir, thereby providing evidence of more recent inputs. Herbage and fodder analysis also provides an indicator of potential animal dietary/nutritional problems.

This data can then be used as a baseline to monitor any significant changes in the baseline data during the lifetime of the plant. The expected ranges of values for the plant/soil extracts are also examined. The maximum soil values for heavy metal concentration in soil dry matter as set out in SI no 183 1991 (Swage Sludge Directive 86/278/EC), Dutch Target (S) and Intervention (I) Values and expected ranges of elements for Irish Soils and plant tissues samples as per Teagasc, Johnstown Castle were all examined. At the time of publishing the EQA's and EQS's for soils were in draft format and not available for comparison.

14.5 Predicted Impacts – Plant Operation

A possible source of impact on soil and herbage quality would be from atmospheric aerial deposition from the stack. Extensive air modeling was carried out and emissions are predicted to be within all relevant legislative standards including the new Daughter Directives for protection of ecosystem. Rigorous abatement controls as outlined In Section 4 of Volume 2 of this EIS will be implemented to minimise discharge to atmosphere and prevent the long term buildup of emissions to the environment. The development of the plant is likely to haw a positive impact on soil and herbage quality. Disposal of PL and SMC by landspreading in areas where no account is taken of existing nutrient requirements or during periods when the land is saturated is having a negative effect on existing soil and herbage quality. Providing a more environmentally friendly disposal route for this material will remove excess nutrient build up in the soil and associated impacts on herbage.

A the waste ash is to be used as a fertilizer it will be tested to ensure that chemical parameters are in the correct balance to provide a valuable fertilizer with known properties which can be landspread when required.

A comparison was conducted with data available from a similar development involved examining soil, herbage and milk samples from an area around Eye Power Station (ETSU B/FW/00235/REP) which burns poultry litter for power generation. Analysis on soil and foliage samples within indicated that results were within normal range and *that* the variations from before the commissioning levels to the final assessment were minimal (i.e. there was no evidence of additional accumulation). Plant samples m i n e d *showed* no symptoms attributable to airborne pollutants from the power station.

With regard to dioxins and furans, their primary mechanism for entering the food chain has been identified as through atmospheric deposition. Milk sampling is considered to be a suitable mechanism for measuring dioxin levels in the food chain as cows are free ranging and forage for food at will. Dioxin sampling was carried out both for preliminary and post commissioning analysis at two farms located at approximately 1 and 2kms downstream of EYE Power Station Stack at 3 month intervals far 15 months. Results indicated *that* results were typical of milk obtained from farms in rural areas and no *evidence* of increase in dioxin levels were recorded over the sampling period.

Although for this EIS no dioxin baseline sampling was carried out in milk levels, The EPA has carried out dioxin samplhg In milk in the Monaghan area and results are indicated below

I-TEQ incl ½ LOD pg/kg whole milk	WHO-TEQ incl ½ LOD pg/kg whole milk	PCBs WHO-TEQ incl ½ LOD pg/kg whole milk	Dioxins and PCBs Total WHO-TEQ inc ½ LOD pg/kg whole milk
8.6	10	9	19

(Source dioxin levels in the Irish environment EPA).

This data can be used as baseline monitoring data with which to compare plant performance during its lifespan and results compared with the new EC Regulation (EC/446/2001) on setting legally binding limits on the presence of dioxin and other contaminants in food due to come into force on 1st July 2002.

14.6 Conclusion

Based on atmospheric modeling of anticipated emissions data, no impact is predicted from the development on soil or herbage deposition.

14.7 Interpretation of Results

As may be expected, elements vary in concentration in different soils and urban soils tend to have much higher concentrations of metal elements than rural soils. Higher than normal zinc, lead and, to a lesser extent, manganese and cadmium am typically encountered where repeated heavy additions of sewage sludge have been applied to Band.

Herbage content for elements such as nitrogen phosphorous and potassium sulphur and magnesium result from direct fertiliser application of these element rather than from soil reserves.

Table 14.2: List of Analytical Pa—h [redacted] Baseline Soil onitoring

Sample Number	Sample Depth (m)	Sampling Date	Comments	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Selenium	Molybdenum	Cobalt	Aluminium	Calcium	Iron	Magnesium	Manganese	Vanadium	Tin	PAH	Pesticides	VOC
1	0.1-0.2	11.06.01	1m Soil profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
2	0.1-0.2	11.06.01	1m Soil profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
3	0.1-0.2	11.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
4	0.1-0.2	11.06.01	1m Soil profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
5	0.1-0.2	11.06.01	1m Soil profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
6	0.1-0.2	11.06.01	1m Soil profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
7	0.1-0.2	11.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
8	0.1-0.2	12.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
9	0.1-0.2	12.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
10	0.1-0.2	12.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
11	0.1-0.2	12.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
12	0.1-0.2	12.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
13	0.1-0.2	12.06.01																			x	x	x
14	0.1-0.2	12.06.01																			x	x	x
16	0.1-0.2	13.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
17	0.1-0.2	13.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
18	0.1-0.2	13.06.02		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
19	0.1-0.2	13.06.03		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
20	0.1-0.2	13.06.04		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
21	0.1-0.2	13.06.05		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
22	0.1-0.2	13.06.01	1m Soil profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
23	0.1-0.2	13.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
24	0.1-0.2	13.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
25	0.1-0.2	14.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
26	0.1-0.2	14.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
27	0.1-0.2	14.06.01		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			

