Riverside STC Bioaerosol Risk Assessment

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Thames Water Utilities Ltd
EPR/GB3739DY/V003

IED STC Permitting
4 December 2023

Riverside STC Bioaerosol Risk Assessment

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1. Introduction

The purpose of this Bioaerosols risk assessment is to provide supplementary information to support the permit variation application for a bespoke installation permit for the Riverside Sludge Treatment Centre (STC), EPR/GB3739DY/V003.

1.1 Site description

The STC is located within the Riverside Sewage Treatment Works (STW), west of Rainham, north of the River Thames in the London Borough of Havering between the A13 road and a railway line. The site is located within an industrial area, bounded by a railway line to the north and the A13 to the south. To the west and east are industrial/commercial estates including a number of large-scale warehouses, logistic operations, and waste operations (including commercial physical treatment and transfer station sites). There are also residential properties close to the site entrance. Rainham Creek flows from the north to the south, into the River Ingrebourne, approximately 40m away from the STW boundary and a drainage ditch can be found to the north and west of the site.

The site location plan is shown in Appendix A and the address of the installation is:

Riverside Sludge Treatment Centre

Riverside Sewage Treatment Works

Creekside

Rainham

Essex

RM13 8QS

The STW site and STC is within a Flood Zone 3 area that benefits from flood defences. This means that the STC would have a high probability of flooding without the local flood defences. These protect the area against a river flood with a 1% chance of happening each year, or a flood from the sea with a 0.5% chance of happening each year. Riverside STW is located within an Air Quality Management Area (AQMA) which has been declared for Nitrogen dioxide NO2 - Annual Mean and Particulate Matter PM10 - 24-Hour Mean AQMA by the London Borough of Havering. This is the Havering AQMA an area encompassing the entire London Borough of Havering.

Riverside STW is in close proximity to a number of designated habitats. The closest are the Inner Thames Marshes and Ingrebourne Marshes (SSSIs) located 350 m South-East and 470 m North-East, respectively. Rainham Marshes, Ingrebourne Valley and Beam Valley are LNRs located 435 m South-East, 830 m North-East and 1350 m North-West of the site, respectively. There is an MPA designated site within 10 km of the site. This is the Swanscombe Marine Conservation Zone located approximately 9.2 km South East of the site. There are no Ramsar, Special Areas of Conservation (SAC) or Special Protection Area (SPA) designated sites within 10 km of Riverside STW, and no NNRs located within 2 km. There are 15 non-designated, local wildlife sites (LWS) within 2 km of the site and no areas of Ancient Woodland within 2 km of the site.

1.2 Site Activities

Riverside STC, is located at the Riverside STW, operated by Thames Water Utilities Ltd (Thames Water). The STC undertakes the biological treatment of sludge includes treatment of the indigenous sewage sludge and Surplus Activated Sludge (SAS) from the onsite aerobic treatment process and treatment of imported sewage sludges arriving from the Beckon sludge main to a dedicated sludge import point. The indigenous sewage sludges are generated from the aerobic treatment of waste waters from the sewer network arriving into the site at the works inlet.

There are a number of directly associated activities, including the operation of a biogas fuelled CHP engines for the generation of electricity and heat at the site.

The site includes the following Directly Associated Activities (DAA):

- Imports of waste, including sludge from other sewage treatment works.
- Blending of indigenous sludges and imported wastes/waste sludge prior to treatment.
- Pre-treatment of sewage sludge by Thermal Hydrolysis Process.
- Storage of digestate prior to dewatering.
- Dewatering of digested sewage sludge.
- Transfer of dewatering liquors via site drainage back to the works inlet of the sewage treatment works.
- Transfer of surface water runoff back to the works inlet of the sewage treatment works.
- Storage of dewatered digested sludge cake prior to offsite recovery.
- Storage of biogas.
- Transfer of biogas condensate via site drainage back to the works inlet of the sewage treatment works.
- Combustion of biogas in Medium Combustion Plant Directive (MCPD) and Specified Generator (SG) compliant biogas CHP engines and biogas or natural gas in MCPD boilers units.
- Emergency flare.
- Storage and handling of wastes, including waste oils.
- Storage of raw materials.
- Imported sludge rewetting

The STC can treat up to 3,500,000m^3 of sludge per year (equating to approximately 3,500,000 tonnes). The STC has a total maximum treatment input of 1,717m^3 per day (equating to approximately 1,717 tonnes per day).

Some of this throughput is sludge, which is subject to dewatering and storage as treated sludge cake at the site prior to removal from site for application to land. Within the area covering the permitted activities, there are two Odour Control Units (OCUs) linked to specific tanks or processes which produce potentially odorous air. These units treat the air through a variety of means, including use of biofilters.

The anaerobic digestion process gives rise to biogas, a mixture of biomethane and carbon dioxide, in a mixture with trace components. This biogas is combusted through CHP engines at the site with excess biogas being subject to flaring. The biogas handling system is equipped with pressure relief valves (PRVs) which activate as a safety precaution when there is excess biogas over what the CHP engines and flare can handle.

1.3 Regulatory requirements

The sludge treatment activity has not previously required an environmental permit as the digested sewage sludge from the site is normally sent for recovery to land. However, a permit application has been submitted based on the Environment Agency's recent conclusion that sewage sludge is a waste and therefore the treatment of sewage sludge by anaerobic digestion for recovery is a permittable activity under Schedule 1 of the EPR 2016, specifically Chapter 5, Section 5.4, Part A 1(b)(i).

For new permits, if the site is within 250m of sensitive receptors then there is a requirement to monitor bioaerosols in accordance with the EA technical guidance note[1] '*M9: environmental monitoring of bioaerosols at regulated facilities*'. M9 describes bioaerosols and the risks that they pose, as well as identifying potential sources within biological treatment facilities.

The Riverside Sludge Treatment Centre installation is within 250m of sensitive receptors, as defined by M9. These are detailed in Section 2.5 of this report.

1.4 Bioaerosols

Bioaerosols are found naturally within the environment. They consist of airborne particles that contain living organisms, such as bacteria, fungi and viruses or parts of living organisms, such as plant pollen, spores and endotoxins from bacterial cells or mycotoxins from fungi. The components of a bioaerosol range in size from around 0.02 to 100 micrometres (µm) in diameter. The size, density, and shape of a bioaerosol will affect its behaviour, survivability and ultimately its dispersion in the atmosphere.

