ARUP

Dŵr Cymru Welsh Water

Pont-y-felin

Odour Assessment

Reference: B16789-102503-XX-XX-SP-PA-PR6702

First Draft | 24 February 2023

Job number 275292

Ove Arup & Partners Limited
4 Pierhead Street
Cardiff
CF10 4QP
United Kingdom
arup.com

ARUP

Document Verification

Project title	Pont-y-felin
Document title	Odour Assessment
Job number	275292
Document ref	B16789-102503-XX-XX-SP-PA-PR6702
File reference	4-50

Revision	**Date**	**Filename**	Pont-y-felin Odour Assessment Draft 1		
P1	24 February 2023	**Description**	First Draft		
			Prepared by	**Checked by**	**Approved by**
		Name	Emily Portergill	Cat Dixon	James Bellinger
		Signature			
		Filename			
		Description			
			Prepared by	**Checked by**	**Approved by**
		Name			
		Signature			

Issue Document Verification with Document ☑

Figures

Drawings

No table of figures entries found.

Pictures

No table of figures entries found.

Photographs

No table of figures entries found.

Attachments

No table of figures entries found.

Executive Summary

Arup have undertaken detailed odour dispersion modelling to predict potential changes to odour levels in the vicinity of the Pont-y-felin Combined Storm Overflow (CSO) before and after improvement works.

Overall, the results documented in this report demonstrate that the predicted odour levels at sensitive receptors are below the EA thresholds commonly used to assess odour nuisance and annoyance.

Following the Environment Agency's H4 Odour Management document[4], the modelling method commonly used in the UK calculates a 98th percentile of hourly average odour concentrations over a year. As such, the 98th percentile value was used to represent the results in the odour assessment.

The proposed scheme is predicted not to result in significant impacts of odour. The maximum odour impact at a residential receptor is predicted to be 0.10 OU_E/m^3 as a result of the proposed reedbed. For reference, the Environment Agency Guidance H4 suggests that, for odours classified as "Moderately Offensive", a max level of 3 OU_E/m^3 can be adopted as an upper bound value.

1. Introduction

Ove Arup and Partners Ltd (Arup) has been commissioned by Dŵr Cymru Welsh Water (DCWW) to undertake a detailed odour assessment to predict the odour levels in the vicinity of the Pont-y-felin Combined Storm Overflow (CSO) before and after improvement works (herby referred to as the proposed scheme).

This report covers the following aspects:

- Background information relating to odour standards and guidance;
- Odour modelling of the existing CSO, using library[1]odour emission rates to determine the odour impacts at the site;
- Odour modelling of the operation of the proposed scheme, reed bed channel, reed beds and wetland system was carried out using library[1] odour emission rates to determine the odour impact at the site;
- Summary of all evidence to provide conclusions on the likely odour environment for the proposed scheme.

1.1 Site details

The site is located in New Inn, Pontypool. The CSO sits within the Ponthir Wastewater Treatment Works (WwTW) sewer catchment, and currently discharges to the Afon Lwyd. The CSO has been identified as operating at too high a frequency and a solution has been developed to mitigate its environmental impact. The proposed solution involves a Nature Based Solution (NBS) to treat the effluent to an improved standard before discharging into the Afon Lwyd river. The NBS compromises of a reedbed and wetland system. The new screening chamber and new overflow chamber proposed are typical wastewater network elements. The site boundary can be seen in Figure 1.

The main processes identified on the site that could result in odour due to the proposed scheme are:

- Outfall – the discharge point of flow into the Afon Lwyd;
- Reed bed channel – a engineered covered channel to evenly distribute and present the flows to the reed bed; and
- Reed bed and wetland system – a natural wastewater treatment system that uses bacteria, fungi and micro-organisms to breakdown, digest and clean wastewater to the point where it can be safely discharged.

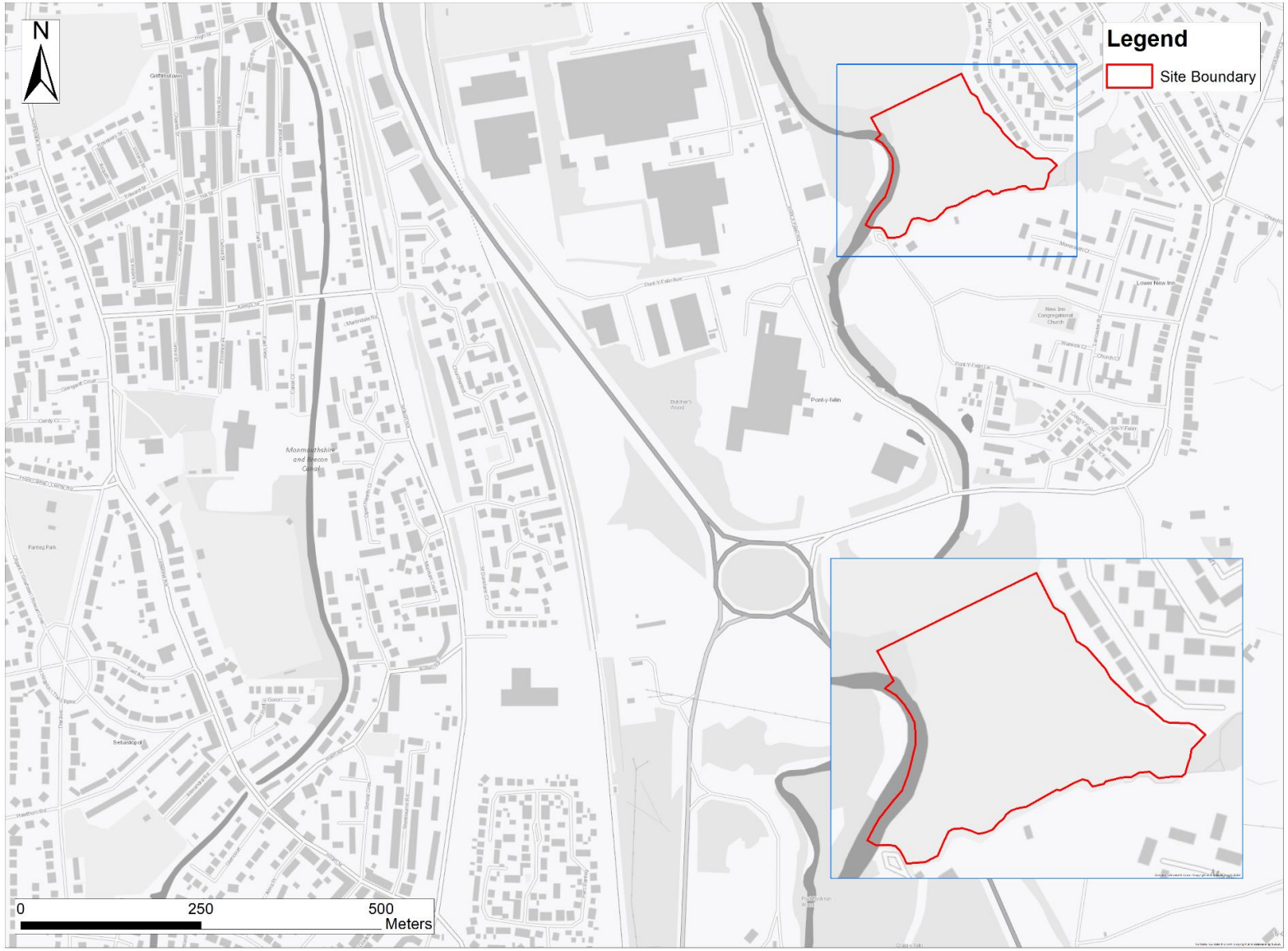
The new CSO screening chamber and overflow chambers have not been included within the assessment as the screening chamber and overflow chambers will be located underground with solid sealed covers installed to mitigate against the egress of odour and gasses.

