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Version:

Rev 14

Date published:

December - 2020

Distribution:
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Report Reference:	**Howdon STW**		
Report title:	**Howdon STW Odour Management Plan**		
Project title:	**Odour Management Plan**		
Author(s):	**Tony Rutherford**		
Reviewer(s):	**Tony Baines, Andrew Hindmarsh, Kevin Stobbs**		
Approver(s):	**Asset Strategy**		
Document type:	**Report**	**Approved?**	
Version:	**Rev 14**		
Date published:	**23/12/2020**		
Expiry date (if relevant):		**Expiry action:**	**Review Amend and Re issue**
Client:	**Production**		
Collaborator:			
Keywords:	**Odour, Customer Complaint**		

Validation of Report	**Approved by reviewer(s)?**	**Date:**
	Approved by approver(s)?	**Date:**

Circulation

Destination	**No. of copies**	**Date of despatch**

Acknowledgements:	**Steve Robson – Works Manager** **Andrew Hindmarsh – Team Leader Operations** **Ed Higgins – Technical Support**

Revisions

Version	Comments	Date and Signature
Revision 1	Initial Draft version for comments	TR
Revision 2	Additions made following draft review.	TR
Revision 3	Additions made prior to AAD.	TR
Revision 4	Inclusion of H4 guidance for EA permitted sites	LS
Revision 5	Additions made identifying ongoing site improvements (AAD & Ancillary Works)	TR
Revision 6	Additions made identifying ongoing site improvements and inclusion of AAD Odour Management Plan	TR
Revision 7	Additions made identifying ongoing site improvements	TR
Revision 8	Additions made identifying ongoing site improvements including NWL operation of Final Dewatering Plant (previously Agrivert Ltd.)	TR
Revision 9	Additions made identifying ongoing site improvements including operation of G2G plant	TR
Revision 10	Additions made identifying ongoing site improvements	TR
Revision 11	Additions made identifying ongoing site improvements & recommendations from EHO meeting 22/11/17	TR
Revision 12	Additions made identifying ongoing site improvements	TR
Revision 13	Additions made identifying ongoing site improvements	TR
Revision 13	Additions made identifying ongoing site improvements	TR

Reviews

Review Date	Comments	Date and Signature
27/04/2010	Address Scrubber labels.	TR 30/12/2010

Content

Introduction

Sewage Treatment Works fall under Section 80 of the Environmental Protection Act 1990, whereby local authorities may consider that a 'statutory nuisance' exists, and may issue an abatement notice if it is considered that the operator is not using 'Best Practicable Means' (BPM) to prevent or counteract the odour. In order to clarify the position, Defra published a voluntary Code of Practice (COP) on Odour Nuisance from Sewage Treatment Works, April 2006.

The **COP** states that BPM may include:

- The general management of the sewage treatment works
- The design, installation and maintenance of plant, buildings and structures
- The operation of the sewage treatment works and processes
- Providing engineering solutions (containment, venting, end of pipe treatment)

Further guidance in the form of H4 has been issued for works, or parts of works covered by the Environmental Permitting Regulations (EPR) 2010 (as amended in 2010), for acceptance of waste where the permit contains an odour condition. These regulations replaced much of the PPC and Waste Management Licensing Regulations. The regulations implement the IPPC and Waste Framework Directives. The AAD Plant and dewatering facilities are covered by EPR and the H4 guidance only applies to this part of the STW. NWL's odour management policies are relevant to all areas of the STW, including the AAD Plant.

Some odour control measures should be put in place by the sewage treatment works operator as a matter of course at **all** sewage treatment works to reduce the risk of odour nuisance being generated in the first instance. These proactive measures are essentially preventative and should be thought of as baseline housekeeping to be used by all sewage treatment works operators. These include planned and routine maintenance of plant equipment, avoiding anaerobic conditions, minimising septicity etc. The COP and H4 refer to the production of and Odour Management Plan as part of baseline odour management practice.

An Odour Management Plan is a document intended to detail operational and control measures appropriate to management and control of odour at the site. The Plan should provide sufficient detail to allow operators and maintenance staff to understand clearly the operational procedures for both normal and abnormal conditions. It is also intended that the OMP should include sufficient feedback data to allow site management (and local authority inspectors) to audit the site operations in line with the sites Working Plan and Environment Agency Licence 64172.

The Code of Practice and H4 states that Odour Management Plans should be prepared for sites where the operator believes there is a significant risk of odorous emissions. The NWL Odour Strategy is that sites requiring detailed, site specific OMP's will be determined through regular assessment of the number, and location of complaints, and through Operator experience and local knowledge. A generic OMP is applicable for all other sites.

Summary of Site - Works Details

Howdon Sewage Treatment Works (STW) provides full treatment to over 1,000,000 population equivalent from the greater Tyneside area, including Newcastle upon Tyne and Gateshead.

Due to the number of potential odour sources and level of site specific odour management systems Howdon was identified as needing a site specific OMP.

Development of Howdon STW & Tyneside Interceptor System began with creation of Tyneside Joint Sewerage Board in 1966, with responsibility being passed to Northumbrian Water Authority in 1974. Howdon and Interceptor System became fully operational in 1979. The STW was expanded in 2000 to provide additional treatment stages to comply with EU legislation.

Howdon Sewage Treatment Works consists of Preliminary, Primary and Secondary Treatment, with Tertiary Treatment in the form of UV. Sludge handling is managed via the Advanced Anaerobic

Digestion Plant (AAD) which treats thickened sludge from Howdon sewage treatment works and the surrounding area. Sludge is transferred from holding tanks to the AAD Plant where the blended sludge is pasteurised in a hydrolysis process then digested to maximise gas production. The biogas produced is used to produce “green energy”. Digested sludge is then de-watered via the Final Dewatering treatment plant operated by NWL following ‘hand over’ from Agrivert Ltd (March 2014). It is then transported off site for agricultural use by a third party haulage contractor. The Final Dewatering facility consists of dewatering, storage and vehicle loading.

Process Overview

Treatment of the incoming sewage comprises:-

Municipal Treatment (Non Permitted Area)

- 6mm screening using fine screens
- Grit removal using Travelling Bridge and Air Blower system
- Primary settlement in mechanically scraped rectangular tanks
- Secondary aeration utilising the conventional activated sludge process plus Settlement tanks
- Primary Sludge Storage
- SAS Sludge Storage
- Primary and SAS Thickening drums
- Thickened Sludge Storage
- UV tertiary treatment of final effluent

Sludge Processing (Permitted Area)

- Transfer pumps and pipelines
- Sludge dewatering
- AAD Plant – See Appendix 5. *Inclusive of G2G plant Appendix 6.*
- Final Dewatering Cake Silo for digested sludge cake storage
- Final Dewatering Sludge Cake Loading Bay

The primary settlement and secondary settlement tanks are automatically desludged and this sludge is treated by drum thickening before transfer to the thickened sludge day tanks, where it is combined with imported sludge from other sewage works. The combined sludge is then transferred to the strategic storage tanks.

There are 4 strategic storage tanks each holding 10500m3. Sludge is pumped from the sludge holding tanks to the AAD Plant where the blended sludge is pasteurised in a hydrolysis process then digested to maximise gas production. The biogas produced is used to produce “green energy”.

Digested sludge is then de-watered via the dewatering treatment plant centrifuge where it is dewatered to approximately 27% dry solids. This product is then transferred by screw conveyor to a sludge cake silo; the final product is then transferred via screw conveyor to bulk tippers for export to agriculture.

Biological treatment is undertaken by the activated sludge process utilising fine bubbled diffused air aeration to supply oxygen for the degradation of organic matter.

A SCADA system is utilised to provide management, control and monitoring of the various treatment processes.

A telemetry system is employed to provide monitoring of the various treatment processes on the site, which provides alarm identification.

The site is manned 24hrs per day and 24hr EMI support is provided.

NWL employs a philosophy of providing standby equipment to minimise the risk of odour release. The extraction system at Howdon Works will fail safe and any potential odours maintained within the system.

NWL has employed an odour management philosophy of containment, extraction and treatment for those parts of the plant identified as having the potential to create an odour impact at the boundary, in conjunction with the utilisation of Best Practicable Means (BPM) as covered in Company operating procedure PDP.09. Reproduced in Appendix 5.

Odour management is viewed as an on-going process and as such the OMP and conditions on site are regularly reviewed with the aim of ensuring a culture of continuous improvement. As a minimum the OMP will be formally reviewed on an annual basis, however, significant changes to treatment processes / equipment will trigger a re-assessment of the OMP in relation to the impacts that the changes may present.

Location of Receptors

The nearest receptor to the sewage treatment works is to the North West of the site which is known as East Howdon.

Identification of Odour Sources

Introduction

Sewage, sewage sludge's and returned liquors can all contribute to odour on a STW. A number of odour release points / areas have been identified on Howdon STW, and a combination of good baseline site management and odour control measures have been implemented to manage these sources.

Odour Control – Operational Areas.

<u>Municipal – Non Permitted area</u>

Operational Areas have been identified at Howdon (See Site Plan). These areas all have odour extraction to extract odorous air from the process units.