[1] Environment Agency. July 2018. M9: Environmental monitoring of bioaerosols at regulated facilities v2, July 2018

Bioaerosols are easily breathed into the human respiratory system, potentially causing allergic responses and inflammation. They also have the potential to cause eye irritation, gastrointestinal illness, and dermatitis.

Bioaerosols are associated with composting, anaerobic digestion and mechanical biological treatment, which are the main processes used to treat organic wastes in the UK. As organic waste material breaks down it goes through different temperature dependent stages that are dominated by certain groups of bacteria and fungi. Bacteria are the most numerous group of microorganisms. Aspergillus fumigatus is a mesophilic fungus that is thermotolerant and is present throughout the different stages of the organic breakdown process. This fungus can cause severe respiratory infection if inhaled.

The dependence on microorganisms to degrade organic material and the way in which the material is processed make biological treatment facilities a potential source of bioaerosols. However, we note that the 2012 EA guidance note[2] for developments requiring planning permission and environmental permits states that the EA do not consider bioaerosols from anaerobic digestion to be a serious concern. This is due to the fact, that anaerobic digestion is generally a wet process undertaken in enclosed tanks and equipment, whereas composting is often undertaken using open systems such as windrows and static piles.

The Riverside STC does not undertake any aerobic composting activities and the anaerobic digestion process on site, undertaken in the Primary Digester Tanks, is an enclosed process with all produced gases captured within the biogas system.

1.4.1 High Risk Activities

The M17 guidance document (section 3.3.3), outlines a number of potential sources and release mechanisms of particulate matter, including bioaerosols from waste management facilities. These potential sources are not graded for importance within M17, and include: the movement of waste to and from the facility; storage of waste (under certain conditions) on site; the handling and processing of waste materials e.g., shredding of green waste, turning of windrows, daily cover; and wind scouring of waste surfaces.

In terms of potential sources of bioaerosol release at the Riverside STC, which meet the M17 guidance, only the storage of sludge cake and export i.e., the handling and storage of waste (under certain conditions) and wind scouring of waste surfaces would apply. Sewage waste to site is received via pipes and is contained and shredding of waste or turning of stockpiles is not undertaken.

1.4.2 Relevant Thresholds

Based on the accepted Levels at sensitive receptors as set out in the Environment Agency M17 guidance[3] 'M17 Monitoring of particulate matter in ambient air around waste facilities', and in line with the Governments regulatory position statement (RPS) 209 outlining when a specific bioaerosol risk assessment and/or monitoring is required and use of the Environment Agency Technical Guidance Note M9[4]; key bioaerosols of interest and their respective threshold Levels (including background) at sensitive receptors are outlined below:

- Total bacteria: 1000 cfu/m^3
- Aspergillus Fumigatus: 500 cfu/m^3

[2] Environment Agency. October 2012. Guidance for developments requiring planning permission and environmental permits

[3] Environment Agency. 2013. Technical Guidance Note (Monitoring) M17: Monitoring Particulate Matter in Ambient Air around Waste Facilities, v2, July 2013 https://www.gov.uk/government/publications/m17-monitoring-of-particulate-matter-in-ambient-air-around-waste-facilities

[4] Environment Agency. 2018. Technical Guidance Note (Monitoring) M9: Environmental monitoring of Bioaerosols at regulated facilities, v2, July 2018

2. Bioaerosol risk assessment

2.1 Introduction

A source-pathway-receptor risk assessment has been undertaken to appraise the potential for risk to human health at sensitive receptors within the relevant distance from operations at the Riverside STC. This risk assessment follows a standardised approach, namely:

- Hazard identification: what sources of bioaerosols are present on site.
- Exposure assessment: what are the mechanisms or pathways allowing bioaerosols to migrate off site and reach a sensitive receptor; and
- Risk evaluation: who is potentially exposed to bioaerosols; what is the probability, magnitude, and duration of that exposure.

The assessment describes:

- The processing techniques and equipment used within the installation.
- Feedstock, tonnages processed and any seasonal variations.
- Potential sources of bioaerosols.
- The site layout, including vegetation around the site.
- What is beyond the site boundaries and the location of sensitive receptors; and
- Local wind direction data.

2.2 Processing equipment and techniques

2.2.1 Waste Reception

The STC comprises of treatment processes for indigenous sludges separated from the UWWTD permitted areas of the site and for treatment processes for imported sludge that arrives at Riverside STC via a subsurface rising sludge main and to two Sludge Import Points.

Co-settled indigenous sludge is removed from the Primary Settlement Tanks of the UWWTD permitted area of the STW, and is passed to the Sludge Buffer Tanks, which act as temporary storage tanks prior to sludge dewatering. The Sludge Buffer Tanks are of concrete construction, covered, subject to odour control and mostly below ground. Sludge is pumped from the Sludge Buffer Tanks, via Sludge Screens to the Sludge Blending Tanks and mixes with incoming sludges from offsite sources. In the event of excess sludge in the Sludge Buffer Tanks, sludge will be diverted to the Sludge Holding Tank which is an aboveground concrete tank that is covered and is subject to odour control. Pumps transfer sludge from the Sludge Holding Tank to the Sludge Blending Tanks, via Sludge Screens.

There is an import point at Riverside STC for permitted imports of sludge from other sites. Sludge is also imported to a Sludge Import Point near to the Sludge Buffer Tanks. Imported sludge is accepted through a data logger which measures both the transferred volume and records the originating site of the material. A site supplied transfer hose is provided to prevent misconnections. Access to the sludge logger is via a key fob that is issued to drivers. Imported sludge is pumped to one of the two Sludge Buffer Tanks where it is mixed with indigenous sludge and subject to screening, as described above.

Riverside STC also receives thickened, blended sludge for biological treatment from offsite sources, via the Beckon Sludge Imports.

Sludge from the two sludge rising mains join at Riverside STC, and are split evenly between the two Sludge Blending Tanks. The two Sludge Blending Tanks are of steel construction on a concrete base, are covered and connected to an OCU for odour abatement. Sludge enters in at the top of the tanks and is removed from near to the bottom of each tank. The Sludge Blending Tanks are fitted with mixer circulation pumps to prevent settling of the sludge and the tanks are connected to the site drainage in the event of being overfilled. Riverside STC also imports undigested sludge for re-wetting in the Cake Barn. Once processed, sludge is pumped to the Sludge Blending Tanks where it combines with indigenous and imported sludge.

