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5.0 ATMOSPHERIC EMISSIONS

5.1 Monaghan County Council's Comments and Requests

"Whether the Killycarran proposal is subject to the requirements of the Directive on the Incineration of Waste (Directive 2000/76) was raised in the previous notice sent by the County Council. Your response asserted that the proposed facility falls within the exclusions contained in Article 2 of the Directive 2000/76. Your submission points to the exclusions relating to biomass and to experimental plants in the Directive and asserts that the operation of this facility is instead subject to the Directive on Large Combustion Plant.

It is difficult to see how the reference to experimental plants in Directive 2000/76 is relevant to this planning application. Moreover, your reference to the exclusions for biomass plants needs to be substantiated. In this respect, Article 2(2) of Directive 2000/76 sets down the following exclusions from its remit:

"(a) Plants treating only the following wastes:

(i) vegetable waste from agriculture and forestry,

(ii) vegetable waste from the food processing industry, if the heat generated is recovered,

(iii) fibrous vegetable waste from virgin pulp production and from production of paper from pulp, if it is co-incinerated at the place of production and the heat generated is recovered,

(iv) wood waste with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating, and which includes in particular such wood waste originating from construction and demolition waste,

(v) cork waste,

(vi) radioactive waste,

(vii) animal carcasses as regulated by Directive 90/667/EEC without prejudice to its future amendments,

(viii) waste resulting from the exploration for, and the exploitation of, oil and gas resources from off-shore installations and incinerated on board the installation; ..."

It would therefore appear that you are indicating that one or more of these exclusions apply to <u>all of the waste</u> to be accepted at this facility. In your response of November 2003, you refer to exclusions relating to "biomass (such as non-treated agricultural and forestry residues)". It would be this local authority's understanding that what been referred to here are the exclusions contained in Article 2(2) (a) (i) and (IV) of Directive 2000/76. The exclusion in Article 2(2) (a) (ii) may also be embraced by this phrase.

In respect of the exclusions in Directive 2000/76, the County Council notes that the first line of Article 2(2) (a) contains the word "only" (see above). This would seem to suggest that, if any wastes other than those listed in Article 2(2) (a) (i) to (viii) are to be accepted, then the exclusion falls and the Incineration Directive applies. Hence it is necessary for you to demonstrate how the spent mushroom compost the used poultry litter fall within the waste types listed in the sub-paragraphs of the directive which are quoted above. This requires you to substantiate, in particular, whether and how mushroom compost and poultry litter fall within the concept of "vegetable waste" in Articles 2(2) (a) and (ii) above.

You are required to provide a detailed breakdown of the composition of the spent mushroom compost, poultry litter and other wastes to be accepted at this facility. Having regards to that breakdown, you are required to set out a detailed case as to why all of these wastes — as well as their constituents — should be regarded as falling within the exclusions contained in Article 2 of Directive 2000/16. It needs to be emphasised that this important issue must be fully and comprehensively justified, hence you may with obtain independent legal advice on this matter. If legal advice is obtained, a copy of the question(s) asked and the actual reply should be included with the response to this notice.

Based on determination as to the nature of this facility, describe how the predicted stack emissions outlined in Table 4.3 page 104 Vol. II for the EIS comply with the findings and justify the use of 11% oxygen correction value as a reference condition

What provisions are proposed for plume suppression?

Clarify and describe the parameters used to determine minimum stack height comply the findings outlined in response with the above queries.

With respect to dust modelling, what particle sizes and associated mass fractions (weight) were used to determine the ground level impact?"

5.2 Response

Licensing and Operation of the proposed facility

It is important to note that the proposed development is a scheduled activity under the Integrated Pollution Control licensing scheme controlled by the Environmental Protection Agency (EPA).

All aspects of the licensed activity's potential impact on the environment are covered under the EU Integrated Pollution Prevention and Control (IPPC) Directive 96/61/EC, including emissions to air and water, energy and resource use efficiency, environmental management systems, and waste and residuals management.

Consequently a significant proportion of the additional information sought is not within the remit of the Planning Authority. Requests for additional information on licensing, waste management, effluent discharges, odour emissions, noise emissions and atmospheric discharges fall within the remit of the Authorised Regulatory Authority (EPA) under the IPPC Directive and not the Planning Authority.

Requests for additional information and clarification on this matter will however will dealt with here in the interest of transparency.

5.2.1 Relevant Legislation

The European Union has adopted legislation that promotes the use of waste in energy production. European Union directives on waste combustion include the Large Combustion Plant (LCP) directive and the Waste Incineration Directive (WID). The answer to whether a power station is licensed under either is dependent on the fuel.

Licensing and operation of the power plant falls under three specified EU Directives namely:

- Council DIRECTIVE 2001/80/EC (Large Combustion Plant Directive)
- Council DIRECTIVE 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market.
- Council DIRECTIVE 2000/76/EC (Incineration Directive)

The Waste Incineration Directive is applied when the plant incinerates or co-incinerates wastes. In the directive on the promotion of electricity produced from renewable energy sources (the RES-E directive), a biodegradable fraction of industrial and municipal waste is classified as biomass. Biomass is linked to the Waste Incineration Directive but plants burning biomass are regulated under the LCP Directive.

5.2.1.1 Council DIRECTIVE 2001/80/EC (Large Combustion Plant Directive)

Council DIRECTIVE 2001/80/EC (Large Combustion Plant Directive) concerns any combustion plant that utilises any solid, liquid or gaseous fuels with the exception of waste covered under:

- Council Directive 89/369/EEC of 8 June 1989 concerns new municipal waste incineration plants

- Council Directive 89/429/EEC concerns the reduction of pollution from existing municipal waste-incineration plants.

- Council Directive 94/67/EC of 16 December 1994 concerns the incineration of hazardous waste

Council DIRECTIVE 2001/80/EC specifies

- biomass as a fuel type to be used in combustion plants.

Council DIRECTIVE 2001/80/EC defines:

- biomass <u>as any whole or part of a vegetable matter</u> from agriculture or forestry which can be used as a fuel for the purpose of recovering its energy content.

- **Council DIRECTIVE 2001/80/EC ANNEX VIII:** Section (A) **specifies**

Competent authorities shall require continuous measurements of concentrations of SO_2, NO, and dust from Combustion plants however it also specifies that continuous measurements may not be required in the following case:

- for SO_2 from biomass firing boilers, if the operator can prove that the SO_2 emissions can under no circumstances be higher than the prescribed emission limit values, continuous measurements may not be required.

Definitions: **Council DIRECTIVE2001/80/EC**

Article 2 Section 6 & 11

(6) "fuel" means any solid, liquid or gaseous combustible material used to fire the combustion plant with the exception of waste covered by Council Directive 89/369/EEC of 8 June 1989 on the prevention of air pollution from new municipal waste incineration plants (1), Council Directive 89/429/EEC of 21 June 1989 on the reduction of air pollution from existing municipal waste incineration plants (2), and Council Directive 94/67/EC of 16 December 1994 concerning the incineration of hazardous waste (3) or any subsequent Community act repealing and replacing one or more of these Directives;

(11) "biomass" means products consisting of any whole or part of a vegetable matter from agriculture or forestry which can be used as a fuel for the purpose of recovering its energy content and the following waste used as a fuel:

(a) vegetable waste from agriculture and forestry;

(b) vegetable waste from the food processing industry, if the heat generated is recovered;

(c) fibrous vegetable waste from virgin pulp production and from production of paper from pulp, if it is co-incinerated at the place of production and the heat generated is recovered;

(d) cork waste;

(e) wood waste with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood preservatives or coating, and which includes in particular such wood waste originating from construction and demolition waste;

5.2.1.2 COUNCIL DIRECTIVE 2001/77/EC

Council Directive 2001/77/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market defines renewable energy and biomass under Article 2 as follows:

Article 2

Definitions

For the purposes of this Directive, the following definitions shall apply:

(a) '***renewable energy sources***'	shall mean renewable non-fossil energy sources (wind, solar, geothermal, wave, tidal, hydro-power, **biomass**, landfill gas, sewage treatment plant gas and biogases);
(b) '***biomass***'	shall mean the biodegradable fraction of products, waste and residues from agriculture (including vegetable and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste

5.2.1.3 COUNCIL DIRECTIVE 2000/76/EC

Directive 2000/76/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 December 2000 on the incineration of waste replaces the Directives 89/369/ECC, 89/429/CEE and 94/67/ECC on the incineration of municipal waste and hazardous waste incineration plants.

The Directive does not give a definition of biomass but within the scope of this Directive it excludes incineration plants treating only the following wastes:

- (i) vegetable waste from agriculture and forestry,
- (ii) vegetable waste from the food processing industry, if the heat generated is recovered,
- (iii) fibrous vegetable waste from virgin pulp production and from production of paper from pulp, if it is co-incinerated at the place of production and the heat generated is recovered,
- (iv) wood waste with the exception of wood waste which may contain halogenated organic compounds or heavy metals as a result of treatment with wood

preservatives or coating, and which includes in particular such wood waste originating from construction and demolition waste,

(v) cork waste,

(vi) radioactive waste,

(vii) animal carcasses as regulated by Directive 90/667/EEC without prejudice to its future amendments,

(viii) waste resulting from the exploration for, and the exploitation of, oil and gas resources from off shore installations and incinerated on board the installation;

This exclusion is a variation to the definition of biomass as defined within Council DIRECTIVE 2001/80/EC which specifies biomass as <u>any whole or part of a vegetable matter from agriculture or forestry</u> which can be used as a fuel for the purpose of recovering its energy content and the following waste used as a fuel.

A clear distinction therefore is made between municipal waste and biomass waste residues from agriculture including vegetable and animal substances and wood waste from forestry industries. Chicken litter and spent mushroom compost are regarded by the EU as a secondary resource suitable as a fuel for the purpose of energy recovery.

- Spent Mushroom compost is biodegradable waste from agriculture.
- Chicken Litter is a waste residue from agriculture containing vegetable and animal substances.
- Wood waste is the biodegradable fraction of forestry waste.

In summary, Directive 2000/76/EC concerns Industrial, hazardous and municipal solid waste. Directive 2001/80/EC concerns any solid, liquid or gaseous fuels (including biomass) with the exception of waste covered under 2000/76/EC.

5.2.1.4 National Definition of Biomass in Ireland.

Definition of Biomass: SUSTAINABLE ENERGY IRELAND

“The term biomass encompasses a variety of fuels and technologies used to produce renewable energy. Biomass refers to land and water-based vegetation, organic wastes and photosynthetic organisms. These are non-fossil, renewable carbon resources from which energy can be produced and used as fossil fuel substitutes. Examples of biomass include: wood, grasses, crops, agricultural and municipal wastes. Agricultural residues e.g. animal slurry and manure, chicken litter, spent mushroom compost and straw. Disposal of some of these residues poses an environmental problem. Wet wastes such as cattle and pig manure are suitable for anaerobic digestion, while wastes with lower moisture content e.g. chicken litter and spent mushroom compost can be combusted."

5.3 Composition of Waste

Licensing of the proposed facility including waste management is the responsibility of the Regulatory Authority, the Environmental Protection Agency. Consequently it is not within the remit of the Local Authority to seek additional information on this matter. Requests for additional information and clarification on this matter will however will dealt with here in the interest of transparency.

The specific composition of all fuel types have been detailed in Appendix 13 of the original EIS document. A summary of the composition of the Spent Mushroom Compost, Poultry Litter and Wood are presented in Tables 5.1 to 5.3.

