Swindon STC Bioaerosol Risk Assessment

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Thames Water Utilities Ltd
EPR/BP3590SR/V002

IED STC Permitting
20 November 2024

Swindon STC Bioaerosol Risk Assessment

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Jacobs U.K. Limited

7th Floor, 2 Colmore Square
38 Colmore Circus, Queensway
Birmingham, B4 6BN
United Kingdom

T +44 (0)121 237 4000
www.jacobs.com

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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 Swindon Sludge Treatment Centre (STC), EPR/BP3590SR/V002.

1.1 Site description

The Swindon STC is located at Swindon STW, approximately 2 km north-west of the town of Swindon. The location is largely urban with business and retail premises to the east and south. The nearest residential receptors are approximately 170m to the south of the wider STW. To the west and north is open green space, including Swindon Lagoons Nature Reserve, giving way to further commercial and industrial premises. On the north-east boundary of the STW is an industrial estate with a number of uses including permitted waste sites for metal recycling, vehicle storage and depollution. A surface water body, the River Ray, can be found approximately 100 m west of the site and is the nearest surface water body. There are also a number of lagoons which form the Swindon Lagoons Nature Reserve to the west of the site.

The west of the STW is within a Flood Zone 2, including aspects of the STC including the acid phase digesters and two of the cake pads. This indicates there is an increased risk of flooding on the western side of the site, with between a 1 in 100 and 1 in 1,000 annual probability of river flooding. Most of the STC and the eastern side of the STW are within a Flood Zone 1, indicating that there is a low probability of river flooding (less than 1:1000 annual probability of flooding).

There are two statutory designated habitat sites within the relevant distances of the site. Radnor Street Cemetery is a Local Nature Reserve (LNR) located approximately 1.7 km south-east of the site and Rushey Platt Canalside Park is a LNR located approximately 1.7 km south of the site. There are no Special Areas of Conservations (SAC), Special Protection Area (SPA), or Ramsar sites within 10 km of the site and no Sites of Special Scientific Interest (SSSI) within 2 km of the site. There is one area of Ancient Woodland within 2 km of the site, an unnamed area of Ancient and Semi-natural Woodland approximately 1.6 km north-west of the site. There are 17 non-statutory designated local wildlife sites (LWS) within 2 km of the site.

The site is not within a Source Protection Zone (SPZ) or within an Air Quality Management Area (AQMA).

The address of the installation is:

Swindon Sludge Treatment Centre;

Swindon Sewage Treatment Works,

Barnfield Road,

Rodbourne,

Swindon,

SN2 2DJ.

1.2 Site Activities

Swindon STC is located at the Swindon Sewage Treatment Works (STW), operated by Thames Water Utilities Ltd (Thames Water). The STC undertakes the biological treatment of sewage sludge, both indigenous and imported from other wastewater treatment sites, by anaerobic digestion, with a capacity above the relevant thresholds for requiring an environmental permit. It also includes the importation of specified wastes to the works inlet for treatment through the Urban Waste Water Treatment directive (UWWTD) regulated works.

There are a number of directly associated activities, including the operation of a biogas fuelled CHP engine and boilers 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 acid phase digestion
- Storage of digestate prior to dewatering.
- Dewatering of digested sewage sludge.
- Transfer of dewatering liquors back to the head of the sewage treatment works.
- Transfer of surface water runoff back to the head of the sewage treatment works.
- Storage of dewatered digested sludge cake prior to offsite recovery.
- Storage of biogas.
- Transfer of biogas condensate back to the head of the sewage treatment works.
- Combustion of biogas in a Medium Combustion Plant Directive (MCPD) and Specified Generator (SG) compliant biogas CHP engine.
- Combustion of biogas or natural gas in boilers.
- Operation of an emergency flare.
- Storage of wastes, including waste oils.
- Storage of raw materials.

The STC can treat up to 730,000m^3 of sludge per year (equating to approximately 730,000 tonnes). The STC has a total treatment of 429m^3 per day (equating to approximately 429 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 a Combined Heat and Power (CHP) Engine at the site with excess biogas being subject to Emergency Flare Operation. 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 Engine and Emergency Flare can handle.

1.3 Regulatory requirements

Swindon STW currently has a waste operation environmental permit for a non-hazardous sludge treatment site (EPR/BP3590SR/A001) for waste import and treatment by biological treatment. 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 Swindon Sludge Treatment 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.

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.

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

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 Swindon STC does not undertake any aerobic composting activities and the anaerobic digestion process on site, undertaken in the primary digesters, is an enclosed process with all produced gases captured within the biogas system.

1.4.1 High Risk Activities

The M17 guidance document, in 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 bioaerosols release at the Swindon STC, which meets the M17 guidance, only the storage and handling (movement within the Cake Pads and during export) of sludge cake would apply. There is no shredding of waste or turning of stockpiles as part of the management process and all sewage waste is contained and received via pipes.