Sludge is removed from the two Sludge Blending Tanks by dedicated feed pumps which transfer the sludge via a subsurface pipeline to the Pre-THP Dewatering Plant that are located within the dewatering building. A powder polymer is dosed into each centrifuge to aid coagulation of the sludge. The dewatered sludge falls into a common line where a screw conveyor transfers the dewatered sludge to one of two Thermal Hydrolysis Plant (THP) Feed Silos. Liquor from the Pre-THP Dewatering Plant gravitates to an external Liquor Return Tank outside of the dewatering building. This Liquor Return Tank is of concrete construction, covered and connected to an OCU for odour abatement with a subsurface element. Liquor is returned to the inlet for further treatment via the UWWTD route without any additional form of liquor treatment. The Pre-THP Dewatering Plant are subject to odour abatement via an OCU.

2.2.2 Waste Treatment

The THP Feed Silos are aboveground tanks of steel construction, which are covered and connected to an OCU for odour abatement. Sludge is subject to re-wetting on extraction from the THP Feed Silos and two sets of pumps transfer the sludge into one the THP streams via an aboveground sludge line within a pipe-bridge, with each THP Feed Silo dedicated to a single THP stream. Level controls within the THP Feed Silo prevent the overfilling of the tanks by inhibiting the upstream dewatering pumps in the event of a high-level alarm.

The THP process uses the application of temperature and pressure to enhance the digestion of the sludge which enhances the availability of biogas within the digestion process. At Riverside STC, the THP process operates 24/7 using approximately 6 bar of pressure and a temperature of approximately 165° C for approximately 30 minutes. This process also sterilises the sludge, destroying pathogens in the sludge so it exceeds the requirements for subsequent use in agriculture. The THP process is entirely aboveground, of steel construction, located within a bunded area of engineered concrete that is connected to the site drainage. The THP process is monitored by the site Supervisory Control and Data Acquisition (SCADA) equipment.

The THP is a batch process with the two streams operating in parallel. The first stage is for a fresh batch of sludge to be pumped to the THP Pulper Tank where it is mixed with warmer sludge by an external recirculation pump and warmed by steam recovery from the THP Reactor Tanks. Level controls within each Pulper Tank inhibit the transfer pumps to prevent overfilling of a tank. When a THP Reactor Tank is ready to receive sludge, the required volume is pumped from the Pulper to the duty Reactor Tank for treatment and the cycle commences. Once filled with sludge, the reactor is filled with steam until the required pressure and temperature is reached in order to hydrolyse the sludge and held for the appropriate duration of time. Once the hydrolysis has been completed, a valve is opened to gradually reduce the pressure, with the steam released to the Pulper Tank for pre-heating of another batch of sludge. The sludge is then discharged via a second valve in the base of the tank into the THP Flash Tank where any excess steam is vented back to the Pulper Tank

The sludge is transferred onwards to the THP Coolers to lower the temperature to be more optimal for anaerobic digestion. The THP Flash Tank provides a thermal buffer to release excess energy from the sludge prior to it entering downstream processes. Tanks are fitted with high-level floats to prevent overfilling and PRVs to prevent over-pressurisation of the vessels, which are linked to the site SCADA system, amongst other monitoring and safety features.

Sludge is then pumped to the Primary Digester Tanks by one of three digester feed pumps. There are four Primary Digester Tanks at Riverside STC that are all of the same concrete construction, with fixed roofs and are mostly aboveground except for a small subsurface extent which is conical in shape. Each of the Primary Digester Tanks is fitted with mixer pumps to prevent settling of the sludge and Pressure and Vacuum Relief Valves (PVRVs) that would operate in an emergency. Each Primary Digester Tanks operates on a continuous basis. Fresh hydrolysed sludge is introduced by the feed pumps depending on the levels within the Primary Digester Tanks, which is monitored by levels connected to the site SCADA system. Digested sludge gravitates out of each Primary Digester Tanks via a limpet chamber to a subsurface sludge line to the two Digested Sludge Dewatering Buffer Tanks (DSDBTs). There is no additional heat input to the Primary Digester Tanks at Riverside, instead the Primary Digester Tanks are kept at the optimal temperature via a re-circulation loop of the incoming warm hydrolysed sludge which under normal operations requires cooling to maintain the optimal temperature for anaerobic digestion. Biogas generated within the digestion process, largely methane, rises through the Primary Digester Tanks and is captured and transferred via a mostly aboveground common line into one of the two dual membrane Biogas Storage holders which are located between the Primary Digester Tanks.

Sludge gravitates to the two DSDBTs located at the site. Digested sludge rises from a subsurface line and enters into each DSDBT near to the top of the tank, which is of steel construction and situated on a concrete base. The tanks are enclosed and connected to an OCU for odour abatement with air mixing to prevent settling of the sludge. Fully digested sludge is then pumped via a subsurface sludge line from the DSDBT and into the dewatering building where the digested sludge is dewatered by Sludge Dewatering Presses.

Each of the Sludge Dewatering Presses is serviced by a dedicated belt press feed pump. A powder polymer coagulant is dosed into each belt press by dedicated polymer feed pumps. Liquor from each press drains to the external return Liquor Return Tank before it is returned to the inlet for further treatment via the UWWTD route without any additional form of liquor treatment.

2.2.3 Digested cake

Digested sludge cake is removed from each belt press via a screw conveyor and deposited into the Cake Barn below. The Sludge Dewatering Presses are odour abated via an OCU and fitted with sensors that would inhibit the feed pumps if a blockage were identified.

Digested sludge cake falls onto the floor of the Cake Barn into one of five bays. The Cake Barn is fully enclosed with solid concrete floors and solid concrete internal walls. Digested sludge cake is subject to removal from site under the Sludge Use in Agriculture Regulations 1989 (SUiAR), and in accordance with the Biosolids Assurance Scheme (BAS). As the Cake Barn is totally enclosed there is a low risk from bioaerosols from stored digested sludge cake although there are sensitive receptors within 250 m of the Cake Barn.

2.2.4 Odour Control Units

Sewage treatment works have a number of potentially odorous sources within their boundary. Some of these sources may be linked to OCUs to treat potentially odorous compounds given off by the process. These units take air extracted from the above mentioned tanks or process areas and treat the odour compounds by means of different methodologies dependent upon the nature of the odour compounds. Treatment methodologies include activated carbon systems; biofilters or other biological treatment; and chemical scrubbing. Individual OCUs may use one or more of these methodologies in series.

