Title	**Comparative odour potential assessment**
Site	**CAMBRIDGE WRC**
Purpose of report	**Evaluate the impact on odour potential of the changes to the treatment process**

Project Personnel and Contacts

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Version Control

VERSION	DATE	BY	AMENDMENT	REASON
1	21-03-14	RL	-	
2	26-03-14	RL	Section 2	Additional information

CONTENTS

1 Executive Summary

The proposed changes to the biological treatment phases of the Cambridge water recycling centre (WRC) are required to enable the process to meet current and future regulatory standards.

An AERMOD (version 8.2.0) odour model of Cambridge WRC has been developed in order to assess the comparative change to the odour potential of the WRC as a result of the planned changes to the treatment process.

Emission rates based on olfactometry analysis undertaken in 2012 and standard emission rates published in the UKWIR Technical Report (Odour Control in Wastewater Treatment) Ref. 01/WW/13/3, were used for the modelling studies.

Certified pre-processed meteorological data (2009-2011) from Cambridge meteorological station, representative of Cambridge WRC was obtained from Atmospheric Dispersion Modelling Ltd for the modelling study. A copy of the certification is given in Appendix 1 of this report.

The atmospheric dispersion model was used to predict the dispersion of odour from the WRC, utilising meteorological data and the emission rates. A model run was completed with each year of meteorological data to determine the odour impacts on the surrounding area from the existing treatment processes and from the proposed changes to these processes.

The results showed that the model run with 2011 meteorological data gave the greater dispersion range and therefore worst case scenario, of the three modelled years.

The results indicated that the predicted odour impact range would noticeably reduce as a result of the planned changes to the WRC process.

It is noted that the planned changes and improved reliability will also reduce the potential for short duration, peak odour emissions.

2 Introduction

Cambridge water recycling centre (WRC) is located at the northern edge of the main conurbation of Cambridge.

The land surrounding the WRC is the subject of various development proposals and dispersion modelling was undertaken in 2012 to evaluate the potential encroachment risk and to advise on the suitability of the effected land for a variety of uses.

The original WRC processes where established in 1895 and have been substantially enhanced since, with the current treatment process formed by three biological process streams, which operate in parallel. However, further changes are required to enable the WRC to meet existing and planned regulatory performance standards. Specifically, there is a requirement to increase the biological treatment capacity of the WRC process and this will be achieved by introducing a new process stream to replace two of the existing, which are operating beyond their asset life and have a diminished reliability.

The purpose of this assessment is to establish how this change will affect the odour potential of the WRC as a whole and whether the encroachment risk identified in 2012 will be significantly altered.

2.1 The Existing Treatment Processes

The treatment process at Cambridge WRC is typical of numerous WRC in the UK involving biological treatment of crude screened and settled sewage, utilising a combination of conventional biofilter and activated sludge processes.

The process includes preliminary treatment (screening, grit detrition and storm separation) and primary treatment (primary settlement tanks), to which all flows are subject. Biological treatment is provided by three parallel streams as follows: Stream A and Stream B use percolating filters followed by secondary settlement in humus tanks, while Stream C is an activated sludge plant (ASP) followed by final settlement tanks. Tertiary treatment by sand filter is common to all flows.

Suspended solids in the form of sludge, is settled out of the sewage in primary settlement tanks (PST) from where it is removed periodically and pumped to the sludge storage tanks prior to thickening and blending with surplus activated sludge (SAS) removed from the aeration lanes of Stream C.

Thickened indigenous sludge is homogenised with screened and thickened imported sludge prior to treatment by hydrolysis followed by anaerobic digestion (AD) in the sludge treatment centre (STC).

The STC produces biogas to power CHP engines and a digested sludge cake for use in agriculture. The centre comprises storage tanks and thickening equipment, which are a common prominent odour source and as such are covered, with headspace air extracted and treated in various odour control plant. The STC operation is subject to an environmental permit, which is regulated by the Environment Agency.