- Inlet Works, Screening and Grit removal areas (OS 5 & ODC 13)
- Primary Settlement Tanks (OS 1-4)
- Aeration Lanes (OS6 & 7)
- Sludge Storage and handling Area (OS8 & 9)
- Final Sludge Dewatering (OS 10, ODC11 & 12)

Preliminary Treatment Area; The screenings handling plant and the associated screen hall, conveyors and skips are all enclosed in a single building. The grit removal system is also enclosed within a building and the treatment unit is covered. Odorous air from these locations is extracted and treated by an Odorgard chemical scrubber (OS 5). Odorous air from the covered grit lanes is extracted and treated by an acid Venturi scrubber (ODC13).

Primary Settlement Tanks: The primary settlement tanks accept municipal wastewaters pumped to the works from South of the Tyne and from the North interceptor. Return liquors from the sludge treatment process are also transferred to the primary tank distribution chamber..All primary tanks are covered and ventilated via a central plenum that is served by four Odorgard scrubbers in parallel (OS1-4). Odorous air is extracted through a GRP ductwork system to be treated by the scrubbers, which are designed so that one can be taken out for service, if required, whilst there is sufficient capacity in the remaining scrubbers to treat the air from the tanks.

Secondary Aeration: The Aeration Lanes and Aeration Mixing and Distribution Chambers are closed concrete structures from which odorous air is extracted via GRP ductwork by duty/standby extraction fans. The scrubbers (OS6 and OS7) were installed in 2001 to extract odours from the secondary treatment aeration lanes. Normally such aeration is open to the atmosphere, but with the size of plant and proximity of the Royal Quays retail centre, the covering of the aeration lanes became a planning requirement. If required, odours can be extracted, with aeration off-gases, from the roof of each lane via a series of ducts and duty/standby fans, to stacks immediately above each scrubber. The operation of the scrubbers is similar to that described above. A number of passive activated carbon filters are located on the secondary distribution chambers and RAS/SAS wet well, these areas are not thought to be a significant area of concern.

Sludge Thickening and Strategic Storage Area: Odorous air is extracted from various process units by duty/standby extraction fans for treatment by two Catalytic Iron Filters followed by twin Odorgard scrubbers OS8 and 9. Some of the extraction legs have booster fans in series with the main fans. The system extracts and treats odours from the following sources:

- Primary sludge buffer tank
- Secondary sludge buffer tank
- Thickened sludge day tanks 1 and 2 (under drum thickeners)
- Drum Thickening Equipment
- Imported sludge screen building
- Strategic sludge storage tanks (including air generated by fluidic mixers)

The scrubbers (OS8 and OS9) were built for duty/standby operation, each with 2 no catalytic iron filters (CIFs) preceding it to attenuate incoming H2S levels. Odorous air is blown through the CIFs and then enters the chemical scrubber for further treatment.

Permitted area

AAD Plant – See Appendix 5
G2G Plant – See Appendix 6

Final Dewatering Plant

Sludge Dewatering:
Duty/standby fans extract odours from various parts of the Centrifuge dewatering facility and Sludge Liquors wet well. Odours are passed through a four stage chemical scrubbing system (OS10, ODC11&12).

The main components of the dewatering facility are described below;

Centrifuge; A duty/standby centrifuge arrangement is used to dewater the digested sludge from the AAD Plant. The centrifuge is contained within a building which is extracted. The sludge flow to the unit is via sealed pipework and the centrate return is piped into a manhole via rigid pipework and returned to the STW for further treatment.

Cake Silo
The cake silo is sealed and extracted.

Loading Bay
Rigid bulk haulage tippers are utilised to transport the final product to agriculture. They are filled directly from the cake silo within a loading bay. Each vehicle is fully sheeted and the sheets are automatically deployed after loading prior to leaving the bay. The loading bay area is extracted and the building is sealed.

Primary Odour Control Measures

Northumbrian Water Limited (NWL) employs a range of systems for managing odour at Howdon STW.

Routine and non routine activities are reviewed for their impact upon the potential for odour generation in line with PDP.09.

Process Monitoring and Alarm Systems:

A Supervisory Control and Data Acquisition (SCADA) system controls and monitors processes, and a failure of equipment trigger will result in alarm generation and management response. Operators routinely access the system throughout their work period.

The SCADA system generates alarms to the company's Regional Control Room (RCR) which is manned 24hr/d who subsequently contact the site operators to alert them of the condition. Alarms generated and their response codes are as follows;

Alarm CODE	Control Room Response
Priority 1	Inform Ops. Immediately
Priority 2A	Inform Ops. as soon as possible
Priority 2B	Control room to investigate, analyse and action alarm appropriately
Priority 3	No control room action
Priority 4	No control room action

Site personnel perform routine inspections and checks as well as good housekeeping activities, as part of their daily, weekly and monthly duties, company procedures can be found in Sharepoint.

Good Housekeeping – a number of good housekeeping practices are employed at Howdon STW

- Skips containing screenings and grit are stored within enclosed, odour-controlled buildings, and are removed from site as soon as practicable.
- Primary Tanks, associated channels and sludge tanks are all sealed and odour extracted.
- Auto desludging of the primary tanks is performed to minimise sludge retention within the tanks, and ensure that effective and efficient sludge removal is maintained.
- Scum is automatically removed from the primary tanks, within a contained system, for treatment in the sludge thickening facility.
- Under normal operations sludge levels are kept to a minimum within the covered and odour extracted strategic sludge storage tanks. This minimises the risk of aging sludge's (and the associated increased odour potential this poses) and contributes to the efficient performance of the dewatering process. The level in the strategic tanks is monitored daily. If the combined level in the tanks approaches 80% full then discussions take place (between the Biosolids

Manager, Works Manager & Team Leader) as to the reasons for this and potential actions to remedy the situation.
- Management of spillages of sewage and sludge is undertaken in accordance with PDP.09.G2

Routine plant assessments:
Site personnel periodically assess the performance of odour containment and extraction systems utilising smoke generation equipment to compare actual vs. designed air changes / hr, or to identify leakage points on systems. Any issues identified will be addressed and then a re-assessment performed to confirm issue resolution. In addition, the site has a Jerome monitor to periodically measure levels of hydrogen sulphide at a number of locations around the site. Site personnel use the Jerome to collect hydrogen sulphide data and this information is collated and entered into a software package that generates a map contouring the levels of hydrogen sulphide across the site. This information can then be used to identify any changes that may require further investigation, or may have occurred as a result of other measures employed on the site.

Maintenance:

NWL's maintenance strategy is based upon Planned Preventative Maintenance (PPM) activities combined with reactive maintenance support. To aid the business in this activity the company operates a computerised asset database and maintenance management system. The system automatically generates job sheets of PPMs for assets on an on-going basis. In addition, reactive maintenance can be requested, prioritised and recorded on the system, resulting in the generation of work sheets for maintenance personnel to complete.

- Standby equipment on odour control systems are not stored on site but can be hired as required.

- The site personnel use company quality procedure (PRD 26) when making job requests to assist in appropriate prioritisation and work planning.

- In emergency or urgent situations, EMI assistance can be requested immediately to ensure as rapid response and resolution as possible. A standby system is operated for EMI personnel outside of normal working hours, providing support as required.

- All EMI personnel are qualified in their individual fields, having served a recognised apprenticeship, as well as undergoing specialist supplier training as appropriate.

- See Appendix 5 for information on the AAD Plant.

Contingency Control Measures

Failures or abnormal situations:

A number of conditions may occur that have the potential to affect the main processes, or odour abatement processes or equipment, resulting in the release of odours to the atmosphere.

- Seasonal variations in weather: Low influent flows and warm temperatures can contribute to increased odour potential of the influent and septic conditions in the preliminary treatment process.

- Power failure: In the event of a power failure a standby generator will take over the supply to the Inlet Works.

- Illegal / uncontrolled discharge of chemicals into the sewerage system: NWL issues consents to discharge to its commercial customers to control the constituents and volumes of discharges received into its systems. NWL personnel actively monitor and police these discharges, to ensure trade effluent compliance and resolve issues as they develop. However, a situation could occur where the treatment process could be impacted upon as a result of an illegal or uncontrolled discharge, resulting in the potential for odour release.

Depending upon the seriousness of the situation, NWL has a corporate system that can employ the Emergency Management Manual (located in Live-Link PRD Corporate/Strategies/Emergency Planning) that assists in the management of such events. Possible actions to recover the situation could include the re-seeding the secondary treatment facility with healthy biomass from another STW, emptying and cleaning of tanks and pipelines, and removal of contaminated / odorous material for off-site disposal

- Failure of equipment: A number of measures are in place to minimise the risk of an odour release as a result of equipment failures. SCADA monitoring and control, and the RCR are all measures that have been put in place to minimise an impact due to equipment failure.

- Spillages or leaks of odorous liquids / materials: The site has an outline spillage plan that identifies actions that should be implemented if an event occurs. The greatest risk for odour release would come from a release of sewage sludge, and this is most likely to occur in the sludge treatment area of the site or during tanker offloading. Good housekeeping minimises this risk from routine activities by ensuring any spills are contained and hosed away to a site drainage system as soon as possible. In the case of a non-routine or serious leak then the procedure described in PDP.09.G2 would be followed.

Odour Release Points

Routine:

- As part of normal operational activities on STWs it is necessary to access areas where there is a potential of odour release, for example to complete planned preventative maintenance. The maintenance team is conversant with the site and is aware of any operational issues that could impact on their tasks.

