anglianwater

CAMBRIDGE SEWAGE TREATMENT WORKS Odour Dispersion Modelling Report

August 2012

Project Personnel and Contacts

ROLE	NAME	LOCATION
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Version Control

VERSION	DATE	BY	AMENDMENT	REASON
1	31/08/2012	OS	-	

CONTENTS

1 Executive Summary

An AERMOD (version 7.4.0) odour model of Cambridge Sewage Treatment Works (STW) has been developed in order to assess the odour impact of the works on the surrounding area.

Modelling investigation was carried out considering all emission sources with UKWIR standard emission rates (Odour Control In wastewater Treatment – report ref. No. 01/WW/13/3) and emission rates used in report produced by Cambridge Environmental Research Consultants Ltd (CERC) dated 17/05/2012. No sources from sludge treatment centre were considered in these studies.

Certified pre-processed meteorological data from Cambridge meteorological station representative of Cambridge STW 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 AERMOD was used to predict the dispersion of odour from the works utilising meteorological data and the odour survey results.

The results show that based on the maximum predicted 98th percentile of hourly average odour concentration (OU/m^3), all areas within the 665m radius from the site centre (X=547460, Y= 261670) could be affected by the 5 odour unit contour.

The impact of the odour nuisance will be greater when the sludge treatment centre at Cambridge STW is operational.

It should be remembered that odour dispersion modelling is the best tool that we have available but is not without uncertainties. The gathering and analysis of the strength of the emissions contain inherent assumptions. The meteorological data is taken from a nearby weather station and processed for the site. Short term emissions (for example the loading of sludge tankers and pumping mains) will not be represented.

2 Introduction

Cambridge STW is located close to the A14 (52.23N, 0.154W). north of Cambridge. The site serves a population equivalent of approximately 200,000 comprising domestic effluents from Cambridge and surrounding villages, in addition there are a number of trade wastes received and treated at the site. Following primary treatment in five circular

settlement tanks, biological treatment is provided within parallel process streams; comprising two biological filter plants and an activated sludge process.
The site also has a sludge treatment centre including comprising dewatering, pasteurisation, digestion and post storage facilities.

2.1 Odour assessment and modelling

Investigative modelling study was carried out to assess odour impacts from Cambridge STW on the surrounding area.

3 Atmospheric Dispersion Modelling

Atmospheric dispersion modelling is the mathematical simulation of how air pollutants disperse in ambient atmosphere. It is solved by computer programmes that solve mathematical equations and algorithms which 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 program (release 7.4.0). 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 Modelling Method

Six steps were followed in the modelling of odour dispersed from Cambridge STW.

1. Certified, pre-processed meteorological data was purchased from an independent source (Atmospheric Dispersion Modelling).
2. Building downwash and terrain data was processed for use in the model.
3. Source emission data was commissioned from independent surveyor (H&M Environmental).
4. The pre-processed Met data, process units, sources emission data were all inputted into the AERMOD model.
5. The AERMOD model was compiled and ran.
6. Results from AERMOD are processed by the graphical post-processor. This gives a graphical representation of the odour dispersal on a map of the affected area. These are presented in Section 4 of this report.

Investigative modelling work followed the method described above and utilised the same independent survey and certified meteorological data.

Graphical representations of the resultant odour dispersal models over a map of Cambridge are presented in Section 4.

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 for the year's 2009 to 2011 representative of the site was obtained from Atmospheric Dispersion Modelling Ltd. The longitude and latitude of both the study area i.e. Cambridge STW and of the met station (Cambridge) are given in Table 1.

Table 1: Key AERMET Parameters

PARAMETER		VALUE
CAMBRIDGE STW	Longitude	52.23N
	Latitude	0.152W
Cambridge Met. Station	Longitude	52.20
	Latitude	0.18W

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.

Wind roses from Cambridge Met station for years 2009-2011 are presented in figures 1 to 3.