Legend Core samples taken for VOC,PAH, Pesticide analysis highlighted ; Samples 1-12; 16-27 taken for soil and herbage analysis

Fig 14.2: Archaeological Soil Recording Chart

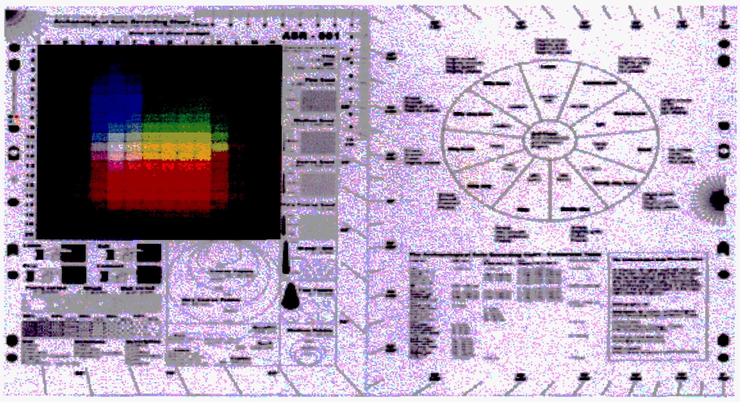


Table 14.3: Typical Symptoms of Air Pollution Injury on Vegetation

Foliage of Narrow Leaved Species

Sulphur Dioxide

Water – soaked appearance, later becoming necrotic. Bleached tips. Necrosis at tips and points where leaves bend. Nectrotic streaks between veins coalesce across whole leaf. Necrosis is often light brown or ivory in colour rather than dark brown. Wheat can show a red discoloration

Nitrogen Oxides

Water soaked appearance later becoming nectrotic. Glazing. Necrotic streaking, often coalescing across whole leaf, especially at tips and points of bending. Necrosis can be yellow/orange in grasses. Awns of barley can show tip necrosis.

Hydrogen Chloride
Interveinal water-soaked streaks later becoming necrotic. Necrotic lesions at tip and points of bending. Necrosis is often yellow/brown

Foliage of Broad Leaved Species

Sulphur Dioxide
Large, bifacial necrotic spots on leaf margin. Browning of lower surface. Shot-holing. Water soaked apperaance, later becoming necrotic. Marginal necrosis or irregular, interveinal necrosis. Sharply defined boundary between affected and healthy tissues may develop about three weeks after exposure. Leaves often drop off.

Nitrogen Oxides
Interveinal necrosis. Tip necrosis. Water soaked appearance later becoming necrotic. Bronzing/glazing

Hydrogen Chloride
Bronzing/glazing of lower surface. Bleached areas around necrotic spots. Bronzing later becoming necrotic. Shot-holing. Necrosis sometimes orange or reddish.

Fig 14.3: 1m Soil Profile S1 Site

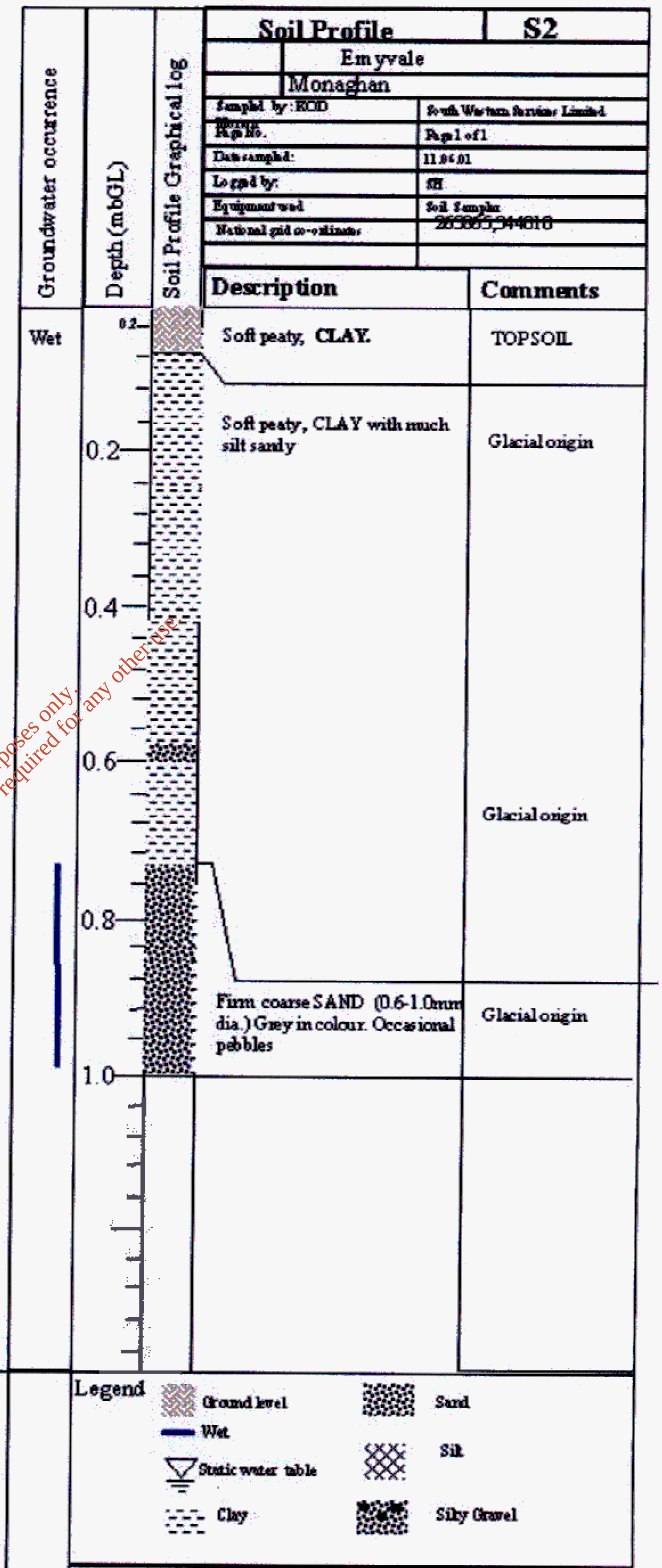
Soil Profile	S1
	Emyvale
	Monaghan
Sampled by: RCD	South Western Services Limited
Page No.	Page 1 of 1
Date sampled:	11.06.01
Logged by:	SH
Equipment used	Soil Sampler
National grid co-ordinates	26383;344028