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 Swindon 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 any screens, bunds, or trees around the site.
- What is beyond the site boundaries and the location of sensitive receptors.
- Local wind direction data.

2.2 Processing equipment and techniques

2.2.1 Waste Reception

Waste is received from tankers through an enclosed connection via a data logger where it mixes with waste from the sewer and is subject to aerobic treatment under the Urban Waste Water Treatment Directive (UWWTD) permitted process outside of the installation boundary.

Indigenous primary sludge from the Primary Settlement Tanks is drawn off and pumped for thickening by one of two pumps to the Primary Sludge Thickening Plant.

Sludge can also be imported by road tanker from other waste water treatment sites to a Sludge Import Tank. Imported sludge is discharged from tankers (via two import hoses and through a data logger) directly into the Sludge Import Tank. The sludge is then pumped to the Sludge Blending Tank via Sludge Screens where it mixes with indigenous primary sludge and Surplus Activated Sludge (SAS). SAS from the UWWTD Process is thickened with SAS Thickening Plant.

If a sludge spillage occurs, spill kits are available on site and staff are trained in their use. Sludge is viscous and not highly mobile, and operators would clean-up in a timely manner.

2.2.2 Waste Treatment

The waste treatment process of the sludge covered by this assessment, starts at the Thickening Plant. A polymer is dosed into the Primary Sludge Thickening Plant to aid dewatering of the sludge. The thickened sludge is then pumped to the Sludge Blending Tank where it mixes with indigenous SAS and imported sludge. The Primary Sludge Thickening is connected to an OCU for odour abatement.

SAS from the aerobic treatment process is pumped to the SAS Thickening Plant for thickening, with the addition of a liquid polymer coagulant. Thickened SAS is then pumped via an above ground sludge line to the Sludge Blending Tank where it mixes with indigenous primary sludge and imported sludge.

The Sludge Blending Tank is an above ground tank and is connected to an OCU. It contains level controls, ultrasonic alarms and high-level floats that are connected to the site SCADA system to prevent over-filling. In the event of a high-level alarm, upstream processes are inhibited. From the Sludge Blending Tank, sludge is pumped to the Acid Phase Digester Tank.

Swindon STC has one Acid Phase Digester Tank which receives batches of undigested sludge from the Sludge Blending Tank. The site also has one Acid Phase Digestion Buffer Tank which receives sludge that has been

processed by the Acid Phase Digester Tank. The Acid Phase Digester Tank is covered. Sludge is pre-treated within the Acid Phase Digester Tank for an average of 2 days to improve the pathogen kill, increase the dewatering capability of the sludge, and increase the biogas production in the downstream process. Sludge is heated to approximately 38°C using heat received from the CHP Engine or heat generated by the auxiliary boilers on the site. The tank is fitted with PRVs and Vacuum Relief Valves (VRVs) for safety that operate in an emergency. The tank has radar detection and pressure transducers that are monitored by the site SCADA system and would inhibit the feed pumps in the event of an alarm. A biogas line transfers generated biogas to the Biogas Storage holder and is equipped with biogas pressure detectors which would inhibit operations in the event of an emergency. A condensate pot captures entrained moisture from the generated biogas and discharges it to the site drainage system. After the appropriate amount of time, sludge is pumped to the covered Acid Phase Digestion Buffer Tank (also fitted with a PRV and level transducers for safety) and then pumped to one of the three Primary Digester Tanks (PDTs), which have fixed roofs.

The Primary Digester Tanks operate on a continuous basis, with the normal retention time being approximately 12 days. Sludge is introduced to the PDT at the top of the tank and gravitates out and into a common sludge manifold, which transfers the sludge to a Secondary Digester Tank. Each PDT is fitted with dual pressure and vacuum relief valves (PVRVs). In the event of abnormal conditions, the digester feed pumps would be inhibited to prevent further sludge feeding from the Acid Phase Digestion Buffer Tank.

There are three Secondary Digester Tanks at Swindon STC which operate in parallel. In normal operation, one tank fills, one tank empties and one tank will hold sludge for digestion and pathogen kill. Each of the tanks is open topped and above ground tank. The tanks are connected to the site SCADA system. In the event of a high level, the digester feed pumps will be inhibited to prevent overfilling. After approximately two days, the Secondary Digester Tank is emptied via a manifold where three pumps transfer the digested sludge for dewatering.

Digested sludge is pumped from the sludge manifold to Digested Sludge Dewatering Plant. Dewatered digested sludge is then transferred by covered conveyors to the adjacent digested sludge Cake Pad A. The Digested Sludge Dewatering Plant are subject to odour abatement via an OCU. Dewatered digested sludge is then transferred by covered conveyors to Cake Pad A.