Table 5.1 Composition of Irish Spent Mushroom Compost

Constituent	Mean	Minimum	Maximum
Available Nutrients			
pH	6.6	5.9	7.4
EC (mS/cm)	750	580	903
NO_3 – N	62	21	87
NH_4 – N	49	2	133
P	31	11	73
K	2130	1450	2650
Na	253	160	350
Cl	118	40	157
Total Nutrient content			
N (g/kg DM)	25.5	23.1	28.2
P	12.5	10.3	15.3
K	25	17	32
Ca	72.5	42	99
Mg	6.7	5.2	8.7
S	15.9	9.6	22
Na	2.67	1.7	3.2
Fe (mg/kg DM)	2153	1300	3200
Mn	376	320	460
B	37	32	43
Cu	46	36	65
Zn	273	220	390
Bulk density (g/l)	319	257	395
% Dry Matter (DM)	31.5	24.1	35.1
% Ash	35	30.4	41.5

(Source: Teagasc) units: mg/kg

Table 5.2 Chemical Composition Poultry Litter

Dry Fuel Analysis – % by Weight Dry	Broiler Litter	Breeder Litter	Rearer	Composite Mixture
Carbon	42.4	35.8	38.45	27.98
Hydrogen	5.7	4.8	5.3	3.78
Nitrogen	4.9	2.5	34.45	2.66
Oxygen	31	34.5	4.05	24.2
Chlorine	0.5	0.35	0.8	0.34
Total sulphur	0.6	0.45	0.7	0.41
Ash	14.9	21.45	16.25	13.28
Moisture range	20-45	25-40	20-30	
Lower Heating value kJ/kg	11,265	9,008	11,500	10,216

Table 5.3 Wood Composition

Parameter	Value
Moisture content %	50-60
Ash content %	<5
Particle size mm	25-50

(Irish Biofuel Report 1999)

Note: Only untreated wood waste will be considered as a potential fuel resource.

5.4 Predicted Stack Emissions

The proposed development is a scheduled activity under the Integrated Pollution Control licensing scheme controlled by the Environmental Protection Agency (EPA).

All aspects of the licensed activity's potential impact on the environment are examined and determined under the EU Integrated Pollution Prevention and Control (IPPC) Directive 96/61/EC, including emissions to air and water, energy and resource use efficiency, environmental management systems, and waste and residuals management.

Licensing, waste management, effluent discharges, odour emissions, noise emissions and atmospheric discharges fall within the remit of the Authorised Regulatory Authority (EPA) under the IPPC Directive and not the Planning Authority.

Requests for additional information and clarification on this matter will however will dealt with here in the interest of transparency.

The EU has a set of common rules on permitting for industrial installations. These rules are set out in the so-called IPPC Directive of 1996. IPPC stands for Integrated Pollution Prevention and Control. All installations covered by *Annex I* of the Directive are required to obtain an authorisation (permit) from the authorities in the EU countries. Unless they have a permit, they are not allowed to operate. The permits must be based on the concept of Best Available Techniques (or BAT), which is defined in Article 2 of the Directive. The Authorised Regulatory Authority in Ireland is the Environmental Protection Agency.

The facility will be licensed by the EPA whereby actual emission limits will be set taking into consideration a number of items of legislation including the principles of best available techniques (BATs) under Directive 96/61/EC. Compliance by the operator with the conditions of the licence will ensure that significant environmental pollution does not result from the licensed activity.

11% Oxygen Reference is commonly used for Biomass fuel types but it may be decided that the 6% value applies as specified under the Large Combustion Directive for solid fuels. A lower oxygen reference value will, in essence, require tighter emission limits to be met.

Predicted emission levels stated in the original EIS Table 4.3 were based on a worse case scenario, actual levels are anticipated to be significantly lower. Process emissions will be maintained within relevant limits by control of boiler operation and also the rate of desulphurisation will be maintained at 92% or better in order to ensure compliance in situations where elevated SO_2 arise.

Under the Large Combustion Plant Regulations (SI 644/2003), Type B Plant limits apply to any installations developed after 27th November 2003. Specific emissions are listed for Biomass as a fuel as presented in Table 5.4

Table 5.4 Limits for Type B plants as per Second Schedule of the Regulations

Fuel Type:	Emission Limit Values (mg/Nm^3)		
Biomass	**50-100MWth**	**100-300MWth**	**>300MWth**
SO_2	200	200	200
NO_X AS NO_2	400	300	200
Dust	50	30	30

O_2 Content = 6%

Note:

Where the emission limit values for SO_2 cannot be met due to the characteristics of the fuel, installations smaller than 300 MWth shall achieve either 300 mg/Nm^3 SO_2 or a rate of desulphurisation of at least 92 %. Larger plants must achieve a rate of desulphurisation of at least 95 per cent or a maximum of 400 mg SO_2/m3.

5.4.1 Provisions for Plume Suppression

Flue gas will be conditioned and cleaned prior to emission. A turbine exhaust condenser will be installed to capture water vapour and return it to the boiler feed.

The flue gases will subsequently be treated by a dry absorption flue gas cleaning system which reduces the SO_2, HCl and dust content.

The conditioning is by means of evaporative cooling with water to a relative humidity to approximately 40% and acid gas removal by introduction of lime into the system. Water is continuously evaporated to achieve flue gas cooling to a stable temperature. This is achieved by monitoring the gas temperature downstream of the mixing chamber and controlling the cooling water supply appropriately.

The treated exhaust gas will pass through a fabric bag filter to remove particulates. The filter is divided into compartments of rectangular shape, as the exit gas passes through the compartments it will further lose velocity as it spreads out into each chamber and also due to impaction with the filter itself.

5.4.2 Dispersion Modelling

Dispersion modelling was conducted using an advanced Gaussian dispersion model, MODMAP details of which are contained in Chapter 4 and Appendix 4 of the EIS document. This model takes into account the dispersion characteristics of a plume depending on differences in temperature between stack emissions and ambient air, efflux velocity and stack height. Dispersion modelling was conducted based on concentrations presented in Table 5.5 and source characteristics as in Table 5.6. The concentrations listed are maximum values that will be expected following an initial three month commissioning period.

Table 5.5 Emission Data

Parameter	Maximum Concentration
Nitrogen oxides – as NO2	400 mg/Nm3
Sulphur Dioxide – SO2	300mg/Nm3
Particulates	20mg/Nm3
Hydrogen Chloride – HCl	35mg/Nm3
Carbon Monoxide - CO	200mg/Nm3
Dioxins and Furans – PCDD and PCDF	0.1ng/Nm3
Organic Substances – as total C	30mg/Nm3

24 hour average value concentrations under standard conditions,

Table 5.7 Source Characteristics

OS Grid Location	E: 344276 N: 263914
Stack internal diameter	1.750m
Exit Temperature	100oC
Flow rate	40.3kg/s
Flue Gas density	- 0.86 kg/m3
Exit velocity	19.6m/s
Stack Location	Rural
Terrain	Low elevation rolling landscape
Location of nearest sensitive receptor (m)	175

Calculations were conducted for various stack heights in Chapter 5 and Appendix 5 of the original EIS. Predicted Ground Level Concentrations (GLC's) for a 50m stack are summarised in Table 5.7 below.

Table 5.7 Maximum GLC's for 50m Stack Height

Parameter	Maximum GLC, µg/m^3	Averaging Basis	Limit value, µg/m^3
NO_2	14.96	Hourly average (98%ile)	200
	0.66	Annual Average	40
SO_2	18.69	Hourly average (98%ile)	350
	17.07	Daily Average	125
	0.82	Annual average	20
Dust, (PM_{10})	0.13	Daily average (90%ile)	50
	0.033	Annual Average	40
CO	14.85	8- hour average	10,000
HCl or VOCs	0.21	Hourly average (95%ile)	NS

Note:
Current Limit Values are quoted from the Air Quality Standards Regulations, 2002
NS = None Specified for HCl or VOCs

Existing ambient air quality at the site is typical of a rural background levels (detailed in EIS Chapter 4) and the predicted maximum GLC's for all parameters are significantly below limits as quoted in the Air Quality Standards Regulations 2002.

It is anticipated therefore that emissions will have minimal impact on the surrounding environment even during start-up operations at the plant.

5.4.3 Stack Height

As stated in the EIS Chapter 4 Section 4.6 Air Quality Mapping/Stack Height Determination
"The model was run on five stack heights 50m, 60m, 70m, 80m, 90m and 100m for all parameters. The outputs from the model were analysed and comparisons with air quality criteria undertaken for each modelled pollutant as illustrated below." Graphs of modelled data were included in Appendix 4 of the EIS.

Chapter 4, Figure 4.8 of the EIS clearly illustrates the results of modelled data for dust including 98^{th} percentile of year hourly average, 90^{th} percentile of daily average and dust annual average for stack heights 50m, 60m, 70m, 80m, 90m and 100m.

In addition Figure 4.8.1 provides the maximum predicted annual average ground level NOx concentration for stack heights 50m, 60m, 70m, 80m, 90m and 100m and illustrates the results in reference to air quality standards.

In determining the acceptable stack height for emission points it must be based on the objectives of providing adequate pollutant dispersion without creating any undue visual impact.

It was determined that the concentrations from the 50m stack complied with all air quality standards. Consequently a 50m stack was selected.

5.4.4 Dust

Modelling was conducted treating dust as an aerosol and thus may be used to approximate particles below 10 microns in diameter. This fraction has been identified as the most important when determining adverse health risks associated with dusts.

Fly ash will be removed by the bag filter system where filtration of the larger particles will occur, the removal of smaller particles will be facilitated by impaction and adhesion within the chamber.

Dust emission limits and ground level concentrations are anticipated to be well within emission limits and ground level concentrations significantly lower than applicable air quality limits.

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6.0 AQUATIC EMISSIONS

6.1 Monaghan County Council's Comments and Requests

"The discussion set out under the section "water" in your response to the County Council's 2003 notice is totally inadequate. In addition, it is not sufficient for you to assert that matters to do with the effluent discharge to the ditch on the site are issues that only the EPA is concerned with. In this respect, you should be aware that the Planning and Development Act, in conjunction with either the EPA Act or the Waste Management Act, allows for this type of - planning application to be refused due to it being unacceptable on environmental grounds. Moreover, the full documentation of the main effects of a development on the environment is an obligatory requirement for any valid EIS (see Schedule 6 paragraph 1(c) to the Planning and Development Regulations 2001). It remains the County Council's view that wastewater discharges from this proposal fall within this requirement.

Page 72 of the EIS indicates that the 4.8 m^3 per hour of wastewater is to be discharged from the proposed Killycarran plant. At peak flow, the rate could be 31 m^3 per hour. What notably vague in the EIS and is not clarified at all adequately in your response the County Council's notice (where information seems to have been provided in relation to a watercourse a number of miles from the facility)- are the requisite full details and an adequate assessment of the receiving capacity of the watercourse that will accept this discharges. In this respect the flow on that watercourse is described as being a trickle in Volume III to the EIS. The EIS also seems unclear on the cumulative effect of this discharge in conjunction with inclement weather-related water discharges from the proposed roofs and hardstandings at the site. Finally, both the EIS and your response to the Council's notice vaguely state that an alterative might be discharge to "soil percolation" and then to groundwater.

You are required to accurately determine the flow rate, in proximity to the proposed facility of the stream referred to on page 31 of your response of November 2003. You are also required to submit a drawing showing its precise location and the location of all discharge points from the proposed site. A copy of the calculations — including any assumptions made — to determine the minimum, average and peak flows of wastewater discharges from the site should be provided, along with those relating to similar figures for surface water run-off from the plant as a whole.

A full and adequate assessment of the implications of water discharge from the plant- both treated wastewater and that arising from roofs/roadways/hardstandings - should be provided, which should also set out the effects of the heightened flow-rate to the environment downstream of the facility. Any proposal that such discharges are to be made instead v percolation to groundwater should be fully described, relevant calculations should be supplied and compliance with the Water Pollution Acts and — particularly - the EU Groundwater Directive (80/68) be clearly demonstrated."