Non-Routine

- Non-Routine release points can occur due to a failure of odour abatement measures, urgent situations, or as a result of a business need to perform a non-routine activity that has been planned. Such events can lead to customer odour complaints and a procedure PDP.09 has been developed to ensure that the activity is managed as effectively as possible to minimise potential odour release and / or impact. NWL engages the EHO wherever possible on planned non-routine activities to discuss the work and measures taken to minimise the potential for odour release.

Customer Complaints:

- NWL operates a Customer Contact Centre that employs a number of management systems and procedures to provide an efficient and effective service for our customers. Customer contacts can be received by telephone (CC-05) or as a written communication (CC-06), with the majority of contacts being received by telephone. On receipt of an odour complaint, site personnel will perform an investigation as described in a process map in PDP.09.G1.

- The Customer Contact Centre is the central point of contact for the company, with the Regional Control Room (RCR) taking on this role outside of the Call Centre opening hours. Complaints are assessed and dealt with by the Customer Contact Centre in conjunction with site management as necessary, and liaison with local stakeholders is managed by the these two groups in conjunction with the Communications Dept (as appropriate). Where significant schemes are involved, site management, Customer Contact Centre and Communications Dept. will be involved and employ a range of techniques to communicate with local stakeholders (e.g.: letter drops, newsletters, face-to-face meetings). Wastewater Production Management have the responsibility for dealing with those complaints assessed as significant, as well as the liaison with Environmental Health and the local authority on issues.

Pity Me Customer Contact Centre opening hours for Operational Calls

Monday – Friday 7am – 8pm

Saturday 8am – 6pm

Sunday 9am – 5pm
Emergency Out of Hours until 11pm
Outside above hours, all calls handled by RCR.

Training:

- Training at Howdon STW for operators is a combination of general competency and awareness, combined with specific awareness of the OMP.

- Sewage treatment awareness and competency is achieved through a range of techniques, including gaining operational experience and knowledge of treatment processes and site procedures (utilising site O&Ms and guidance from Team Leader), as well as specific training packages – for example a number of operators have achieved a City & Guilds in Process Control (Utility Operations) and/or NVQ2 Operating Process Plant Waste Water, whilst others are acquiring the appropriate experience and knowledge, prior to assessment and accreditation.

Odour Monitoring System.

Odour Monitoring is undertaken in line with the companies Odour Monitoring Protocol, This protocol covers;

Performance Monitoring
- H_2S inlet and outlet of odour abatement kit – annual basis

Investigative Monitoring
- Stage 1 - In house matrix monitoring – monthly basis
- Stage 2 – triggered by results from Stage 1 –
  - Detailed survey – level assessed by Odour Investigation team
- Stage 3 – triggered by results from Stage 2 –
  - Odour modelling – to design or check appropriate level of abatement

Complaints Monitoring
- Odour contacts review (3- 6 months) carried out by Asset Strategy

History of Improvements.

In 1979 the works provided primary treatment which included screening, de-gritting and settlement of sewage from the surrounding area.

1997-1998: Odorous air from the inlet screens/screenings handling plant and the associated screen hall/skip bays, as well as the adjacent grit channels, conveyors and skip bays, enclosed in a separate building, is extracted by duty/standby fans to an Odorgard catalytic scrubber and stack (OS1) between the buildings. All primary tanks are covered and ventilated via a central plenum that is served by four Odorgard scrubbers in parallel (OS2-5).

In 2000 the plant was further upgraded to include Secondary treatment. Secondary treatment is undertaken by biological removal using a conventional activated sludge process.

2001: As part of the expansion of the treatment processes to provide secondary treatment for compliance with the UWWTD, containment, extraction and wet chemical scrubbing was provided on the Secondary Aeration System, Sludge Area and Sludge Dewatering Facility.

2003: Primary Tank Refurbishment – programme carried out to replace original scraper system to improve reliability and minimise breakdowns, reducing risk of odour releases. Residents and EHOs were notified before project began of the potential for increased odours during the project. Dewatering Facility – chemical dosing of feed sludge pipeline and sludge feed to belt presses and skip bays installed to reduce odour load. Installation of water de misting fans above skip bay doors and around compound.

2004: CIF media in OS 8-9 replaced (February) following a reduction in performance, the media was still effective, however, a decision was taken to replace the media earlier than necessary to ensure optimum performance of the plant in the summer months. Auto desludging of primary tanks commissioned following completion of primary tank refurbishment. A new type of sludge mixer was installed in the thickened sludge and strategic sludge holding tanks. These mixers have no internal moving parts, resulting in a significant reduction in the need to enter the tanks to maintain and repair sludge mixers, thereby reducing potential odour releases. A new dewatering and lime stabilisation facility was built and commissioned in August, employing new technology to reduce odour potential (Senior EHO engaged in discussion of chosen technology and visited working facility to assess improvements). Existing dewatering facility mothballed. New sludge tanker off-loading facility commissioned, reducing odour potential from tankering operations.

2005: Following completion of screen replacement project thickened sludge tanks and strategic sludge tanks were drained and cleansed to reduce risk of blockages and the need for intrusive work, thereby reducing potential odour release. The senior EHO was consulted with prior to the activity, covering aspects concerning additional temporary measures to combat potential odour release, and a letter drop to inform local stakeholders of the activity was instigated prior to and following completion of the project. A new pumping facility was installed and commissioned to provide a steady feed of sludge to the dewatering facility, resulting in a reduction of odour load from the facility on to the odour treatment facilities servicing the dewatering asset. Air valve chamber on sludge liquors rising main sealed and ducted into containment system for primary tanks 1a/b, removing localised point source of odour. Smoke testing performed across containment systems on the site.

2008 - 2009 OS5 Inlet Area scrubber packing was cleansed removed and replaced prior to the stack height being increased. OS8&9 CIF media was replaced following a reduction in performance.

2009: OS 1-4 Primary Settlement and OS10 Sludge Dewatering scrubbers packing was cleansed, removed and replaced. ODC Scrubbers 11, 12 and 13 were constructed and commissioned to provide enhanced odour treatment in the relevant areas. The drainage system surrounding the Sludge Dewatering area was extended in line with the Waste Management Compliance Regulations adhering to the spillage procedure described in PDP.09.G2.

2009 - 2010: Inlet Works Project undertaken to refurbish the screenings removal and skip systems. The Grit lanes are covered with a travelling bridge grit removal system and individual odour extraction points.

2010: Strategic Sludge Holding Tanks odour extraction pipe work repaired. Primary Settlement Tanks odour dampers replaced.

2011: Removal of Wet Well Booster Fans with new odour ductwork installed to extract Sludge Liquors to OS10/ODC11&12.

2012: Existing site upgrade consisting of *New* PST Desludge pumps, Day Tank pumps, Scum pumps, Sludge Tanker Offloading and Sludge Screening facility

2012: Installation of Final Effluent Pumping Station to supply FE for Advanced Anaerobic Digestion (AAD) plant. Natural gas and potable water supplies installed for AAD services.

2012: Advanced Anaerobic Digestion (AAD) Installation (covered by new bespoke EA permit & modification to existing standard rules permit) – Appendix 5 – Howdon AAD Odour Management Plan.

2012: Removal of Strategic Sludge Storage Tanks (2&4) paddle mixers

2013 - 2014: Digested sludge dewatering facility refurbishment (Final Dewatering) – Now fully operational Duty/Standby Centrifuge arrangement operated by NWL following 'hand over' from Agrivert Ltd.

2014: Removal of Strategic Sludge Storage Tank H3 paddle mixer & removal of Strategic Sludge Storage Tank H1 paddle mixer. OS8&9 Sludge Odours CIF media replacement

2015: Biomethane Project (biogas upgrading plant) brought on line (see appendix 6 for detailed description of plant. Chemical storage tanks 001/002 decommissioned – New Hypochlorite & Caustic Tanks installed at OS8&9

2016 - 2017: PST 1a&b Refurbishment April 16 – June 17. Tank scraping system renewed and new covers installed

2017 - 2018: PST 3a&b Refurbishment July 17 – May 18. Tank scraping system renewed and new covers installed

2018: PST 4a&b Refurbishment began in July 18. Tank scraping system renewed and new covers to be installed

2018: AAD Drainage PS refurbishment completed April – December. Consisting of concrete repairs to the interior of the wet well

2019: AAD Raw Centrifuges diversion of centrate away from AAD drainage to RLPS with improvements to existing odour extraction duct work

2019: Engine number 4 installation for increased power generation

2019: Return Effluent P/S installation

2020: PST 2a&b refurbishment complete, tank scraping system renewed and new covers installed. Odour Scrubbers 1-4 refurbished and outlet H2S monitoring instrumentation installed – PST Project complete April 2020

Imported sludge PS refurbishment project complete – October 2020

Primary Sludge Buffer tank structural repairs complete – November 2020

Further Capital Work Identified

Reject Gas system for recovery of rejected biomethane commissioning – 2020/21

OS10-12 refurbishment – 2020/21

Sludge Odours OS8&9 CIF media replacement 2021

AAD Plant Odour control Bio filter refurbishment 2021

Programme for Review

The Odour Management Plan is a living document and should be regularly reviewed.

It is intended the OMP for this site will be reviewed within 12 months, or as appropriate depending upon the programme of ongoing work and improvements.

Appendix 1 References

NWL O&M Manuals – Site operation and maintenance manual
NWL Standard Operating Procedures

Appendix 2 Glossary / Abbreviations

SCADA – Supervisory Control and Data Acquisition, computerised system that monitors the process and provides flow data, equipment status and valve positions.