Groundwater occurrence	Depth (mbGL)	Description	Comments
	0.2	Heavy, medium brown, **CLAY.**	TOPSOIL
	0.2	Stiff, fresh, medium brown, CLAY with silt and occasional medium to coarse sand, (~0.2-0.6mm dia).	Glacial origin
No	0.4 – 1.0	Stiff, firm, **CLAY** with much silt and and medium to coarse sand (0.063-0.6mm dia.)	Glacial origin

Remarks: Land used for rough grazing.
Very compact soil

Legend: Ground level; Wet; Static water table; Clay; Sand; Silt

Fig 14.4: Soil Profile S2 Site



Remarks: Land used for rough grazing.
Very compact soil

SWS

Fig 14.5: Soil Profile S4 Site

Soil Profile	S4
	Emyvale
	Monaghan
Sampled by: EOD	South Western Services Limited
Rig No.	Page 1 of 1
Date sampled:	11.06.01
Logged by:	SH
Equipment used	Soil Sampler
National grid co-ordinates	263972:344124

Groundwater occurrence	Depth (mbGL)	Description	Comments
Wet	0.0 – 0.15	Compact **CLAY.** Medium brown	TOPSOIL
	0.15 – 0.4	Loose friable CLAY light brown with mixed medium - fine sand	Glacial origin
	0.4 – 0.75	Soft friable CLAY striated with medium - fine sand 2-6mm diam	Glacial origin
	0.75 – 1.0	Firm coarse SAND (0.6-1.0mm dia.) Grey in colour. Occasional pebbles	Glacial origin

Depth scale: 0.2, 0.4, 0.6, 0.8, 1.0

Remarks: Land used for rough grazing.
Very compact soil. Unmanaged.