Biogas from the Acid Phase Digester Tank and the Primary Digester Tanks is captured and transferred to the Biogas Storage holder. The biogas transfer pipeline is fitted with condensate pots that capture entrained moisture from the generated biogas. The Biogas Storage holder is fitted with biogas detection systems, monitored by the site SCADA system and PRVs that operate in an emergency as a safety precaution in the event of over pressurising the system. When the levels within the Biogas Storage holder reaches a high setpoint, biogas is automatically diverted to an Emergency Flare. In the event of an emergency, slam shut valves found on the biogas line would isolate the supply. The biogas is taken from the Biogas Storage holder, passing through biogas boosters and dehumidifiers, for combustion within a CHP Engine. There are two carbon-based siloxane filters upstream of the CHP Engine, to remove impurities from the biogas prior to combustion.

In the event there is excess biogas within the Biogas Storage holder, i.e., more than the CHP Engine or boilers can utilise, or in the event that the CHP Engine or boilers are unavailable, there is a ground mounted emergency flare (waste biogas burner), which is used during periods of essential maintenance and emergency use. This is utilised under 10% of the year, less than 876 hours per year and operates automatically based on the levels of biogas within the Biogas Storage holder, which is controlled by the site SCADA.

2.2.3 Digested cake

All three of the cake pads at Swindon STC are open cake pads and constructed of engineered concrete with drainage. Digested sludge cake on the Cake Pad A is removed from site under the Sludge Use in Agriculture Regulations 1989 (SUiAR), and in accordance with the Biosolids Assurance Scheme (BAS).

Alternatively, digested sludge cake can be removed for stockpiling to one of the other two cake pads at Swindon STC, either the Cake Pad B or C. Digested sludge cake can then be subsequently removed from the site from either of these pads. In the event of non-conforming cake being produced at Swindon STC, it is transferred to Cake Pad C for an extended period of time to achieve the required level of pathogen kill and the area marked as containing non-conforming cake.

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 all 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, cake storage on site, both in relation to duration and volume, varies across time. 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 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 twelve 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?
A1	CHP Engine	X
A2	Auxiliary Boiler 1	X
A3	Auxiliary Boiler 2	X
A4	Auxiliary Flare	X
A6	Acid Phase Digester Tank PRV	X
A7	Acid Phase Digestion Buffer Tank PRV	X
A8	Primary Digester Tank PRV	X
A9	Primary Digester Tank PRV	X
A10	Primary Digester Tank PRV	X
A11	Biogas Storage PRV	X
A12	OCU 6	✓
A13	OCU 3	✓

The open Cake Pads (A, B and C) are also illustrated in Appendix B. These are additional potential sources for consideration of bioaerosols release to atmosphere.

2.3.1 Source Assessment

The CHP Engine, Boilers, and Emergency Flare (points A1 – A4) 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 OCU emission points to air (A12 & A13) serving the STC. OCU 6 (A12) serves the Sludge Import Tank, Sludge Screens, Primary Sludge Thickening Plant and Sludge Blending Tank, and OCU 3 (A13) serves the Digested Sludge Dewatering Plant. OCU 6 is a biofilter and carbon OCU, and OCU 3 is a biofilter OCU using a lava rock system. The extracted air passes from the tanks through the support media, within the biofilter, while water is irrigated from above. The microbes on the support media, remove potentially odorous contaminants. In OCU 6 the partially treated air from the bio-trickling filter is passed to Activated Carbon adsorbers to achieve a stack emission standard of <= 1000 $OuEm^3$ at the outlet. Treated air discharges via the stack. The configuration of the OCU means that any bioaerosols emitted from the biofilter stage should be captured by the activated carbon stage, and therefore, the likelihood of bioaerosol release is anticipated to be minimal, if at all.

The PRVs (points A6 – A11) are normally closed and do not emit to atmosphere. However, in the event of an abnormal situation such as the failure of the Emergency Flare and/or CHP Engine, the PRV's would open to relieve excess biogas pressure, potentially resulting in the release of bioaerosols. 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 to the point sources identified above, there is also an unchanneled potential release from treated, dewatered sludge cake, which is deposited from the covered conveyors onto Cake Pad A. The sludge cake is then moved from Cake Pad A offsite or to Cake Pad B and C for temporary storage. The site also receives digested sludge cake for storage from other facilities. The type of waste and its location within the pad is logged.

2.3.2 Risk

The overall treatment process is considered to be a low source of bioaerosols. As discussed above, there are 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.