6.2 Response: Report prepared by QED Engineering Ltd

The proposed development is a scheduled activity under the Integrated Pollution Control licensing scheme controlled by the Environmental Protection Agency (EPA).

All aspects of the licensed activity's potential impact on the environment are examined and determined under the EU Integrated Pollution Prevention and Control (IPPC) Directive 96/61/EC, including emissions to air and water, energy and resource use efficiency, environmental management systems, and waste and residuals management.

Licensing, waste management, effluent discharges, odour emissions, noise emissions and atmospheric discharges fall within the remit of the Authorised Regulatory Authority (EPA) under the IPPC Directive and not the Planning Authority.

Requests for additional information and clarification on this matter will however will dealt with here in the interest of transparency.

In March 2005, QED Engineering Ltd were commissioned to prepare a report addressing the requests as outlined above. The report overleaf, entitled "Clarification of Aquatic Emissions at the proposed Biomass CHP plant" is based on a detailed site survey and current information on aquatic emissions from the proposed site provided by AET, the plant designers, Monopower Ltd the Plant developers, SWS Environmental Services and public bodies including; The Eastern Regional Fisheries Board, the Environmental Protection Agency and Monaghan County Council, Sanitary Services

Clarification of Aquatic Emissions at Proposed Biomass CHP Plant

for

Monopower Ltd.
Killycarran
Emyvale
Co. Monaghan

by

Q.E.D. Engineering Ltd
11 Market Street
Monaghan
tel: 047-72060
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March 2005

Table of Contents

1. Introduction

Monopower Ltd, Killycarran, Emyvale, Co. Monaghan has made a Planning Application to Monaghan County Council for the construction of a Biomass Combined Heat & Power Plant (Planning Ref. 03/446). On 1/12/04 a request for further information was made by the council regarding aquatic emissions from the facility. The request can be summarised as follows;

1. Accurately determine the flow rate of the stream beside the site
2. Provide drawing showing the precise location of the stream and the location of all discharge points from the proposed site.
3. Provide calculations – including any assumptions made – on the minimum, average and peak flows of wastewater discharges from the site, and similar figures for surface water runoff from the plant.
4. Provide a full and adequate assessment of the implications of the water discharges from the site (process and storm-water), to include the effects of the heightened flow rate to the environment downstream of the facility.
5. Describe proposal to discharge via percolation to groundwater and include calculations.
6. Demonstrate compliance with Water Pollution Acts and EU Groundwater Directive (80/68).

The following report addresses all of the above issue. The report has been carried out by Patricia Murtagh and Hugh Doherty of Q.E.D. Engineering Ltd and is based on a site survey and on available information supplied by

1. Monopower Ltd, the developer
2. SWS Environmental Services, Cork, who compiled the Environmental Impact Statement for the development
3. Lars Bronden, Aalbork Energie Technik a/s (AET), Denmark, the designer and supplier of the Biomass CHP plant
4. The Eastern Regional Fisheries Board
5. Environmental Protection Agency
6. Monaghan County Council, Sanitary Services

2. Flow Rate in Stream

An accurate determination of flow rate in a stream can only be provided if reliable flow records are available for a long period of time. The stream beside the site does not have a continuous flow recorder installed so only spot measurements have been taken, when required. The Mountain Water River, into which the stream discharges has a flow recorder installed at Glaslough since 1980, however, this location is approximately 7km from the stream beside the proposed site. In addition, knowing the flow in the main channel of the Mountain Water at Glaslough is of no assistance in getting the flow in a tributary of this river i.e. in our stream of interest.

The principal methods of flow measurement in a stream/river are

(i) Velocity Area Method
(ii) Discharge Measuring Structures
(iii) Dilution Methods
(iv) Electromagnetic and Ultrasonic Methods.

The vast majority of the flow measurement stations in Ireland are calibrated with flow measurements carried out using the velocity-area method. Structures, in the form of notches and wiers are also used mainly for measurement of low discharges on small rivers. On a number of large rivers, flat vee wiers have been constructed to facilitate measurement of river flows.

The velocity area method consists of measuring the velocity of water (by current meter) and the cross sectional area. The velocity is measured at a number of verticals in the cross section. The flow is obtained by summing the products of the velocity and corresponding area for a series of observation in a cross section. The flow is given in cubic meters per second. The relevant standard used is ISO1070/BS 3680 Methods of Measurement of Liquid Flows in Open Channels.

In the stream beside the site, water velocity and cross sectional areas of the stream were measured on 4/3/05. The velocity was measured using a Geopacks Flow Meter. Because the stream was shallow (7-8cm) during the survey, it was not possible to measure the flow at a number of verticals. The locations of sampling are provided in Figure 1, and the results of measurements taken are provided in the following table;

Table 1. Flow Rate in Stream

Location	Height m	Width m	CSA m2	Flow rate m/s	Flow m3/s
1	0.07	0.5	0.035	0.3	0.0105
2	0.07	0.5	0.035	0.1	0.0035
3	0.07	1	0.07	0.1	0.007
4	0.08	0.75	0.06	0.33	0.0198
				Average Flow	**0.0102**

Therefore the average flow recorded in March 2005 was $0.01m^3$/sec (10.2 litres/sec). February 2005 was a dry month in terms of rainfall - Clones recorded 41.4mm of rainfall in Feb 2005 – so this may have contributed to the low flow in the stream at this time. Only by setting up a permanent flow recording station in this stream will a fully accurate and reliable determination of flow rate be available for this location.

3. Drainage Map of Site

3.1 Existing Drainage

A drainage map of the site is provided in Figure 1. Drainage consists of ditches at the perimeter of the fields. The drainage ditches are open and water falling on the proposed site area will flow over-ground to the ditches or it will percolate through the soil and drain to the ditches, which are at a lower level than the fields themselves. The arrows along drainage ditches in Figure 1 indicate the likely direction of flow in times of high rainfall. In March 2005 when all ditches were visually examined those to the west of the proposed site were dry and those to the east contained water, but it was not flowing.

At one point in the proposed site area surface water leaves the site and gradually flows a distance of 38m along an open drainage ditch in the next field to the stream (tributary of the Mountain Water). The field beside the site along the road to the front has its own separate ditches draining to the stream.

Figure 1.
Existing Surface Water Drainage at the Proposed Development Site

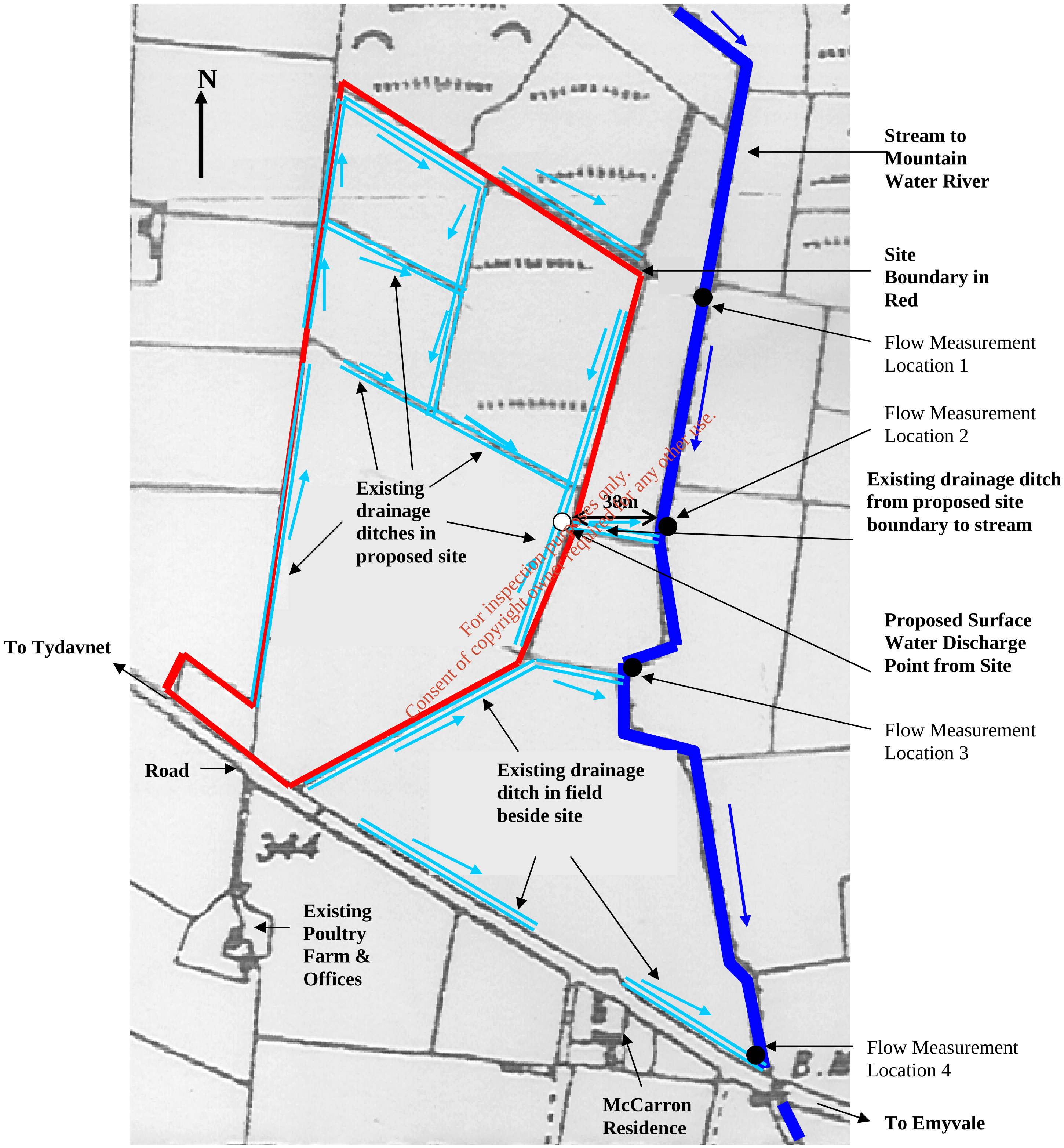
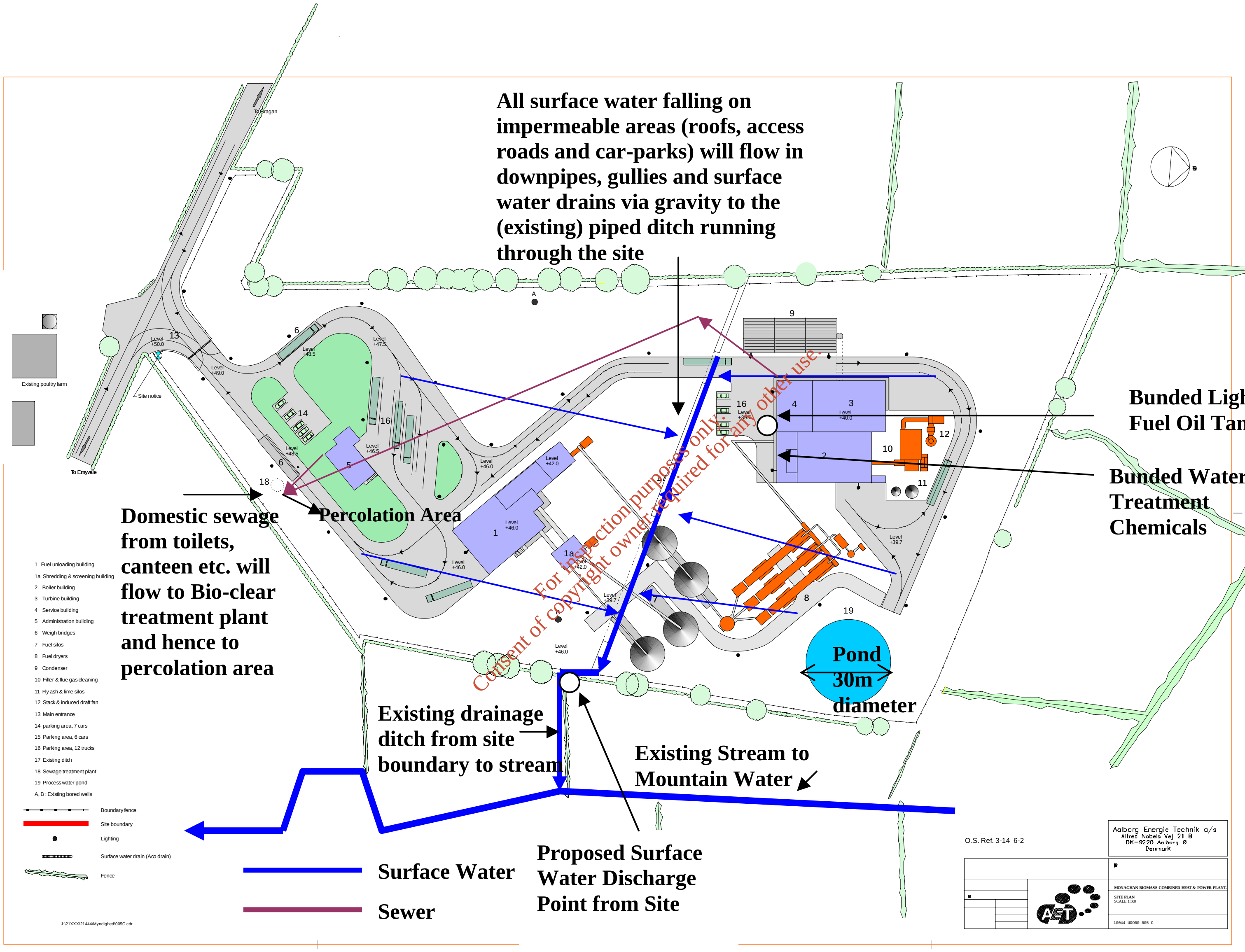