Legend: Ground level; Wet; Static water table; Clay; Sand; Silt; Silty Gravel

SWS

Table 14.5 Soil Sampling 0-5km grid - Sampling: 12-13.06.01

Sample Identity	Depth (cm)	Aluminium mg/kg	Arsenic mg/kg	Calcium mg/kg	Cadmium mg/kg	Cobalt mg/kg	Chromium mg/kg	Copper mg/kg	Iron mg/kg	Mercury mg/kg	Magnesium mg/kg	Manganese mg/kg	Molybdenum mg/kg	Nickel mg/kg	Lead mg/kg	Selenium mg/kg	Tin mg/kg	Vanadium mg/kg	Zinc mg/kg	pH	Potassium mg/kg	Nitrogen mg/kg	Phosphorous mg/kg
SAMPLE 1	10-20	675	7	976	<1	2	11	20	2780	<1	1475	89	2	8	16	<1	<10	6	18	6.56	312	61	28
SAMPLE 2	10-20	690	5	2332	<1	2	9	51	2034	<1	1324	99	<1	7	15	1	<10	8	29	6.56	118	46	61
SAMPLE 3	10-20	1145	12	1808	<1	9	14	19	3738	<1	1635	190	4	16	8	<1	<10	13	40	6.08	79	60	47
SAMPLE 4	10-20	1518	8	2015	<1	3	16	32	1974	<1	1933	70	2	12	11	<1	<10	8	27	5.38	168	82	33
SAMPLE 5	10-20	1189	11	5261	<1	5	26	25	3666	<1	1132	76	3	22	6	<1	<10	8	18	4.58	21	11	7
SAMPLE 6	10-20	690	5	1665	<1	2	9	39	2117	<1	251	94	2	6	9	<1	<10	<1	18	6.12	58	27	22
SAMPLE 7	10-20	780	7	924	<1	2	11	24	2987	<1	1203	76	2	8	10	<1	<10	12	20	6.3	133	69	63
SAMPLE 8	10-20	1627	8	2024	<1	5	20	35	3909	<1	2020	208	2	15	12	<1	<10	13	28	6.44	28	24	33
SAMPLE 9	10-20	806	4	3447	<1	3	18	30	2638	<1	553	149	4	16	12	2	<10	14	22	7.13	42	50	28
SAMPLE 10	10-20	264	<1	2533	<1	<1	20	8	787	<1	130	35	7	22	5	<1	<10	<1	9	6.01	21	55	28
SAMPLE 11	10-20	441	2	1688	<1	2	21	15	1418	<1	235	64	7	24	6	<1	<10	13	18	6.33	44	83	22
SAMPLE 12	10-20	580	2	8899	<1	3	17	19	2204	<1	518	455	5	16	21	<1	<10	12	99	7.46	220	92	51
SAMPLE 13	10-20	1144	13	1489	<1	6	19	18	4714	<1	2449	397	2	12	326	<1	<10	19	45	5.92	61	39	14
SAMPLE 14	10-20	1203	8	1687	<1	5	57	27	4491	<1	2355	258	6	14	71	<1	<10	14	38	6.29	45	37	4
SAMPLE 16	10-20	1353	10	>32000	<1	6	21	35	3550	<1	5401	251	1	21	228	2	<10	20	65	7.7	90	29	11
SAMPLE 17	10-20	968	12	7711	<1	3	62	40	2840	<1	2007	134	8	13	343	<1	<10	15	38	7.42	200	60	42
SAMPLE 18	10-20	706	7	2033	<1	5	36	24	3779	<1	283	514	4	5	39	<1	<10	11	26	7.15	65	48	23
SAMPLE 19	10-20	1035	12	3198	<1	3	30	18	3207	<1	419	93	3	6	338	<1	<10	18	29	6.87	37	66	8
SAMPLE 20	10-20	471	4	2281	<1	1	46	11	1851	<1	110	29	6	5	78	<1	<10	11	12	6.26	26	32	12
SAMPLE 21	10-20	1074	7	3043	<1	6	60	98	4191	<1	2501	515	7	15	35	<1	<10	15	85	7.14	45	29	68
SAMPLE 22	10-20	849	16	2263	<1	2	75	36	2372	<1	368	67	10	11	301	<1	<10	13	29	6.46	37	20	6
SAMPLE 23	10-20	935	11	900	<1	3	41	29	2555	<1	319	90	5	8	318	<1	<10	18	26	5.82	30	12	7
SAMPLE 24	10-20	792	5	1340	<1	2	17	23	2378	<1	507	74	1	8	63	<1	<10	8	26	5.81	34	28	58
SAMPLE 25	10-20	925	<1	3697	<1	2	14	15	1163	<1	256	73	1	5	38	<1	<10	<1	23	5.3	120	165	51
SAMPLE 26	10-20	887	6	491	<1	4	21	53	2610	<1	533	171	2	5	79	<1	<10	7	20	5.46	41	12	31
SAMPLE 27	10-20	1244	7	1927	<1	5	40	31	4068	<1	2413	361	4	14	33	<1	<10	15	34	6.45	43	4	20
Dutch S Values			**29**		**0.8**		**100**	**36**		**0.3**			**10**	**35**	**85**				**140**				
Dutch I Values			**55**		**12**		**380**	**190**		**10**			**200**	**210**	**530**				**720**				
Sewage Sludge Directive Threshold Levels mg/kg*					1			50		1				30	50				150				
Total contents of trace elements in Irish Agricultural Soils (Teagasc)			1-50.		0.1-1	1-25.	5-250	2-100.		0.03-0.8		20-3000.	0.2-3.0	0.5-100	2-80.	0.2-2		20-250	10-200				

Exceedences are highlighted

* applies where pH of soil is between 5-7. Where pH is >7, these values may be exceeded by not more than 50%, provided that there is no resulting hazard to human health, the environment or ground water.

Table 14.6: Soil Analytical ResultsVolatile Organic Compounds (EPA 624/8260)
Sampling Date: 12-13.06.01

CAS No	Compound	Units	VOC - F2	VOC - F3	VOC - 0.1km	Sample 22	Sample 24	Dutch MACs S-Value	Dutch MACs I-Value
75-71-8	Dichlorodifluoromethane	µg/kg	<1	<1	<1	<1	<1		
74-87-3	Chloromethane	µg/kg	<1	<1	<1	<1	<1		
75-01-4	Vinyl Chloride	µg/kg	<1	<1	<1	<1	<1		100
74-83-9	Bromomethane	µg/kg	<1	<1	<1	<1	<1		
75-00-3	Chloroethane	µg/kg	<1	<1	<1	<1	<1		
75-69-4	Trichlorofluoromethane	µg/kg	<1	<1	<1	<1	<1		
156-60-5	trans-1,2-Dichloroethene	µg/kg	<1	<1	<1	<1	<1		
75-09-2	Dichloromethane	µg/kg	563	600	592	<1	<1		20,000
75-15-0	Carbon disulphide	µg/kg	<1	<1	<1	<1	<1		
75-35-4	1,1-Dichloroethene	µg/kg	<1	<1	<1	<1	<1		
75-34-3	1,1-Dichloroethane	µg/kg	<1	<1	<1	<1	<1		
1634-04-4	tert-butyl methyl ether	µg/kg	<1	<1	<1	<1	<1		
156-59-2	cis-1,2-Dichloroethene	µg/kg	<1	<1	<1	<1	<1		
74-97-5	Bromochloromethane	µg/kg	<1	<1	<1	<1	<1		
67-66-3	Chloroform	µg/kg	<1	<1	<1	<1	<1		
594-20-7	2,2-Dichloropropane	µg/kg	<1	<1	<1	<1	<1		
107-06-2	1,2-Dichloroethane	µg/kg	<1	<1	<1	<1	<1		4,000
71-55-6	1,1,1-Trichloroethane	µg/kg	<1	<1	<1	<1	<1		
563-58-6	1,1-Dichloropropene	µg/kg	<1	<1	<1	<1	<1		
71-43-2	Benzene	µg/kg	<1	<1	<1	<1	<1	50	1,000
56-23-5	Carbontetrachloride	µg/kg	<1	<1	<1	<1	<1		
74-95-3	Dibromomethane	µg/kg	<1	<1	<1	<1	<1		
78-87-5	1,2-Dichloropropane	µg/kg	<1	<1	<1	<1	<1		
75-27-4	Bromodichloromethane	µg/kg	<1	<1	<1	<1	<1		
79-01-6	Trichloroethene	µg/kg	<1	<1	<1	<1	<1	1	60,000
10061-01-5	cis-1,3-Dichloropropene	µg/kg	<1	<1	<1	<1	<1		
10061-02-6	trans-1,3-Dichloropropene	µg/kg	<1	<1	<1	<1	<1		
79-00-5	1,1,2-Trichloroethane	µg/kg	<1	<1	<1	<1	<1		