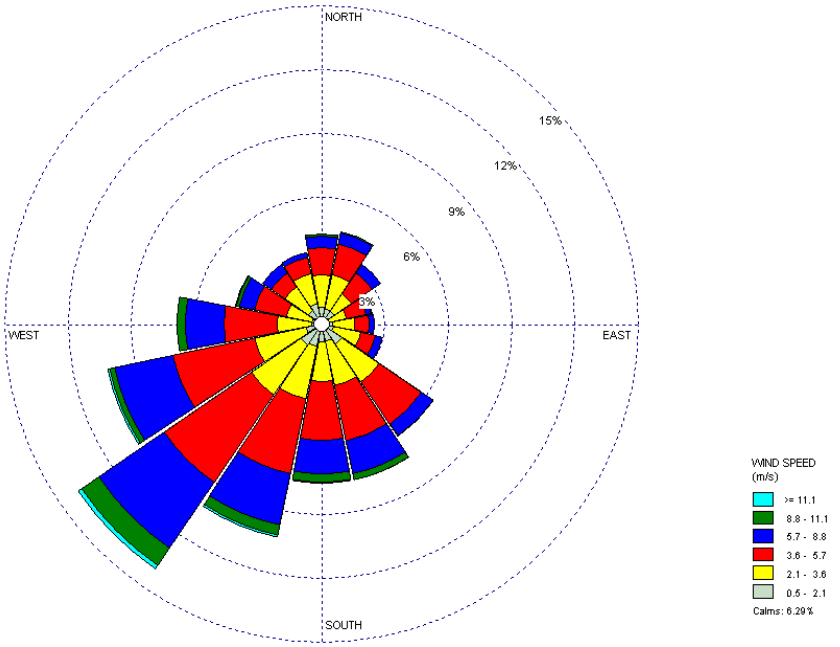

Figure 1: Wind rose from Cambridge Met Station for year 2009

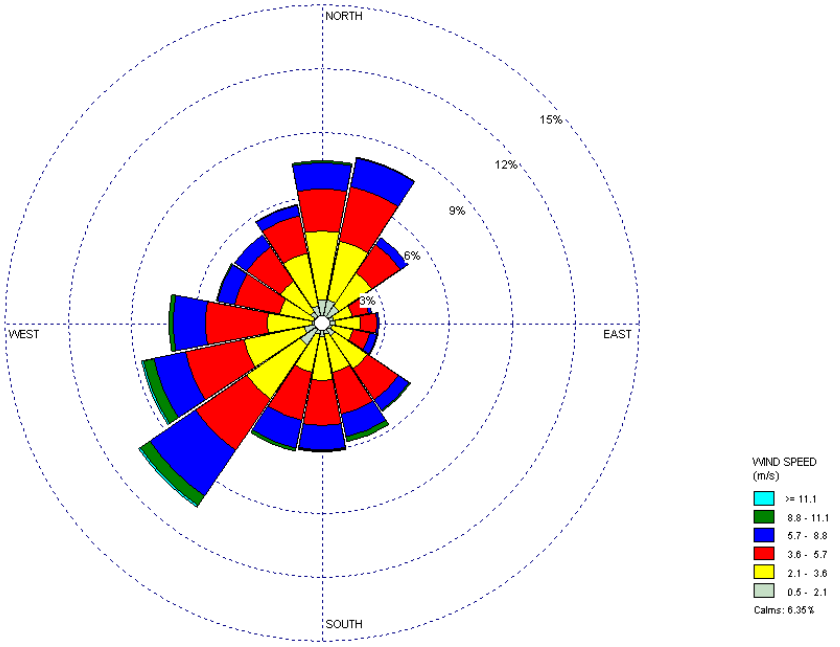

Figure 2: Wind rose from Cambridge Met Station for year 2010

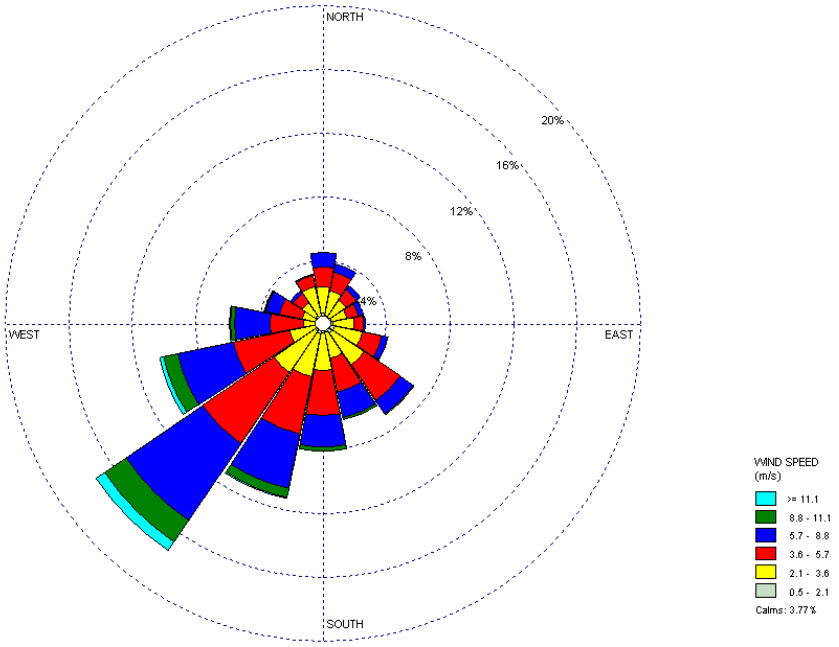

Figure 3: Wind rose from Cambridge Met Station for year 2011

The wind roses indicate the frequency of occurrence of wind from different directions for the number of wind speed ranges.

3.3 AERMOD

This section details the control options; source inputs and receptor networks used in the models.

Gaussian plume air dispersion model: Aermod version 7.4.0. was used for the modelling work. The Aermod atmospheric dispersion modelling system is a steady- state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concept, including treatment of both surface and elevated sources, and both simple and complex terrain.

3.3.1 Control Options

The key parameters for the control options of the model are detailed in Table 2 below.

Table 2: Control Option Parameters

SETTING	VALUE
Dispersion Options	Regulatory Default
Dispersion Coefficient	Rural

Pollutant Averaging time	1 hr
Flagpole Receptors	None

3.3.2 Sources and Emissions Input

The locations of the treatment streams and all the odour sources are shown in figures 4.0 to 4.6.