Under the M9 guidance documents, the Environment Agency has identified that biofilters may give rise to bioaerosols during operation. For completeness OCUs with biofilters and within the permit installation boundary have been included in this assessment.

2.2.5 Seasonality

Sewage treatment is undertaken at the STC on a continuous basis, 24 hours a day 365 days of the year. Sludge cake is, therefore, produced daily and at similar levels across the whole year.

However, digested sludge cake storage on site, both in relation to duration and volume, varies across time. Digested sludge cake is removed from site for spreading to land. Land spreading is controlled under the Biosolids Assurance Scheme and Sludge Use in Agriculture Regulations (1989), as well as the Farming Rules for Water. As such, sludge cake will remain on site longer during wet periods and during autumn and winter periods where there would be limited uptake of nutrients from the solids. This means that there will be more cake within the storage bays during the autumn and winter, under normal conditions, than during the summer period.

2.3 Potential Sources

There are 17 point-source emissions to air from the processes within the installation boundary as presented in Table 1 and illustrated in Appendix B. The references and source descriptions match those in the permit:

Table 1. Point source emissions to Air.

Air emission reference	Source	In scope as a source?
A1a	CHP Engine 1	x

Air emission reference	Source	In scope as a source?
A1b	Steam Boiler 1	x
A2a	CHP Engine 2	x
A2b	Steam Boiler 2	x
A3a	CHP Engine 3	x
A3b	Steam Boiler 3	x
A4	Flare stack	x
A6	THP PRV	x
A7 -A10	Primary Digester Tank PRVs	x
A11	Biogas Storage PRV	x
A12	Biogas Storage PRV	x
A13	OCU 1	✓
A14	OCU3	✓
A15	Cake Barn Ventilation Emission Stack	✓

The location of these emission points is shown on the site layout plan at the emission plan in Appendix B.

The Cake Barn considered an additional but limited source of bioaerosols emissions and is shown on the plan in Appendix B..

2.3.1 Source Assessment

The CHP engines, boilers and flare combust the produced biogas at high temperatures (in excess of 450°C). Due to the combustion of the biogas, these points can be discounted as sources of bioaerosols emissions.

There are two OCUs (point A13 and A14) serving the STC (within the installation boundary).

- OCU 1 (A13) - The Sludge Blending Tanks, Pre-THP Dewatering Plant, THP Feed Silos, Liquor Return Tank, Digested Sludge Dewatering Buffer Tank and Sludge Dewatering Presses are covered and off gases treated in OCU 1. The Pre-THP Dewatering Plant and Sludge Dewatering Presses have individual odour control enclosures and off gases from sludge flows associated with the equipment are also treated in OCU 1.

  The OCU comprises 1 No lava rock bioscrubber units followed by dual activated carbon adsorption units.

- OCU 3 (A14) - The Sludge Buffer Tanks and Sludge Holding Tank are covered and extracted to a biofilter odour control unit. The ventilation is provided by 2 No. fans which are intended to operate as duty/standby.

The configuration of OCU 1 means that any bioaerosols emitted from the biofilter stage should be captured by the activated carbon stage, and therefore, the likelihood of bioaerosols release is anticipated to be minimal, if at all. However, biofilters are considered to be a potential emission source for bioaerosols, whether used in isolation or with a second methodology.

PRVs (points A6 – A12) are normally closed and do not emit to atmosphere. However, in the event of an abnormal situation such as the failure of the flare stack and/or CHP engines, the PRVs would open to relieve excess biogas pressure, potentially resulting in the release of bioaerosols, while the problem is rectified. While the problem is rectified, biogas generation would be limited by reducing or inhibiting the digester feed. These abnormal events are unlikely, temporary, and infrequent due to the extensive monitoring and maintenance programmes undertaken at the site as well as the procedures and warning systems in place.

In addition, there is also a channelled potential release from treated, dewatered sewage cake, which is stored in the Cake Barn, there is no OCU associated with this building however it is enclosed and so bioaerosol release is expected to be minimal via the Ventilation Emission Stack (A15).

2.3.2 Risk

The overall treatment process is considered to be a low source of bioaerosols as discussed above, there are a number of control measures in place at the site to reduce and contain emissions of bioaerosols. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure.

The majority of storage tanks, treatment tanks and associated pipework are enclosed. Sludge screening and dewatering takes place in enclosed units. In addition, the PRVs are only opened in abnormal situations which are temporary and unlikely.

Although there are receptors within 250m of the OCU emission points, the risk of bioaerosols emissions from the OCUs is considered to be low. OCU 1 (A13) is located closer to sensitive receptors than OCU 3 (A14) but is a 2-stage OCU and therefore the risk of bioaerosols being emitted is lower due to the second, carbon adsorption stage.

The digested sludge cake within the Cake Barn has low bioaerosol content as a result of the treatment processes and is moist on deposition within the Cake Barn. The digested sludge cake is managed by dozer and deposited within storage areas where it forms a crust within 24 hours and requires no further treatment or disturbance prior to export onto agricultural land.

The greatest probability of exposure from bioaerosols emitted from the site is from operations not linked to an OCU such as the Cake Barn, however the building is enclosed, has a roller shutter door, is under negative pressure and emissions are via a ventilation stack in the centre of the STW, which is approx. 18m high.

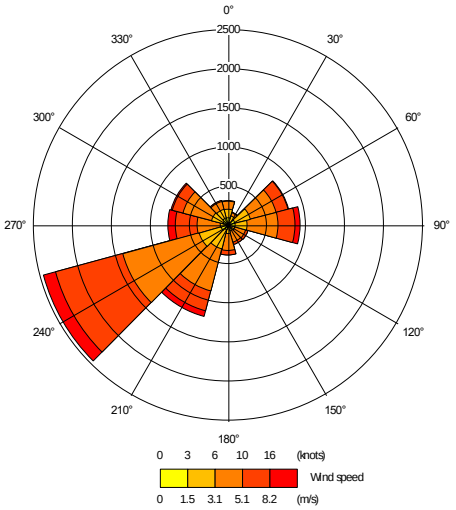
2.4 Pathways

Bioaerosols are very small and light in weight so can easily be transported by the wind from their source to receptor.

The 2020 wind rose for the most representative meteorological site, London City (located approximately 10.1 km West of the Site), is shown in Figure 1.