Figure 2. Proposed Drainage Routes from New Site



3.2 Proposed Drainage

An outline of drainage routes from the proposed site, once constructed is provided in Figure 2. The existing drainage ditch flowing west-east across the centre of the site will be piped and will constitute the main drainage channel into which all surface water from the site will flow. This drain will link up with the ditch in the field beside the site, which will transport water to the stream, as is currently the case.

When the site is constructed it will comprise a number of buildings (administration, fuel/raw materials unloading, shredding, boiler, turbine and service building). The total site area of buildings is in the order of 2,160m^2 (7.6% of the total site area). Rainwater falling on roofs of these buildings will be collected via down pipes and discharge to the surface water drainage system outlined above.

Internal primary roads and hard standing areas will be paved with asphalt (6,900m^2). Areas for handling of containers etc. will be paved with reinforced concrete (450m^2). Secondary roads for service access only will be paved with gravel (950m^2). The asphalt and concrete paving will be impermeable (7,350m^2) so surface water drains / gullies will be installed along roadways and carparks to catch rainwater falling on these areas. This rainwater will discharge to the surface water drainage system outlined above.

The remainder of the site will be permeable, allowing rainwater to percolate through the soil. This area will consist of 950m^2 of gravel paving and the remainder will be grass/landscaped, comprising an area of approximately 17,868m^2.

A process water pond is to be located on the site. This pond is designed to accept any process water generated from the production process. Water is stored here prior to discharge from the surface water system outlined above. The pond allows settlement of discharge water and allows the temperature to stabilise, prior to leaving the site. The pond will also be used as a firewater retention facility.

The site will be fitted with two oil interceptors, one at the oil tank loading area and one at the surface water discharge outlet from site at the eastern boundary.

Domestic effluent on the site, from toilets, sinks, showers and canteen areas will discharge to a dedicated treatment plant –a bio-clear treatment system. This system will be designed for a maximum of 25 staff (working 3 x 8hour shifts). Raw sewage from the administration and services building is discharged to an aerated tank, which fully treats the wastewater, prior to discharge to a percolation area. Within the percolation area, treated effluent is discharged via a network of pipes into the underlying soil, where it undergoes further polishing and treatment, prior to percolation to groundwater. The bio-clear treatment system is a fully enclosed plant, accepting only domestic-type wastewaters. No process water will be discharged to the bio-clear system.

In summary, all surface water runoff from the site will discharge via over-ground flow and via the surface water drainage system to the site outlet at the eastern site boundary and hence to the nearby stream. Process water will drain to a pond, prior to discharge to this location also. A large amount of surface water will also percolate through the soil to ground and groundwater, as over half of the site area (66.4%) is permeable (i.e. grass/landscaped).

4. Wastewater and Surface Water Runoff from Site

4.1 Wastewater Volumes and Concentration

A summary of the water consumption and wastewater to be generated at the Monopower site, as provided by AET are provided in Table 2. Details in this table are provided in the following sections.

Table 2. Monaghan Biomass CHP Plant
Water consumption & wastewater

The figures are based on the information available at the actual stage								
		Flow	**Flow rate**	**Frequency**	**Average**			**Outlet through**
Sootblowing:	Superheaters	1.4	M3/3 min	12-24 hours	0.117	M3/h		
	Economiser	1.1	M3/1 min	12-24 hours	0.092	M3/h		
	Consumption for SB				**0.208**	M3/h	1 g/M3 of Ammonia	Stack
Blowdown:	Consumption for BD			cont.	**1.000**	M3/h	5 g/M3 of phosphate, 1 g/M3 of Ammonia	Sewer/60°C
Water treatment:	Sand filter	4.00	M3/10 min.	7 days	0.024	M3/h	Fe(OH3), MnO2	
	Softening filter	1.44	M3/75 min	7 days	0.009	M3/h	Ca, Mg, 25 Kg/M3 NaCL	
	Reverse osmosis	2.00	M3/h	cont.	2.000	M3/h		
	CIP plant	0.30	M3	3 months	0.00014	M3/h	6 Kg citric acid, 0,15 Kg EDTA, 0,3 Kg NaOH	
	De-ionization plant	0.17	M3/h	cont.	0.170	M3/h		
	Consumption for WTP				**2.203**	M3/h		Sewer/20°C
Various:	Consumption Various				**0.500**	M3/h	1 g/M3 of Ammonia in app. 0.2 M3/h (40% flow)	Sewer/35°C
Service water	Service facilities etc.				**0.500**	M3/h		Sewer/20°C
Flue gas cleaning:	Abnormal operation			cont.	**4.600**	M3/h		Stack
Condensing eco.	Normal operation			cont.	**1.000**	M3/h		Sewer/60°C
Max water treatment plant capacity					5.4	M3/h		
Necessary capacity of treated water					1.708	M3/h		
Load rate (on-off) of water treatment plant					0.316	%		
Raw water consumption during normal operation					**2.905**	M3/h		
Raw water consumption during abnormal operation					**7.505**	M3/h		
Wastewater					**3.697**	M3/h		

1. Soot Blowing

In order to secure a long operation time of the boiler between manual cleanings, efficient soot blowing equipment is installed to provide optimum cleaning of the heating surfaces with minimum steam consumption. Steam soot blowers are provided in the superheater and in the economiser. Possible mounting of soot blowers in the furnace depends on further fuel tests. Soot blowing is carried out according to a pre-set cycle with all or some blowers in automatic rotation. Furthermore, individual soot blowers can be started manually one by one.

Table 2 shows that water consumption for soot blowing is estimated at 0.208m^3/hour. The soot blowing process will contain 1mg/l of ammonia, but this will be emitted, via the flue gas cleaning system to atmosphere via the stack. Sootblowing occurs every 12-24 hours.

2. Blowdown

The purpose of boiler blowdown is to control solids in the boiler water. Blowdown protects boiler surfaces from severe scaling or corrosion problems that can result otherwise. At Monopower, a blowdown tank for collection of the following emissions from the boiler will be installed;

- Boiler blowdown water
- Condensed steam
- Water from drain and vent headers
- Water from desalination valve
- Condensate from preheating

The volume of boiler blowdown water from this plant is estimated at 1m^3/hour. This water will contain phosphate at a concentration of 5mg/l and ammonia at 1mg/l. This water will be at 60^{0}C on exit from the tank. Blowdown is a continuous operation.

3. Water Treatment

Incoming raw water to the site undergoes some treatment prior to being used in the plant. This consists of a sand filter, softening filter, reverse osmosis, CIP (Cleaning In Place) plant and a deionization plant. The water treatment plant will require flushing on a regular basis, so wastewater will be generated during this flushing process. The volume of water estimated from this plant is 2.203m^3/hour and it will contain $Fe(OH)_3$ -, MnO_2, Ca, Mg and 25,000mg/l of NaCL. It will also contain amounts of citric acid, EDTA and NaOH. This water will be at 20^{0}C on exit from the water treatment plant. The discharge from the water treatment plant will be every 7 days from the sand and softening filter, continuously from the reverse osmosis and de-ionization plant and every 3 months from the CIP plant.

4. Various/Service facilities

A figure of 0.5m^3/hour of water consumption is assigned for various / and for service facilities (1m^3/hr in total). It is estimated that up to 1mg/m^3 of ammonia could be present in these waters. Water from these sources is estimated to be between 20-35^{0}C.

5. Flue Gas Cleaning Process

The flue gas cleaning process will generate 4.6m^3/hour (continuously) during abnormal operation.

6. Condenser Economiser

The condensing economiser will generate 1mg/m^3 continuously during normal operation. This wastewater will be at 60^{0}C.

The last three columns in Table 2 provide the volume of raw water to be used at this site during normal operation at 2.905m^3/hour and during abnormal operation at 7.505m^3/hour. The volume of wastewater to be generated is calculated at 3.697m^3/hour. This could increase to up to 10m^3/hour for abnormal operation. The figures and details provided in this section and in Table 2 are deemed accurate by the manufacturer of the plant - AET.

4.2 Surface Water Runoff

The average runoff from a site is the total rainfall less evapotranspriation losses and, where the groundwater resource is small, can be defined as the average river flow. It is also known as the effective rainfall. It defines the magnitude of the total surface water resources in the country. Taking the average rainfall at 1150mm per annum and the average evapotranspiration losses at 450mm, the average total runoff in Ireland is estimated at some 700mm per annum (Source: EPA website). Therefore for the average rainfall figure for an area, the runoff is 61% of that amount (39% is evapotranspiration).

Emyvale has an annual rainfall amount of 966mm. Therefore if this quantity is currently falling on the proposed development site per annum, 607.56mm of rainfall is discharge to surface waters around the site.

When the proposed site is complete, the following impermeable area is estimated;

- Buildings 2,160 m^2
- Asphalt Paving 6,900 m^2
- Concrete Paving 450 m^2

Total Impermeable Area: 9,510m^2

The total site area is in the region of 7 acres or 28,328. Therefore the impermeable area makes up 33.6% of the total site area.
Therefore when the new site is complete, of the 966mm of rainfall falling on the site per annum, the following will be discharged;

- 33.6% of 966mm will fall on an impermeable surface = 324.58mm
- 66.4% of the 966mm will fall on the permeable surface (641.42mm) and 61% of this will contribute to surface water flow = 391.27mm

Therefore the volume of surface water discharge from the site when constructed is predicted at 715.84mm.

This means that surface runoff at the site will increase by 15% per annum (715.84 – 607.56)/715.84*100 = 15%) by the introduction of new buildings and impermeable areas on the site.