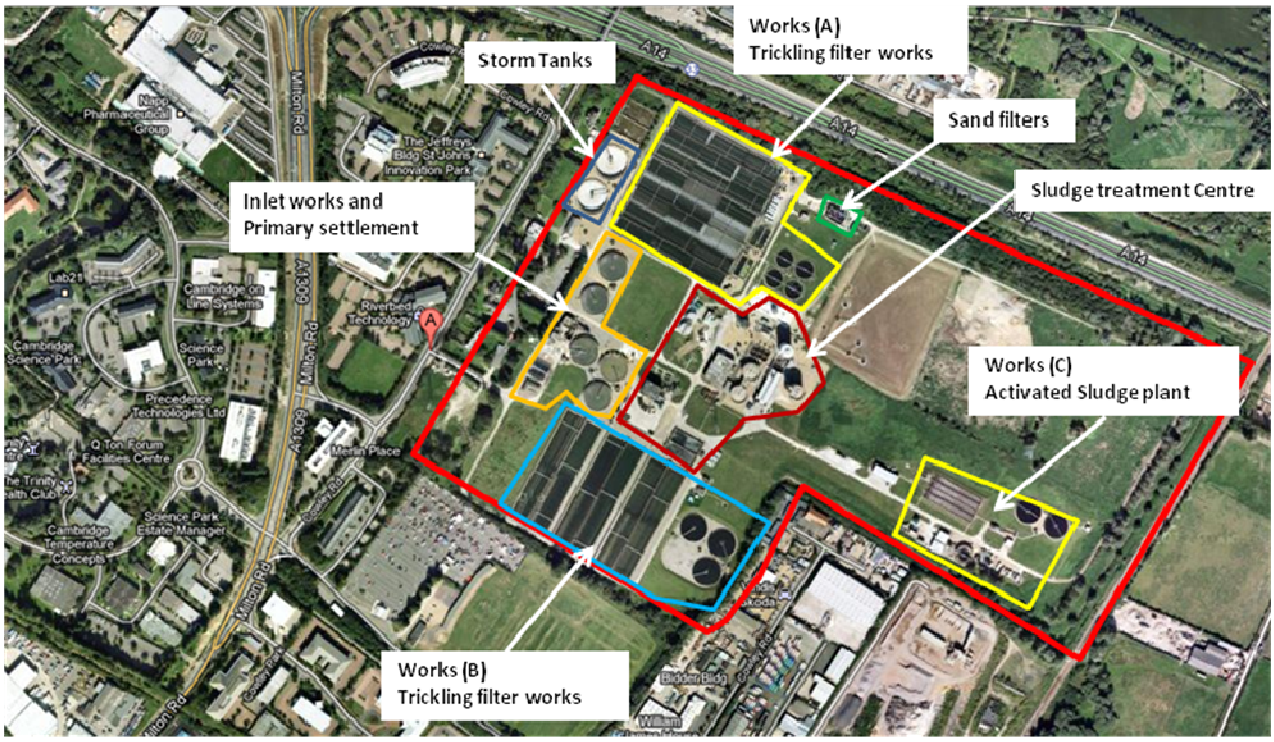

Figure 4.0: Cambridge STW – Location of treatment streams

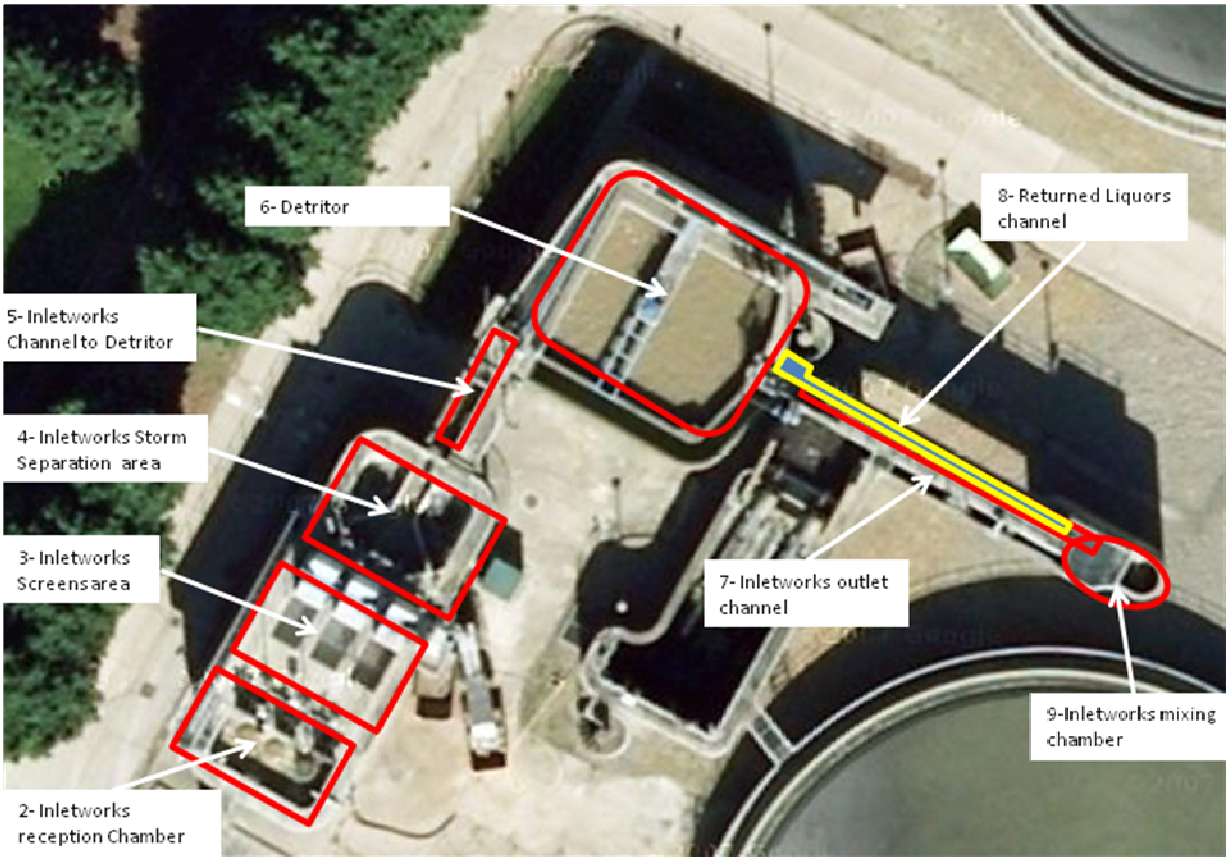