There is a risk of exposure from bioaerosols emitted from the open Cake Pad A and from fugitive releases due to handling operations as sludge cake is moved within the Cake Pad for storage or later disturbed for export. The additional movement of sludge cake to Cake Pad's B and C provide further potential for emissions whilst the cake is handled and the potential for entrainment and resuspension of material from via vehicle tyres as the cake is handled. However, the cake at this stage, has low bioaerosol content as a result of the treatment processes and is moist on deposition to the Cake Pad. The cake is managed by dozer and deposited within the storage areas where it forms a crust within 24 hours. The cake storage areas are monitored for row height and arrangement and require no further treatment or disturbance prior to export onto agricultural land. The probability of exposure from this source is **medium**.

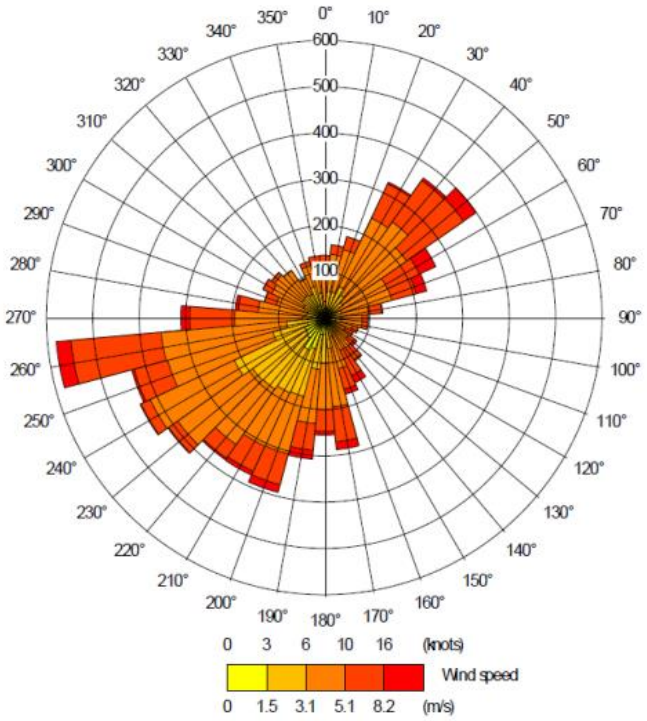
In addition, other than the three Secondary Digestion Tanks, all storage tanks, treatment tanks and associated pipework are enclosed. The wet wells used to receive incoming sludge are covered. Sludge screening and dewatering takes place in enclosed units. In addition, the PRVs are only open in abnormal situations, which are temporary and unlikely. The two-stage biofilter process fitted to the OCU and the maintenance of these assets make the probability of exposure from these sources, **low**, under normal operating conditions.

2.4 Pathways

Bioaerosols are very small and light in weight so can easily be transported by the wind from their source to a receptor. The wind rose for the most representative meteorological site, Lyneham AB (located approximately 13.5 km Southwest of the Site centre), is shown in figure 1.

The wind rose data shows that the site experiences West southwest to Southwest prevailing winds, predominantly in excess of 6 knots. The Swindon STC and surrounding area has a relatively flat topography. The site is bound by a narrow strip of mature trees/ hedgerow along its northern and eastern boundary. The south and western boundary is more densely vegetated offering more screening from the prevailing wind.

Figure 1 – Lyneham AB Meteorological Site Windrose



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. Research Report (RR)786 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 STCs.

As a responsible operator, Thames Water are arranging for bioaerosol monitoring at a number of typical STCs 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 pad, 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

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

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.

Sensitive receptors (identified for the Odour Management Plan (OMP)) and within 250m of potential bioaerosol sources, have been considered and are presented in Table 2 and shown in Appendix C. The distance and direction from each potential bioaerosol emission source to the closest sensitive receptor has been reported.

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

Receptor	Description	Source	Distance from closest source (m)	Direction from the source
R1	Garden Centre (outdoor area)	Cake Pad A	250	East northeast
R2	PJS Autos	Cake Pad B	53	South
		Cake Pad C	133	South
		Cake Pad A	175	Southwest
		OCU (A13)	215	Southwest
R3	Swindon Bus Company (Building façade)	Cake Pad B	79	South southeast
		Cake Pad A	132	South
		Cake Pad C	162	South southeast
		OCU (A13)	179	South
R4	Retail - Service area (Home Bargains)	Cake Pad A	104	South
		Cake Pad B	143	East southeast
		OCU (A13)	160	South
		Cake Pad C	206	Southeast
R5	Supermarket (Lidl)	Cake Pad A	141	Southeast
		Cake Pad B	220	East southeast
		OCU (A13)	230	Southeast
R12	Industrial Yard	OCU (A12)	167	Northeast
		Cake Pad A	204	Northeast

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 two potential sources of bioaerosol release within 250m of static receptors:

- Odour Control Units (A12 and A13)
- Cake Pads (A, B and C).