Extreme rainfall events contribute to increased levels of surface runoff. Table 3 provides the maximum recorded rainfall (mm) for a number of rainfall durations and return periods for the Emyvale rain gauge station. In Table 4, these rainfall amounts are converted to m^3 of rainfall that will be discharged from impermeable areas of the site only (9,510m^2) during the extreme rainfall event. These range from 18m^3 of rainfall for a 5year storm, with a 1 minute return period to 956.1m^3 of rainfall for a 100 year storm, with a 48 hour return period.

Table 3. Extreme Rainfall Return Periods

Location: Emyvale
Average Annual Rainfall: 966

Maximum rainfall (mm) of indicated duration expected in the indicated return period.

Duration	Return Period (years) 1/2	1	2	5	10	20	50	100	Special (loglog) 30
1 min				1.9	2.2	2.6	3.2	3.6	2.8
2 min				3.2	3.7	4.4	5.5	6.3	4.9
5 min				5.8	6.7	8.0	10.0	11.5	8.8
10 min				8.3	9.7	11.6	14.7	17.0	12.9
15 min	5.2	6.5	7.3	10.0	12.3	14.8	18.9	22	16.5
30 min	6.9	8.6	9.6	13.1	16.0	19.1	24	28	21.3
60 min	9.0	11.1	12.5	16.7	20.2	24	30	35	27
2 hour	11.7	14.3	16.0	21.1	25	30	37	43	33
4 hour	15.9	19.2	21.1	27	32	37	44	51	40
6 hour	19.1	22.9	25	32	37	43	52	59	47
12 hour	24.4	29	32	40	47	53	64	73	58
24 hour	30	35	39	48	56	64	76	85	69
48 hour	37	43	47	58	67	76	89	101	82
96 hour									

Notes: Larger margins of error for 1, 2 ,5 and 10 minute values and for 100 year return periods

M560: 16.7 M52d: 55 M560/m52d: 0.30

Table 4. Volume of Rainfall in m^3 Falling on Impermeable Area of Site (9,510m^2) and Discharging to Nearby Stream During Extreme Rainfall Return Periods

	Return Period (years)							
Return period	1/2	1	2	5	10	20	50	100
Volume	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3
1 min				18.0	20.8	24.5	30.3	34.5
2 min				30.8	35.6	42.1	52.3	59.8
5 min				55.2	64.1	76.2	95.3	109.4
10 min				79.0	92.4	110.7	140.1	162.1
15 min	49.2	62.2	69.2	95.2	116.8	141.0	180.0	209.9
30 min	65.5	81.8	91.6	124.3	151.9	182.1	231.2	269.4
60 min	85.2	105.9	118.6	158.8	191.7	228.7	287.5	334.7
2 hour	111.7	136.1	152.2	200.7	239.1	283.6	350.9	407.1
4 hour	151.5	182.9	201.0	258.2	302.5	349.9	423.1	486.9
6 hour	181.6	218.1	238.4	304.3	355.1	407.8	491.0	562.8
12 hour	232.2	278.1	301.7	382.8	444.7	507.2	608.0	689.8
24 hour	283.8	337.5	366.7	460.3	530.9	604.5	718.1	813.0
48 hour	347.4	409.3	447.2	554.4	633.9	722.6	848.4	956.1
96 hour								

5. Assessment of Water Discharges from the Site

The site proposes to discharge surface water from the site at 1 location, as shown in Figure 1. This discharge is to an open ditch, which discharges to the stream 38m from the site boundary. This stream is a tributary of the Mountain Water River. The Mountain Water discharges to the Ulster Blackwater, which in turn discharges to Lough Neagh in Northern Ireland. The site lies in the Neagh Bann International River Bed District. The Mountain Water River is an important local fishing water, and has stocks of Pike, Trench, Roach, Bream, Pearch and Rudd.

Rainwater falling on the site will be diverted to the discharge point. The quantity of rainwater being discharged will increase as a result of the introduction of impermeable areas, so therefore the volume of water in the river and the flow rate may also increase. The introduction of surface water to a stream/river is not problematic once it is clean. Problems can arise at a discharge point when the habitat at that point is altered as a result of the introduction of pools of water at this location. This can be avoided by proper design of the discharge point to prevent any significant alteration of existing conditions within the ditch into which it will discharge and the stream itself. Such design could include having a gradual gradient at the discharge point to prevent pools of water forming and controlling the flow rate from the discharge point, to ensure steady state. It is not considered that there are any negative effects of increased surface water flow from the site to the environment downstream of the facility.

Process water from the site will be treated to the required standard, prior to discharge. Section 4.1 of this report provides information regarding the estimated type and quantities of wastewater to be generated at this facility. Based on the anticipated concentration range, measures to limit the concentration of ammonia and phosphorus are likely to be required. Suggested control techniques for process waters of this type include using a small-scale batch system, whereby process water is treated in stages using coagulants/flocculants, absorbents and pH control in small treatment tanks, prior to discharge.

Data on wastewater generated from a similar plant - Westfield Biomass Plant in Scotland - was sought to determine the likely volume and concentration of wastewater to be expected at the Monopower site. Westfield is a 9.8MW Poultry litter-fuelled power station, in operation since 2001. Wastewater from this plant arises from boiler blowdown predominantly and it is discharged to a public sewer. It is analysed for daily flow and for pH only. Details of readings taken from October to December 2004 are provided in Appendix 1. Effluent flow varies between 0-56.4m^3/day and the average weekly pH is generally neutral.

Because of the nature and capacity of the site, it will be subject to licensing by the EPA. Within this process, emission limit values will be imposed for a number of parameters for emissions to water. Once these parameters are known the required wastewater treatment can be employed for the wastewater generated on this site. The overall objective is to ensure that all wastewater from the site does not impact on the surface and groundwaters in the vicinity of the site and beyond. This will be achieved by the application of best available techniques (BAT) in the design of the plant and in any wastewater treatment required e.g. boiler blowdown.

6. Proposal to Discharge via Percolation to Groundwater.

The site proposed to discharge sewage effluent from the site (from toilets, sinks, canteens and changing areas) to a bio-clear treatment system. Full details of the system to be installed are provided in Appendix 2. The maximum number of employees on the site will be 20-25 once operational, but as this is a 24 hour operation, working 3 shifts, the bio-clear has been designed for a population equivalent of 13.

A site characterisation form was submitted with the last planning submission made by Monpower on 5/11/2003. This form concluded that the T-test result was 40, the P-Test result was 8, so the site was suitable for a Bio-clear mechanical aeration system discharging to a soil polishing filter comprising in-situ subsoil and discharge via percolation to groundwater.

The proposed location of the bio-clear effluent system and percolation area is provided in Figure 2.

7. Compliance with Water Pollution Acts and EU Groundwater Directive (80/68).

The site will operate under an EPA licence, therefore all surface water emissions will be regulated by the emission limit values stipulated in the licence. This will be verified by continuous or intermittent sampling of water discharges from the site, as may be stipulated in any licence issued. There are no direct discharges to groundwater at this site and no contamination is foreseen by the activities proposed. Therefore the site will comply in full with the requirements of the Water Pollution Acts and the EU Groundwater Directive (80/68).

Appendix 1. Wastewater Discharges to Public Sewer from Westfield Poultry-Fuelled Power Station

Quarterly Componenet Report
Westfield Biomass Plant
Report for Quarter 4 of 2004

Date	Effluent Flow M3	Weekly Average Ph	Date	Effluent Flow M3	Weekly Average pH	Date	Effluent Flow M3	Weekly Average pH
01-Oct	21.5		01-Nov	22	Not Known	01-Dec	27	
02-Oct	13.1		02-Nov	0		02-Dec	22.5	
03-Oct	19.1		03-Nov	48.4		03-Dec	36.5	
04-Oct	0	Not Known	04-Nov	19.6		04-Dec	20.8	
05-Oct	14.4		05-Nov	27.5		05-Dec	31.9	
06-Oct	28.9		06-Nov	15.1		06-Dec	29.8	7.5
07-Oct	17.3		07-Nov	27.2		07-Dec	21.8	
08-Oct	0		08-Nov	14	Not Known	08-Dec	26.1	
09-Oct	0		09-Nov	20.4		09-Dec	19.9	
10-Oct	0		10-Nov	8.4		10-Dec	22.1	
11-Oct	0	7.78	11-Nov	39.2		11-Dec	31.6	
12-Oct	0		12-Nov	22.9		12-Dec	15.2	
13-Oct	4.8		13-Nov	25		13-Dec	28	7.66
14-Oct	3.1		14-Nov	47.5		14-Dec	19.9	
15-Oct	15.7		15-Nov	30.4	8.52	15-Dec	13.2	
16-Oct	27.1		16-Nov	26.4		16-Dec	20.1	
17-Oct	10.9		17-Nov	12.9		17-Dec	10.3	
18-Oct	17.8	7.78	18-Nov	33.5		18-Dec	20.5	
19-Oct	27.1		19-Nov	37.7		19-Dec	31.5	
20-Oct	24.8		20-Nov	30.3		20-Dec	26.3	8.03
21-Oct	14.4		21-Nov	33.5		21-Dec	19	
22-Oct	15.8		22-Nov	42.9	7.68	22-Dec	27.9	
23-Oct	25.8		23-Nov	35		23-Dec	21.2	
24-Oct	28.7		24-Nov	33.5		24-Dec	12.7	
25-Oct	18	8.03	25-Nov	26.8		25-Dec	9.4	
26-Oct	28.4		26-Nov	38.9		26-Dec	0	
27-Oct	21.2		27-Nov	33.1		27-Dec	9.2	7.97
28-Oct	35.2		28-Nov	46.2		28-Dec	4	
29-Oct	49.6		29-Nov	28.8	7.27	29-Dec	8.1	
30-Oct	34.8		30-Nov	56.4		30-Dec	4.9	
31-Oct	39.4					31-Dec	10.5	
Total	**556.9**		**Total**	**883.5**		**Total**	**601.9**	

Appendix 2. Details of Bioclear Effluent Treatment System for Domestic Wastewater

bio-clear
treatment systems

Patricia Murtagh,
Q.E.D Engineering,
11,Market St,
Monaghan.

Ref: 13867/13870/PJ
09 March 2005

Dear **Patricia,**

Re: **Development at Monopower, Emyvale, Monaghan with Total Population Equivalent of 13**

Further to our recent discussion, I attach the following in respect of the above development:

- Basis of design
- Extent of supply by Bioclear
- Items not supplied by or the responsibility of Bioclear
- Detailed quotation
- Description of the Treatment System proposed

The system is designed, for the current application, to give the following standard of **final effluent** at maximum loading i.e. (maximum population 13). The performance will be better than these standards when operating on reduced loading.

BOD (Biochemical Oxygen Demand)	**<20 mg/litre**
SS (Suspended Solids)	**<30 mg/litre**

Percolation for this unit will be based on a daily flow of 1,500 Litres, and will require 60m^2 of percolation area, or 67 linear metres of trench 900mm wide.

Please let me know if you require any further information.

Yours sincerely

Philip Johnston
Bioclear Treatment Systems
"Systems for a Cleaner World"

Clearwater Environmental Solutions Ltd – Cullen, Mallow, Co Cork – T 029 79255 – F 029 79266 – Reg in ROI No 367026

Bioclear Quotation Number –13867/13870

Basis of Design

- Commercial development with an expected population equivalent of 13.
- A Bioclear CLP15 Package Sewage Treatment Plant designed to achieve a final effluent quality of (20:30 BOD:Suspended Solids) based on the stated population equivalent, has been selected for this duty.
- The final effluent will be disposed of into land drains. The average daily flow is expected to be in the range of $1.5m^3$.
- There will be a control panel handling the electrical operation of the Treatment Plant.