The wind rose data shows that the site experiences strong prevailing south westerly winds, predominantly in excess of 6 knots.

Figure 1. London City Wind rose (2020)



Because of the dilution effect in open air, bioaerosol concentrations fall away rapidly with distance from the source. It has been shown by research by the HSE[5] that by 100 to 200m away, the bioaerosol concentration has mostly returned to background levels. Between 50m and 100m distances downwind of the process, bioaerosol concentrations were substantially reduced by comparison to those level measurements at source. RR786 confirmed previous published studies which showed that at a distance of 250m from composting activity, in most cases, the bioaerosol concentrations will be reduced to background levels. Note that this research was undertaken on aerobic composting sites, which generate higher levels of bioaerosols than anaerobic digestion sites, although the 250m separation distance has been retained.

At present, Thames Water do not have quantitative data for the levels of bioaerosols that might be associated with the potential sources at their sludge treatment centres. As a responsible operator, Thames Water are arranging for bioaerosol monitoring at a number of typical STC's in order to confirm that the understanding of the wider waste water treatment industry, that sewage sludge treatment processes do not give rise to elevated levels of bioaerosols, is correct. The sampling will be in accordance with the requirements of M9 and M17, and consist of a series of agar gel plates being placed downwind and upwind of the cake barn, including sampling points both directly upwind of the downwind sampling point and additional samples in the direction of the nearest sensitive receptors.

2.5 Receptors

Environment Agency guidance note M9 recommends a screening distance of 250m from bioaerosol emission sources to static receptor locations. Sensitive receptors are defined as: 'permitted activities where people are likely to be for prolonged periods. This term would therefore apply to dwellings (including any associated gardens) and to many types of workplaces. We would not normally regard a place where people are likely to be present for less than 6 hours at one time as being a sensitive receptor. The term does not apply to those controlling the permitted facility, their staff when they are at work or to visitors to the facility, as their health is covered by Health and Safety at Work legislation but would apply to dwellings, commercial or industrial premises nearby where people might be exposed for the requisite period.

[5] Research Report 786 - Bioaerosol emissions from waste composting and the potential for workers' exposure https://www.hse.gov.uk/research/rrhtm/rr786.htm

There are five sensitive receptors found within 250m of potential bioaerosol emission sources at the site, as shown on the site plan found in Appendix C.

For each of these receptors, the distance and direction from each potential bioaerosol emission source to the closest sensitive receptor has been identified. Where multiple assets exist for the same process, only the closest location has been presented. The receptor closest to a potential emission source are commercial /industrial properties off Consul Avenue, approximately 70m South of OCU (A13).

Receptors are numbered as in the Odour Management Plan, with receptors not included if >250m from an emission source or if humans are not likely to be at a receptor location for 6 hours.

Table 2. Static Receptors within 250m of Potential Bioaerosol Sources

Receptor	Description	Source	Distance from closest source (m)	Direction from the Source
R1	New Road - Residential	Cake Barn	200m	North-East
R5	Creekside, Rainham: Residential Properties	OCU 3 (A14)	190m	South-East
R10	Commercial /Industrial- off New Road Rainham –	OCU 1 (A13)	135m	North-East
		OCU 3 (A14)	175m	North-East
		Cake Barn Ventilation Emission Stack (A15)	190m	North
		Cake Barn	85m	North
R11	Consul Avenue, Rainham - Commercial /Industrial (closest Focus Logistics)	OCU 1 (A13)	70m	North-West
		Cake Barn Ventilation Emission Stack (A15)	190m	North-West
		Cake Barn	80m	West
R12	Havering College	OCU 3 (A14)	180m	North-East
		Cake Barn Ventilation Emission Stack (A15)	210m	North-East
		Cake Barn	170m	East

2.6 Risk Assessment

The method used for this bioaerosol risk assessment is adapted from the EA's standard guidance on risk assessments for environmental permitting, which recommends using a Source-Pathway-Receptor model[6] to help determine the magnitude of the risk associated with bioaerosol emissions from a facility.

There are four potential sources of bioaerosols release within 250m of static receptors:

[6] Risk assessments for your environmental permit - GOV.UK (www.gov.uk)

- OCU 1 (A13) - The Sludge Blending Tanks, Pre-THP Dewatering Plant, THP Feed Silos, Liquor Return Tank, Digested Sludge Dewatering Buffer Tank and Sludge Dewatering Presses are covered and off gases treated in OCU 1. The Pre-THP Dewatering Plant and Sludge Dewatering Presses have individual odour control enclosures and off gases from sludge flows associated with the equipment are also treated in OCU 1.

  The OCU comprises 1 No lava rock bioscrubber units followed by dual activated carbon adsorption units.

- OCU 3 (A14) - The Sludge Buffer Tanks and Sludge Holding Tank are covered and extracted to a biofilter odour control unit. The ventilation is provided by 2 No. fans which are intended to operate as duty/standby.
- Cake Barn Emission Ventilation Stack (A15)
- Cake Barn

The receptors within 250m of emission points are located West, North-West, North, North-East, South–East and South-West and the prevailing wind direction is from the South-west. There is potential for wind-borne transportation of bioaerosols to most receptors.

The closest residential receptors are off Creekside, approximately 190m South-East of emission point A14, and the next closest are housing off New Road, 200m from the Cake Barn, this is a significant distance, with various buildings in between for each of these locations which would likely offer protection from any limited bioaerosol release. Creekside properties are also protected to some extent by the prevailing wind direction, and the Cake Barn is fully enclosed meaning very little if any bioaerosol release is anticipated from here.

Industrial and commercial properties are located to the West, North-West, North, North-East of emission point A13, A15 and the Cake Barn. The majority of work is expected to occur within industrial/commercial buildings rather than outdoors meaning that workers are likely to be protected to an extent, however given the greater majority of processes are enclosed and there are expected to be very limited bioaerosols released from OCUs the potential for exposure is considered to be very low. The Cake Barn is also fully enclosed ensuring little to no bioaerosol release from this location while the Cake Barn Emission Ventilation Stack is located more central within the site meaning the separation distance to potential sources is greater.

Overall, the probability of bioaerosols being released from the sludge treatment process and the identified potential sources is considered to be low. The potential duration of release of bioaerosols varies from infrequent to frequent. The magnitude of any releases is considered to be low or minimal.