OMP – Odour management plan, live document stating operational practice, specific to the works

BPM – Best Practicable Means,

PPM – Planned Preventative Maintenance, key items of equipment are maintained as a matter of routine, including calibration checks on instrumentation.

Activated Sludge Process. – The breakdown of organic material in sewage by the biomass, into CO2 and Water, by Biomass, this bacterial culture is kept in suspension by aeration and mixing. The biologically treatable (organic) waste is added to this bacterial culture to form what is referred to as the 'Mixed Liquor'.

COD – Chemical Oxygen Demand, normally quoted as milligrams of COD per litre

BOD – Biochemical Oxygen Demand, normally quoted as milligrams of BOD per litre

MLSS – Mixed Liquor Suspended Solids, normally quoted as milligrams of solids per litre

RAS – Return Activated Sludge, normally quoted as milligrams of solids per litre, it is the portion of the thickened solids from the final settlement tanks which is returned to the front of the aeration lane.

SAS – Surplus Activated Sludge, normally quoted as milligrams of solids per litre, it is the portion of the thickened solids from the final settlement tanks which is removed from the process to maintain a healthy biomass, this can be set as the reproduction rate being greater than the death rate of the bacteria.

Biomass – The bacterial population comprises a concentrated mass of naturally occurring bacteria, together with associated microfauna of protozoa, rotifers and nematodes.

Sludge Age – The sludge retention time determined by the quantity of sludge (biomass) wasted each day.

DO – Dissolved Oxygen, the measure of residual oxygen in the biomass after the bacteria has utilised the oxygen required for respiration and degradation of the organic matter in the sewage.

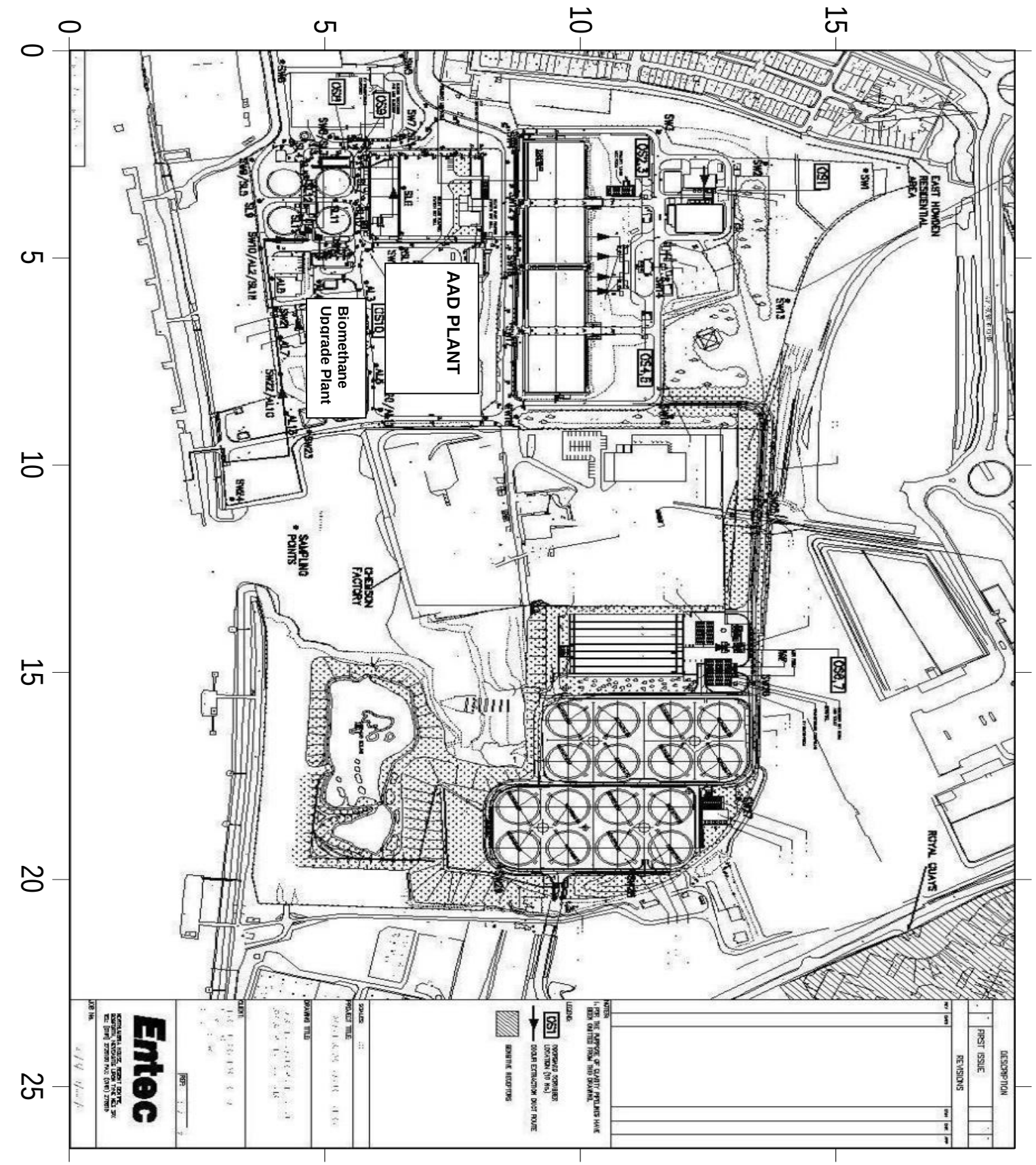
PST – Primary Settlement Tanks, tank which allows a semi quiescent period for the settlement of organic and inorganic solids in the influent sewage.

FST – Final Settlement Tanks, tank which allows a semi quiescent period for the settlement of biomass, the final effluent

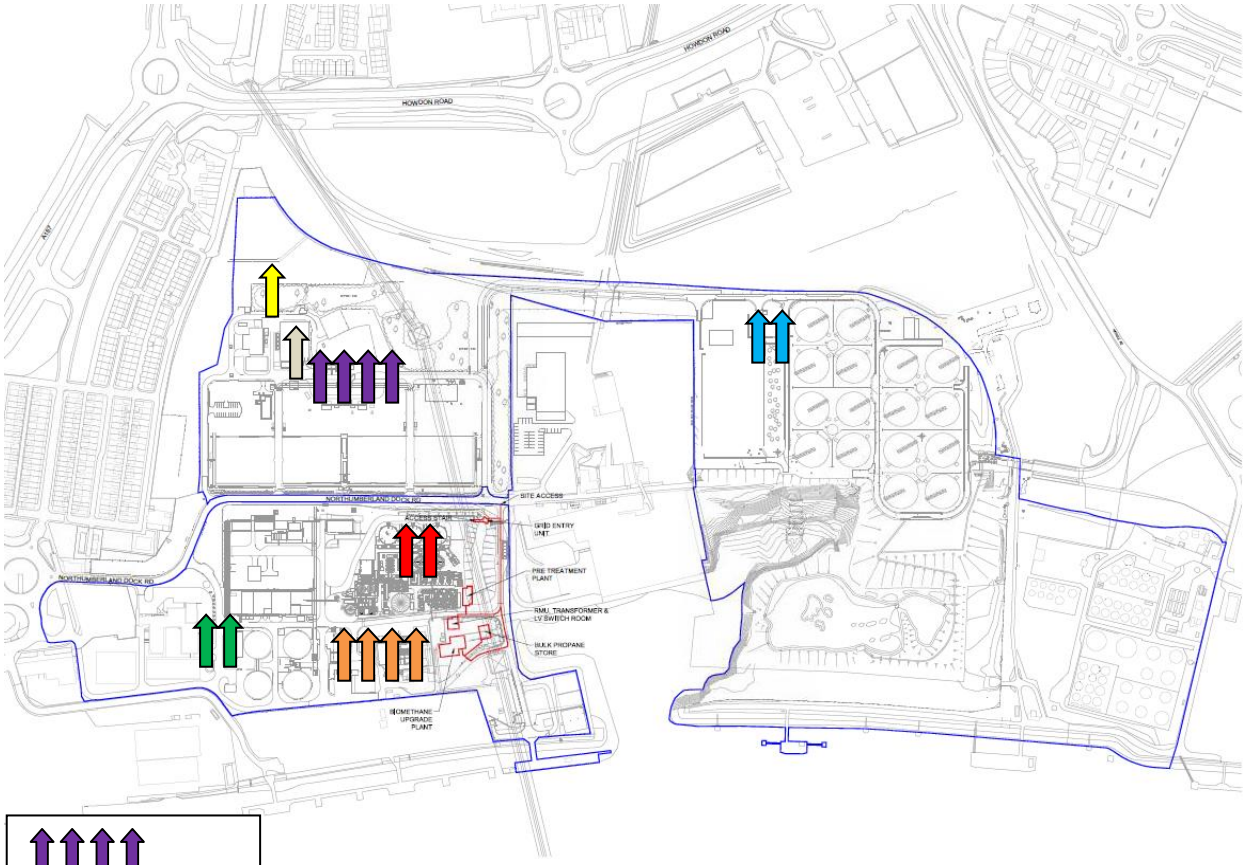
UWWD – Urban Wastewater directive, the EA discharge consent associated with the works, nominally 125mg/l COD or 75% COD removal across the whole works, may also have a solids and Phosphorous consents. Samples are collected over a 24 hour period using a composite sampler which samples every 15 mins of both the inlet and final effluent.