1.2 Overview of complaint history

Dŵr Cymru Welsh Water were approached to understand if any odour complaints had been made by existing residents in relation to the current CSO in recent years. DCWW confirmed that the site has had no formal complaints. The local authority, Torfaen County Borough Council, were not contacted directly, it has been assumed that any odour nuisance within the area that were reported to the council, would be escalated to the asset owner (DCWW). DCWW record all odour complaints and issues. In addition to this a baseline odour survey was undertaken, providing further evidence that there is no existing odour issues. The baseline odour survey results can be found in Appendix A.

[1] Odour Emissions Database – available at: https://www.odourconsultant.co.uk/odour-emissions-database/ [Accessed January 2023]

Figure 1 Site boundary



2. Odour guidance

Odour is a mix of volatile chemical compounds or a single compound that triggers a reaction in the olfactory organ, generally at very low concentrations. Any odour, whether considered to be pleasant or unpleasant, can result in a loss of amenity for occupiers of property if it is unwanted. If the odour is perceived sufficiently often above a threshold level, a statutory nuisance can be considered to exist. Odour can therefore be an important issue in planning when a proposal is made to locate sensitive uses close to an existing odorous process. The National Planning Policy Framework in paragraph 120 also notes that "planning decisions should ensure that new development is appropriate for its location" and "the potential sensitivity of the area or proposed development to adverse effects from pollution should be taken into account".

2.1 Relevant guidance

As noted in the Defra Code of Practice on Odour Nuisance from Sewage Treatment Works[2] (which was withdrawn in 2017, but has not yet been replaced) odour can be characterised by four attributes:

- Concentration: the "amount" of odour present in a sample of air. It can be expressed in terms of parts per million, parts per billion or in mg/m^3 of air for a single odorous compound. More usually a mixture of compounds is present and the concentration of the mixture can be expressed in odour units per cubic metre. Odour concentration is measured in European odour units (OU_E/m^3). The odour concentration at the detection threshold is defined to be 1.0 OU_E/m^3. If an odour sample has been diluted in an olfactometer by a factor of 10,000 to reach the detection threshold, then the concentration of the original sample is 10,000 odour units;
- Intensity: is the magnitude (strength) of perception of an odour (from faint to strong). Intensity increases as concentration increases but the relationship is logarithmic rather than linear so increases or decreases in concentration of an odour do not always produce a corresponding proportional change in the odour strength as perceived by the human nose;
- Quality/Characteristics: this is a qualitative attribute which is expressed in terms of "descriptors", e.g. "fruity", "almond", "fishy". This can be of use when establishing an odour source from complainants' descriptions; and
- Hedonic tone: this is a judgement of the relative pleasantness or unpleasantness of an odour made by assessors in an odour panel. This provides a method to differentiate odours considered to be pleasant (e.g. bakeries) from those considered to be unpleasant (e.g. rotting fish).

The Defra Odour Guidance for Local Authorities[3] (also withdrawn September 2017, but has not yet been replaced) notes that 5.0 OU_E/m^3 would be a 'faint' odour whilst 10.0 OU_E/m^3 would be considered a 'distinct' odour. Generally, an average person would be able to recognise the source of an odour at about 3.0 OU_E/m^3 although this can depend on the relative offensiveness of the odour.

It should be noted that there is no statutory limit in England and Wales for ambient odour concentrations[3] whether set for individual chemical species or for mixtures. However, guideline limits and custom-and-practice standards have been used in some circumstances and there is some experience from other planning decisions.

[2] Defra, Code of Practice on Odour Nuisance from Sewage Treatment Works, 2006

[3] Defra, Odour Guidance for Local Authorities, March 2010

2.1.1 Environment Agency H4 Guidance

The Environment Agency H4 Odour Management document[4] gives "Benchmark Levels" for odour modelled over a year at the proposed development site/installation boundary. The benchmarks are based on the 98th percentile of hourly mean concentrations over a year and are as follows:

- 1.5 OU_E/m^3 for most offensive odours;
- 3.0 OU_E/m^3 for moderately offensive odours;
- 6.0 OU_E/m^3 for less offensive odours.

The 98th percentile value is the parameter used for all currently applied odour standards and unless otherwise stated, all odour concentrations within this report are expressed as the 98th percentile value.

The H4 document states that *"any modelled results that project exposures above these benchmark levels, after taking into account uncertainty, indicates the likelihood of unacceptable odour pollution".*

The guidance provides examples of the different levels of offensive odours which are detailed in Table 2.1.

The document also notes factors that are relevant to sewage handling works. On the basis of the H4 guidance, the level of acceptable odour near a sewage handling works is likely to lie in the range 1.5-3.0 OU_E/m^3, typically a standard of 3.0 OU_E/m^3 is accepted by DCWW as the flow has been classified as moderately offensive odours.

Table 2.1 Examples of activities and their offensiveness

Level of offensiveness	Activities
Most offensive	Processes involving decaying animal or fish remains Processes involving septic effluent or sludge Biological landfill odours
Moderately offensive	Intensive livestock rearing Fat frying (food processing) Sugar beet processing Well aerated green waste composting
Less offensive	Brewery Confectionery Coffee roasting Bakery
Note: Source Environment Agency H4 Guidance[4]	

2.1.2 Relevant planning appeals

Experience from other more recent planning appeals concerning residential development near sewage works suggest that levels of odour considered to be acceptable are below 5.0 OU_E/m^3 as a 98th percentile and on three recent occasions (including most recently in 2016) a level of 3.0 OU_E/m^3 has been accepted and on one occasion a level of 1.5 OU_E/m^3 was used and accepted. These include:

- Land at Stoke Road, Leighton Linslade, APP/P0240/A/09/2110667, in this inquiry the Inspector considered that a level of 5.0 OU_E/m^3 "could be a risk of regular and unacceptable odour annoyance to such an extent that it would detract from the future resident's living conditions";

[4] Environment Agency (2011), H4 Odour Management

- Low Road, Cockermouth, Cumbria CA13 0XE, APP/G0908/A/11/2151737, the inspector concluded that "should odours fall within medium offensiveness, rather than low, (i.e. 3.0 OU_E/m^3) level modelled by the appellant indicates that it would not impinge on the appeal dwellings" (i.e. 3.0 OU_E/m^3 represented acceptable odour conditions).
- Land between Upthorpe Road and Hepworth Road, Stanton, APP/E3525/A/11/2162837, the inspector concluded that "I consider that a more appropriate threshold in this case is 3.0 – 5.0 OU_E/m^3, the level of the Defra guidance's "faint odour". He did note that this was for a small sewage works.
- The Planning Inspectorate, Appeal Ref: APP/N1215/W/15/3005513, Land South of Le Neubourg Way, Gillingham, Dorset, March 2016. The Inspector wrote: "…..I conclude that the appropriate parameter to apply in this case is the 3.0 OU_E/m^3 contour line; a more restrictive approach would preclude from development areas which are comparable in odour terms with extensive areas of existing housing in Gillingham."

It should be noted that evidence presented at these appeals does not contain any new fundamental research on the relationship between odour concentrations and perceived annoyance. Therefore, these appeal decisions can only be regarded as interpretations of other studies.

2.1.3 IAQM odour and planning guidance

The Institute of Air Quality Management (IAQM) has published guidance[5] for assessing odour impacts (on amenity) for planning purposes. This includes information on various assessment methods to be used to undertaken odour assessments for planning.