Extent of Supply of Material and Services by Bioclear

- To deliver the following, to a point on or adjacent to the site easily accessible by lorry:

  - A Bioclear CLP15 Package Sewage Treatment Plant.
  - A Control Panel (single **or** 3 phase, **as requested**).
- A Bioclear Technician will attend and advise during the installation of CLP15, if requested.
- We will commission the plant after installation, when requested.
- Bioclear will perform the first routine service after which a service contract will be available as described elsewhere in this document.

Items Not Supplied by, or the Responsibility of Bioclear

- All materials other than those specified above.
- All civil works including, amongst others, an inlet manhole prior to the CLP15 and an inspection chamber at the outlet from the Bioclear CLP15, are the responsibility of the customer. (All connecting pipework is the responsibility of the customer).
- All electrical work including the installation of the control panel. Full wiring diagrams will be supplied. (**Note** that the pumps within the Bioclear CLP15 are pre-wired only requiring connection from internal isolating switches to the control panel. The Primary Settlement Tank does not have any electrical connections).

Required Maintenance

- The system will require periodic de-sludging (this to be carried out by others). This will depend on the exact usage but is expected to be in the region of every three to four months.
- Routine maintenance is recommended three times per year. Our quotation includes the first routine maintenance of the system. Thereafter, Bioclear is able to offer a bespoke maintenance agreement to meet your exact requirements.

This quotation is valid for 180 days from the date of issue

Bioclear Quotation Number –13867/13870

DATE	09 March 2005.
CUSTOMER	**Monopower Ltd**
SITE	**Killycarran, Emyvale, Monaghan.**
PRODUCT DETAILS	**1 No Bioclear CLP15 Package Sewage Treatment System c/w Control Panel.**
TOTAL PRICE (exc VAT)	**€5,180.00**
VAT	This will be charged at the appropriate rate, currently 21%.
PAYMENT TERMS	**45% with order** **50% on delivery** **5% on commissioning (or 30 days after delivery, whichever is the earlier).**
DELIVERY	**4-8 weeks from receipt of order and initial payment.**
OFFLOADING	Approximate weight for the unit is as follows: Bioclear CLP15 697kgs **Offloading to be carried out by others.**
DESIGN	All Bioclear products, including the Bioclear series of Package Sewage Treatment Plants, are designed and built in accordance with the requirements of BS6297:1983 and, where applicable, Irish Agrément certificate 01/0116.
FINAL EFFLUENT	The final effluent that will be required to be disposed of will be approximately 1.5m^3.
CANCELLATION	Bioclear reserves the right to recover their reasonable costs from any deposit monies paid should a contract be cancelled.

This quotation is valid for 180 days from the date of issue

Bioclear CLP15 Package Sewage Treatment System

Overview

The Bioclear CLP is manufactured in GRP (glass re-enforced plastic). The system has the following design loadings:

Daily hydraulic load	1,500litres
Daily organic load	0.75kgs

Structure

The system has four principal sections, namely-

1. **First Primary Settlement:** (first chamber of the CLP15) where separation of solids from the liquid effluent occur.

   The baffled outlet from here lets the liquid effluent flow to the second settlement chamber in the CLP15.

2. **The Media Section:** This is where the bacteria populate the hard, durable plastic media and where the whole of effluent and the bacteria are aerated by diffusing air to the media bed. The inflowing effluent, being of higher density than the aerated liquids, sinks to the bottom before gradually travelling upwards through the media bed before flowing forward into the final settlement. The outlet from this chamber is so designed that in periods of no or low flow, the effluent will continue to be circulated in this chamber.

   Note that the pump action is not required for the flow of the effluent from chamber to chamber. This is achieved through gravitational flow only.

3. **The Final Settlement:** The clarifier, which permits the humus generated by the biomass to settle out and be re-circulated to the Primary Settlement Tank by a small timed submersible pump.

Performance

The system is designed, for the current application, to give the following standard of **final effluent** at maximum loading i.e. (maximum population 15). The performance will be better than these standards when operating on reduced loading.

BOD (Biochemical Oxygen Demand)	**<20 mg/litre**
SS (Suspended Solids)	**<30 mg/litre**

This quotation is valid for 180 days from the date of issue

Maintenance and De-Sludging

The system requires periodic maintenance and de-sludging to ensure that maximum operating efficiency is maintained.

Maintenance Bioclear offer a full maintenance contract. Details are available on request.

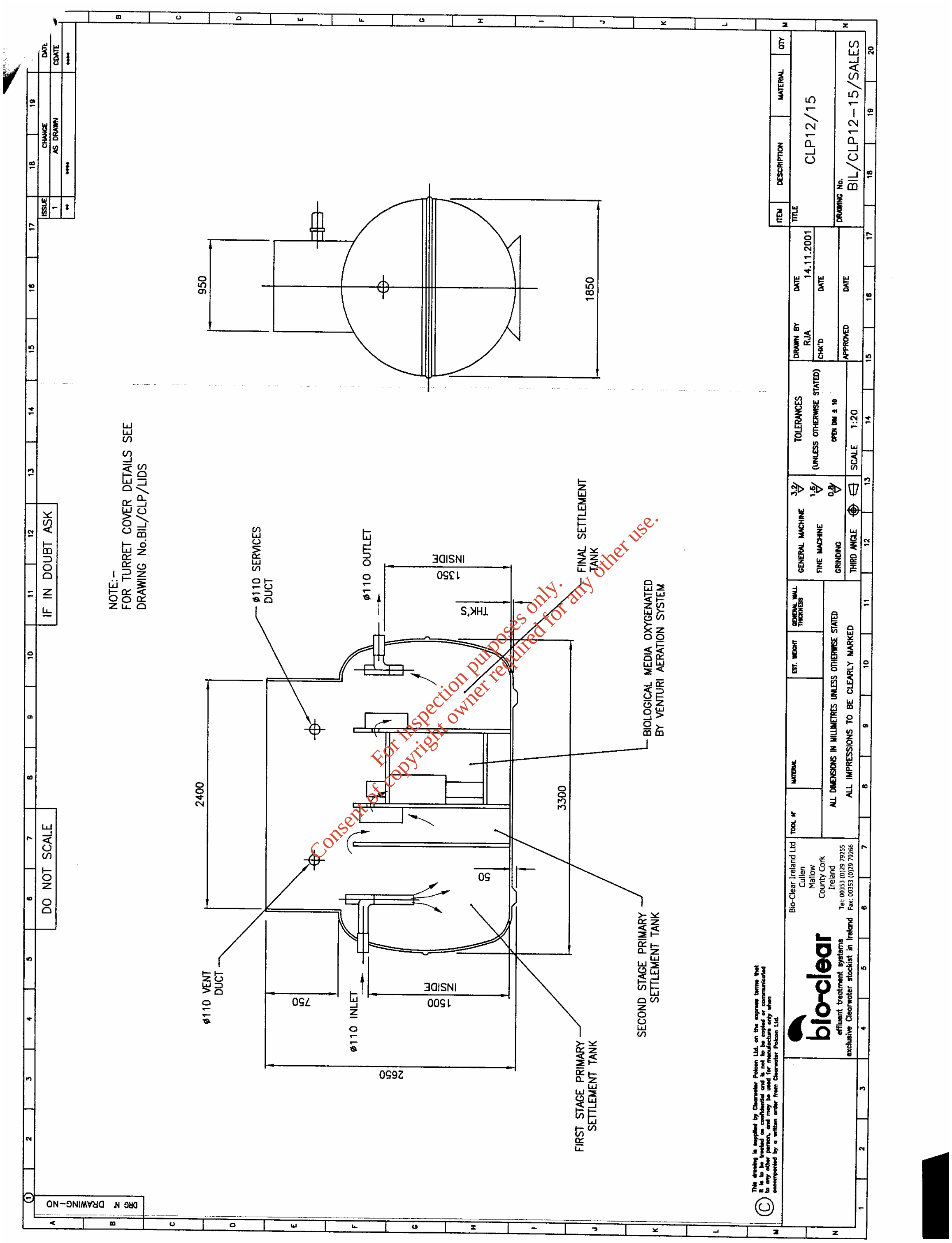
De-Sludging This will depend on the exact usage but is expected to be in the region of every three to four months.

Prohibitions

Do not Exceed the maximum design load of the plant.
Allow surface water to enter the system.
Allow high volume discharges from pools, jacuzzis etc to enter the system.
Allow large quantities of chemicals to enter the system such as:

- water softener regenerate
- disinfectants
- strong acids or alkalis
- oil or grease
- pesticides
- photographic chemicals

This quotation is valid for 180 days from the date of issue


DO NOT SCALE
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exclusive Clearwater stockist in Ireland
Bio-Clear Ireland Ltd
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County Cork
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ALL IMPRESSIONS TO BE CLEARLY MARKED

7

7.0 ODOUR EMISSIONS

7.1 Monaghan County Council's Comments and Requests

"The process of the transportation of spent poultry litter to this facility may well have a significant odour impact. Additional impacts will stem from the unloading of this material and the spent mushroom compost as well as from the long-term storage of these materials and their eventual handling for later combustion purposes. Overall, the preliminary view of this County Council of the issue of odour management and the proposals for the mitigation is that elements are superficial, cursory and require significant substantiation

You are required to undertake an appraisal of the relevant potential odour impact arising from the transportation, unloading, storage and processing of wastes that are proposed to be accepted at the Killycarran facility. Odour dispersion should be modelled and the impacts assessed; a 'worst-case' scenario should be used to portray maximum odour effects. Adequate details of mitigation measures should be provided facility during the site selection process."

7.2 Response: Report prepared by QED Engineering Ltd

Licensing of the proposed facility will be the responsibility of the Regulatory Authority, the Environmental Protection Agency. Consequently it is not within the remit of the Local Authority to seek additional information on this matter. Requests for additional information and clarification on this matter will however will be dealt with in the interest of transparency

In March 2005, QED Engineering Ltd were commissioned to prepare a report addressing the requests as outlined above. The report overleaf, entitled "Odour Impact Modelling Study" is based on a desktop research model and current information regarding odour emissions from the proposed site which was provided by AET, the plant designers, Monopower Ltd the plant developers, SWS Environmental Services and public bodies including; The Environmental Agency UK and the Scottish environment Agency (SEPA). A number of reference documents were also utilised in the study.

Odour Impact Modelling Study

for

Monopower Ltd.
Killycarran
Emyvale
Co. Monaghan

by

Q.E.D. Engineering Ltd
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Monaghan
Ireland
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March 2005

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1. Introduction

Monopower Ltd, Killycarran, Emyvale, Co. Monaghan has made a Planning Application to Monaghan County Council for the construction of a Biomass Combined Heat & Power Plant (Planning Ref. 03/446). On 1/12/04 a request for further information was made by the council regarding odour emissions from the facility as follows;
"You are required to undertake an appraisal of the relevant potential odour impacts arising from the transportation, unloading, storage and processing of the wastes that are proposed to be accepted at the Killycarran facility. Odour dispersion should be modelled and the impacts assessed; a 'worst-cast' scenario should be used to portray maximum odour effects. Adequate details of mitigation measures should be provided.

The following report addresses potential odour emissions from the site. The report has been carried out by Patricia Murtagh and Hugh Doherty of Q.E.D. Engineering Ltd and is based on a site survey and on available information supplied by

1. Monopower Ltd, the developer
2. SWS Environmental Services, Cork, who compiled the Environmental Impact Statement for the development
3. Lars Bronden, Aalbork Energie Technik a/s (AET), Denmark, the designer and supplier of the Biomass CHP plant
4. Environment Agency, UK, two Inspectors of poultry litter fuelled power stations in Eye, and Thetford, England
5. Scottish Environmental Protection Agency (SEPA), one inspector of a poultry litter fuelled power station in Westfield, Scotland

A number of reference documents were also consulted as part of this report.