Figure 4.1: Cambridge STW – Inletworks area odour sources

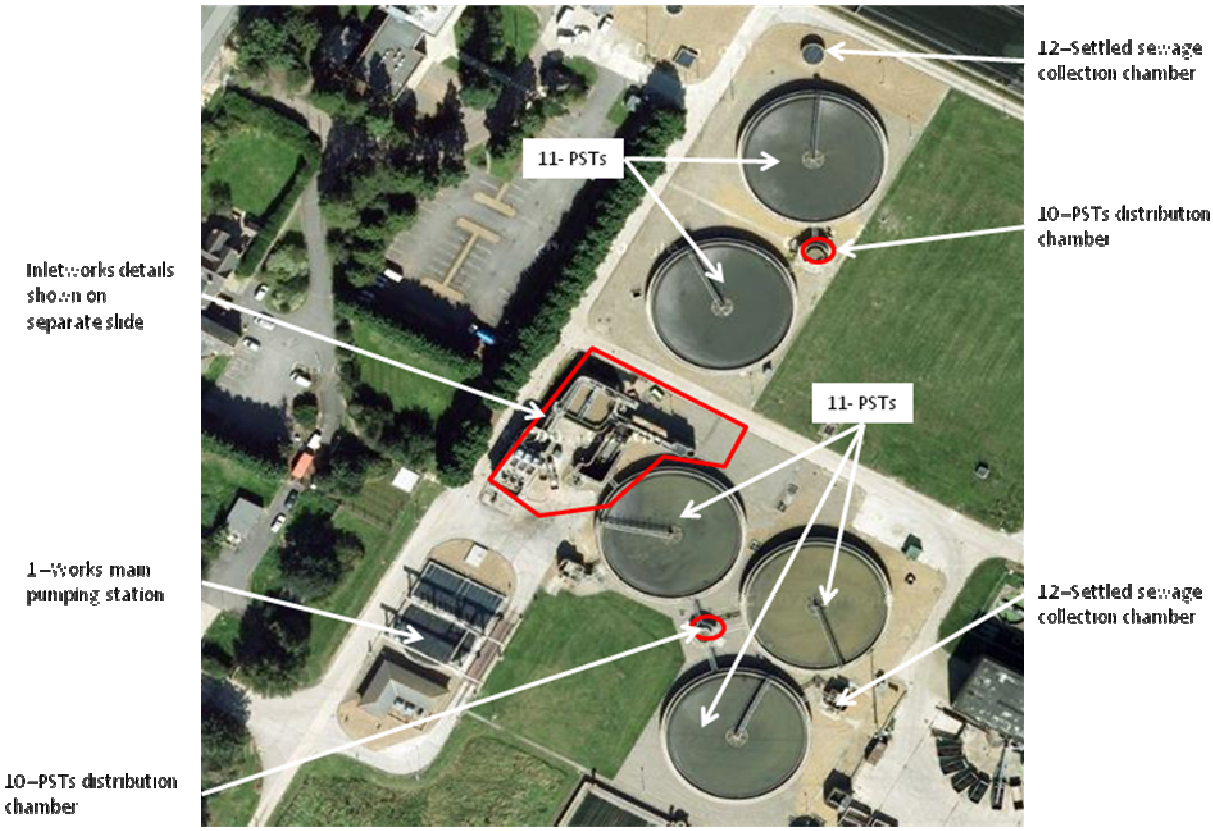

Figure 4.2: Cambridge STW – Inletworks area and primary settlement tanks odour sources