WRA – Water Resources Act. The EA discharge consent associated with the works, nominally BOD:SS consent, may also include ammonia, samples are collected as a spot sample of the final effluent only.

Appendix 3 Site Plan



Appendix 3.1 Site Plan with Odour Control Plant Locations



OS 1-4

OS 5

OS 6 & 7

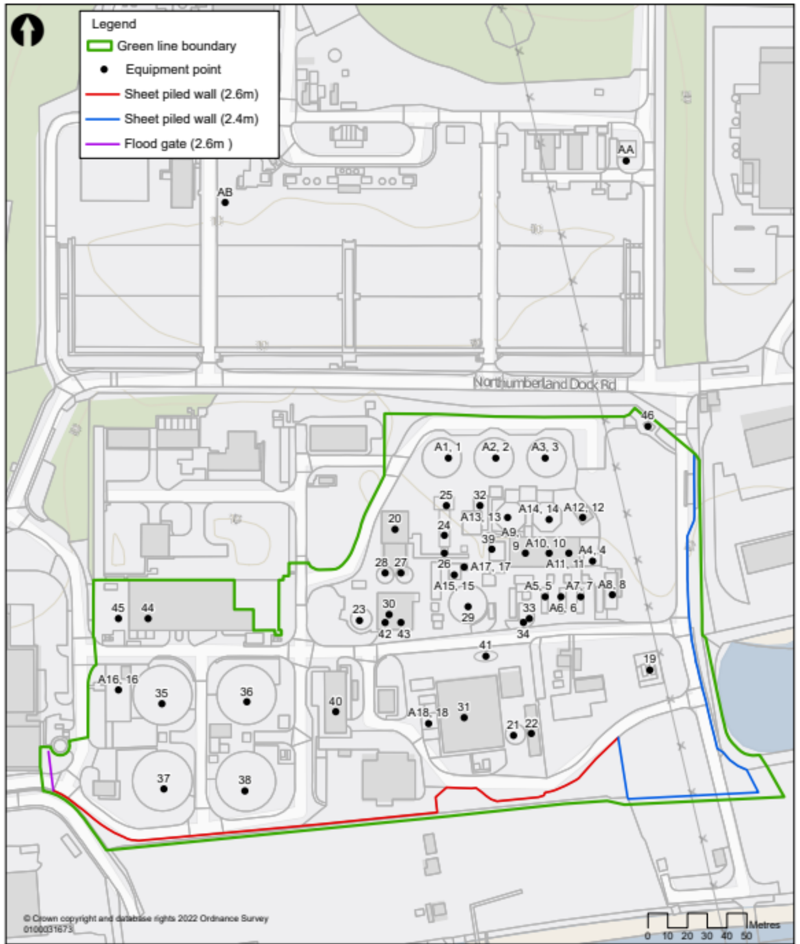
OS 8 & 9

OS 10-12

OS 13

OS 14 & 15

Appendix 3.2 Site Plan Permitted Area



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Title
Howdon STC
Site Layout Plan

MOTT MACDONALD
Mott MacDonald House
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T +44 (0)20 8774 2000
W mottmac.com

Date	Drawn	Checked	Approved	Scale at A4	Drawing Number	Status	Rev
23/02/23	M Pinney	WJ Goh	A Manns	1:2,100	100105164_MSD_SiteLayoutPlan_HOW	INF	05

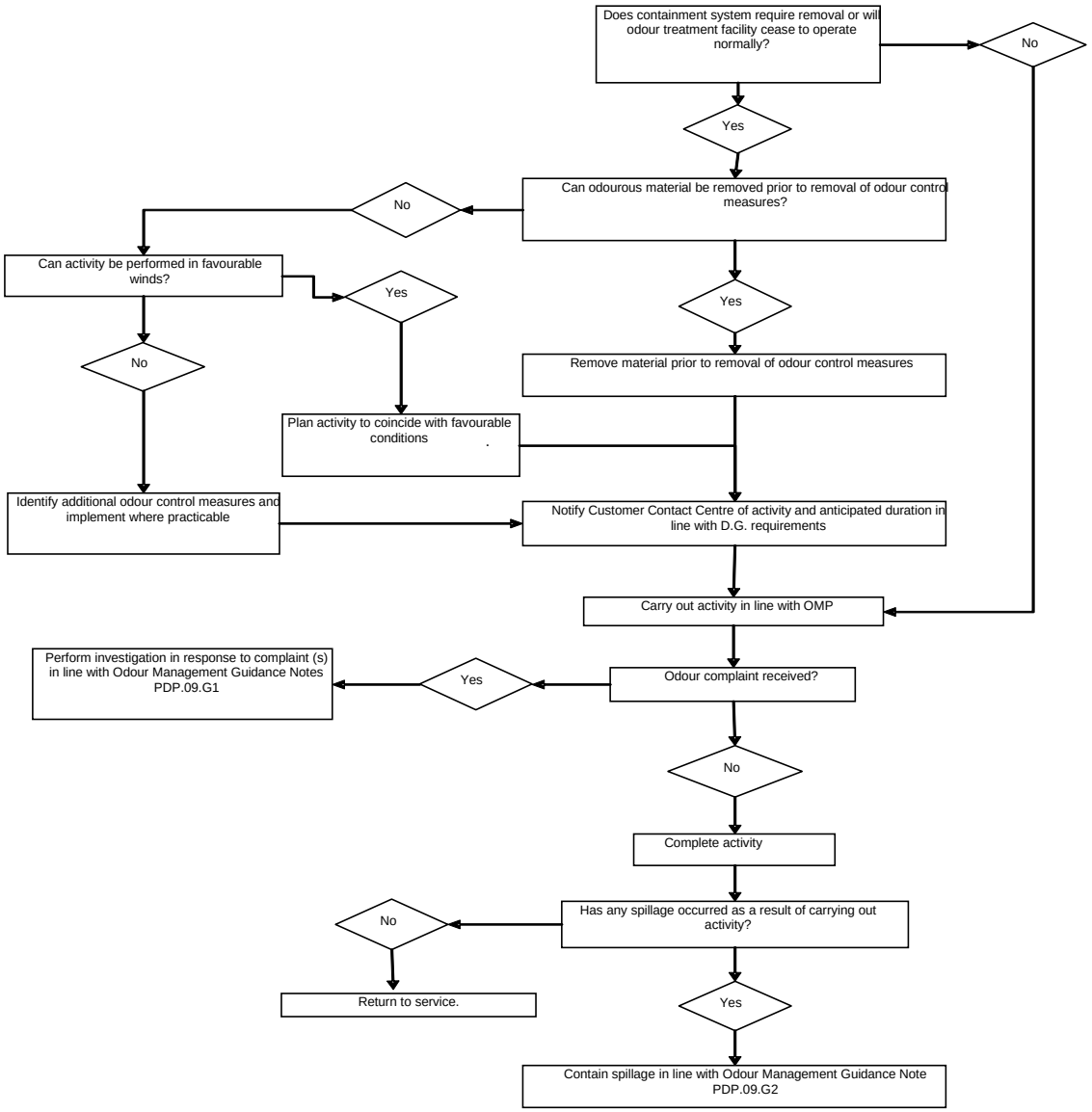
Emissions Ref	Emissions Points	Asset Ref	Asset	X	Y
A1	Advanced anaerobic digester 1: Whessoe valve	1	Advanced anaerobic digester 1	433580	566390
A2	Advanced anaerobic digester 2: Whessoe valve	2	Advanced anaerobic digester 2	433604	566390
A3	Advanced anaerobic digester 3: Whessoe valve	3	Advanced anaerobic digester 3	433629	566390
A4	CHP and boiler stack	4	CHP and boiler stack	433653	566338
A5	CHP engine 1 - Bursting disc (exhaust gas)	5	CHP engine 1	433629	566320
A6	CHP engine 2 - Bursting disc (exhaust gas)	6	CHP engine 2	433637	566320
A7	CHP engine 3 - Bursting disc (exhaust gas)	7	CHP engine 3	433647	566320
A8	Natural gas engine	8	Natural gas engine	433663	566321
A9	Composite boiler 1 - Boiler safety valve, Economiser safety valve and Safety valve	9	Composite boiler 1	433619	566342
A10	Composite boiler 2 - Boiler safety valve, Economiser safety valve and Safety valve	10	Composite boiler 2	433631	566342
A11	Composite boiler 3 - Boiler safety valve, Economiser safety valve and Safety valve	11	Composite boiler 3	433641	566342
A12	Flare stack	12	Flare	433648	566360
A13	Gas bag holder 1	13	Gas bag holder 1	433610	566360
A14	Gas bag holder 2	14	Gas bag holder 2	433631	566359
A15	AD biofilter	15	Biofilter	433583	566331
A16	Odour control unit 1	16	Odour control unit 1	433413	566273
A17	Odour control unit 2	17	Odour control unit 2	433588	566335
A18	Odour control unit 3	18	Odour control unit 3	433570	566256
AA	Inlet works			433670	566540
AB	Effluent discharge			433467	566519
		19	Biomethane upgrade plant	433682	566283
		20	Cake reception building	433553	566354
		21	Cake Silo	433613	566250
		22	Cake loading area	433622	566251
		23	Screened sludge buffer tank	433535	566308
		24	THP reactors	433578	566351
		25	THP flash tanks	433579	566366
		26	THP pulper	433578	566342
		27	THP buffer tanks (feed silos) 1	433556	566332
		28	THP buffer tanks (feed silos) 2	433548	566332
		29	Post digestion storage tank	433590	566315
		30	Dewatering building and Centrifuges (x2)	433550	566311
		31	Final stage dewatering building and Centrifuges (x2)	433588	566259
		32	Back-up generator	433596	566366
		33	Fuel oil storage tank	433621	566309
		34	Gas engine lubricant/ Waste oil tank	433618	566307
		35	Strategic sludge storage tank 1	433435	566266
		36	Strategic sludge storage tank 2	433478	566267
		37	Strategic sludge storage tank 3	433436	566223
		38	Strategic sludge storage tank 4	433477	566222
		39	Water treatment plant (boilers)	433602	566344
		40	Imported sludge reception building	433523	566262
		41	General waste bins (x2)	433599	566290
		42	Screening skip 1	433548	566307
		43	Screening skip 2	433556	566307
		44	Drum thickeners	433428	566309
		45	Thickened sludge day tanks (x2)	433413	566309
		46	Grid entry unit	433681	566406