108-88-3	Toluene	µg/kg	<1	<1	<1	<1	<1	50	130,000
142-28-9	1,3-Dichloropropane	µg/kg	<1	<1	<1	<1	<1		
124-48-1	Dibromochloromethane	µg/kg	<1	<1	<1	<1	<1		
106-93-4	1,2-Dibromoethane	µg/kg	<1	<1	<1	<1	<1		
127-18-4	Tetrachloroethene	µg/kg	<1	<1	<1	<1	<1	10	4,000
630-20-6	1,1,1,2-Tetrachloroethane	µg/kg	<1	<1	<1	<1	<1		
108-90-7	Chlorobenzene	µg/kg	<1	<1	<1	<1	<1		
100-41-4	Ethylbenzene	µg/kg	<1	<1	<1	<1	<1	50	50,000
108-38-3*	p/m-Xylene	µg/kg	<1	<1	<1	<1	<1	50	25,000
75-25-2	Bromoform	µg/kg	<1	<1	<1	<1	<1		
100-42-5	Styrene	µg/kg	<1	<1	<1	<1	<1	100	100,000
79-34-5	1,1,2,2-Tetrachloroethane	µg/kg	<1	<1	<1	<1	<1		
95-47-6	o-Xylene	µg/kg	<1	<1	<1	<1	<1		
96-18-4	1,2,3-Trichloropropane	µg/kg	<1	<1	<1	<1	<1		
98-82-8	Isopropylbenzene	µg/kg	<1	<1	<1	<1	<1		
108-86-1	Bromobenzene	µg/kg	<1	<1	<1	<1	<1		
95-49-8	2-Chlorotoluene	µg/kg	<1	<1	<1	<1	<1		
103-65-1	Propylbenzene	µg/kg	<1	<1	<1	<1	<1		
106-43-4	4-Chlorotoluene	µg/kg	<1	<1	<1	<1	<1		
95-63-6	1,2,4-Trimethylbenzene	µg/kg	<1	<1	<1	<1	<1		
99-87-6	4-Isopropyltoluene	µg/kg	<1	<1	<1	<1	<1		
108-67-8	1,3,5-Trimethylbenzene	µg/kg	<1	<1	<1	<1	<1		
95-50-1	1,2-Dichlorobenzene	µg/kg	<1	<1	<1	<1	<1	10	
106-46-7	1,4-Dichlorobenzene	µg/kg	<1	<1	<1	<1	<1	10	
135-98-8	sec-Butylbenzene	µg/kg	<1	<1	<1	<1	<1		
98-06-6	tert-Buylbenzene	µg/kg	<1	<1	<1	<1	<1		
541-73-1	1,3-Dichlorobenzene	µg/kg	<1	<1	<1	<1	<1	10	
104-51-8	n-Butylbenzene	µg/kg	<1	<1	<1	<1	<1		
96-12-8	1,2-Dibromo-3-chloropropane	µg/kg	<1	<1	<1	<1	<1		
120-82-1	1,2,4-Trichlorobenzene	µg/kg	<1	<1	<1	<1	<1	10	
91-20-3	Naphthalene	µg/kg	<1	<1	<1	<1	<1		
87-61-6	1,2,3-Trichlorobenzene	µg/kg	<1	<1	<1	<1	<1		
87-68-3	Hexachlorobutadiene	µg/kg	<1	<1	<1	<1	<1		

Legend: S2: On site. S3: On site; S6: 0.2km SW; S22:1km SW; S24: 1km SE

Table 14.7 **Polyaromatic Hydrocarbons**
Sampling Date 12-13.06.01

	VOC – S2	VOC - S3	VOC -S6	S-22	S-24	Dutch	
Compound	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	Value	I - Value
Naphthalene	64	99	26	13	64		
Acenaphthylene	2	4	2	2	6		
Acenaphthene	23	29	2	9	9		
Flourene	17	19	4	6	7		
Phenanthrene	43	53	16	55	45		
Anthracene	12	12	6	19	11		
Flouranthene	17	15	13	56	34		
Pyrene	18	17	15	41	28		
Benz(a)anthracene	11	a	8	9	6		
Chyrsene	10	10	7	19	10		
Benz(b)flouranthene	13	6	7	11	8		
Benzo(k)flouranthene	5	4	2	10	8		
Benzo(k)pyrene	5	4	3	17	8		
Indeno (123cd)pyrene	8	3	2	16	13		
Dibenzo(ah)anthracene	4	2	<1	7	6		
Benzo(ghi)perlene	7	5	3	17	9		
Total 16 PAH	**258**	**291**	**117**	**306**	**274**	**1000**	**40000**