2.2 Planned changes to the biological process

The planned changes to the biological treatment involve decommissioning the percolating filter beds of Stream A and Stream B, along with the associated humus tanks and replacing these processes with a new Stream D, comprising an activated sludge plant and final settlement tanks.

The activated sludge plant of Stream C will remain operational in its current form.

The preliminary treatment, primary settlement, tertiary treatment and STC processes will not be changed.

2.3 Factors effecting odour potential

Odour potential is a function of the odour emission rate, expressed as odour units per second ($OU_E/m^2/sec$) from a source or reactor and the source release area, which is generally the size of the reactor.

The planned changes to the process will see the replacement of 21700m^2 of filter beds in Stream A and 23000m^2 of filter beds in Stream B with 8000m^2 aeration lanes forming the new ASP of Stream D. This is a substantial reduction in reactor size to less than 20% of the existing.

Offensive odour emissions are caused when volatile compounds are released from solution by evaporation or agitation. Turbulent flow conditions will produce more emissions and such conditions are a common characteristic of distribution chambers, at which flows are split and diverted to the difference process streams.

Reducing the number of streams and distribution points (percolating filters entail more flow distribution points than aeration lanes) will in turn reduce the odour release from turbulent inter-stage chambers.

The emission rate is related to the concentration of volatile compounds in the effluent being treated. Anaerobic effluent will contain more volatile compounds and will be more odorous.

Both percolating filters and aeration lanes are aerobic treatment processes and neither is considered to be a prominent odour source if operating correctly and within capacity. Odours emitted from these processes are not generally considered as offensive odours. However, as the rate of aerobic oxidation occurring in the aeration lanes is much higher than in percolating filters these are often significantly less odorous.

Therefore, the planned change from the percolating filters of Streams A and B to an activated sludge plant of Stream D will reduce both the emission rate and source reactor release area.

2.3.1 Residual and Secondary Effects

Although the processes and operation at the STC will remain unchanged there will be a slight difference in the composition of the sludge treated in the preliminary phase of the STC. Prior to hydrolysis and anaerobic digestion, which will be unaffected by the planned changes to the WRC biological treatment, indigenous sludge is thickened and blended with imported sludge.

Although largely covered and with restricted venting to atmosphere, this process unavoidably involves the turbulent and agitated flow conditions, through which odour is released. The planned changes will increase the relative proportion of indigenous SAS to primary sludge and thus the proportion of aerobic sludge to more volatile primary sludge. This is not expected to significantly alter the overall proportion of sludge types treated in the AD plant but the preliminary thickening and blending of indigenous sludge may be marginally less odorous due to the increased proportion of (aerobic) SAS.

Percolating filter beds, such as those forming the biological treatment in Streams A and B operate by forming a biofilm on the surface of the stone media that comprises the filter.

This biomass contains the microbial colonies that are essential to aerobic oxidation of the effluent but are also a dynamic ecosystem, providing a food source for a variety of insect species, particularly flies. In hot dry periods, with relatively low flows, all percolating filters are susceptible to generating an increase in fly concentrations, which can cause nuisance to adjacent property.

By contrast, the biomass in an activated sludge plant is submerged and is therefore largely inaccessible to insects and will not generate the potential for fly nuisance associated with the percolating filters.

3.0 Atmospheric Dispersion Modelling

Atmospheric dispersion modelling is the mathematical simulation of how air pollutants disperse in ambient atmosphere. It uses computer programmes that solve mathematical equations and algorithms to simulate the pollutants dispersion. The dispersion models are used to estimate or to predict the downwind concentration of air pollutants emitted from sources such as wastewater treatment plants, industrial plants and vehicular traffic.

Atmospheric dispersion modelling is a well documented and recognised technique to predict the dispersion of malodours. Modelling was undertaken using the AERMOD computer programme (release 8.2.0). AERMOD is recognised by the Environment Agency, UK Met Office and the US Environmental Protection Agency. AERMOD uses meteorological data, terrain data and emission data as input to predict the dispersion of odours.