Appendix 4.1 Odour Management Quality Document– PDP.09

TITLE:	**ODOUR MANAGEMENT – WASTEWATER ONLY**	**REF:**	**PDP.09**
PURPOSE:	**To ensure the Odour Management Plan (OMP) is used effectively on relevant sites and the equipment is fully operational and any source of odour is contained or dealt with in an appropriate manner to reduce and control impact on the environment.**		
SCOPE:	**All Wastewater sites excluding Bran Sands.**		

PROCEDURE:

In preparing to perform a routine or non – routine activity that may impact upon the potential for odour generation, a number of questions shall be answered prior to proceeding with the activity and reviewed by Team Leader and / or Works Manager.



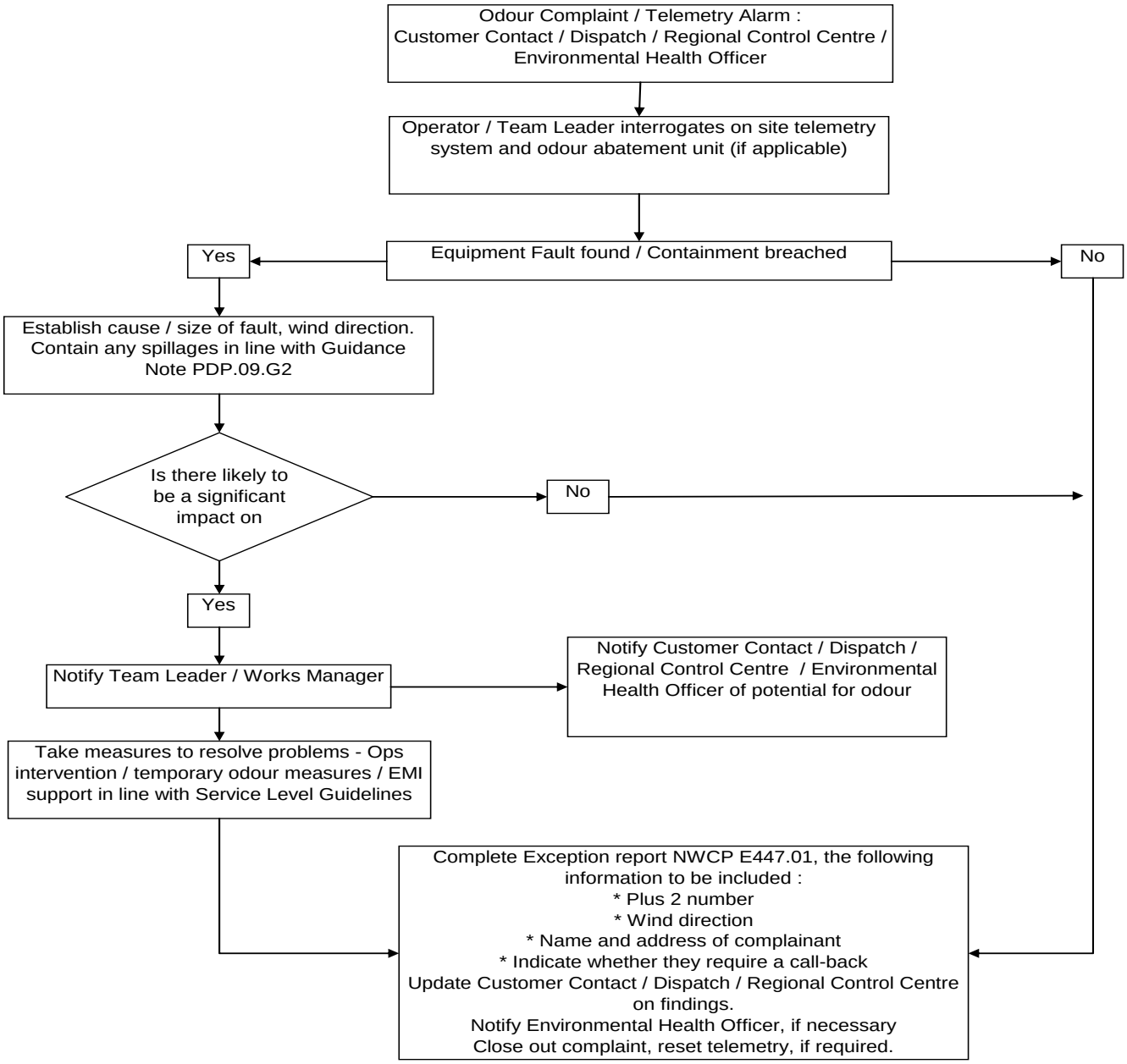
REFERENCES:

Odour Management Guidance Notes PDP.09.G1
Odour Management Guidance Notes PDP.09.G2
Telephone / Verbal Contacts CC.05
Written Complaints CC.06

Appendix 4.2 Odour Management Quality Document– PDP.09.G1

TITLE:	ODOUR MANAGEMENT – Investigation Guidance	REF:	PDP.09.G1
PURPOSE:	**To ensure the Odour Management Plan (OMP) is used effectively on relevant sites and Investigation of an Odour or Equipment Failure that may result in an Odour release is dealt with in an appropriate manner to reduce and control the impact on the environment.**		
SCOPE:	**All Wastewater sites excluding Bran Sands.**		

PROCEDURE:



Appendix 4.3 Odour Management Quality Document– PDP.09.G2

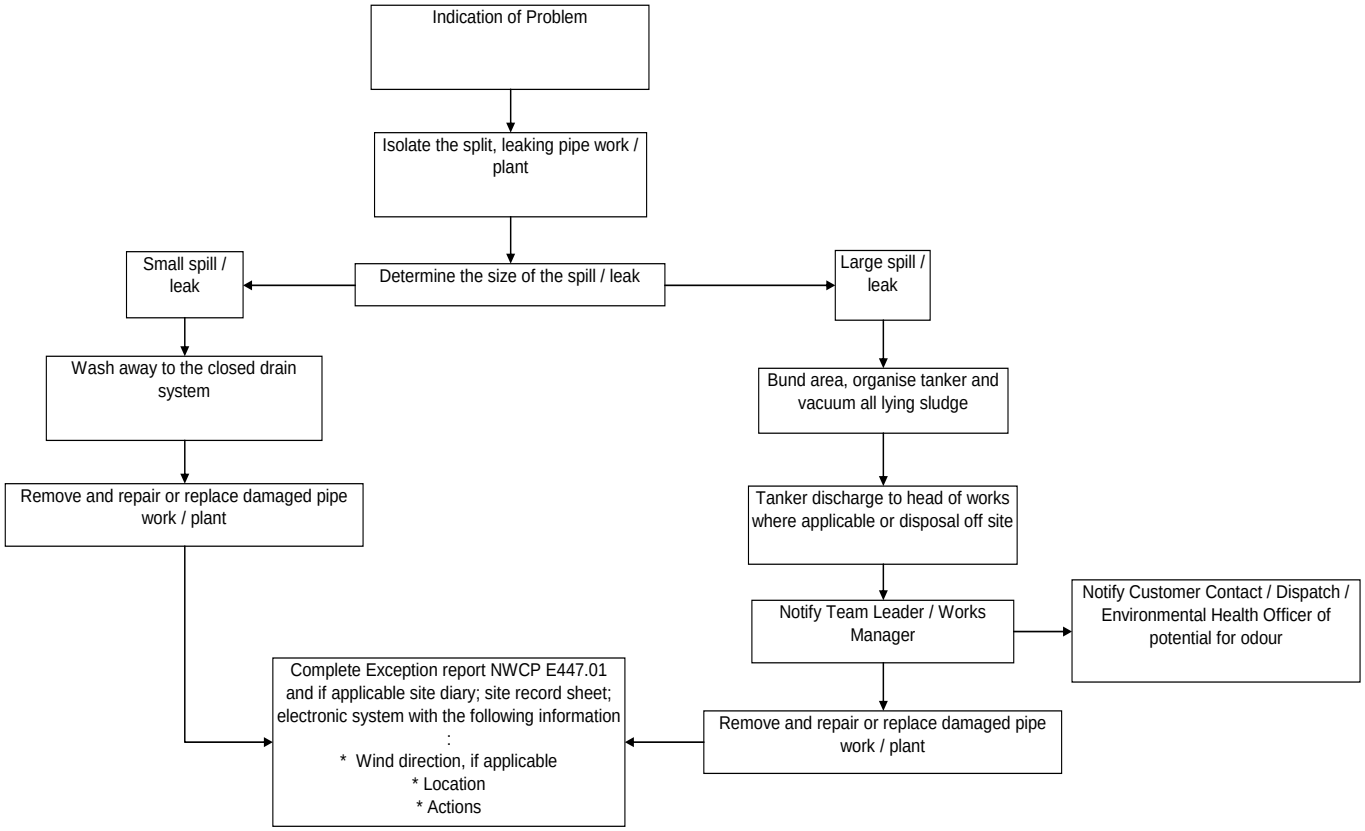
TITLE:	**ODOUR MANAGEMENT – Spillage Guidance**	**REF:**	**PDP.09.G2**
PURPOSE:	**To ensure the Odour Management Plan (OMP) is used effectively on relevant sites management of a spillage that may result in an Odour release is dealt with in an appropriate manner to reduce and control the impact on the environment.**		
SCOPE:	**All Wastewater sites excluding Bran Sands.**		

PROCEDURE:

- Operators receive an Alarm from the Telemetry system (pump flows, valve failure etc).
- Operators receive a telephone call from the Regional Control Centre.
- Spill discovered by site personnel

Identify the location of the fault/burst/spill or leak.