The following report provides information on the raw materials to be used at the Monopower site and their potential odour impact. Air dispersion modeling of 'worst-case' conditions is then detailed along with all measures to be taken at the site to prevent odour emissions to atmosphere from the operation.

2. Odour Nuisance

The perception of odour at some point downwind of an emission source depends on the type of odour compound and the air concentrations of the odorous gas. The measure used to quantify odour nuisance potential is the odour concentration (odour unit per cubic meter, ou_E/m^3). An odour concentration of $1ou_E/m^3$ is the level at which there is 50% probability that, under laboratory conditions using a panel of qualified observers, an odour may be detected. At levels below $1ou_E/m^3$ the concentration of the gaseous compound causing the odour in air will be less than the detection level and so although the gas is still present in the air, no odour will occur. The intensity of an odour ranges from 1 ou_E/m^3 = odour detection, 2 ou_E/m^3 = slight odour up to 5 ou_E/m^3 where the odour is easily recognisable with higher levels of $10\text{-}20ou_E/m^3$ likely to result in nuisance complaints. The level at which the strength of an odour causes a community nuisance also depends on the locality. For example, in areas where agricultural activities are common a higher tolerance of odours may exist compared to residents in a suburban environment well away from farmland activities. Since the duration of the odour at a particular location also determines whether or not a nuisance situation may occur and averaging time of 15-30 minutes is commonly used as a basis for the minimum time period when a complaint may be reported.

Proposed target and limit values for odour indicative criteria have been published by the Irish EPA for intensive agriculture. In addition the Irish EPA commissioned a report to review odour control in mushroom compost production and the same odour indicative criteria were proposed in this report. The proposed structure of target and limit values for odour concentration is as follows;

Target value: C_{98}, 1-hour, ≤1.5 ou_E/m^3

The target value provides a general level of protection against odour annoyance for the general public, aiming to limit the percentage of people experiencing some form of odour induced annoyance to 10% or less. The target value is to be used as an environmental quality target for all situations.

The target value is achieved when the calculated odour exposure criteria for all locations of odour sensitive receptors is less than an hourly average odour concentration of $1.5ou_E/m^3$ in 98% of all hours in an average meteorological year.

Limit value for new production facilities: C_{98}, 1-hour, ≤3.0 ou_E/m^3

The limit value for new production facilities provides a minimum level of protection against odour annoyance, aiming to limit the percentage of those experiencing some form of odour induced annoyance to 10% or less in the general public, assuming some degree of acceptance in the vicinity of the rural nature of their living environment.

The limit value for new production units shall not be exceeded in the vicinity of production facilities, to ensure a minimum environmental quality.

The limit value for new production facilities is complied with when for all locations of odour sensitive receptors the calculated odour exposure is less than an hourly average odour concentration of $3.0ou_E/m^3$ in 98% of all hours in an average meteorological year.

Limit value for existing production facilities: C_{98}, 1-hour, ≤6.0 ou_E/m^3

The limit value for existing production facilities provides a minimum level of protection against odour annoyance, aiming to limit the percentage of people experiencing some form of odour induced annoyance to 10% or less in the most tolerant selection of the population.

The limit value for existing production facilities shall not be exceeded in the vicinity of existing production facilities, to ensure the minimum environmental quality in an agricultural setting. A phased plan must be made to reduce the odour impact, with time, to the limit value for new production facilities and, eventually, the target value.

The limit value for existing production facilities is complied with when for all locations of odour sensitive receptors the calculated odour exposure is less than an hourly average odour concentration of $6.0ou_E/m^3$ in 98% of all hours in an average meteorological year.

3. Potential Odour Sources on Monopower Site

Three main raw materials are to be utilised on the Monopower Biomass CHP plant. These are Poultry Litter (PL), Spent Mushroom Compost (SMC) and Wood Chips (WC). Product will be transported to the site by lorry, carrying 20 tonnes of product each. Deliveries will be made 8 hours per day. Annual consumption of raw materials is summarised on the following table;

Table 1: Summary of Raw Materials from Monopower Site

Material	**Capacity (tonnes/year)**	**No. of lorry deliveries / year**
Poultry Litter (PL)	155,000	7,750
Spent Mushroom Compost (SMC)	198,000	9,900
Wood Chips (WC)	When available	-
TOTAL	353,000	17,650

SMC will account for 56% of the raw materials, PL 44% and WC when available.

3.1 Spent Mushroom Compost

Mushroom Compost is produced on specially designed sites. The raw ingredients in mushroom compost are poultry manure, straw, gypsum and water. These ingredients are mixed together and allowed to ferment in various stages (termed Phase 1 composting) until the final pasteurised compost is produced (termed Phase 2 composting), which is inoculated with mushroom spawn. This product is sold on to mushroom growers (termed Phase III spawning) and when the mushroom crop is harvested, the compost is now termed “spent mushroom compost” and is a waste product of the mushroom growing industry.

The production of mushroom compost is highly odorous unless adequate controls are in place at the production sites e.g. in-house composting with negative air pressure discharging odorous air to bio-filters. Odour on mushroom compost sites arises from mixing of raw materials, turning of compost (in Phase I) and from leachate storage and movement. Phase II composting and Phase III spawning is not considered significant in terms of their contributions to total odour impact on mushroom compost production sites.

Odour monitoring on mushroom composting sites has been carried out in the past by Q.E.D. Engineering Ltd in the preparation of Waste Licence Applications for six mushroom compost producers. A summary of odour concentration from mushroom compost production is provided in the following table, to illustrate the phases in the process with high/low odour concentration rates.

Table 2. Emission Factors for odour impact assessment of mushroom compost production facilities in Ireland

Source	Result	Units
Percolate effluent sump/runoff liquid, unaerated	500	$ou_E/m^2/s$
Wetted Straw	20	$ou_E/m^2/s$
Poultry Manure Storage	150	$ou_E/m^2/s$
Chicken litter mixed with gypsum	500	$ou_E/m^2/s$
Horse Manure	200	$ou_E/m^2/s$
Horse Manure, aerated	200	$ou_E/m^2/s$
Phase I clamps, loose pile mix	120	ou_E/tonne mixture (FW)/s
Phase I windrows	170	ou_E/tonne P1 (FW)/s
Phase I, indoors	325	ou_E/tonne P1 (FW)/s
Phase I compost product, stored outdoors	17	$ou_E/m^2/s$
Phase II total process	27	ou_E/tonneP2(FW)/s
Phase III, spawning	0.6	ou_E/tonne P2 (FW)

Source: OdourNet UK Ltd, *Review of Odour Control Technologies in Mushroom Compost Production*, Commissioned by the EPA (Ireland), 15th October 2002.

As can be seen in the above table, emissions from the Phase III process are insignificant in comparison with both Phase I and Phase II. SMC arises after the Phase III spawning of mushroom compost, so it is also a non-odours material, which Monopower will utilise as its main raw material in its Biomass CHP plant.

This fact is further illustrated by information contained in the Sustainable Energy Ireland publication "An Assessment of the Renewable Energy Resource Potential of Dry Agricultural Residues in Ireland." Under the "Landspreading of SMC" section of this report, it states;
"Application of SMC to grassland has advantages over the application of animal manure. There is no odour problem and the evidence from farmers who have used it is that animals will graze the land soon after application."

A draft code of practice for field storage and land-spreading of spent mushroom compost is provided in the "Report of Mushroom Taskforce" issued by the Department of Agriculture and Food, May 2004. This report states that "SMC may be stored in the fields where land application will take place i.e. in areas not continuously used for storing SMC, until applied for the next crop but for no longer than 180 days."
Therefore if Department of Agriculture and Food guidelines permit storage of SMC for 180 days in the open, this further confirms that the product is not problematic in terms of odour.

It can therefore be concluded that the transportation, unloading, storage and processing of 198,000 of spent mushroom compost at the Monopower site per annum will not present an odour problem to areas in which the materials will travel through, or within the site or its environs.

3.2 Wood Chips

Wood chips do not present an odour problem, therefore the transportation, unloading, storage and processing of this material at the Monopower site per annum will not present an odour problem to areas in which the materials will travel through, or within the site or its environs.

3.3 Poultry Litter

This is the bedding material from broiler houses. It usually comprises material such as wood shavings, shredded paper or straw, mixed with droppings. It has a high variable moisture content of between 20% and 50% depending on husbandry practices. Poultry litter is an odorous material when moved, agitated, when wet (>45% moisture) and when transported, unloaded and stored incorrectly. The processing of poultry litter at the Monopower site is summarised as follows;

a) Transport of poultry litter from source i.e. poultry houses to the site

Transport will be undertaken on 20 tonne lorries. The lorries will be covered using standard heavy-duty plastic covers or metal sheeting, depending on the lorry design. The main objective of covering the load is to secure it and to prevent odours emissions as the lorries drive to the site. Odour will be generated in this part of the process at the poultry house, when the poultry litter is agitated by transferring from the poultry house to the lorry. The removal of poultry litter at all poultry houses is currently undertaken in this manner, so the level of odour generated here will be no more than currently exists. In addition, transporting poultry litter by lorries on national and secondary roads is currently undertaken in this region. In summary there is no odour expected by transporting PL on covered lorries, as this represents best practice for the transport of this material.

b) Disposal of PL in the fuel unloading building

This building has a large door, which the driver opens, drives in and closes again. The building is maintained under negative pressure. This means that air is extracted from the room at all time by fans, so that when the door is open, air is sucked in from outside the door and not discharged out, with the potential for odour escape. Air extracted from the fuel storage building is fed to the boiler, where SMC, WC and PL will be burnt. The boiler has a constant need for air, so will be supplied in this way. Therefore having a poultry litter unloading building maintained under negative pressure at all times deems that odours from this area will not be permitted to escape to atmosphere.

c) Transfer of poultry litter from fuel unloading building via conveyors to the magnetic separator, silo and boiler

The movement of poultry litter once disposed in the fuel unloading building is a totally enclosed process, therefore no odour is permitted to escape to atmosphere.

Table 2 provided a list of odour emissions from mushroom composting production. Stored poultry litter was shown to have a high specific odour emission rate of $150ou_E/m^2/s$. Covered storage of poultry litter, considered the Best Available Technique (BAT) in poultry rearing installations will prevent this odour dispersion into the atmosphere causing a nuisance to those nearby. On the Monopower site covered storage will be employed for the transport, unloading, storage and processing of the material. In addition, negative air pressure will be in place in the fuel unloading building, where the potential for the most odour exists due to the disposal of up to 550 tonnes of

PL per day. However, here odorous air will at all times be collected within the building and directed to the boiler, thereby preventing escape to atmosphere.

4. Worst-Case Scenario

The county council requested that a 'worst-case' scenario should be used to portray maximum odour effects at this site. From previous discussions, it is evident that the PL is the main source of potential odour at the site. In worst case conditions, the negative pressure system may fail on the fuel unloading building, therefore emissions of poultry odour could emerge from the door of the poultry storage bay when open, so this is assumed to be the odour source. The concentration of odour from poultry litter is assumed to be that provided in Table 3, a figure derived from odour monitoring of a mushroom compost site for a waste licence application.

Table 3: Odour Monitoring Results

Description	Odour Units ou_E/m^3	Odour Emission Rate $ou_E/m^3/s$
Poultry Manure	5218	150

Source: Odour survey of Greenhill Compost Ltd, Carnagh Upper, Kilcogy, Co. Cavan, September 1999, by Silsoe Research Institute.