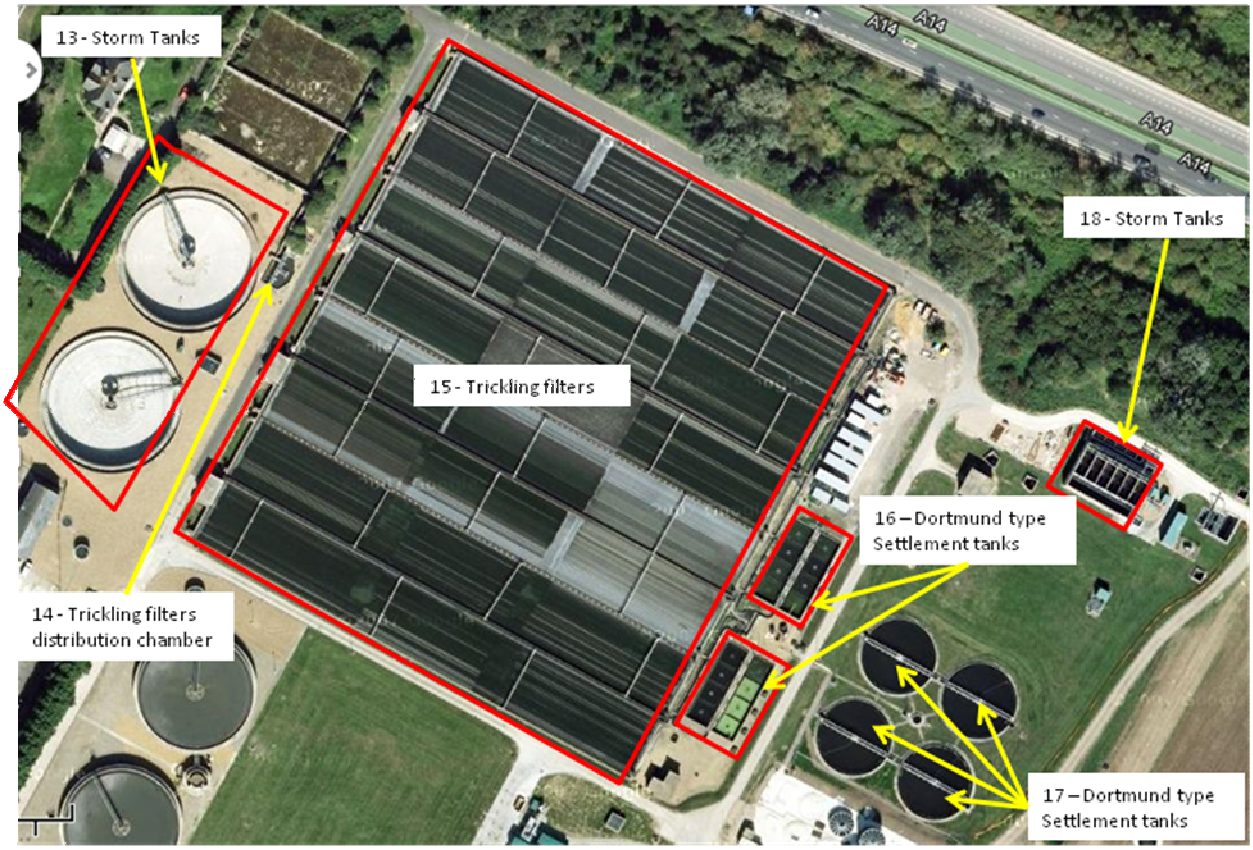

Figure 4.3: Cambridge STW – Works (A) Trickling filter works, storm tanks & sand filters odour sources

Figure 4.4: Cambridge STW – Works (B) Trickling filter works odour sources

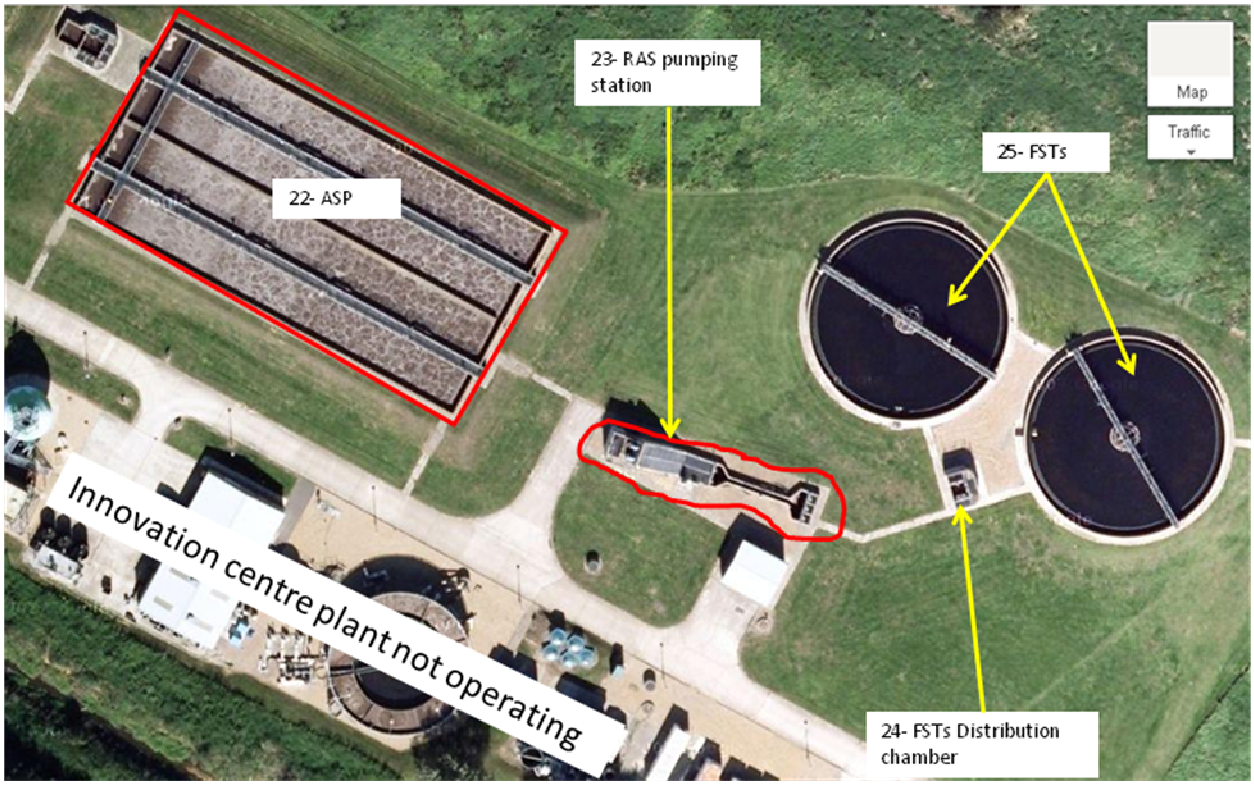

Figure 4.5: Cambridge STW – Works (C) Activated sludge plant &Innovation centre plant not operational