Planned monitoring of bioaerosol emissions by Thames Water is expected to validate the assumption that process contributions from sewage sludge treatment works would comply with the ‘acceptable level’ thresholds.

Table 3 summaries the risk assessment.

Table 3. Risk Assessment of Potential Bioaerosols Sources

What has the potential to cause harm? Source	How can the source reach the receptor? Pathway	Who can be affected? Receptors	Assessing the risk Probability of Exposure	Consequence (what is the harm that can be caused)	Managing the risk (Control Measures)	Overall/residual risk
Odour Control Unit 1 - (A13)	Inhalation via wind-borne transportation	R10, R11	Probability of exposure from A13 is considered to be **low** given that the potential for bioaerosol release from OCUs is likely to be minimal. These receptors are also industrial/commercial buildings (the distance measured was the closest point of each estate), workers in these locations, whilst some work may be carried out outside, the majority of workers are expected to be within buildings and protected.	Impact on human health (considered to be a sensitive receptor).	Most storage tanks, treatment tanks and associated pipework are enclosed. Where tanks are not gas tight and vent to atmosphere, these are connected to an OCU. There are a number of types of odour control, given the types of OCU, the likelihood of bioaerosol release is anticipated to be minimal. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure.	Low
Odour Control Unit 3 - (A14)	Inhalation via wind-borne transportation	R5, R10, R12	Probability of exposure from A14 is considered to be **low** given that the potential for bioaerosol release from OCUs is likely to be minimal. These receptors are also a considerable distance from A14 (closest is 175m) and so there are a number of buildings providing protection between A14 and receptors.	Impact on human health (considered to be a sensitive receptor).	Most storage tanks, treatment tanks and associated pipework are enclosed. Where tanks are not gas tight and vent to atmosphere, these are connected to an OCU. There are a number of types of odour control, given the types of OCU, the likelihood of bioaerosol release is anticipated to be minimal. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure.	Low
Cake Barn Emission Ventilation Stack (A15)	Inhalation via wind-borne transportation	R10, R11, R12	Probability of exposure from A15 is considered to be **low** given that the sludge cake is fully digested and forms a crust upon deposition.	Impact on human health (considered to be a	The risk of bioaerosols from digested sludge cake has been assessed under COSHH by TWUL and determined to be low risk.	Low

What has the potential to cause harm? Source	How can the source reach the receptor? Pathway	Who can be affected? Receptors	Assessing the risk Probability of Exposure	Consequence (what is the harm that can be caused)	Managing the risk (Control Measures)	Overall/residual risk
			Receptors are at located 190m from the stack which is approx. 18m high.	sensitive receptor).	Digested sludge cake is post treatment, so the pathogen content is significantly reduced, especially post THP. Cake Barn ventilation is emitted via an approx. 18m high stack meaning it is likely to be more widely dispersed on release.	
Cake Barn	Inhalation via wind-borne transportation	R1, R10, R11, R12	Probability of exposure from the Cake Barn is considered to be **low**. The Cake Barn is fully enclosed and so there is little to no possibility of release of bioaerosols and ability for there to become windborne. The sludge cake is also expected to retain sufficient moisture that it is very unlikely to disperse and dust or bioaerosols.	Impact on human health (considered to be a sensitive receptor).	The risk of bioaerosols from digested sludge cake has been assessed under COSHH by TWUL and determined to be low risk. Digested sludge cake is post treatment, so the pathogen content is significantly reduced, especially post THP. Digested sludge cake is stored within an enclosed barn with little ability to become windborne.	Low

2.7 Abnormal Situations

In the event of plant failures or abnormal situations, an alarm would be raised on the Site Supervisory Control and Data Acquisition (SCADA) or telemetry systems, which will be reacted to by on-site or regional control room operators and Duty Managers. Depending upon the nature of the fault or emergency, where required, an operator would contact a mechanical or electrical technician, both of whom are on-call 24-hours, to attend site as soon as practicable.

If the on-call technicians are already engaged upon other response work, there is the facility to access staff from other TW geographic divisions, coordinated by the Duty Manager. All faults, breakdowns and emergencies are logged electronically together with records of the action taken and the solutions reached. One such abnormal event would be failure of the flare stack and/or CHP engines. Such an event would result in releases of biogas from the PRV's located on the roofs of the Primary Digester Tanks and in the Biogas Storage compound, which would release bioaerosols. This occurs to prevent over pressurisation of the Primary Digester Tanks and Biogas Storage Holders . While the problem is rectified, biogas generation is reduced by reducing or inhibiting the digester feed.

3. Conclusions

A source-pathway-receptor risk assessment has been undertaken to appraise the potential for risk to human health in dwellings and other nearby buildings from bioaerosols arising from operations at the Riverside STC. The risk assessment followed a standardised approach, namely:

- Hazard identification: what sources of bioaerosols are present;
- Exposure assessment: what are the mechanisms or pathways allowing bioaerosols to migrate off site and reach a receptor; and
- Risk evaluation: what is the probability of exposure. This considered control measures in place to reduce the probability or magnitude of release.

A small number of potential sources of bioaerosols within the site processes have been identified, however only four are within 250m of a static receptor. However, given the distances from the emission points, intervening buildings providing protection and the control measures in place to contain or prevent bioaerosol release the overall (residual risk) to receptors is considered to be low.

3.1 Sampling

Thames Water confirms it will use MCERTS accredited providers for the sampling from the following locations and will sample each OCU on a bi-annual basis:

- OCU 1 (A13) TQ 51346 82415
- OCU 3 (A14) TQ 51497 82288
- Cake Barn Ventilation Emission Stack (A15): TQ 51426 82328

In addition, sampling will also take place in relation to TQ 51412 82413 (approx. NGR of centre of Cake Barn) which is a diffuse source and hence will be monitored purely by agar plates. Downwind samples will tend to be towards the east of the site, as the prevailing wind is from the South-west, so receptors R5 & 11 are least likely to be impacted from this potential source.