The guidance states that for assessing site suitability of proposed development land (e.g. residential) around an existing odour source, the odour effect would normally be assessed using predictive methods (which may be qualitative or modelling). Atmospheric dispersion modelling should use source terms that have been measured by Dynamic Dilution Olfactometry or if not available, use literature values.

The modelling will provide predicted concentrations (OU_E/m^3) as a 98th percentile of 1-hour means. The guidance recommends that in terms of comparing predicted concentrations with odour assessment criteria, practitioners should observe from the various scientific studies, case law and practical examples of the investigation of odour annoyance cases and then determine an appropriate criterion. This criterion could lie somewhere in the range of 1.0 to 10.0 OU_E/m^3 as a 98th percentile of hourly mean odour concentrations.

The guidance considers odour assessment approaches including dispersion modelling where it notes in Section 4.1 that "*Even when the model is a good representation of the real situation and the assumptions and input data are reasonable, the uncertainty for predictions from dispersion modelling can be considerable*". The guidance therefore recommends a "multi-tool" assessment approach – i.e. an assessment approach that uses at least two methods to assess the odour impacts.

Section 6 of the IAQM guidance provides advice on drawing conclusions from assessment results. It notes that:

"the conclusion on the overall significance of likely odour effects will usually involve the practitioner drawing together the findings of several different odour assessment tools, each of which will have their own inherent strength and weakness and uncertainties";

It notes that this "weight of evidence" approach differs from normal assessment which or usually based on the results of one (usually dispersion modelling) assessment tool. The IAQM guidance advises that when coming to a conclusion regarding the odours impact, the right weight to the results provided by each tool needs to be given based on how well suited it is to the study scenario.

It particularly notes that for an existing activity or process, observations are possible regarding what is happening "on the ground" and that considerable weight should be placed on the findings of community

[5] IAQM (2014) Guidance on the assessment of odour for planning.

based tools such as complaints analysis, community surveys and odour diaries. Dispersion modelling can be used as a supporting tool if this provides value to the study.

The IAQM guidance therefore strongly cautions on basing an assessment of an existing process only on the use of dispersion modelling and suggests that observations in the community should carry more weight.

One alternative approach to modelling suggested is the use of a Source-Pathway-Receptor (SPR) model and is one of the approaches used in this assessment. The risk of an adverse odour impact is determined by examining the source characteristics, how effectively the odours can travel from the Source to a Receptor (i.e. the Pathway) and examining the sensitivity of the Receptor. Example risk factors presented in the guidance are shown in Table 2.2.

Table 2.2 Example risk factors for the SPR assessment methodology

Source Odour Potential	Pathway Effectiveness	Receptor
Factors affecting the source odour potential include: The magnitude of the odour release How inherently odorous the compounds are The unpleasantness of the odour	Factors affecting the odour flux to the receptor are: Distance from source to receptor The frequency of winds from source to receptor The effectiveness of any mitigation in reducing flux to the receptor The effectiveness of dispersion/dilution in reducing the odour flux to the receptor Topography and terrain	Use professional judgement based on the expectation of the users at the receptor location.

2.1.4 Other relevant guidance and research

CIWEM has produced a Policy Position Statement[6] on odours which states that for a level of less than 3.0 OU_E/m^3, "complaints are unlikely to occur and exposure below this level are unlikely to constitute significant pollution or significant detriment to amenity unless the locality is highly sensitive or the odour highly unpleasant in nature".

UK Water Industry Research (UKWIR)[7] published a study in 2001 that examined modelled odour concentrations and their relationship to complaints around sewage works. This was based on a review of the correlation between reported odour complaints and modelled odour impacts in relation to nine wastewater treatment works in the UK with ongoing odour complaints. The findings of this research indicated the following:

- At modelled exposures of below 5.0 OU_E/m^3, complaints are relatively rare, at only 3% of the total registered;
- At modelled exposures between 5.0-10.0 OU_E/m^3 , a significant proportion of total registered complaints occur; (38% of the total);
- The majority of complaints occur in areas of modelled exposure greater than 10.0 OU_E/m^3, 59% of the total.

There is some consistency within these sources but it must be recognised that all these studies are based on limited information. As noted in the H4 guidance, any assessment not only has to take into account the applicable standard but also the uncertainty inherent within the assessment.

The works being assessed in this modelling are not as intrusive as a wastewater treatment site however, the odour emission levels are considered relevant to this study due to the material being treated.

[6] http://www.ciwem.org/policy-and-international/policy-position-statements/control-of-odour.aspx

[7] UKWIR Odour Control in Wastewater Treatment – A Technical Reference Document Report 01/ww/13/3, 2001.

3. Assessment methodology

The AERMOD atmospheric dispersion model (version 15181) has been used to carry out this assessment. AERMOD is widely accepted for use in the UK. AERMOD was run from the ADMS version 5.2 interface.

Dispersion models require input details of the emission sources, meteorological data and receptor details. Details of the input data used for this assessment are provided in the following sections.

3.1 Odour sources

Existing scenario

The existing scenario has considered odour generated by the current operating CSO on site as well as impacts from the existing outfall. Suitable emission rates were obtained from an odour emissions database[1] determined using professional judgement, based on the best available information at the time of writing. The locations of the sources are shown in Figure 2. Table 3.1 shows the emission parameters associated with the existing CSO and existing outfall. Emissions are in units of $OU_E/m^2/s$.

The existing CSO is located underground, accessible via a steel cover, odour sources are assumed to escape via the access covers of the CSO. Sources have been modelled as open area sources i.e. without sealed access covers installed, which therefore provides a conservative approach. Typically, an underground CSO with sealed covers would not be modelled, however to assess a worst case scenario and to obtain a baseline odour emission rate, it has been included in this assessment as an open source. The rest of the sewage network is covered and underground and is not an issue as a result and therefore has not been included in this assessment.

Table 3.1 Existing odour emission rates

Source	Type of sewage	Emission rate ($OU_E/m^2/s$)	Area (m^2)	OU/s	OU/day	Frequency of use
CSO	Unscreened sewage	20[a]	0.76	15.2	1,313,280	All year
Existing outfall	Diluted sewage	1.9[b]	0.44	0.8	72,230	138 times spill a year

Note: [a] Median value for detritors collected from different waste water facilities, obtained from an odour emission database[1]

[b] Median value for storm tanks collected from different waste water facilities, obtained from an odour emission database[1]

Proposed scheme

The proposed scheme odour assessment has considered odour generated from the existing outfall, reedbed channel and reedbed and wetland system. The locations are shown in Figure 2. Some adjustments and simplification of geometries are required for the input into the dispersion model. The emission parameters associated with the proposed scheme are detailed in Table 3.2. Odour sources have been assumed to escape via access covers where appliable and all sources have been modelled as open area sources and therefore, modelling provides a conservative assumption.

Based on professional judgement, a median value for percolating filters collected from different wastewater activities has been used as a proxy for the reed bed channel, as a conservative approach. The reed bed channel contains screened storm effluent flows therefore, it will have a lower odour emission rate than the new overflow chamber, outlined in Table 3.2.

A dilution rate of sewage input into the primary reed bed was calculated based on the volume of sewage and the volume of water in the primary reed bed. This provided a dilution factor of 0.00017 which was then used as a ratio for the median value for percolating filters, which is used as a proxy value. The secondary reed bed contains treated flows, therefore a lower emission rate has been applied.