5. Air Quality Dispersion Modelling

A gaussian air quality dispersion model was used to compute the 98th percentile, 1 hour average of ground level concentration of odour emissions from the site. (The 98th Percentile is the concentration below which 98% of values fall). The model used was the Atmospheric Dispersion Modelling System (ADMS-3) developed by Cambridge Environmental Research Consultants (CERC).

This model provides a significant improvement in air quality dispersion modelling compared to the 2nd generation Industrial Source Complex models (ISC) developed by the U.S. Environmental Protection Agency over the past 15 years. The ADMS-3 takes account of substantially improved understanding of dispersion of an emission plume within the atmospheric boundary layer. The effects of buildings on the dispersion of an emission plume from a nearby source can also be included in the model to take account of the effect of building wake and the resulting downwind concentration pattern.

The long term average concentration was carried out with a single year (1999) of hourly sequential meteorological data obtained from the nearest meteorological station, Clones, Co. Monaghan. The dry bulb temperature, wind speed, wind direction and total cloud cover parameters were utilised in the model. The Wind Rose for the year's data is provided in Figure 1.

The ground level odour concentration was calculated at a distance of 1,000m either side of the site. All buildings on the site were input into the model. Terrain data was not utilised in the model. It is not always necessary to include the effects of surrounding terrain in a modelling calculation. Usually terrain effects are only included if the gradient exceeds 1:10.

6. Results

The 98th percentile 1 hour average ground level concentration of odour around Monopower site is presented graphically in Figure 2.

The site is shown in red, with contour lines, representing the predicted odour concentration shown, to within 1km of the site shown in blue. The highest 98th percentile, 1-hour average odour concentration of 2.54ou_E/m^3 occurs on the site. However, with increasing distance from the site, the odour concentration decreases dramatically and odour concentrations outside the site boundary are extremely low.

The prevailing wind at this site is from a southerly direction, predominantly from the south west. This is reflected in the above results, whereby the highest dispersal of odours is in a north easterly direction.

Comparison of the results with the odour indicative criteria in section 2 shows that the maximum 98th percentile result of 2.54ou_E/m^3 is lower than the limit value for new production facilities: C_{98}, 1-hour, ≤3.0 ou_E/m^3. The target value: C_{98}, 1-hour, ≤1.5 ou_E/m^3 is exceed on the site and just outside the boundary, but this level is not expected to impact on any sensitive locations (houses) nearby.

7. Conclusion

Poultry litter is the only raw material to be utilised on the Monopower site which has the potential to cause odour nuisance. Spent mushroom compost and wood chips are not odorous. Odour from poultry litter will be controlled by

1. Ensuring all lorries that transport waste to the site are covered.
2. Ensuring that the fuel unloading building is kept under negative pressure at all times to collect odorous air and discharge it to the furnace for the combustion process.
3. Ensuring that poultry litter movement from the fuel unloading building to the furnace is totally enclosed at all times.
4. Continuous management and maintenance of the above three systems will ensure that odour nuisance is not problematic on this site.

The air dispersion modelling conducted for ‘worst-case’ conditions showed that the odour will be high on the site if the negative pressure on the fuel unloading building failed, but odour levels decrease dramatically with distance. This event will not occur as negative pressure will be maintained on buildings at all times.

Three plants exist in the UK where poultry litter is used as a fuel for power generation. A summary of the three plants is provided in the table below.

Table 4. Summary of UK Poultry Litter Fuelled Power Stations

Name	Capacity	Fuel	Date of Commission	Permits/ Authorisations	Odour Problems*
Fibrepower Ltd, Eye Power Station, UK	12.7MW	Poultry litter, Horse bedding 12% and Feathers 7% (160kt/yr)	July 1992	IPC Licence No. BY6559 & Planning Permission	Oldest site in UK, so some odour problems exist, but site is being upgraded to meet IPC requirements
Fibrothetford Ltd, Thetford Power Station, UK	38.5 MW	Poultry litter, 420,000 tonnes/year	June 1999	IPC Licence No. BY5595 & Planning Permission	Modern site with similar design criteria to Monopower, no odour complaints issued to site
EPR Scotland Ltd, Westfield Power Station, Scotland	9.8MW	Poultry litter (110 kt/yr)	Jan 2001	IPC Authorisation and Planning Permission	Modern site with similar design criteria to Monopower, no odour complaints issued to site

* Source: Environment Agency Inspector for site.

The oldest site in the UK using poultry litter as a fuel was constructed in 1992 and is not as technologically advanced as modern sites. Most technical issues associated with using poultry litter as a fuel have now been resolved and transport and storage of the fuel is carefully controlled so that odour does not escape into the surrounding environment.

It can therefore be concluded that, based on current knowledge of the site, the operation of the biomass CHP plant by Monopower will not cause an odour nuisance.

Figure 1. Wind Rose, Clones, Co. Monaghan, 1999

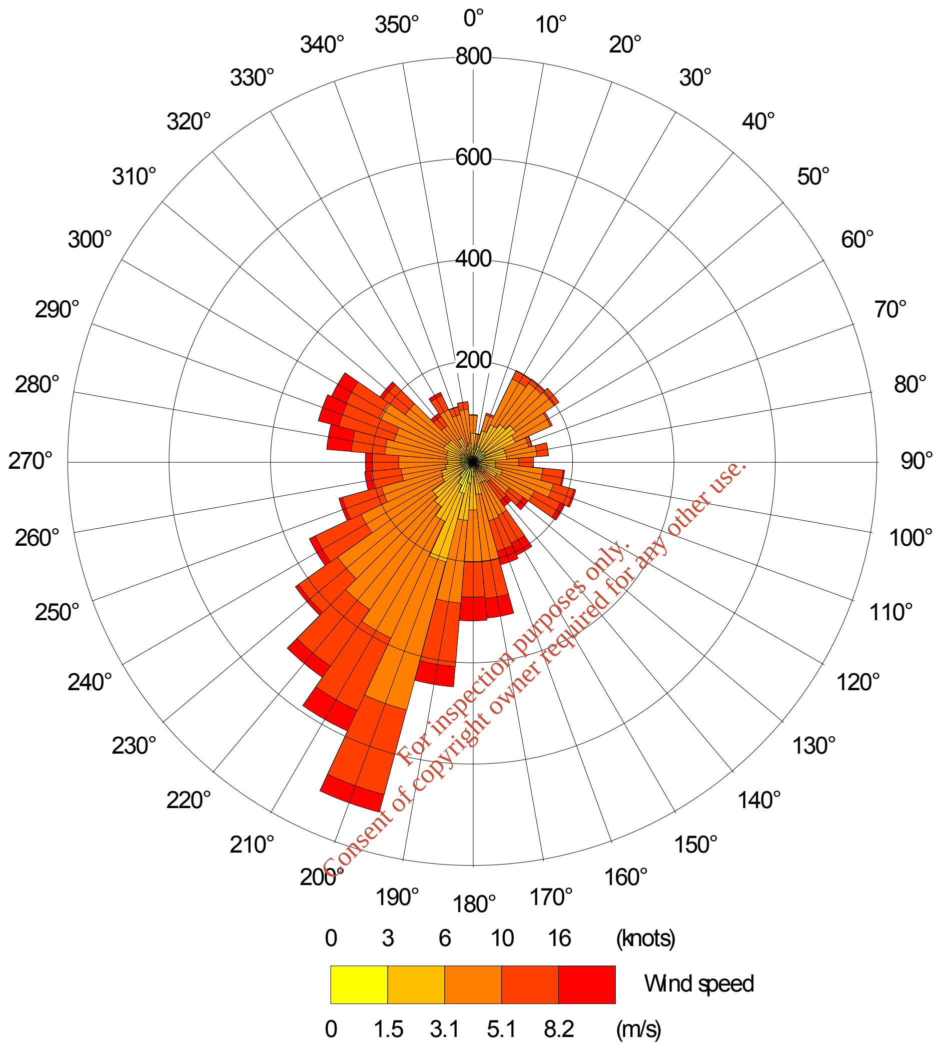
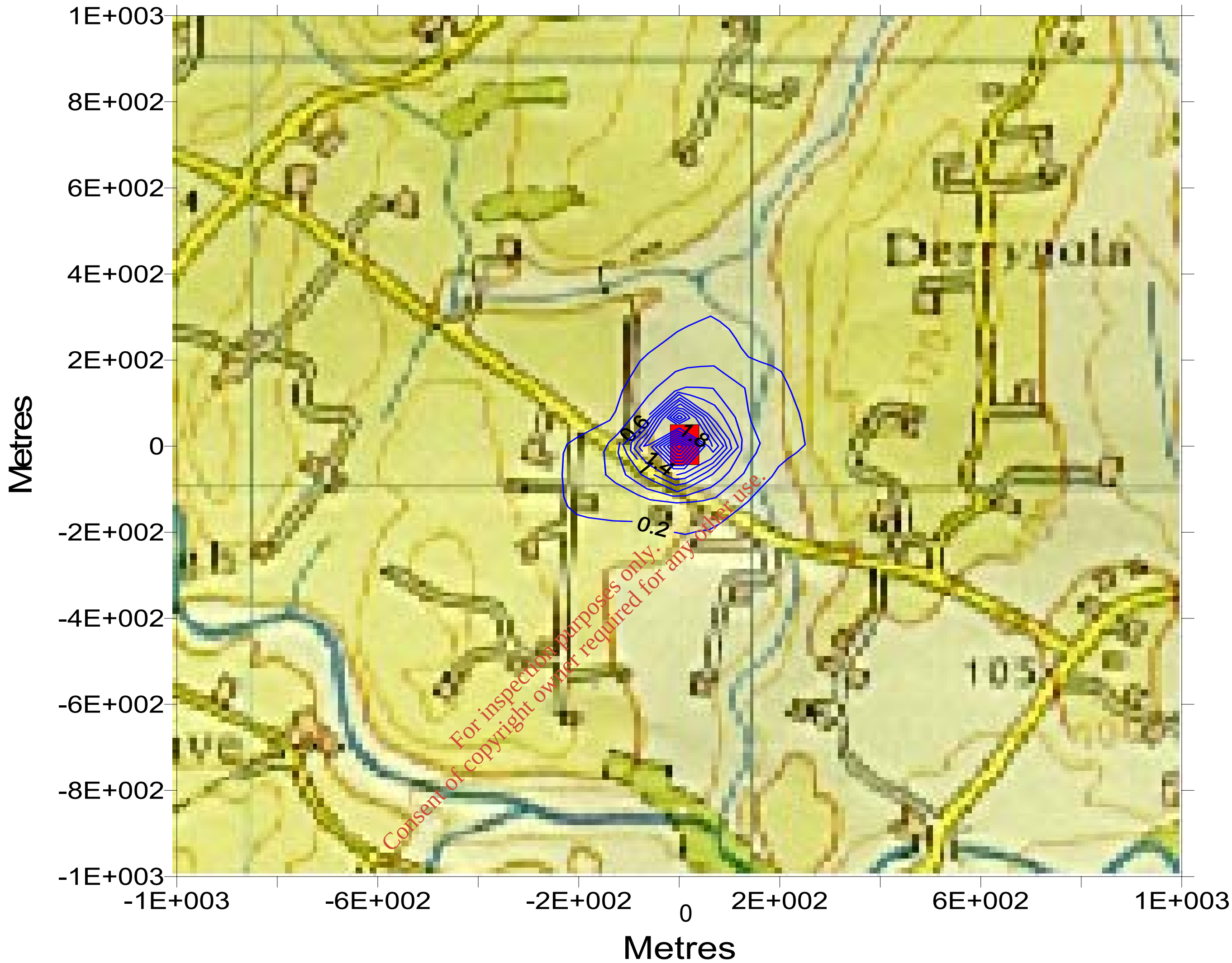


Figure 2. Monopower, 98th Percentile Odour Concentration during Worst-Case Conditions



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