Legend: S2: On site. S3: On site; S6: 0.2km SW; S22:1km SW; S24: 1km SE

Table 14.8 **Organochlorine Pesticides Sampling** Period **12-13.06.01**

Compound	Units	VOC - S2	VOC - S3	VOC S6	S 22	S 24
Tecnazene	µg/kg	<1	<1	<1	<1	<1
Trifluralin	µg/kg	<1	<1	<1	<1	<1
alpha-HCH (lindane)	µg/kg	<1	<1	<1	<1	<1
Hexachlorobenzene	µg/kg	<1	<1	<1	<1	<1
beta-HCH (Lindane)	µg/kg	<1	<1	<1	<1	<1
gamme - HCH (Lindane)	µg/kg	<1	<1	<1	<1	<1
Quintozene	µg/kg	<1	<1	<1	<1	<1
Triallate	µg/kg	<1	<1	<1	<1	<1
Chlorothalonil	µg/kg	<1	<1	<1	<1	<1
Heptachlor	µg/kg	<1	<1	<1	<1	<1
Aldrin	µg/kg	<1	<1	<1	<1	<1
Triadimethalin	µg/kg	<1	<1	<1	<1	<1
Pendimethalin	µg/kg	<1	<1	<1	<1	<1
heptachlor epoxide	µg/kg	<1	<1	<1	<1	<1
o,p - DDE	µg/kg	<1	<1	<1	<1	<1
Endosulfan I	µg/kg	<1	<1	<1	<1	<1
p,p - DDE	µg/kg	<1	<1	<1	<1	<1
Dieldrin	µg/kg	<1	<1	<1	<1	<1
p,p - TDE (DDD)	µg/kg	<1	<1	<1	<1	<1
Endrin	µg/kg	<1	<1	<1	<1	<1
Endosulphan II	µg/kg	<1	<1	<1	<1	<1
o,p - TDE	µg/kg	<1	<1	<1	<1	<1
o,p - DDT	µg/kg	<1	<1	<1	<1	<1
p,p - DDT	µg/kg	<1	<1	<1	<1	<1
Endosulphan Sulphate	µg/kg	<1	<1	<1	<1	<1
o,p - Methoxychlor	µg/kg	<1	<1	<1	<1	<1
p,p - Methoxchlor	µg/kg	<1	<1	<1	<1	<1
Permethin	µg/kg	<1	<1	<1	<1	<1
Total	**µg/kg**	**<1**	**<1**	**<1**	**<1**	**<1**

Legend: S2: On site. S3: On site; S6: 0.2km SW; S22:1km SW; S24: 1km SE

Table 14.9 Organophosphorous Pesticides Sampling Period 12-13.06.01

Compound	Units	VOC - S2	VOC - S3	VOC - S6	S 22	S 24
Dichlorvos	µg/kg	<1	<1	<1	<1	<1
Mevinphos	ug/kg	<1	<1	<1	<1	<1
Dimethoate	µg/kg	<1	<1	<1	<1	<1
Propetamphos	µg/kg	<1	<1	<1	<1	<1
Diazion	µg/kg	<1	<1	<1	<1	<1
Etrimphos	µg/kg	<1	<1	<1	<1	<1
Chlorpyrifos methyl	µg/kg	<1	<1	<1	<1	<1
Methyl Parathion	µg/kg	<1	<1	<1	<1	<1
Pirimiphos methyl	µg/kg	<1	<1	<1	<1	<1
Fenitrothion	µg/kg	<1	<1	<1	<1	<1
Malathion	µg/kg	<1	<1	<1	<1	<1
fenthion	µg/kg	<1	<1	<1	<1	<1
Chlorpyrifos methyl	µg/kg	<1	<1	<1	<1	<1
parathion	µg/kg	<1	<1	<1	<1	<1
Chlorfenvinphos	µg/kg	<1	<1	<1	<1	<1
Ethion	µg/kg	<1	<1	<1	<1	<1
Triazophos	µg/kg	<1	<1	<1	<1	<1
Carbophenothion	µg/kg	<1	<1	<1	<1	<1
Phosalone	µg/kg	<1	<1	<1	<1	<1
Azinphos methyl	µg/kg	<1	<1	<1	<1	<1
Azinphos ethyl	µg/kg	<1	<1	<1	<1	<1
Total		<1	<1	<1	<1	<1

Legend: S2: On site. S3: On site; S6: 0.2km SW

Table 14.10 **Soil Analytical Results: Polychlorinated Biphenyls - Background Levels**
Sampling Date: 12-13.06.01

CAS Number	Units	VOC-S2 µg/kg	VOC-S3 µg/kg	VOC-S6 µg/kg	Sample 22 µg/kg	Sample 24 µg/kg	Dutch MAC Values S	Dutch MAC Values I
12674-11-2	Aroclor 1016							
11104-28-2	Aroclor 1221							
11141-16-5	Aroclor 1232							
53469-21-9	Aroclor 1242							
12672-29-6	Aroclor 1248							
11097-69-1	Aroclor 1254							
11096-82-5	Aroclor 1260							
	Total	<1	<1	<1	<1	<1	20	1000

Legend:

S - level: Dutch Guideline for normal uncontaminated soil

I- Level: Dutch Guideline for intervention

< - Below Laboratory Detection Limit

Analysis carried out by GCMS

Table 14.11: Dioxin Sampling Results

Total Toxic Equivalent Amounts EC/NATO/CCMS/I-TEQ

S1	S2	S 6	S22	S24
2.2	1.2	0.73	0.53	1.7

Legend: All Results expressed in ng/kg

Results based on samples on a dried and ground basis

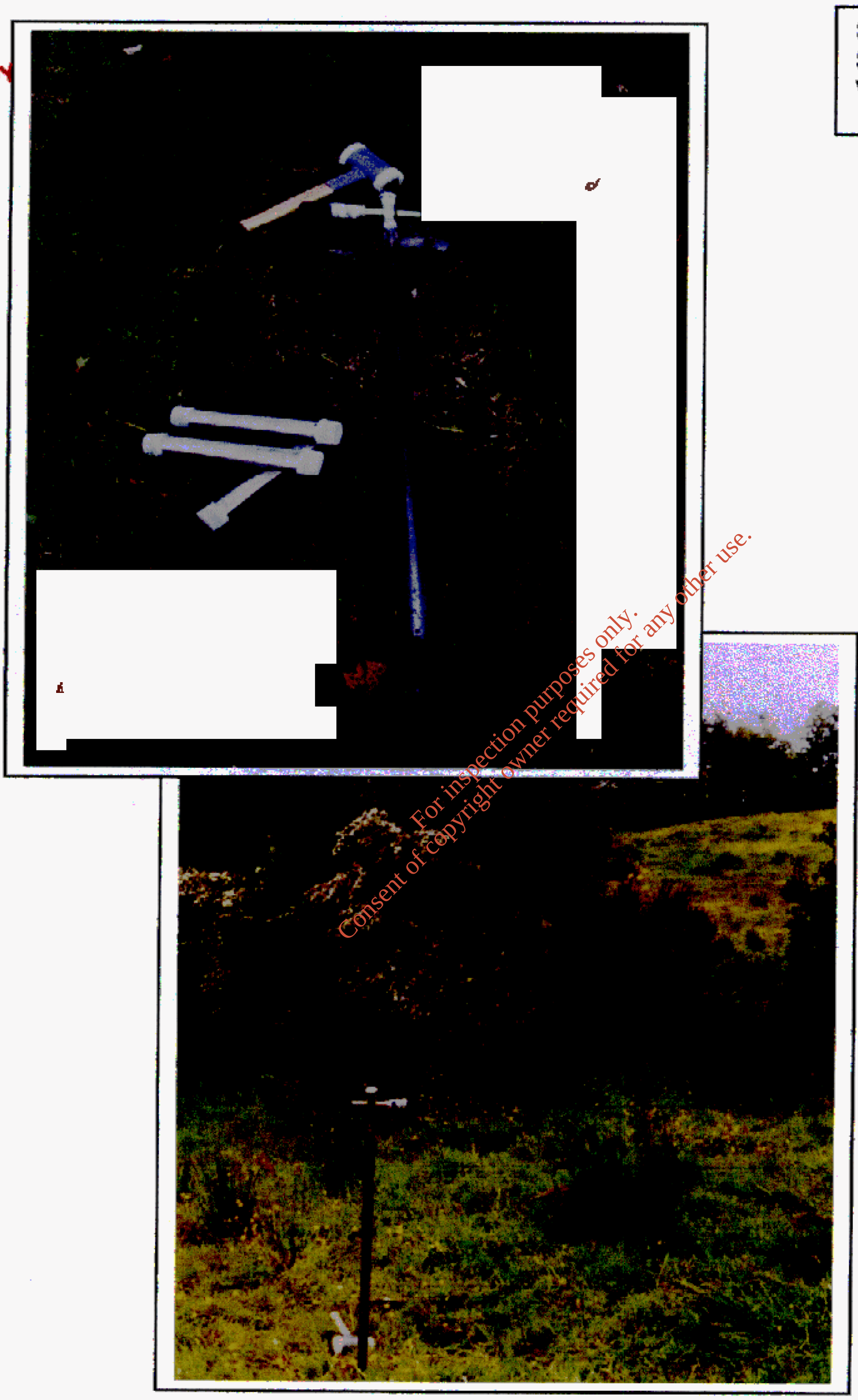
Detection limits between 0.2-0.4ng/kg per contringer

In the case of quantification of isomers other than 2378 containing ones, the RRFs of the first eluting isomer of the same degree of chlorination are used