Table 3.2 Proposed scheme odour emission rates

Source	Type of sewage	Emission rate ($OU_E/m^2/s$)	Area (m^2)	OU/s	OU/day	Frequency of use
Outfall	Very diluted sewage	0.9[a]	0.44	12.4	1,071,533	138 times spill a year
Reed Bed Channel	Screened storm effluent flows	0.9[a]	55	49.5	4,276,800	All year
Primary Reed Bed	Screened storm effluent flows	0.000153	3400	0.5	44,945	All year
Secondary Reed Bed	Treated storm effluent flows	0.000085	2650	0.2	19,462	All year

Note: [a] Median value for percolating filter collected from different waste water facilities, obtained from an odour emission database[1]

To ensure that the conditions remain favourable within the reedbeds routine maintenance checks along with a fully adjustable aeration system will be installed to control reedbed and odour conditions. Aeration will avoid any areas of the reedbed becoming septic which could result in odours being emitted. The following control plan has been applied to the system to prevent septicity:

- Aeration for 24 hours at the start of a spill;
- Aeration for 24 hours after a spill;
- Aeration will activate for 1 hour every 8 hours.

The aerated reed bed is an aerobic bioreactor. It is aerated to create a stable environment for the bacterial oxidation of reduced compounds commonly found in wastewater. Normally, odours stem from these reduced compounds that are sulfurous and/or nitrogenous in nature (e.g., Hydrogen Sulfide, Methyl Mercaptan, Dimethyl Sulfide, Ammonia, etc.). Under the “oxic” conditions found in aerobic bioreactors, the reduced, odiferous compounds are oxidized to molecules with much higher odor thresholds (e.g. Sulfate, Nitrate, and Carbon Dioxide). In short, hydrogen molecules are replaced with oxygen molecules rendering the odiferous compounds less noxious. It is for this reason that aeration (oxygen delivery) is critical to the process and will result in negligible odour emissions from the system.[8]

Although the evidence suggests there should be no odour emissions associated with the aerated reed beds, odour emissions from the reed bed channel and the reed bed and wetland system have been added into the model to provide a conservative assessment.

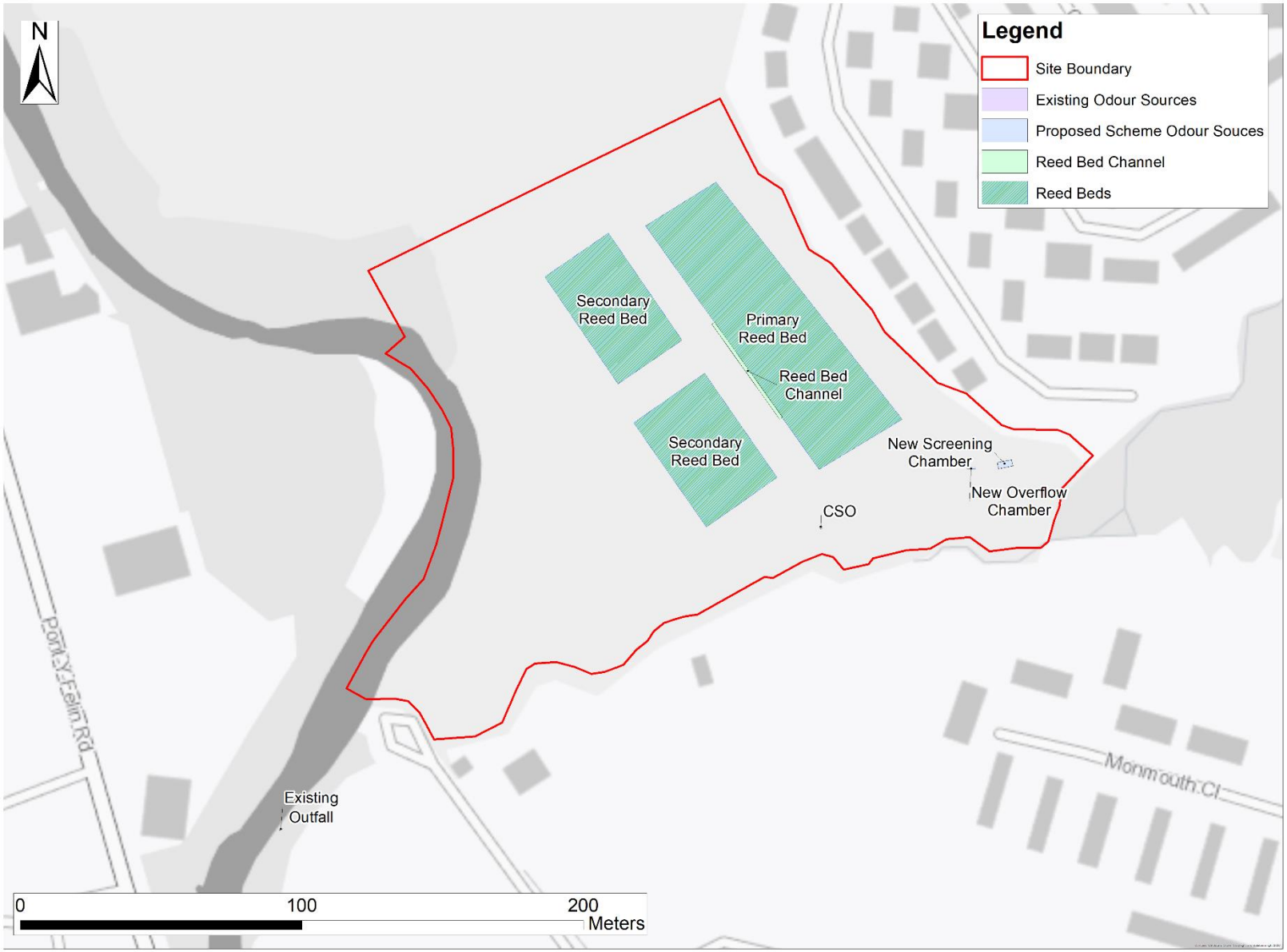
Assumptions and limitations

The following assumptions have been used to model the odour sources:

- odour emission rates for the proposed scheme were not available during the preparation of this assessment, however suitable emission rates were obtained from an odour emissions database[1] determined using professional judgement;
- the existing outfall emission rate is larger than the outfall for the proposed scheme as it is expected the proposed scheme would treat the effluent to an improved standard before discharging into the Afon Lwyd.
- The proposed CSO and Screening chamber will require regular maintenance, it is expected that during maintenance activities the access covers will be open and a minor increase in odour is to be expected. This will be for short durations, and it is not expected that the odour emission rate to exceed 3.0 OUE/m^3 at the nearest receptor.

[8] Information obtained directly from the reed bed suppliers, Natural Wastewater Solutions

Figure 2 Location of the odour sources



3.1.1 Model set-up

All odour sources have been modelled as area sources at ground level, with emissions at ambient temperature and an emission velocity of 0m/s, to represent the diffusive nature of the odour emissions from the sources.

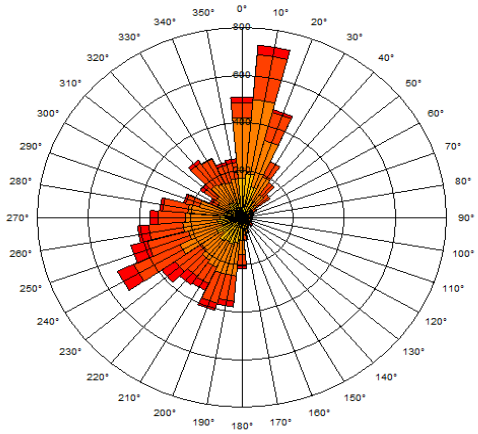
Meteorological data and model parameters

The AERMOD model requires meteorological data as an input. Numerical Weather Prediction (NWP) meteorological data has been used for this assessment, as it is considered to be the most appropriate for this assessment. Observed weather stations nearby are considered to be not representative, as they are affected by the valley effect caused by the Brecon Beacons and the coastal effect from the Severn Estuary. The model was run for each year of meteorological data from 2016 to 2020, the most recent years of data available at the time of writing. The annual 98th percentile of hourly mean odour concentrations for each year was calculated.