The closest sensitive receptors to potential bioaerosols emission sources are within and 53m of Cake Pad B (receptor R2). The closest receptor to Cake Pad A (in continuous use) is approximately 104m and is R4. The receptors within 250m of potential bioaerosol emission points are situated predominantly South or West of identified emission sources and are upwind of the prevailing wind direction at the site, which is West southwest to Southwest. The frequency of an effective pathway is therefore small. Receptor R12 is 167m and 204m respectively, from OCU point emission (A13) and Cake Pad A and is down-wind of the prevailing wind direction. The dilution effect as a result of the dispersion distance would reduce the concentration of a release and there is some screening by vegetation at the site boundary.

The daily throughput of sludge is greater than 429m^3/day (equivalent to 429 tonnes per day). The fully digested sludge is dewatered however, the sludge cake remains damp as it passes from the presses onto Cake Pad A. The moisture content in the cake prevents it drying out and the cake forms a crust after 24 hours in storage, so does not give rise to dust readily. The sludge cake is shovelled to storage areas on Cake Pad A, B or C and is not disturbed, until it is removed for export, further minimising the potential to generate bioaerosols emissions to air. The bioaerosol content within the digested sludge cake is low as a result of the treatment processes prior to storage.

In addition to this, the 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 is two types of odour control, a two-stage biofilter and activated carbon scrubber and a single stage biofilter. Given the type of OCU, the likelihood of bioaerosol release is anticipated to be very low.

The probability of exposure from bioaerosols generated from the permitted processes on site is considered to be **Medium.** However, when considering the location of receptors, receptor distances from source, the prevailing wind direction and the onsite management and mitigation measures in place, the overall risks of bioaerosols being generated from the permitted processes on site is likely to be **Low** to **Very Low**.

Planned monitoring of bioaerosol emissions by Thames Water is expected to validate the expectation that process contributions of bioaerosols from sewage sludge treatment works, would comply with the 'acceptable level' thresholds, set out within EA guidance.

Table 3 summarises the risk assessment.

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

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	What is the harm that can be caused? Consequence	Control Measures Managing the Risk	Overall / Residual risk
Cake Pad A	Inhalation via wind-borne transportation	R1, R2, R3, R4, R5, R12	Receptor R4 is the closest receptor to Cake Pad A at approximately 104m. Other receptors are set further back and would receive lower concentrations in the event of a release. The closest receptors are upwind and frequency of wind directions from the Northeast is much smaller in relation to the prevailing wind direction. The concrete wall surrounding the Pad reduces the likelihood of wind-blown transmissions during handling or export. Bioaerosol content is considered to be small and colony forming units anticipated to be within acceptable levels. Probability of exposure is considered to be **medium**.	Impact on human health (considered to be a sensitive receptor).	The cake conveyors are covered, reducing likelihood of bioaerosol release. The cake conveyor and dozer drop heights are minimised to reduce wind borne transportation during deposition, handling and movement off site. Water content in the cake reduces susceptibility of wind-borne releases. Sludge cake is moved when required to minimise disturbance on the pad. The cake pad is bunded and stockpile levels are managed so that under normal operating conditions it does not exceed the height of the surrounding bund wall. Spillages are cleaned up in a timely manner to reduce generating windblown bioaerosols.	Low
Cake Pad B		R2, R3, R4, R5	Receptor R2 is the closest receptor to Cake Pad A at approximately 53m. Other receptors are set further back and would receive lower concentrations in the event of a release.		Dozer drop heights are minimised to reduce wind borne transportation during handling and movement around the site.	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	What is the harm that can be caused? Consequence	Control Measures Managing the Risk	Overall / Residual risk
			The closest receptors are upwind and frequency of wind directions from the Northeast is much smaller in relation to the prevailing wind direction. The concrete wall surrounding the Pad reduces the likelihood of wind-blown transmissions during handling or export. Bioaerosol content is considered to be small and colony forming units anticipated to be within acceptable levels. Probability of exposure is considered to be **medium**.		Water content in the cake reduces susceptibility of wind-borne releases. Sludge cake is moved when required to minimise disturbance on the pad. The cake pad is bunded and stockpile levels are managed so that under normal operating conditions it does not exceed the height of the surrounding bund wall. Spillages are cleaned up in a timely manner to reduce generating windblown bioaerosols.	
Cake Pad C		R2, R3, R4	R2 is the closest receptor to Cake Pad C, at approximately 133m. Other receptors are set further back and would receive lower concentrations in the event of a release. The closest receptors are upwind and frequency of wind directions from the Northeast is much smaller in relation to the prevailing wind direction. The Pad is used to store unfit sludge, which is removed expediently. The likely source of emissions from this is lower than A or B, due to less frequent use.	Impact on human health (considered to be a sensitive receptor).	Dozer drop heights are minimised to reduce wind borne transportation during handling and movement around the site. Water content in the cake reduces susceptibility of wind-borne releases. Sludge cake is moved when required to minimise disturbance on the pad. The cake pad is bunded and stockpile levels are managed so that under normal operating conditions it does not exceed the height of the surrounding bund wall.	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	What is the harm that can be caused? Consequence	Control Measures Managing the Risk	Overall / Residual risk
			Concrete wall surrounding the Pad reduces the likelihood of wind-blown transmissions during handling or export. Bioaerosol content is considered to be small and colony forming units anticipated to be within acceptable levels. Probability of exposure is considered to be **medium**.		Spillages are cleaned up in a timely manner to reduce generating windblown bioaerosols.	
Odour Control Units	Inhalation via wind-borne transportation	R2, R3, R4, R5, R12	The closest receptor (R4) is approximately 160m from OCU (A13) in a southerly direction. It is neither upwind nor downwind (of prevailing WSW to SW wind direction). The frequency of winds from a northerly direction are small, therefore a lower probability of a release blowing towards sensitive receptors. Other receptors are set further back. Closest receptors within 250m of an OCU and downwind of the prevailing wind direction are represented by R12, which is approximately 167m from OCU (A12). Mature treeline/ hedgerow offers some screening between sensitive receptors and the site. Probability of exposure from the biofilter OCUs is considered to be **low**	Impact on human health (considered to be a sensitive receptor).	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. The OCU is a two-stage biofilter unit, with the final state being an activated carbon absorber, which is designed to achieve a stack standard of <= 1000 $OuEm^3$. In addition, the OCU is monitored and regularly maintained making the uncontrolled release of bioaerosols very unlikely. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure.	Very 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 Emergency Flare and/or CHP Engine. 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 holder compound, which would release bioaerosols. This occurs to prevent over pressurisation of the digesters and gas systems. 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/ community spaces from bioaerosols arising from operations at the Swindon 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, magnitude, and duration of exposure. This considered control measures in place to reduce the probability or magnitude of release.