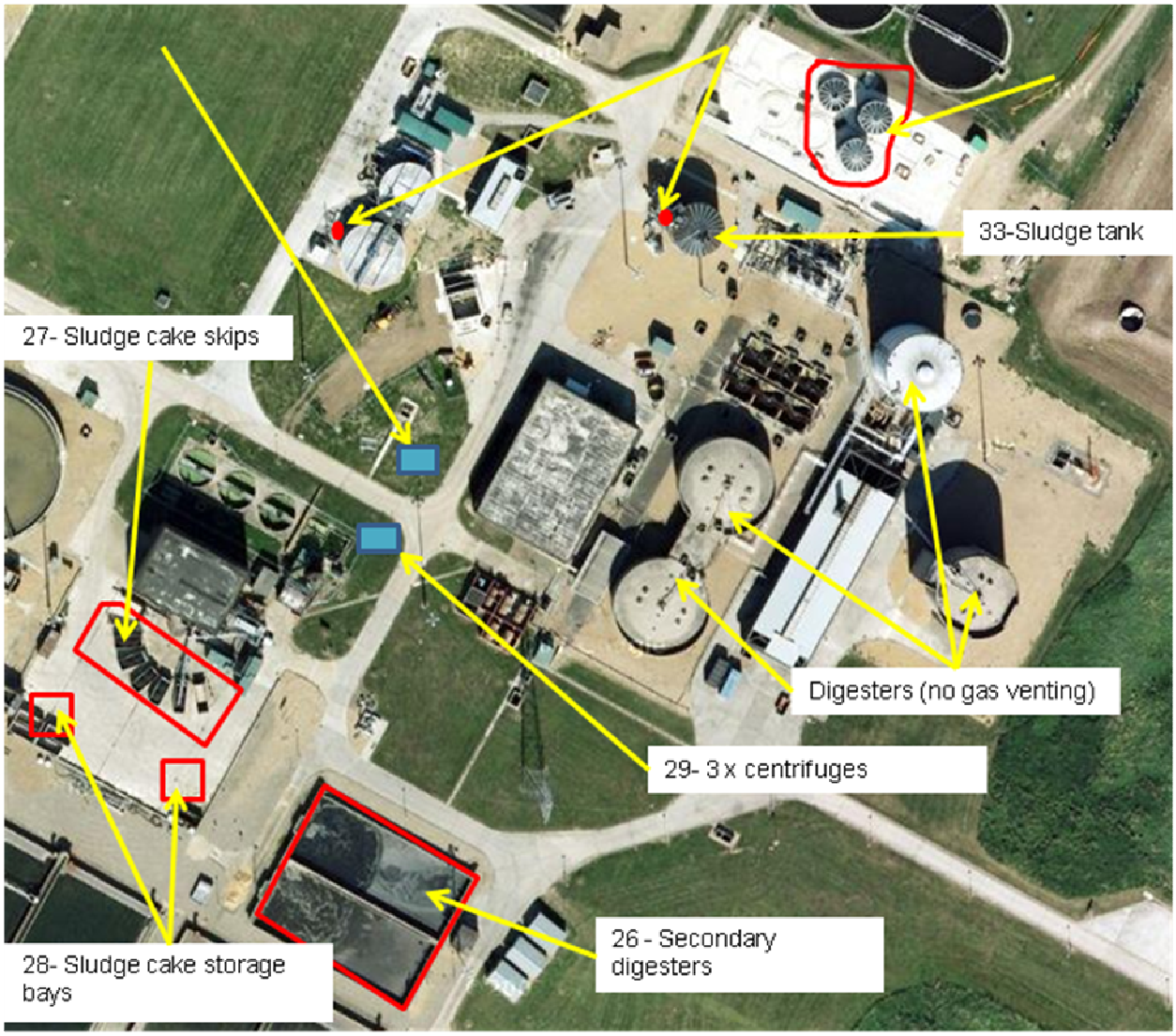

Figure 4.6: Cambridge STW – Sludge treatment centre

The details of all the odour sources and the corresponding emission rates use for modelling are shown in table 3.

Table 3: Cambridge STW odour sources Surface areas, release heights and emission rates