Table 14. 4 Herbage Smplie Results

Sample Identity	Aluminium	Arsenic	Calcium	Cadmium	Cobalt	Chromium	Copper	Iron	Mercury	Magnesium	Manganese	Molybdenum	Nickel	Lead	Selenium	Tin	Vanadium	Zinc
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
SAMPLE 1	2249	<1	>32000	<1	<1	11	48	2254	<1	14350	1967	69	14	17	<1	22	<1	258
SAMPLE 2	2864	<1	>32000	<1	<1	11	43	2433	<1	8576	1857	101	13	43	<1	<10	73	327
SAMPLE 3	3555	4	>32000	2	5	31	72	3621	<1	11350	1701	61	26	120	<1	24	14	283
SAMPLE 4	1233	<1	>32000	<1	3	2	38	1168	<1	9867	2294	68	15	23	<1	14	45	232
SAMPLE 5	1233	<1	>32000	<1	2	2	39	2345	<1	7390	2252	12	14	<1	<1	<10	22	296
SAMPLE 6	1090	<1	>32000	<1	2	8	46	2053	<1	16480	2066	42	14	35	<1	12	<1	343
SAMPLE 7	5870	9	>32000	<1	2	24	90	6125	<1	11410	1931	61	21	81	<1	11	65	350
SAMPLE 8	7334	2	>32000	<1	5	23	55	8277	<1	13210	1870	14	24	47	<1	13	64	178
SAMPLE 9	2753	<1	>32000	<1	5	13	<1	6073	<1	6757	532	17	18	32	<1	14	<1	139
SAMPLE 10	383	<1	>32000	<1	<1	8	53	1138	<1	16550	874	52	13	44	<1	<10	<1	285
SAMPLE 11	2674	<1	>32000	<1	3	11	84	4255	<1	16670	1964	34	18	44	<1	15	<1	282
SAMPLE 12	970	2	>32000	<1	3	10	<1	3564	<1	7929	435	48	8	38	<1	16	5	266
SAMPLE 13	3925	<1	28440	<1	1	13	45	4328	<1	12730	1044	33	30	1	<1	<10	38	259
SAMPLE 14	1210	<1	27910	<1	<1	<1	29	2101	<1	8110	248	35	7	20	<1	19	13	219
SAMPLE 16	1461	<1	>32000	<1	<1	9	99	2099	<1	10860	218	38	9	22	<1	<10	<1	202
SAMPLE 17	186	<1	>32000	<1	<1	4	87	574	<1	10330	490	42	8	5	<1	16	<1	288
SAMPLE 18	3306	4	>32000	<1	<1	13	32	4724	<1	12040	1058	34	10	11	<1	11	<1	235
SAMPLE 19	5623	<1	>32000	<1	3	15	145	4949	<1	12720	1560	38	13	26	<1	11	17	311
SAMPLE 20	863	<1	>32000	<1	<1	5	62	1210	<1	12560	2036	3	9	35	<1	17	<1	275
SAMPLE 21	315	<1	31100	<1	<1	13	77	728	<1	12550	1686	45	18	31	<1	18	<1	387
SAMPLE 22	535	7	>32000	<1	<1	14	77	858	<1	8213	1110	52	25	<1	<1	15	<1	280
SAMPLE 23	1922	11	>32000	<1	1	15	123	2558	<1	19100	3531	24	39	<1	<1	27	<1	368
SAMPLE 24	1870	<1	>32000	<1	<1	15	136	2130	<1	25810	1653	32	22	31	<1	10	<1	450
SAMPLE 25	591	1	28070	<1	<1	6	48	823	<1	10410	1532	13	8	27	<1	14	<1	271
SAMPLE 26	1935	11	>32000	<1	<1	18	87	2507	<1	19730	1480	22	27	51	<1	<10	<1	380
SAMPLE 27	3831	<1	>32000	<1	<1	17	48	4997	<1	16070	2477	31	25	30	<1	19	<1	252
Optimum Range ppm	70-120	-	5000-7000	-	>0.2	0.5-2	10-15.	100-150	-	2000-2500	50-100	<1.0	-	-	0.15-0.25	-	-	40-60
Expected Normal Range ppm	30-300	0.05-0.5	2000-12000	0.01-1	0.03-0.2	0.1-3	2-15.	60-500	0.01-0.5	900-4000	20-300	0.2-4	0.5-4	0.1-12	0.03-0.5	-	-	20-80

Soil Corer – Sampling for VOC's



APPENDIX 15
Role and benefits of GIS in Planning and Site Selection Process

15.1 Role and benefits of GIS in Planning and Site Selection Process

A primary role of GIS as a tool in environmental management is that it can serve as a means to integrate ever-increasing volumes of diverse spatial and non-spatial environmental data, from numerous sources at local, regional and national scales into a manageable whole.

Since a GIS collates and manages environmental data in a standardised manner its use is likely to result in more efficient date collection and analysis, since common environmental data sets need be captured only once, but then can be used for many different functions, by many interested organisations.

GIS database visualising tools provide all those with an interest in environmental and planning matters with the means to visualise and analyse data on the desktop. Users are able to utilise GIS functionality to query, display and produce maps and reports from data sets held in the GIS.

GIS functionality provides a powerful set of tools for modelling spatial problems where several layers of graphical and tabular data may be involved.

Because of its spatial modelling capabilities GIS can provide useful support to management decision making. A more informed choice can then be made by using GIS as a decision support tool. It can also be used to display the results of other environmental models such as air and water pollution dispersion models together with other layers of information held in the GIS to 'add value' to analytical results and their implications.

The imaginative application of Geographical Information Systems (GIS), or computer-based mapping, is providing new insights into solving a variety of complex energy resource and environmental problems. Indeed, GIS is directly assisting the successful deployment of renewables in the UK and Europe. Examples where energy applications of GIS are well-advanced include wind farms, short rotation coppice and other biomass-to-energy schemes (both direct combustion - such as a poultry litter-fired power station - and centralised anaerobic digestion). In addition, GIS are providing useful inputs to modelling of emission plumes, environmental monitoring and site identification.

15.2 GIS Development

The objectives of developing a GIS for this project were to:

- draw together as much of the existing data on SMC and poultry litter production into a manageable whole

- display all attributes relating to the area and their distribution and infrastructure
- use the spatial analyses functions to help establish sensitive locations, boundaries and suitable locations

The result is an integrated methodology for the assessment of resource availability, financial viability and environmental factors for biomass-to-energy options at a regional level. This report presents possible scenarios of a future development, where the location of demand and supply Is considered, along with and a set of environmental, economic and other restrictions.