A number of potential sources of bioaerosols within the site processes have been identified, connected to the storage and movement of treated digestate sludge cake at the site and the operation of the 2-stage bio-filter odour control units. The risk from abnormal releases from pressure relief valves was scoped out.

Although only qualitative data is available at this stage, the overall bioaerosol risk to the identified, receptors within 250m of potential bioaerosol sources associated with the sludge treatment process is considered to be **Low** to **Very Low** based on the receptor distances, probability of exposure and onsite management and maintenance, which would minimise the magnitude of any releases.

3.1 Sampling

Thames Water confirms it will use MCERTS accredited providers for the sampling from location A12 – OCU 6 (NGR SU 13161 85639) A13 – OCU 3 (NGR SU 13179 85586) and will sample each OCU on a bi-annual basis.

In addition, sampling will also take place in relation to:

- Cake Pad A SU 1318 8556 (approx. NGR of centre of cake pad)
- Cake Pad B: SU 1307 8548 (approx. NGR of centre of cake pad)
- Cake Pad C: SU 1302 8555 (approx. NGR of centre of cake pad)

Which are diffuse source and hence will be monitored purely by agar plates.

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 the 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
OCU 6	SU 1311 8563	SU 1321 8564	SU 1320 8567	SU 1320 8562
OCU 3	SU 1313 8557	SU 1322 8559	SU 1321 8561	SU 1322 8556
Cake Pad A	SU 1314 8555	SU 1323 8559	SU 1324 8557	SU 1323 8554
Cake Pad B	SU 1302 8547	SU 1311 8552	SU 1312 8549	SU 1312 8546
Cake Pad C	SU 1298 8554	SU 1307 8559	SU 1308 8556	SU 1307 8554

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

KEY:

Site Location

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Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	JUL 2021	FOR INFORMATION	AR	MM	JK	MM

Jacobs
Jacobs House, Shrewsbury Business Park, SY2 6GG
Tel:+44(0)1743 284 8000 Fax:+44(0)1743 284 800
www.jacobs.com

Client: Thames Water

Project: STC IED PERMIT
SWINDON STW

Drawing title: FIGURE 1
SITE LOCATION PLAN

Drawing status: PERMITTING

Scale	1:25,000	DO NOT SCALE
Jacobs No.	B22849AM	Rev P01
Client no.		