					emissions used by CERC		Ukwir emissions	
					ou/m2/sec	ou	ou/m2/sec	ou
number	source	dimension	Area (m2)	height (m)	emission rate	Total emission	emission rate	Total emission
1	works main sewage pumping station	7m radius semi-circular area	80	0.5	36.4	2912.0	50.0	4000.0
2	Inletworks reception chamber	rectangular 5m x 4m	20	6	36.4	728.0	5.0	100.0
3	Inletworks screen area	rectangular 5m x 4m	20	6	36.4	728.0	5.0	100.0
4	Inletworks storm seperation area	rectangular 5m x 4m	20	6	36.4	728.0	5.0	100.0
5	Inletworks channels to detritor	rectangular 5m x 1m	5	6	6.0	30.0	50.0	250.0
6	Detritor	rectangular 8m x 8m	64	6	6.0	384.0	6.0	384.0
7	Inletworks outlet channel	rectangular 10m x 1m	10	6	6.0	60.0	6.0	60.0
8	Returned Liquors channel	rectangular (9m x 0.5m) + (3m x 3m)	13.5	7	6.0	81.0	6.0	81.0
9	Inletworks mixing channel	rectangular 4m x 1.5m	6.8	6	6.0	40.8	6.0	40.8
10	PSTs distribution chamber	2 x 4.8m dia circular chambers	39.2	4	250.0	9800.0	250.0	9800.0
11	PSTs	5 x 16 Dia PSTs	4021	4	2.3	9248.3	2.0	8042.0
12	Settled sewage collection chamber	2 x 5m dia circular chambers	39.2	3	0.0	0.0	250.0	9800.0
13	Storm tanks	2 x 35m dia circular tanks	1924.2	1.5	2.0	3848.4	2.0	3848.4
14	A works trickling filter distribution chamber	polygon source	39.4	2.5	0.0	0.0	250.0	9850.0
15	A works trickling filters	155x140	21700	2	2.3	49910.0	1.5	32550.0
16	A works dortmund humus tanks	2 x (24x14)	672	0	2.3	1545.6	1.0	672.0
17	A works circular humus tanks	4 x 21m dia	1385.6	0	2.3	3186.9	1.0	1385.6
18	Sand filters	20x17	340	5	0.0	0.0	0.1	34.0
19	B works trickling filters distribution chamber	circular 6m dia	28.3	3	0.0	0.0	250.0	7075.0
20	B works trickling filters	3 x (140x50)	21000	2	2.3	48300.0	1.5	31500.0
21	B works circular humus tanks	3 x 16m dia	2412.6	0	2.3	5549.0	1.0	2412.6
22	C works ASP	60x30	1800	2	2.3	4140.0	4.0	7200.0
23	C works RAS pumping station	polygon source	96.2	2.5	2.3	221.3	4.0	384.8
24	C works FSTs distribution chamber	6x3	18	1.5	0.0	0.0	4.0	72.0
25	C works FSTS	3 x 30m Dia FSTs	2120.7	1	2.3	4877.6	1.0	2120.7
26	secondary digesters	37x32	1184	2	0.0	0.0	4.0	4736.0
27	sludge storage skips	9 x (5x2.5)	112.5	2	0.0	0.0	40.0	4500.0
28	sludge cake bays	2 x (5x5) = 50 m2	50	1.5	0.0	0.0	40.0	2000.0
29	centriuges	3 centrifuges each 3x1m	9	3	0.0	0.0	0.0	0.0
30	drum thickeners	3 drum thickeners each 5x1m	15	3	0.0	0.0	0.0	0.0
31	sludge lagoon	130x100m	13000	0	0.0	0.0	0.0	0.0
32	picket fence thickeners (covered)	3 x 7m dia	115.5	6	0.0	0.0	0.0	0.0
33	sludge tank (covered)	12m dia	113	6	0.0	0.0	0.0	0.0

The sludge treatment centre at the time of site visit was not operating and therefore was not included in the modelling studies.

3.3.3 Receptor Network

A uniform Cartesian grid of 2500m x 2500m with spacing of 100m as recommended by Environment Agency (EA) was placed over the map of the area as receptors network providing 676 receptors in and around the sewage works.

The odour contour maps generate by centring the map on a reference point located approximately at the site centre (X=547460, Y= 261670) with a zoom radius of 1300m.

4 Dispersion Modelling Results

Modelling investigation was carried out considering all emission sources with UKWIR standard emission rates (Odour Control In wastewater Treatment – report ref. No.

01/WW/13/3) and emission rates used in report produced by Cambridge Environmental Research consultants Ltd (CERC) dated 17/05/2012.

No sources from sludge treatment centre were considered in these studies.

The 98th percentile of hourly mean odour concentrations has been calculated. Contour lines for four odour concentrations (1.5, 3, 5, and 10) have been included for all the scenarios.

4.1 Modelling Scenarios for existing works

The details of the modelling scenarios examined are shown in table 4. The model was run using the three metrological years in order to test the variability of odour concentration results among the different years. It was found that the spread of the entire 98 percentile hourly contour plots were very similar. Therefore, the 2011 metrological data was used for the modelling.

Table 4: Modelling Scenarios

Scenario	Figure	Met data	Emission data used	Description
1	4	2011	UKWIR	All odour sources with no sludge centre reactors
2	5	2008	CERC report 17/05/2012	All odour sources with no sludge centre reactors

The odour contour maps for the above scenarios are shown in figures 5 and 6.