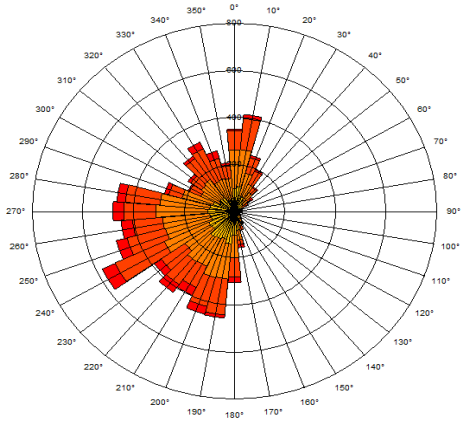
The wind roses derived from the NWP meteorological data used in the study are shown in Figure 3. They show the predominant wind direction is south-westerly with some north north-easterly components.

Figure 3 NWP Wind roses for the site from 2016 to 2020

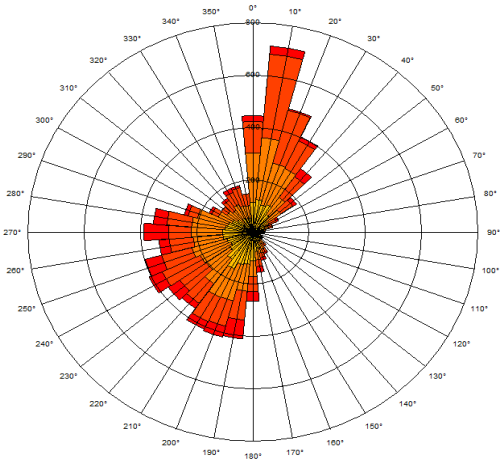
2016



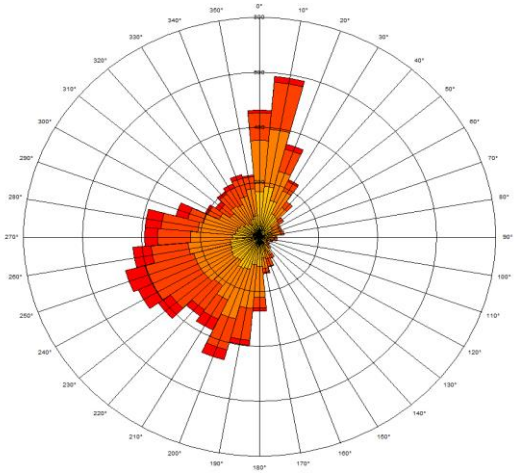
2017



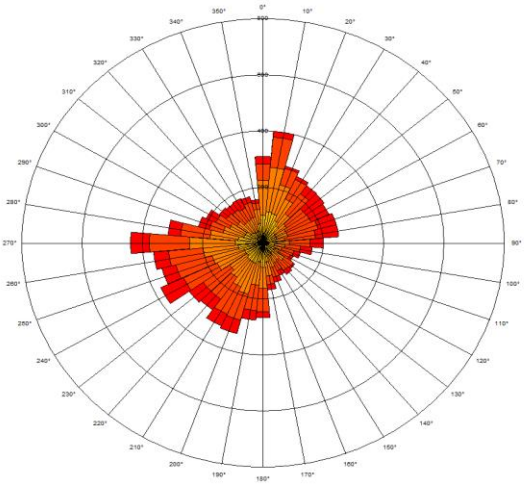
2018

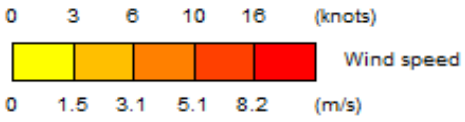


2019



2020





Other values used in the model for the required inputs are shown below:

- Surface roughness: 0.3m at the site, land use in the local study area can be described as open moorland with some small towns and industrial areas
- Monin-Obukhov length: 10m at the site, representing “small towns” <50,000 population
- Surface albedo – 0.23 (model default, representative of ground that is not snow-covered)

Receptors

Modelling has been undertaken to predict impacts at discrete and gridded receptors. Gridded receptors have been modelled using a grid area of 2km x 2km from the centre of the Site Boundary with a grid spacing of 25m and a model height of 1.5m.

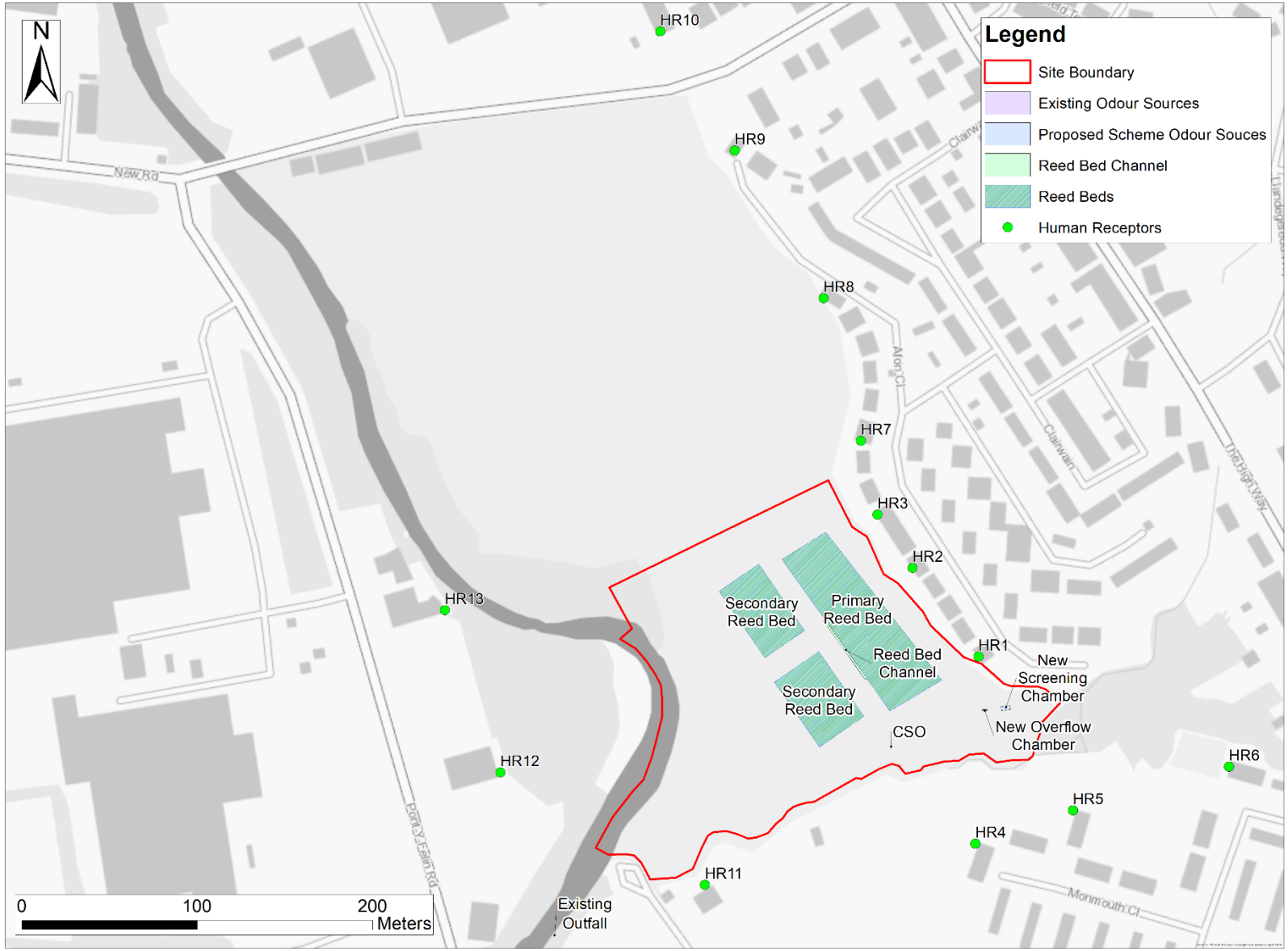
A desk-top study was undertaken to identify the existing sensitive receptors in the vicinity of the site. The closest receptors are on Afon Close (HR1, HR2 and HR3), directly to the east of the site. Receptors have been modelled at a height of 1.5m, corresponding to the average height of human exposure, and increased by increments of 3.0m to represent multiple heights where necessary.