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

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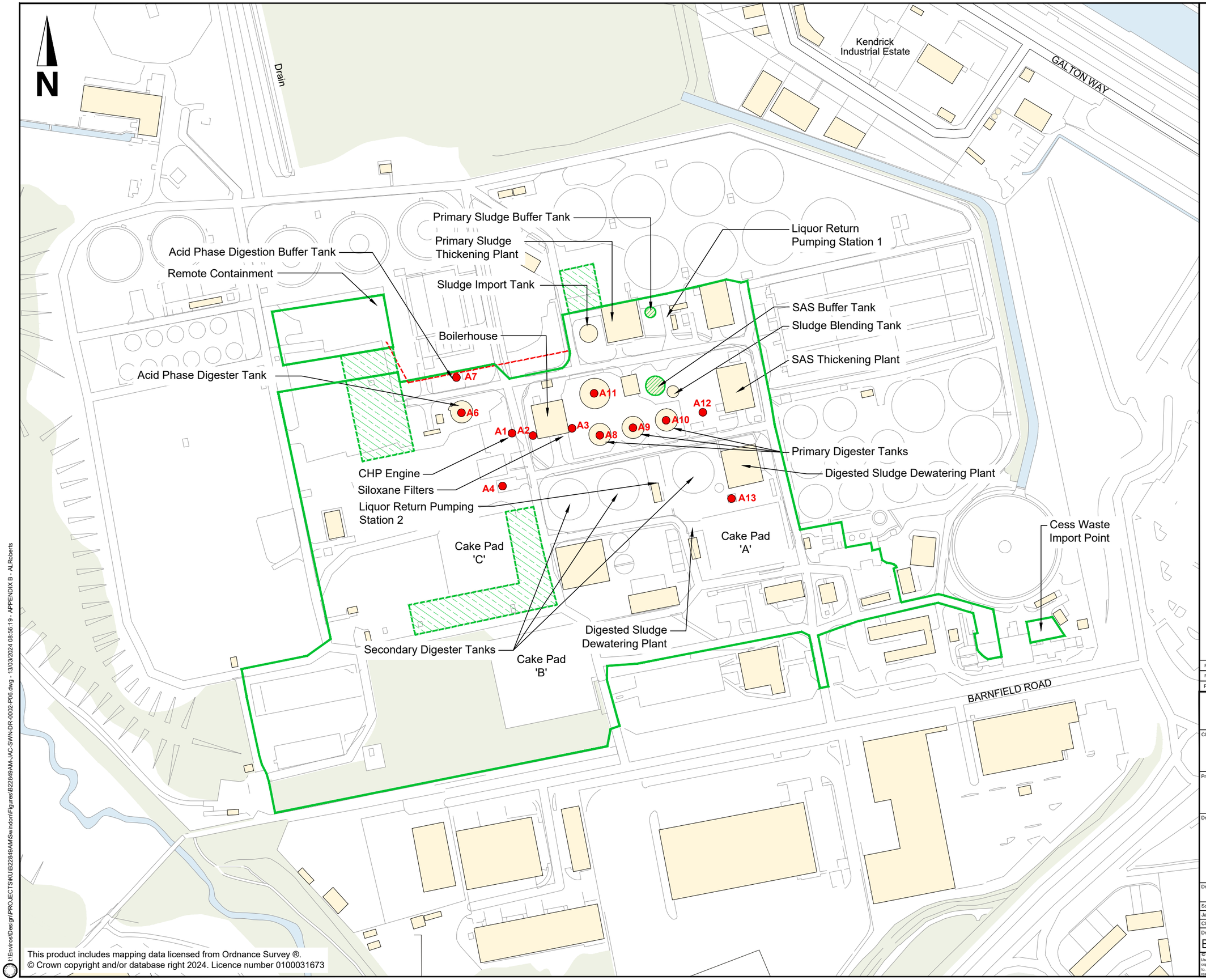
Appendix B. Installation Boundary and Air Emission Points



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KEY:

- Installation Boundary
- Tanks Excluded from Permit Scope
- Spill Transfer Pipework
- Area of future expansion under sludge growth AMP investment. Areas will form part of the permit upon completion of commissioning

A1 - CHP Engine
A2 - Auxiliary Boiler 1
A3 - Auxiliary Boiler 2
A4 - Auxiliary Flare
A6 - Acid Phase Digester Tank PRV
A7 - Acid Phase Digestion Buffer Tank PRV
A8 - Primary Digester Tank PRV
A9 - Primary Digester Tank PRV
A10 - Primary Digester Tank PRV
A11 - Biogas Storage PRV
A12 - OCU 6
A13 - OCU 3

0 20 40 60 80 100
METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P03	MAR. 2024	FOR INFORMATION	AR	JK	JK	MM
P02	NOV. 2023	FOR INFORMATION	AR	JK	JK	MM

Jacobs
1180 Eskdale Road, Winnersh, Reading RG41 5TU
Tel:+44(0)118 946 7000
www.jacobs.com

Client: Thames Water

Project: STC IED PERMIT
SWINDON STW

Drawing title: APPENDIX B
INSTALLATION BOUNDARY
AND AIR EMISSION POINTS

Drawing status: PERMITTING

Scale	1:2000 @A3	DO NOT SCALE
Jacobs No.	B22849AM	Rev P03
Client no.		