In line with M9, ambient sampling will be conducted to identify background emissions. A sampling round, consisting of four induvial sampling points, each with its own agar plate will be carried out. One point will be located 50m upwind of each OCU stack to give a background concentration, and three will be located in a fan like arrangement downwind and at the same distance to the nearest sensitive receptor (as per M9):

Source	Upwind Location NGR	Downwind Location 1 NGR	Downwind Location 2 NGR	Downwind Location 3 NGR
OCU1	TQ 5130 8238	TQ 5137 8247	TQ 5140 8245	TQ 5138 8241**
OCU3	TQ 5146 8227***	TQ 5158 8244	TQ 5164 8238	TQ 5167 8229
Cake Barn Ventilation Emission Stack	TQ 5138 8230	TQ 5151 8249	TQ 5158 8242	TQ 5161 8233

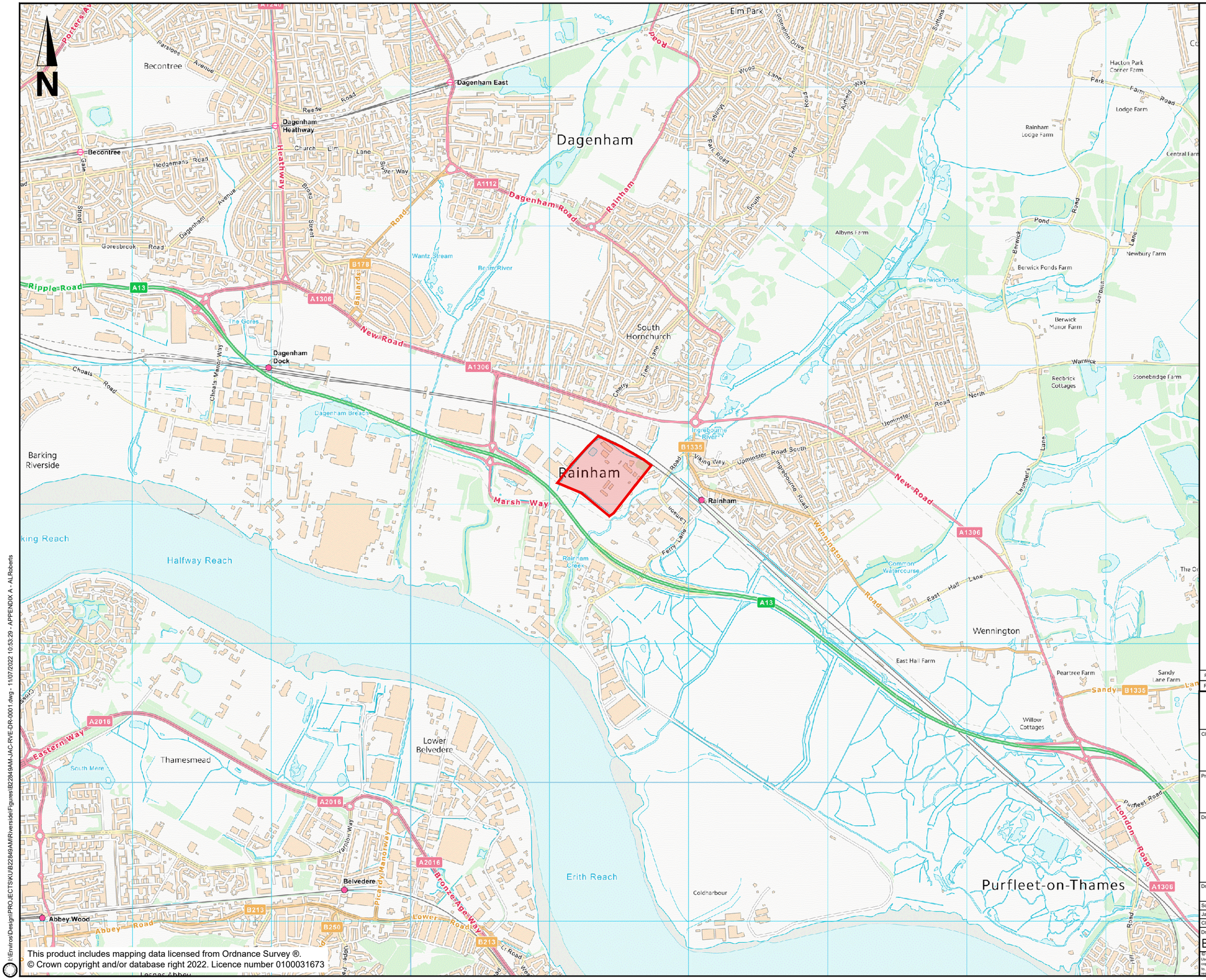
*Location points may require to be changed due to the presence of existing structures making access unsafe or impractical
** OCU 1 downwind location 3 NGR only 35m from source as building structure prevents sampling at 70m.
*** OCU3 upwind location only 35m from source as building structure prevents sampling at 50m.

Cake Barn:

- Upwind sample location which is approx. 50m SW of the Cake Barn: NGR TQ 5137 8238
- Downwind sample location 1 which is approx. 80m N of the Cake Barn: NGR TQ 5145 8248
- Downwind sample location 2 which is approx. 80m NE of the Cake Barn: NGR TQ 5148 8245
- Downwind sample location 3 which is approx. 240m E of the Cake Barn: NGR TQ 5149 8241

NGR's for sampling locations are only 8 digits at present, to allow the contractor flexibility as to precise location, taking into account the ability to safely locate and access (and security) of the sampling plates.

Appendix A. Site Location Plan



Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	JUL 2022	FOR INFORMATION	AR	HEK	JK	MM

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Client: Thames Water

Project: STC IED PERMIT
RIVERSIDE STW

Drawing title: APPENDIX A
SITE LOCATION PLAN

Drawing status: PERMITTING

Scale	1:25,000	DO NOT SCALE
Jacobs No.	B22849CZ	Rev P01
Client no.		

Drawing number: B22849AM-JAC-RVE-DR-0001

Appendix B. Potential Bioaerosol Emission Points

N

College

Cake Barn

Dewatering Building Containing:
- Pre-THP Dewatering Plant
- Sludge Dewatering Presses

Mobile Cake Rewetting Plant

Digested Sludge Dewatering Buffer Tanks

Liquor Return Tank

Return Liquor Pumping Station

THP Feed Silos

Primary Digester Tank

Ferric Chloride Tanks

Biogas Storage

Primary Digester Tank

Sludge Blending Tanks

Beckton Sludge Imports

A13

A1a
A1b

A2a
A2b
A3a
A3b

A6

A4

A9

A8

A12

A10

A7

A15

A11

Siloxane Filters

CHP Building

Sludge Coolers

THP Plant

Primary Digester Tank

Biogas Storage

Biogas Boosters

Sludge Holding Tank

Buffer Tank Pumping Station

Sludge Import Point

Sludge Buffer Tanks

A14

Sludge Import Point

KEY:

Installation Boundary

Area Excluded from Permit Scope

A1a - CHP Engine 1
A1b - Steam Boiler 1
A2a - CHP Engine 2
A2b - Steam Boiler 2
A3a - CHP Engine 3
A3b - Steam Boiler 3
A4 - Emergency Flare
A6 - THP PRV
A7 - Primary Digester Tank PRV
A8 - Primary Digester Tank PRV
A9 - Primary Digester Tank PRV
A10 - Primary Digester Tank PRV
A11 - Biogas Storage PRV
A12 - Biogas Storage PRV
A13 - OCU 1
A14 - OCU 3
A15 - Cake Barn Ventilation Emission Stack

0 20 40 60
METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P02	DEC. 2023	FOR INFORMATION	AR	MM	JK	MM
P01	JUL. 2022	FOR INFORMATION	AR	HEK	JK	MM

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Client: Thames Water

Project: STC IED PERMIT
RIVERSIDE STW

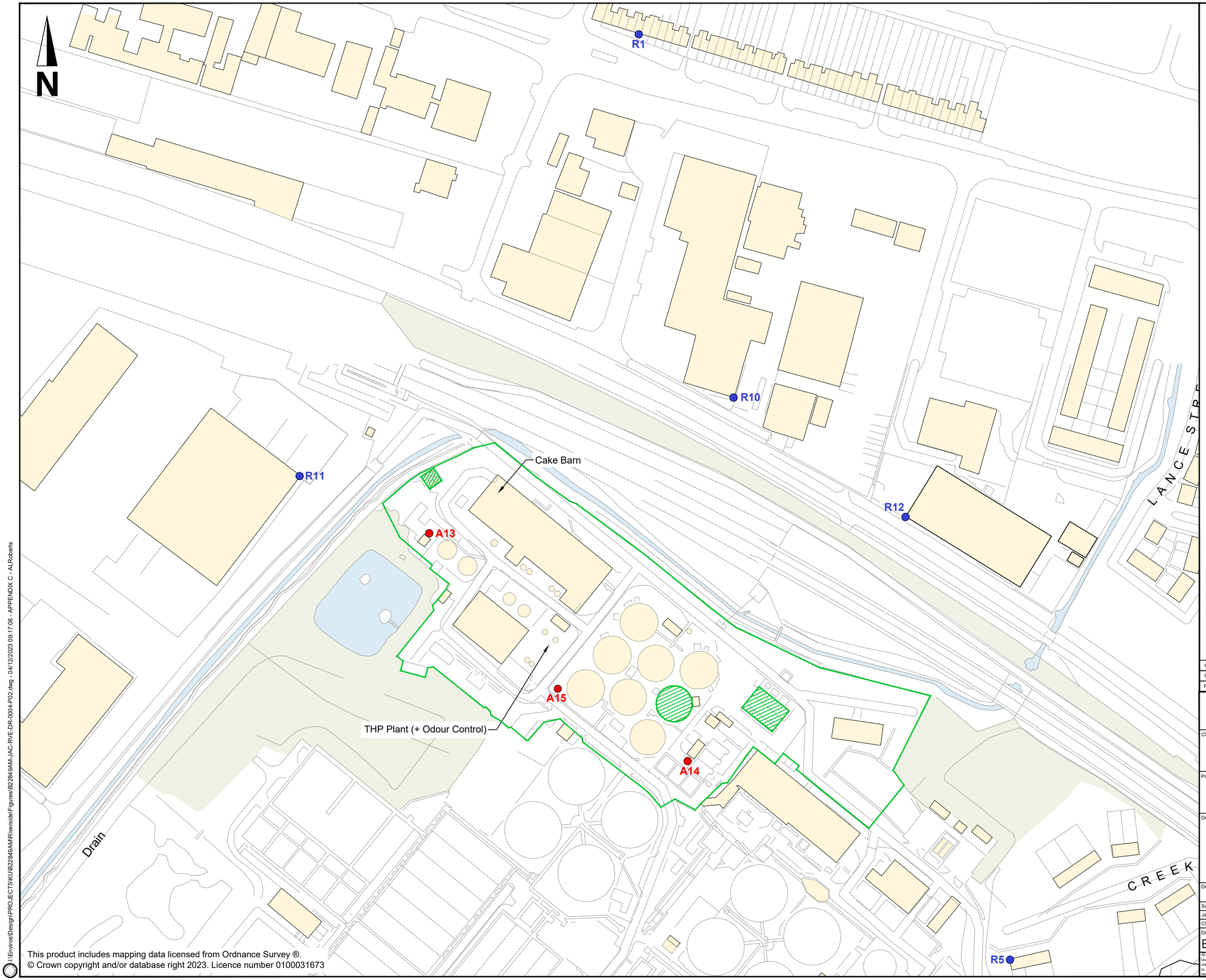
Drawing title: APPENDIX B
INSTALLATION BOUNDARY AND POTENTIAL BIOAEROSOL EMISSION POINTS

Drawing status: PERMITTING

Scale	1:1250 @A3	DO NOT SCALE
Jacobs No.	B22849AM	Rev P02
Client no.		

Drawing number: B22849AM-JAC-RVE-DR-0002

Appendix C. Receptors within 250m of potential emission points



KEY:

- Installation Boundary
- Area Excluded from Permit Scope
- Air Emission Point
- Receptor Point

A13 - OCU 1
A14 - OCU 3
A15 - Cake Barn Ventilation Emission Stack

R1 - New Road : Residential
R5 - Creekside, Rainham: Residential Properies
R10 - Commercial/Industrial - off New Road, Rainham
R11 - Consul Avenue, Rainham: Commercial/Industrial (closest Focus Logistics)
R12 - Havering College

0 20 40 60 80 100
METRES

P02	DEC. 2023	FOR INFORMATION	AR	JK	JK	MM
P01	JUL. 2022	FOR INFORMATION	AR	HEK	JK	MM
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

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Client: Thames Water

Project: STC IED PERMIT
RIVERSIDE STW

Drawing title: APPENDIX C
RECEPTORS WITHIN 250m OF POTENTIAL EMISSION POINTS

Drawing status: PERMITTING

Scale	1:2000 @A3	DO NOT SCALE	
Jacobs No.	B22849CZ	Rev	P02
Client no.			

Drawing number: B22849AM-JAC-RVE-DR-0002