Sensitive receptors have been modelled at the facades of nearby existing buildings (including residential properties and other sensitive locations), as these are closest to the odour sources. Details of human receptors are given in Table 3.3 and their locations are shown in Figure 4.

Table 3.3 Modelled sensitive receptors

ID	Receptor	National Grid Reference		Heights (m)
		X	Y	
HR1	62 Afon Close	330319	199124	4.5
HR2	55 Afon Close	330282	199174	4.5
HR3	50 Afon Close	330262	199205	4.5
HR4	Monmouth Close 1	330320	199016	1.5, 4.5
HR5	Monmouth Close 2	330376	199035	1.5, 4.5
HR6	Lancaster Road	330463	199060	1.5, 4.5
HR7	46 Afon Close	330252	199247	4.5
HR8	37 Afon Close	330231	199328	4.5
HR9	Silver Birches, Afon Close	330180	199412	4.5
HR10	125 New Road	330138	199480	4.5
HR11	Pear Tree Cottage	330163	198994	1.5
HR12	Fraser Lloyd	330047	199058	1.5
HR13	Polo Ground Motor Services	330015	199150	1.5

Figure 4 Modelled sensitive receptors



3.1.2 Assessment of odour emissions

For the existing scenario, the results have been calculated using the 98th percentile hourly odour concentrations for the CSO. For the existing outfall, the results have been calculated taking the frequency of use of the odour source into account (detailed in Table 3.1), using the highest 138 hourly concentrations from the worst case meteorological conditions.

For the operation of the proposed scheme, the results have been calculated using the 98th percentile hourly odour concentrations for the outfall, reedbed channel, reed bed and wetland system. Results have been calculated taking the frequency of use of the odour source into account (detailed in Table 3.2). The highest 138 hourly concentrations from the worst case meteorological conditions were used.

3.2 Odour sampling

A baseline odour survey was undertaken on the 12th January and 1st February 2023. The odour survey comprised spot odour measurement at a number of locations within the site. The sampling included:

- hydrogen sulphide (H_2S);
- subjective observation; and
- measurement of Total Volatile Organic Compounds (TVOC)

4. Dispersion modelling results

4.1 Existing scenario

All receptors were modelled for each year of meteorological data and the combined results from each source are shown below in Table 4.1.

The highest predicted concentrations occur at HR1 (62 Afon Close, a residential receptor). HR1 is approximately 70m north-east of the nearest odour source, the CSO. The highest concentration at HR1 was 0.05 OU_E/m^3 in 2017, well below the 3.0 $OU_E/m^2/s$ threshold commonly used to assess odour nuisance and annoyance[4] and not likely to result in significant impacts.

Table 4.1 Predicted odour concentrations for the existing scenario (OU_E/m^3)

Receptor	Modelled height (m)	98th percentile odour emission rate (OU_E/m^3)*				
		2016	2017	2018	2019	2020
HR1	4.5	0.04	0.05	0.05	0.05	0.03
HR2	4.5	0.02	0.02	0.02	0.02	0.02
HR3	4.5	0.01	0.01	0.01	0.01	0.01
HR4	1.5	0.04	0.04	0.04	0.04	0.02
HR4	4.5	0.04	0.04	0.03	0.04	0.02
HR5	1.5	0.02	0.02	0.03	0.02	0.02
HR5	4.5	0.02	0.02	0.03	0.02	0.02
HR6	1.5	0.01	0.01	0.01	0.01	0.01
HR6	4.5	0.03	0.03	0.01	0.01	0.01
HR7	4.5	0.01	0.01	0.01	0.01	0.01
HR8	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR9	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR10	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR11	1.5	<0.01	0.03	0.03	0.03	0.02
HR12	1.5	0.02	0.02	0.02	0.01	0.01
HR13	1.5	0.01	0.01	0.01	<0.01	<0.01
* results are to 2 decimal places						

4.2 Proposed scheme

4.2.1 Reed bed channel

All receptors were modelled for each year of meteorological data and the combined results from each source are shown below in Table 4.2.

The highest predicted concentrations occur at HR2 (55 Afon Close, a residential receptor). The highest concentration at HR2 was 0.10 OU_E/m^3 in 2017, well below the 3.0 $OU_E/m^2/s$ threshold, commonly used to assess odour nuisance and annoyance[4].

Table 4.2 Sensitivity analysis: predicted odour concentrations from the reed bed channel (OU_E/m^3)

Receptor	Modelled height (m)	98th percentile odour emission rate (OU_E/m^3)*				
		2016	2017	2018	2019	2020
HR1	4.5	0.05	0.06	0.06	0.05	0.04
HR2	4.5	0.09	0.10	0.09	0.10	0.06
HR3	4.5	0.06	0.06	0.06	0.06	0.04
HR4	1.5	0.02	0.01	0.01	0.01	0.01
HR4	4.5	0.02	0.01	0.01	0.01	0.01
HR5	1.5	0.01	0.01	0.01	0.01	0.01
HR5	4.5	0.02	0.01	0.01	0.01	0.01
HR6	1.5	0.01	0.01	0.01	0.01	0.01
HR6	4.5	0.01	0.01	0.01	0.01	0.01
HR7	4.5	0.02	0.02	0.02	0.02	0.02
HR8	4.5	0.01	0.01	0.01	0.01	0.01
HR9	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR10	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR11	1.5	0.01	0.01	0.01	0.01	0.01
HR12	1.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR13	1.5	<0.01	<0.01	<0.01	<0.01	<0.01
* results are to 2 decimal places						

4.2.2 Reed bed and wetland system

All receptors were modelled for each year of meteorological data and the combined results from each source are shown below in Table 4.3.

The highest predicted concentrations occur at HR2 (55 Afon Close, a residential receptor). The highest concentration at HR2 was <0.01OU_E/m^3 in 2016, well below the 3.0 $OU_E/m^2/s$ threshold, commonly used to assess odour nuisance and annoyance[4].

Table 4.3 Sensitivity analysis: predicted odour concentrations from the reed beds (OU_E/m^3)

Receptor	Modelled height (m)	98th percentile odour emission rate (OU_E/m^3)*				
		2016	2017	2018	2019	2020
HR1	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR2	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR3	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR4	1.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR4	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR5	1.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR5	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR6	1.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR6	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR7	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR8	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR9	4.5	<0.01	<0.01	<0.01	<0.01	<0.01

Receptor	Modelled height (m)	98th percentile odour emission rate (OU_E/m^3)*				
		2016	2017	2018	2019	2020
HR10	4.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR11	1.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR12	1.5	<0.01	<0.01	<0.01	<0.01	<0.01
HR13	1.5	<0.01	<0.01	<0.01	<0.01	<0.01
* results are to 2 decimal places						

5. Odour sampling results

The survey results showed that with manhole covers closed, no sewage/wastewater odour was noted by subjective observation for H_2S concentration measurement within the study site and more general surrounding area. The results of the baseline odour survey align with odour modelling results, which are below the 3.0 $OU_E/m^2/s$ threshold commonly used to assess odour nuisance and annoyance.