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

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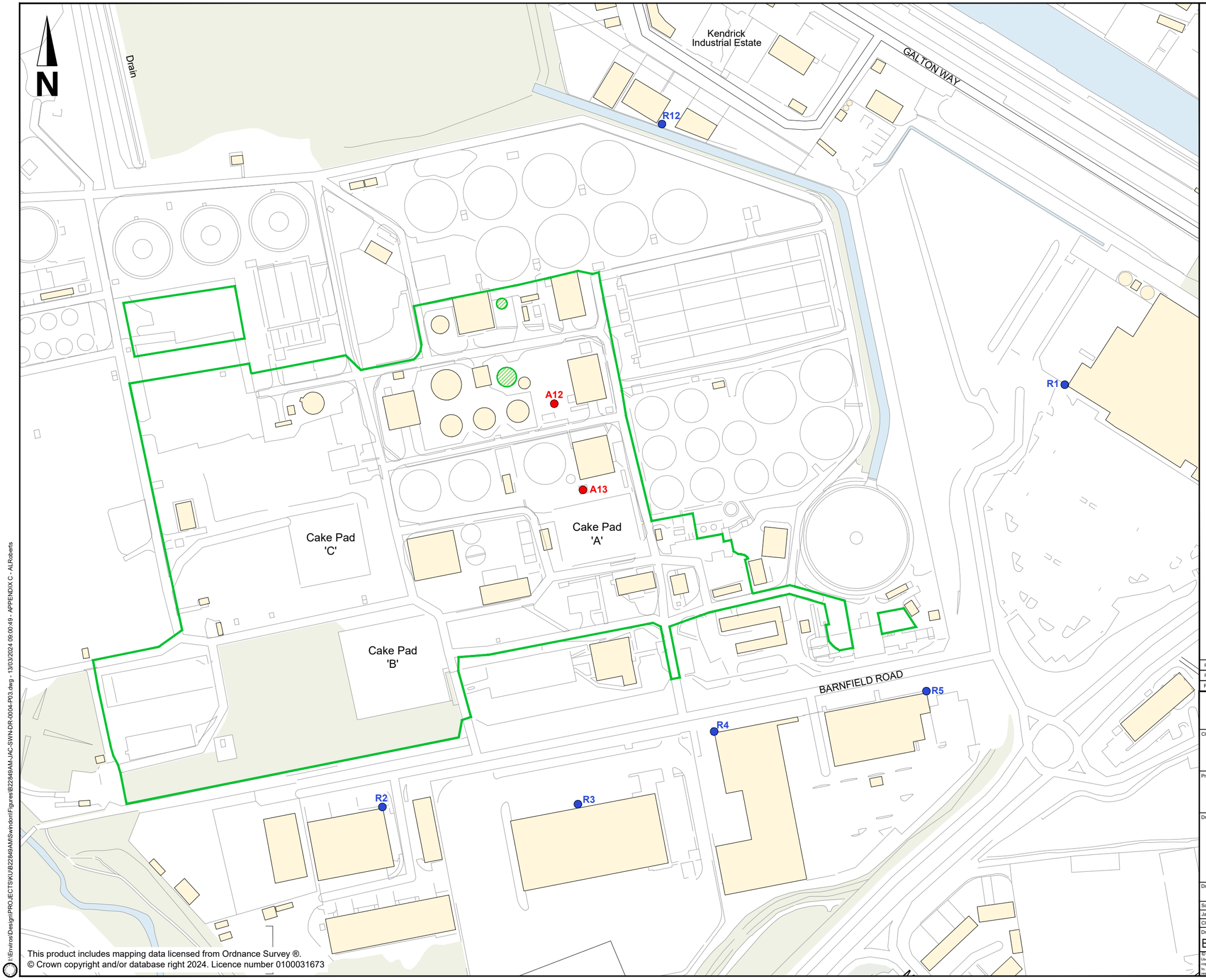
Appendix C. Receptors within 250m of Potential Bioaerosol Emission Sources



KEY:

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

A12 - OCU6
A13 - OCU3

0 20 40 60 80 100
METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P03	MAR. 2024	FOR INFORMATION	AR	JK	JK	MM
P02	NOV. 2023	FOR INFORMATION	AR	JK	JK	MM

Jacobs
1180 Eskdale Road, Winnersh, Reading RG41 5TU
Tel:+44(0)118 946 7000
www.jacobs.com

Client: Thames Water

Project: STC IED PERMIT
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Drawing title: APPENDIX C
RECEPTORS WITHIN 250m OF POTENTIAL BIOAEROSOL EMISSION SOURCES

Drawing status: PERMITTING

Scale	1:2000 @A3	DO NOT SCALE
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