3.1 Odour Emissions Data

Emission rates were established for the current processes using olfactometry carried out in 2012 and also standard emission rates detailed in the **Technical Report on Odour Control in Wastewater Treatment (Ref. 01/WW/13/3)** published by UKWIR for those processes that could not be directly measured.

The emission rates for the planned Steam D activated sludge plant were derived using measurements from the existing ASP of Stream C and with reference to UKWIR 01/WW/13/3 as above.

3.2 Meteorological Data

AERMOD requires the input of data that include hourly averaged values for wind speed and direction, cloud cover, ambient temperature, solar radiation, the amount of atmospheric turbulence, the height of mixing layer and other parameters.

Certified pre-processed meteorological data (2009-2011) from the Cambridge meteorological station representative of the WRC was obtained from Atmospheric Dispersion Modelling Ltd for the modelling study. This data is obtained from an independent, accredited source. A copy of the certification is given in Appendix 1 of this report. The certificate of meteorological data includes all the surface characteristics used in the model.

Longitude and latitude of both the study area i.e. Cambridge WRC and of the meteorological station are given in Table 1.

Table 1: Longitude and latitude of Sewage works and Meteorological Station

PARAMETER		VALUE
CAMBRIDGE WRC	Latitude	52.23N
	Longitude	0.152E
Cambridge Met Stn	Latitude	52.2N
	Longitude	0.18E

4.0 Dispersion Modelling Results

The model was run using the three meteorological years (2009-2011) in order to test the variability of the odour concentration results among the different years.

The 98th percentile of hourly mean odour concentrations has been calculated. Contour lines for odour concentrations from 1.5 to 20 OU_E/m^3 have been included for the two scenarios comprising the existing WRC processes and the planned changes.

The model identified that the 2011 meteorological year produced the largest dispersion range of the three modelled years and is therefore considered the worst case scenario for odour impact.

Figure 1 on page 10 shows the odour contour plot for the existing WRC operation and demonstrates the 1.5 OU_E/m^3 odour concentration extending out 1150m from the centre of the site.

Figure 2 on page 11 shows the odour contour plot for the planned WRC process operation and demonstrates the 1.5 OU_E/m^3 odour concentration extending out 897m from the centre of the site.

Table 2 below details the emission plume radius and area by odour concentration for each scenario.

Existing WRC process			Planned WRC process		
Odour concentration OU/m^3	Area (m^2)	Radius (m)	Odour concentration OU/m^3	Area (m^2)	Radius (m)
1.5	2317706	1150	1.5	1539755	897
3	1153522	788	3	801534	633
5	716054	635	5	519854	525
10	401011	510	10	281825	413

5.0 Conclusions

The dispersion modelling output indicates that the planned changes to the treatment process at Cambridge WRC, replacing the percolating filter beds with a new activated sludge plant, will noticeably reduce the overall odour potential of the WRC.

It should be noted that atmospheric dispersion modelling is a steady state analysis technique, establishing the extent of the 98th percentile of average hourly dispersion. It is not currently possible to model short duration, isolated peaks in odour emission without greatly distorting the indicative dispersion range.

However, the secondary effects of the planned changes to biological treatment phases, such as the reduction in flow distribution points and increased proportion of aerobic indigenous sludge, will reduce the sources and circumstances that generally give rise to short duration peak emissions.

Furthermore, as odour emissions from the treatment of waste water are corollary with flow rate and retention, the general improvement in efficiency that modernisation will bring, will also supress biochemical volatility of the effluent and inhibit the odour emission rate.