6. Sensitivity analysis

As noted in the IAQM guidance[5] a multi-tool approach is recommended for odour assessments. This is due to the fact that whilst modelling is a valuable tool there are uncertainties from dispersion modelling and therefore a preference to combine modelling with observational tools to corroborate or check the reasonableness of results is useful.

This assessment did not have site specific odour emission rates as the sources are planned and not yet in operation. Suitable library values were selected and a method for consideration of the dilution of the sewerage in the reed beds was considered.

The uncertainties of the modelling are considered alongside the information provided by the reed bed design team, the on-site survey and complaint data. The key points from each are as follows:

- The design team confirmed that the reed beds would be suitable managed to reduce the risk of odours.
- The on-site survey confirmed the low baseline levels from the existing CSO and confirmed that with the covers in place limited odour was detected.
- No complaints for the current process have been recorded.

Taking the above into account alongside the modelling results the risk from uncertainty of the odour emission rates associated with the proposed development has been considered and the combined results from modelling, review of complaints, design experience and on-site sampling provide confidence in the results.

7. Summary and conclusions

An assessment of odour has been undertaken, using library odour emission rates to determine the likely odour levels in the vicinity of the Pont-y-felin NBS. The modelling was added to with a review of information from the reed bed design team, a review of complaint data and an on-site odour survey.

Odour modelling was undertaken using the AERMOD model and odour emission rates for each of the processes identified on site have been calculated and applied within the model. Conservative assumptions were made in terms of the emission rate values and sources were modelled as open sources (rather than covered). Predicted concentrations were compared with a 98th percentile hourly criterion, following the Environment Agency's H4 Odour Management document[4].

The maximum predicted odour concentration for the existing scenario was 0.05 OU_E/m^3, which was predicted at receptor HR1, 70m north-east of the nearest odour source. The odour emission rate of 0.05 OU_E/m^3 is below the Environment Agency's H4 guidance value of 3.0 OU_E/m^3. The output results from the modelling are aligned with what was observed onsite during the baseline odour survey (Appendix A).

The maximum predicted odour concentration for the proposed scheme was 0.10 OU_E/m^3, which was predicted at receptor HR2, 25m -east of the nearest odour source. The odour emission rate of 0.10 OU_E/m^3 is below the Environment Agency's H4 guidance value of 3.0 OU_E/m^3.

Uncertainty from modelling has been taken into account and modelled results considered alongside observational and design information. The uncertainty from dispersion modelling has been reduced by using the observation data to corroborate the reasonableness of the predictions. The results from the multi-tool approach indicate that it is not expected that the proposed scheme will cause excessive odour emissions to the local community.

Appendix A

Baseline Odour Survey

H&M Environmental Ltd
Aikrigg Barn
Beckside
Killington
Carnforth
Lancashire LA6 2EY 01524 276030

Morgan Sindall
Pont-y-Felin CSO

Baseline Odour Survey

February 2023

H&M 2023/02/02

Table of Contents

1 Introduction

Arup and Morgan Sindall have been commissioned by Dwr Cymru Welsh Water (DCWW) to propose a Nature Based Solution (NBS) to treat effluent from the existing Pont-y-Felin CSO.

Morgan Sindall commissioned H&M Environmental to undertake a baseline odour survey at and around the site listed above. This survey undertaken on the 12th January and 1st February 2023 is reported below. The results from this survey can be used, if required, as a baseline survey to compare with future survey results.

1.1 Pont-y-Felin CSO

The existing Pont-y-Felin CSO and proposed treatment within a field between New Inn and Lower New Inn, 2.75km southeast of the town of Pontypool, Monmouthshire. It is located east of the A4042 and the Afon Lwyd. The nearest residential properties are Afon Close along the NE boundary of the site, Monmouth Close 50m to the SE of the current CSO and a Pear Tree Cottage on Pont-y-Felin Lane 50m SW of the site. To the west of the river is an industrial estate, an agricultural field is to the south and a rugby playing field to the north

The existing gravity wastewater sewer flows down the SE side of the site with the CSO chamber approximately halfway down the site. The existing CSO spills to the Afon Lwyd.

1.2 Scope of Odour Survey

The odour survey comprised spot odour measurement, at a number of locations within the site on 12th January and 1st February 2023. as characterised by:

- Hydrogen sulphide (H_2S),
- subjective observation
- Measurement of Total VOC (TVOC)

In the period between the two site visits, H2S data loggers were installed within the CSO Chamber and within a manhole chamber above the upstream sewer.

1.3 Odour Control Measures

There are no odour control measures provided at the existing CSO, although the existing sewer and CSO chamber are covered; no vent stacks were noted. It is thought that historically, operation of the current CSO has not been the subject of odour complaints.

2 Fieldwork Measurements

2.1 Hydrogen sulphide as a marker for sewage treatment odours

Hydrogen sulphide is typically present as a major constituent of the many hundreds of odorous compounds that may comprise a sewage treatment odour. Hydrogen sulphide has the advantage of being readily measurable with portable equipment (see below). Given the presence of other odorous compounds, measurement purely of hydrogen sulphide is likely to under-estimate the intensity and extent of dispersion of an odour. Never the less in the absence of reliable technology to readily monitor other odorous compounds hydrogen sulphide remains an extremely useful tool for the identifying hot spots of odour emission and monitoring, over a period of time, patterns of odour emission and generation at a site.

Atmospheric hydrogen sulphide can be rapidly measured to below its odour threshold concentration of 2ppb using portable Jerome gold film resistance meters. Such equipment has an accuracy of ± 3% at 100 parts per billion (ppb). The Jerome 631 analysers used by H&M Environmental can measure sulphide in the range 1 part per billion (ppb) to 50 parts per million (ppm). A current, valid calibration certificate for the instrument used in this survey is available upon request. Gas detection tubes are used to measure hydrogen sulphide where concentrations greater than 50ppm are anticipated.

2.2 Survey weather conditions

The survey was carried out after a wet winter period followed by cooler dryer conditions. The first survey was conducted after heavy rain with the CSO in operation. The temperatures average for the time of year. During the surveys the site was generally operating normally, with no particular reported operational issues, conditions were generally dry during the H_2S data logging period.

Table 1: Survey Weather Conditions

Date	Weather conditions
Thursday 12th January	9°C Overcast after very heavy rain, strong breeze from W.
Wednesday 1st February	8°C Overcast with some sun, light breeze from W.

2.3 Spot H_2S Measurements

On the 12th January and 1st February 2023 visits atmospheric hydrogen sulphide concentrations were measured across the site at preidentified points (these points were specified within a specification prepared by Arup in November 2022). The position of the sample points and the logger locations are shown in Figure 1.

Figure 1: Hydrogen Sulphide Spot Measurement Points

Results from these surveys are presented in Table 2.

Table 2: Hydrogen Sulphide Spot Measurement Results

Number	Sample Location	12/01/2023	01/02/2023
		H_2S ppb	H_2S ppb
1	NW of flats Monmouth Close	0	0
1a	N of flats Monmouth Close	0	0
1b	W of flats Monmouth Close	0	0
2	SE corner of site	0	0
2a	Upstream Manhole	0	0
2a	Inside Upstream manhole	7	33
2b	Garages SE end Afon Close	0	0
3	Existing CSO manhole	2	3
3	Inside existing CSO manhole	0	0
4	Mid point Afon Close	0	0
5	Mid point NE edge of site	0	0
5a	N corner of site	0	0
6	Centre of site	0	0
7	Mid point SW edge of site	0	0
7a	S corner of site	0	0
8	NW corner of site	0	0
9	S edge of site nearest to Pear Tree Cottage	0	3
9a	Gate to site	0	0
9b	Pont-y-Felin Lane outside Pear Tree Cottage	0	0

2.4 TVOC Measurements

Total VOC concentration measurements were taken, using an Ion Science Tiger Phocheck VOC Meter, at the points identified in Table 2. None of the samples taken produced results at or above the instrument minimum level of detection of 0.1ppm.