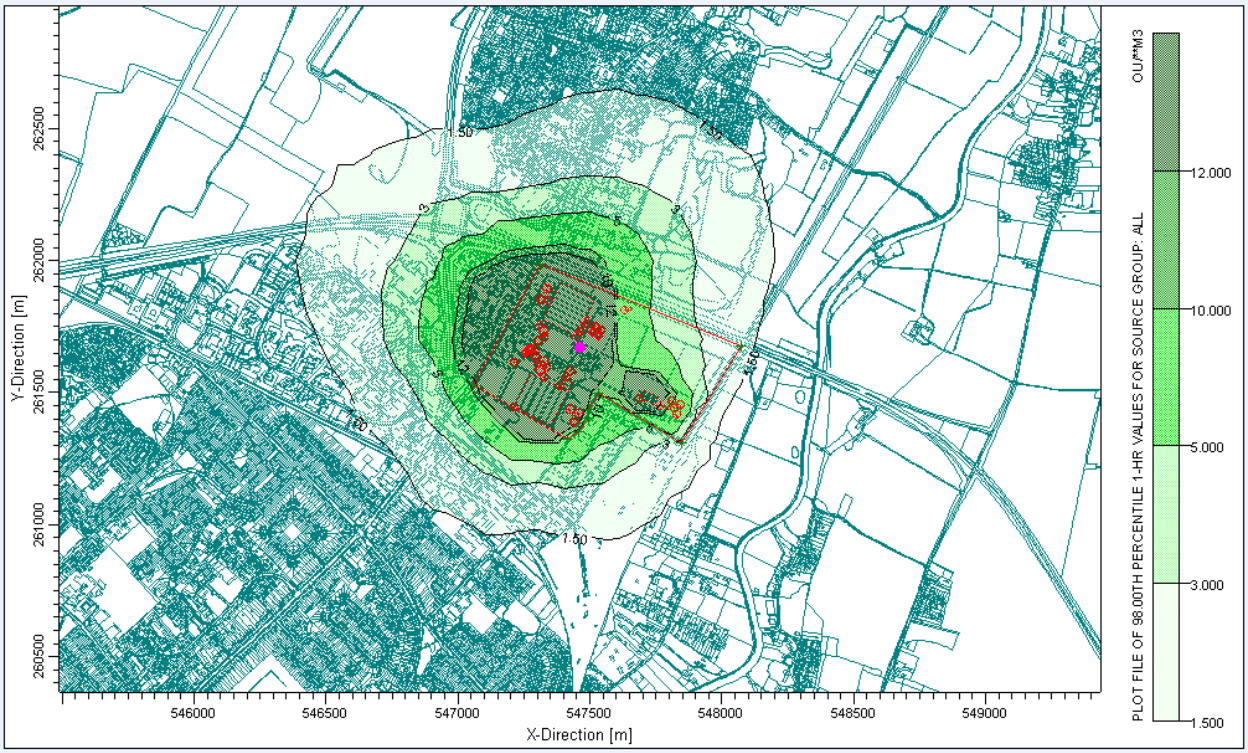

Figure 5: Cambridge STW 98%ile hourly means odour contour map (year 2011). Based on UKWIR typical emission rates

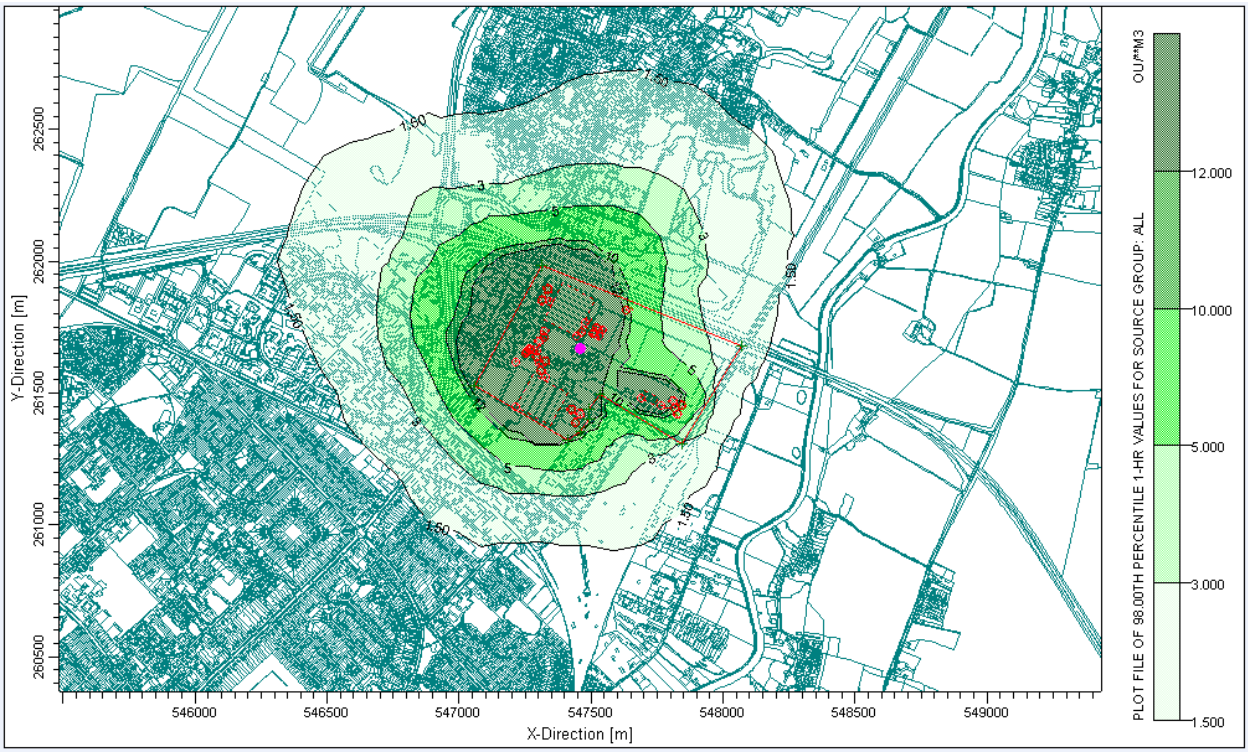

Figure 6: Cambridge STW 98%ile hourly means odour contour map (year 2011) Based on emission rates from CERC report 17/05/2012

The results show that based on the maximum predicted 98th percentile of hourly average odour concentration (OU/m^3), all areas within the 665m radius from the site centre (X=547460, Y= 261670) could be affected by the 5 odour unit contour.

In odour impact criteria recommended in the Charted Institution of Water and Environmental Management (CIWEM), complaints may occur and depending on the sensitivity of the locality and nature of the odour, the 5 OU_E/m^3 level may constitute a nuisance.

The impact of the odour nuisance will be greater when the sludge treatment centre at Cambridge STW is operational.

Appendix 1 – Certificate of Met data

Atmospheric Dispersion Modelling

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

Registered Office

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