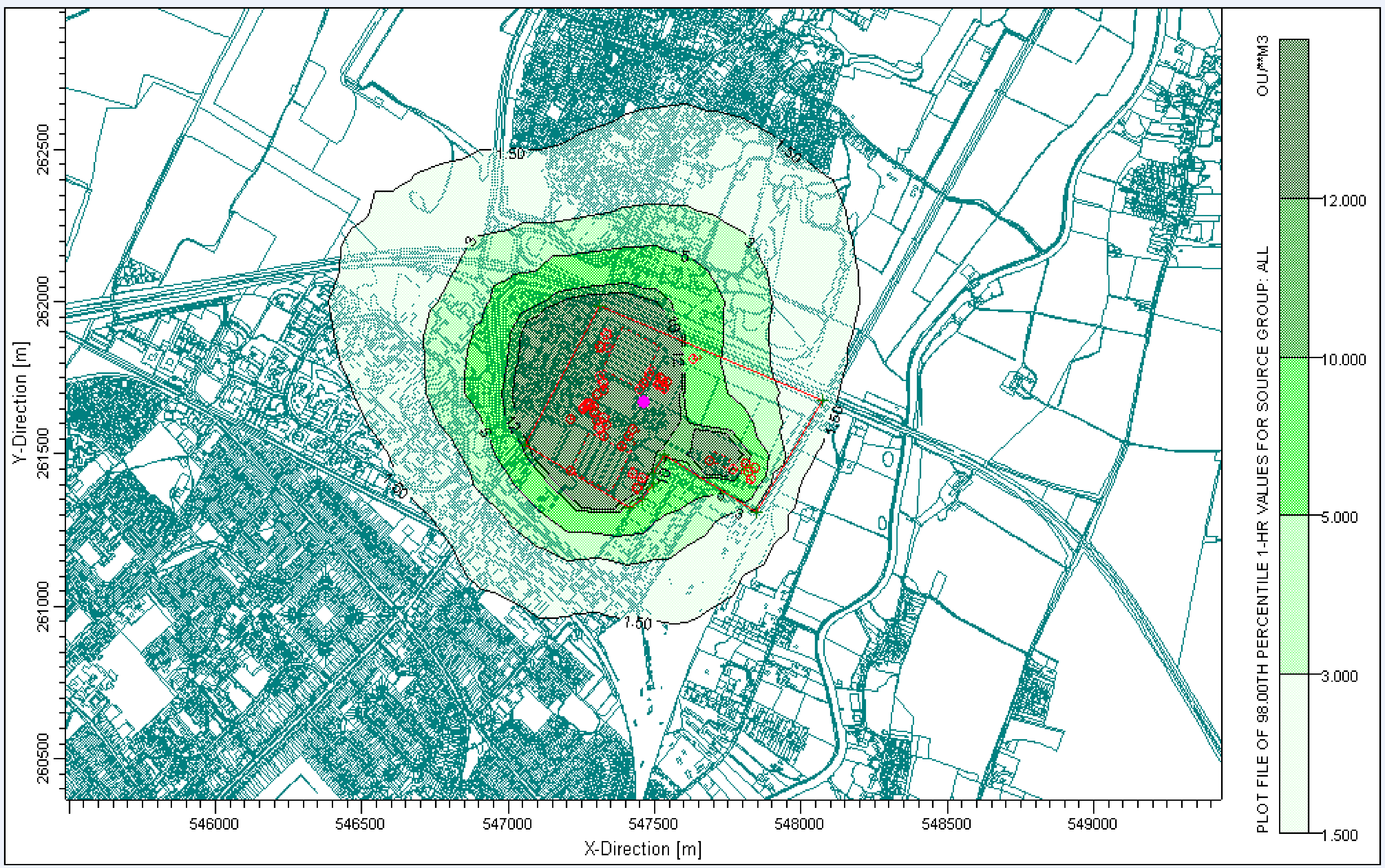

Figure 1: Existing WRC odour potential in 2011 met data

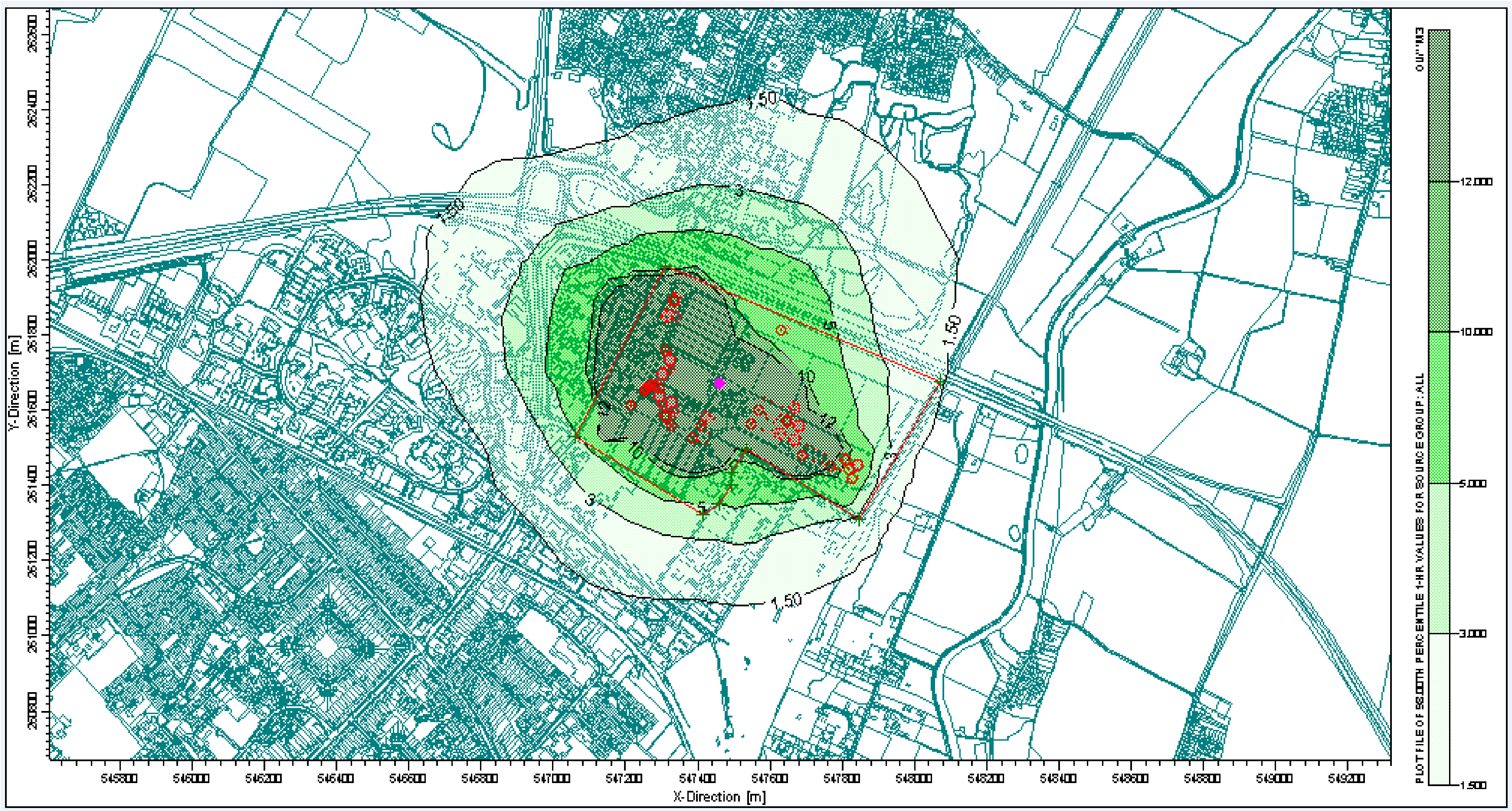

Figure 2 Odour potential of planned WRC in 2011 met data

Appendix 1 – Certificate of Met data

Old Chambers
93-94 West
Street
Farnham
Surrey
GU9 7EB

18 February 2011

Anglian Water
Thorpe Wood House
Thorpe Wood
Peterborough
Cambs
PE3 6WT

Statement of Met Data – Cambridge STW

AERMOD ready met data provide from observations made at Cambridge with missing data from Mildenhall (2009-2011)

Details of Parameters used to process the met data shown below

	Observing Station	Modelling Site
Description	Cambridge	Cambridge STW
Long	52.2 N	52.23 N
Lat	0.18 W	0.154 W
Albedo	0.2	0.24
Bowen	1.0	1.19
Roughness	0.5	0.5

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