2.5 Subjective Observations

The surveyor also recorded any subjective observations of odour. Generally, very little was noted within the study site or surrounding area. Within the manhole above the upstream manhole a musty sewage odour was noted. This was also noted, more faintly in the manhole above the existing CSO. With the manhole covers closed, no sewage/wastewater odour was subjectively noted within the

study area or surrounding area. No other particular background odours were noted.

3 H_2S Data Logging

The hydrogen sulphide spot measurements represent a “snapshot” of the pattern of odour generation and emission from a site at a particular point in time. There is always a danger that intermittent sources of odour may not be present, or the concentration measured is not representative, during the collection of data required to produce a “snapshot”. For this reason, it is desirable to also record hydrogen sulphide continuously in order to more reliably identify and quantify odour sources. At Pont-y-Felin continuous hydrogen sulphide data logging was employed, using Odalog Units (detection range 0.1 – 200 ppm) at two locations on the site for the period between the two site visits. The data loggers recorded instantaneous H_2S concentrations at three-minute intervals.

The loggers were positioned as below:

1. Inside Upstream Sewer Manhole – Figure 2
2. Inside CSO Manhole – Figure 3

Within the graphs presented below the green line represents recorded ambient temperature, and the blue line instantaneous H_2S concentration.

Figure 2: H_2S Results: Upstream Sewer Manhole (Maximum 1.0ppm Average 0.1ppm)

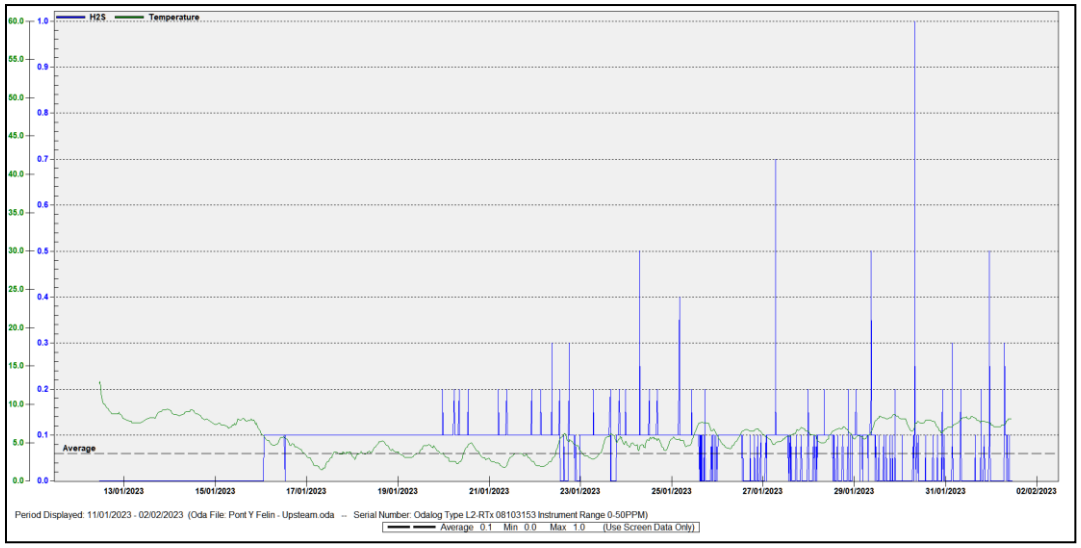
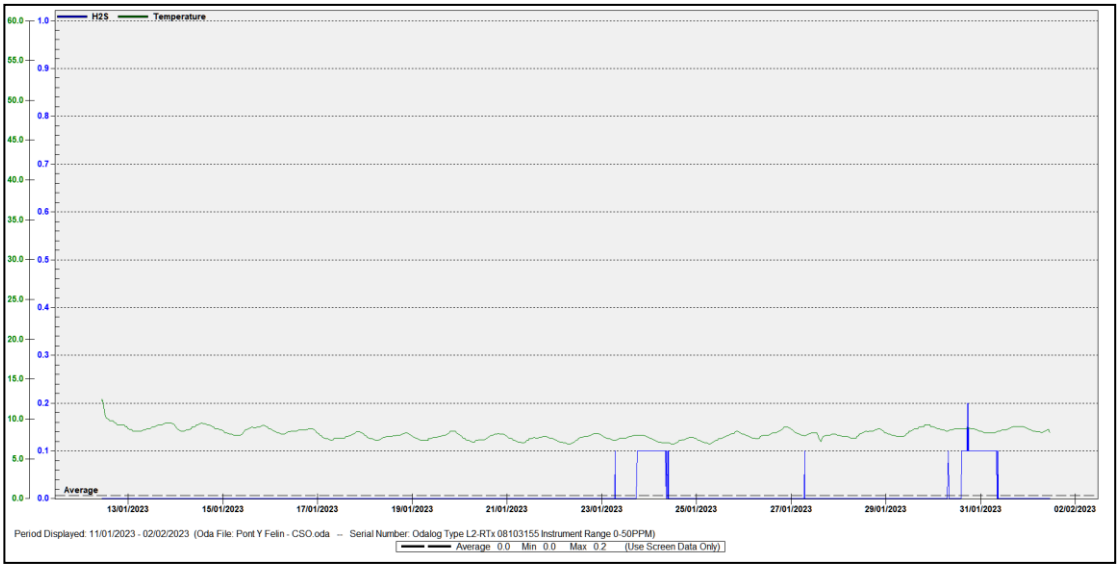


Figure 3: H_2S Results: CSO Manhole (Maximum 0.2ppm Average 0.0ppm)



4 Discussion

4.1 Interpretation of Results

When using hydrogen sulphide as a marker for sewage treatment odours, it is not possible to say that there is an absolute level of odour that will generate odour complaint. Background levels can be in the range 1 to 5ppb, or even higher. In rural areas background levels can be zero, although these can be raised by intermittent operations such as storing and handling agricultural wastes. In urban areas background levels will be slightly raised, principally as a result of vehicle engine exhausts. During any particular survey, the variation in background concentration is usually slight.

When used as a marker for sewage treatment odours the threshold odour concentration of hydrogen sulphide is in the region of 2ppb above the background concentration at a given point. At this concentration the most sensitive 50% of the population may sense some odour. For example, if the background concentration was 2ppb, the concentration downwind of the sewage works would have to be at least 4ppb before even a sensitive individual is likely to detect sewage treatment derived odours. During the Pont-y-Felin surveys background concentrations were of the order of 0 to 2ppb.

4.2 Summary

The following points are recorded:

- That with manhole covers closed, no sewage/wastewater odour was noted by subjective observation or H_2S concentration measurement within the study site and the more general surrounding area.
- The only sewage odour detected during the surveys was inside the upstream manhole and the CSO manhole. The H_2S loggers at these points recorded a maximum H_2S concentrations of 1.0ppm within the upstream manhole and 0.2ppm within the CSO Chamber Manhole.
- The slightly higher spot recorded and data logged H_2S concentrations levels occurred towards the end of the monitoring period: when ambient conditions were dryer. It is unlikely that the CSO operated during the data logging period.
- The surveys were conducted during cool winter weather; odour concentrations may generally be expected to be higher during warmer & drier, summer weather conditions.
- In general terms, the H_2S concentrations recorded within the existing manholes are not untypical for a semi-urban gravity sewerage system.