Split pipe work, leaking valves, taps or sample points are to be removed / replaced or repaired as per company resources and time scales in line with Maintenance Service Level Guidelines



REFERENCES: **Odour Management Guidance Notes PDP.09**
Odour Management Guidance Notes PDP.09.G1
Exception Report NWCP E447.01

Appendix 5.0 Howdon AD Odour Management Plan - P700/OMP/001

Contents

INTRODUCTION

1.1 PROJECT DESIGN BRIEF

The primary objective of this project is to minimise the operating costs for the treatment and disposal of waste water sludge's at the Howdon STW. The project will also make a substantial contribution to NWL's commitment to reducing its carbon footprint. The blended sludge will be pasteurised in a hydrolysis process then digested to maximise gas production. Biogas will be used to produce "green energy". Digested sludge will be de-watered for off-site disposal.

The project has provided:

- Refurbishment and improvement to the existing sludge management / treatment system relating to sludge screening
- Provision of raw cake dewatering and storage
- Provision of raw cake reception system (in a building)
- Provision of Thermal Hydrolysis Plant
- Provision of a MAD (Mesophillic Anaerobic Digestion) plant;
- Provision of CHP (Combined Heat and Power) plant to supply steam and hot water for the operation of the enhanced digestion plant; and to generate electricity from renewable sources
- Reuse of digested sludge de-watering plant
- Refurbishment of return liquor treatment plant.

The Northumbrian Water Limited Works Information as reference:

Howdon Advanced Digestion

Volume 2 Works Information

ST007/0091-4.A

41517323

December 2010

The Northumbrian Water Limited Site Information as reference:

Howdon Advanced Digestion

Volume 3 Site Information

ST007/0091-4.A

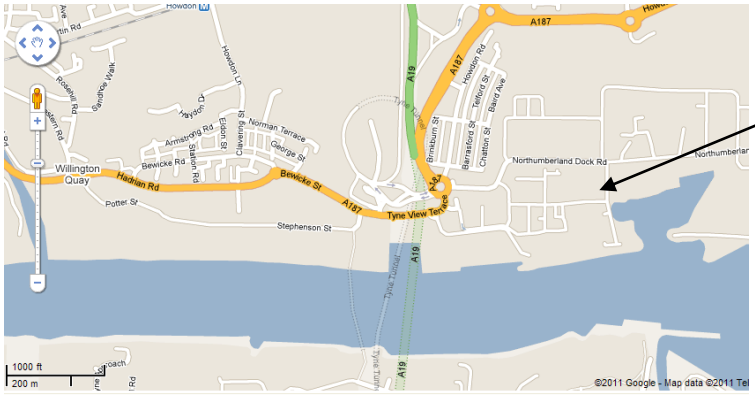
41517323

CS-NN-129-0B

January 2011

1.2 DESCRIPTION OF EXISTING WORKS

The STW at Howdon lies on the north bank of the River Tyne within the National Grid References squares NZ 3366 and 3466



1.3 DESCRIPTION OF NEW AAD WORKS

The advanced digestion process includes:

- Indigenous and imported sludge treatment including screening, storage and dewatering;
- Cake storage and blending;
- Thermal hydrolysis;
- Sludge anaerobic digestion;
- Digested sludge storage and transfer;
- Biogas collection and storage;
- Waste biogas burner;
- Biogas combustion in Combined Heat and Power (CHP) units for electrical power generation;
- Heating systems including boilers, heat exchangers and boiler ancillaries;
- Boiler and CHP exhaust flue stack;
- Final effluent treatment for process water;
- Odour extraction and treatment;
- Various motor control centre kiosks and operational enclosures;
- Access roads and general access ways.

Construction works included:

- Earth works for the works preparation for piling and foundations;
- Piling, foundations and retaining wall construction;
- Excavation and installation of below ground services including potable water, natural gas, electrical power, drainage and various process pumped/gravity mains;
- Construction of digesters, various steel super structures and erection of kiosks/ enclosures;
- Installation of the various process plant, piping and instrumentation;
- Installation of electrical/ control cabling;
- Interfacing with existing process systems and utilities to feed and discharge process streams feeding and discharging from the new process.

The AAD works is divided into the following areas:

Area 00	General
Area 01	Liquid Sludge
Area 02	Dewatered Raw Sludge
Area 03	Thermal Hydrolysis Plant
Area 04	Sludge Digestion
Area 05	Biogas System
Area 06	Energy Plant
Area 07	HV System
Area 08	Digested Sludge
Area 09	Return Liquors
Area 10	Not Used
Area 11	Service Water
Area 12	Not Used
Area 13	Odour Control System

1.4 PROCESS DESCRIPTION

The process stream as a whole is based around the inclusion of a Thermal Hydrolysis Process (THP) fed by a partially thickened sludge outputting to anaerobic digesters.

In general the process stream sequence is:

- Liquid sludge pumping through screens
- Screened sludge buffer tank
- Pre-dewatering by centrifuges
- Imported sludge cake facility
- THP feed silos
- Pumping to THP system including partial dilution split to feed 2 THP streams
- THP batch processing split into 2 streams.
- Pumping and further dilution to pre digester cooling.
- Anaerobic digestion in 3 identical digesters
- Digested sludge storage tank
- Post-dewatering process (to be carried out using existing centrifuge on site)

Under everyday conditions the process system will be fed by liquid sludge from the four main works strategic sludge storage tank. This feed may be from a single tank or in any combination of the four as circumstances dictate.

This sludge will be passed through screenings removal plant and temporarily stored in the screened sludge buffer tank prior to being passed through the centrifuge.

From the centrifuge cake at a nominal 20+% dry solids (ds) will pass to the THP silos via screw conveyors

Occasionally sludge in cake form will be imported from elsewhere and will enter the system downstream of the centrifuges. This imported cake is intended to be of a similar dry solids content to the output from the system centrifuges and will feed to the THP system following further dilution to a nominal 16.5%DS.

There are 2 identical streams which will normally operate together. THP system is a continuous batch process whereby sludge is fed into a pre heater tank (Pulper), distributed in turn to one of four other

tanks - known as reactors - in the stream. The reactors have a fill time then process with steam under pressure time period, followed by an empty time when sludge is discharged under its own pressure to a de pressurisation tank – known as the flash tank. For all relevant purposes the input and output of the THP streams is continuous.

The resultant high temperature sludge is then further diluted as it is pumped forward to the digester. The sludge is of too high a temperature to enter the digesters directly and is blended with sludge recirculating through the digesters mixing system and a proportion is passed through water/sludge coolers before entering the digesters. The temperature of this sludge at the outlet of the coolers is such that the overall digester temperature is maintained at a fixed temperature.

This continuous process displaces sludge from the digesters which passes under gravity to the digested sludge holding tank where it is maintained in an aerobic condition to suppress any further gas production caused by continuing digestion and strip any residual methane to create an un-zoned area for downstream processes.

In addition to the main process stream there are a number of infrastructure items and streams the main ones of which are:

- Imported cake building, hoppers and feed screws
- Biogas off take and two storage vessels from the digesters
- Three multi fuel steam generating boilers supplying steam to a steam header to support the THP process (Natural gas, Biogas, Gas oil)
- Three Combined Heat & Power (CHP) biogas driven electrical generating engines providing electrical power, steam generation via waste heat recovery and further low temperature waste heat recovery from engine cooling water systems.
- HV equipment and systems
- Odour Control from various nodes of the system
- Service and potable water feeds and waste returns
- Boiler feed water generation – from potable water
- Low temperature hot water (LTHW) circuit to recover energy from the CHP engines cooling circuits.

ODOUR SOURCES

The following odour sources were identified and extracted to the new odour control system (OS14&15):

Source	No. of units	Filling rate (m3/h)	Unit volume (m3)	No. of air changes per hour	Extraction rate per unit (Nm3/h)	Total extraction rate (Nm3/h)	H2S (ppm)		Mercaptans (ppm)		NH_3 (ppm)	
							Max	Ave	Max	Ave	Max	Ave
Cake reception building – included in Cake reception hopper extraction	1			2		4252	-	-	-	-	-	-
Cake reception hoppers	2	2240	65	30	2126	4252	60	15	32.5	10	50	5
THP feed silos	2	40	400	1	440	880	50	20	30	10	50	5
Screened Sludge Buffer Tank	1	-	600	1.3	800	800	200	75	5	2	-	-
Thermal hydrolysis plant	2	-	-	-	30	60	-	-	-	-	-	-
Return liquors pumping station	1	550	40	10	550	550	150	75	5	1	50	5
Centrifuges	2				200	400	200	75	5	2	-	-
Post Digestion Tank	1		4500	0.5	1500	1500	30	7	5	1.5	180	80
Screening skips	2	8	26.5	1	29.15	58	200	75	5	2	-	-
					Total	**8500**	**80**	**27**	**21**	**7**	**65**	**17**

The table above represents the odour loading on the new odour control system. However, as the Cake Reception Building will not frequently be utilised, the table below compares the average loadings and peak loadings during cake imports:

	H2S (ppm)	Mercaptans (ppm)	NH3 (ppm)
	Ave	Ave	Ave
Average - Incl Imports	**27**	**7**	**17**
Average - Excl Imports	**19**	**2**	**15**
Peak - Incl Imports	**80**	**21**	**65**
Peak - Excl Imports	**50**	**5**	**40**

Odour Mitigation Measures.

Cake Import Facility:

The cake import building will allow the cake importing trailers to discharge their cake into the reception silos behind the closed door (operation of internal doors and external doors electrically interlocked). This will prevent odours from escaping to the local atmosphere during cake offloading periods. In addition, continuous room extraction through the cake import hopers will be directed to the new odour control unit (OCU) to minimise on the build-up of odours within the cake import building and import hoppers.

Each of the two import hoppers are fitted with odour extraction hoods which will only be open when trailers are discharging to the silos. This discharge period should only take 10-15 minutes to complete. The combustion fumes from the vehicle will be extracted to through the odour control system to prevent the build up of diesel fumes within the enclosed building during cake deliveries. This is to prevent any discharge of odour to atmosphere which could arise due to the ventilation of the building.

There will be continuous odour extraction from both silo's to the new odour control unit to ensure that odours are not released back into the cake import building.

Raw Sludge Dewatering Building and Sludge Buffer Tank:

There are 6No. Strainpreses discharging into 2 No. Skips, and 2 No. centrifuges located within the dewatering building. Point source extraction is provided from the operating equipment. To facilitate odour extraction from the screenings skips, odour control skip covers are provided. The skip covers are designed to allow the removal of the skips.

The sludge buffer tank is covered and extracted to the new odour control system.

Raw Cake Silos

Two new covered cake buffer silos are continuously extracted, combined with odours from the Cake Import Facility and dewatering building before being abated through the new odour control unit. This will ensure that there will be no odorous releases during raw sludge storage and mixing.

Thermal Hydrolysis Plant:

The process is under pressure and sealed and there are no direct emissions to atmosphere. As a result, there is no requirement to directly connect the reactor vessels to the new odour control unit. However, due to the potential operation of the vents to prevent over pressure or vacuum in the process, there is the potential for release of odours to the environment. This is mitigated by connecting these vents to the new odour control unit.

Periodic pressure check inspections will be required on each tank (to meet pressure regulations). The vessels will be emptied and cleaned out in an appropriate manner to minimise the potential for odour release. A detailed maintenance procedure will be in place beforehand.

Post Digested Sludge Holding Tank:

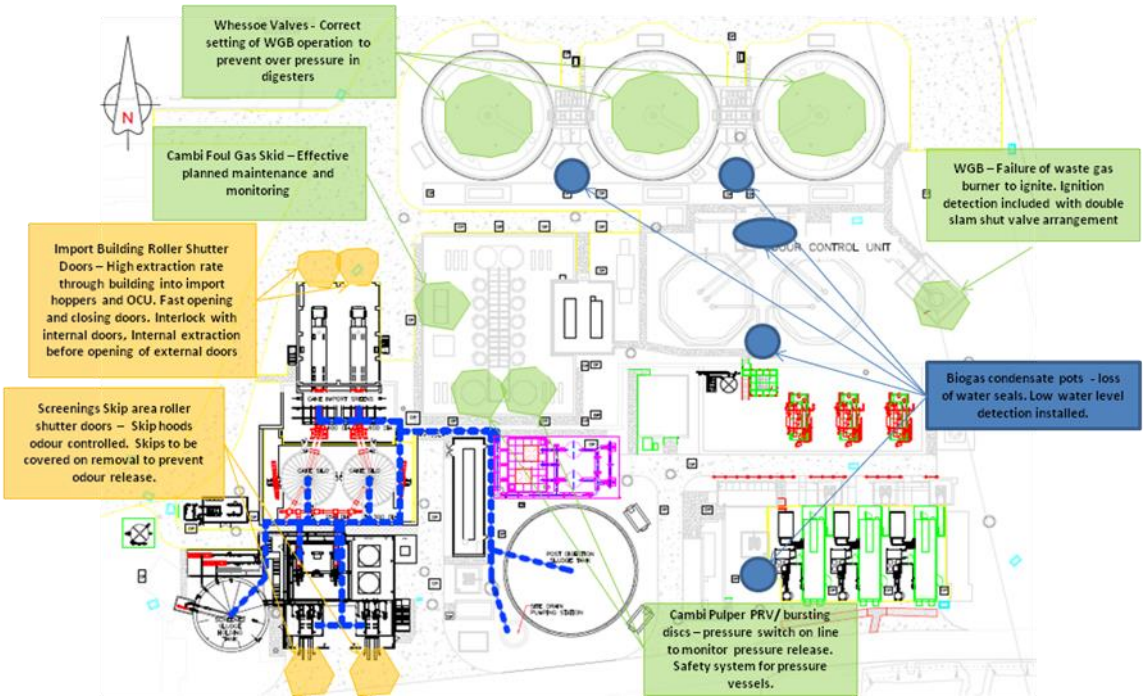
Following the digestion process, the sludge is held in a covered post digestion storage tank until it is transferred to be dewatered in the existing dewatering facility. This tank is aerated to prevent further biogas generation and to keep the tank mixed. The tank is covered and extracted to the new odour control unit at an extraction rate to prevent any explosive environment due to the presence of residual biogas from the digestion process.

General Maintenance

All planned maintenance will follow the procedure described in PDP.09 in the OMP S 06-07-162.
If the work cannot be completed in line with this procedure, further mitigation will be implemented by enclosure and work method statement written collectively with experienced operational/ site personnel.

Fugitive Emissions

The table below indicates the potential fugitive emissions for the AD facility:



Location	Source of Emission	Actions/ Mitigations
Screenings Area	Screenings skip	Skip hoods are odour controlled
	Skip removal	Skips to be covered on removal to prevent odour release
Import Building	Normal operation	High odour extraction rate, extracted from each import hopper. Hopper unavailable if OCU fails.
	Opening building roller shutter door	Building doors interlocks with hopper doors. No building door can open if either hopper door is opened

Location	Source of Emission	Actions/ Mitigations
		Fast opening and closing building doors
	Leakage of sludge from hoppers before import hoppers self-sealed	Occurs only during initial commissioning. Washdown of sludge where possible. Commissioned with digested cake from Bransands, with low odour impact.
Cake Screw conveyor over pressure burst flaps	The bursting disks are required to prevent catastrophic failure if a screw fails and is not detected.	Due to the design and operation of the screw conveyor system, double failure needs to occur before bursting flaps are required. If bursting flaps operate (alarmed), will require immediate clean up to reduce the odour impact.
Cambi bursting discs	Odour release from bursting discs	Pressure switch to monitor pressure release and shut the relevant stream down.
Cambi PRV	Odour release from PRV	Odour release is due to lack of maintenance. Scheduled maintenance on valves.
Cambi foul gas skid		Effective planned maintenance and monitoring
Digester Whessoe Valves	Odour release from whessoe valves	Correct settings on waste gas burner and gas holder blowers to prevent over-pressure. Preference for burning biogas before over pressure occurs.
Gas holders hydraulic valve	Loss of fluid	Low level detection installed and alarmed.
	Odour release due to high pressure	Correct settings on waste gas burner and gas holder blowers to prevent over-pressure. Preference for burning biogas before over pressure occurs.
Biogas Condensate and Drainage Pots	Loss of fluid/ water seal	Low level detection installed and alarmed.
Waste gas burner	Failure to ignite	Ignition detection included, double slam shut arrangement when burner fails. Small pilot flame pipework to reduce the quantity of biogas released due to ignition failure.

Description of Dedicated Odour Control System (OS14 and 15).

The overall strategy for the advanced digestion process is to mitigate against potential odours being generated and released from the various stages of the digestion process in order to prevent them from dispersing from the site. This approach has been designed to:

- contain the odours at source by enclosing these odour sources with suitable containment covers
- direct and combine these odorous air volumes from the various sources via a network of plastic ductwork to a system which will
- abate these odours to a pre-agreed quantity on the stack outlet via a two stage odour control system

The process utilise is a well established proven odour control technological system comprising of a two stage treatment process (OS14 & OS15). The two stage system is made up of the primary stage which will be capable of removing up to 90% of the incoming odours and will be based on a biologically based abatement process, followed by the secondary or final polishing stage which will

function to reduce the odours down to the agreed odour levels before they are expelled to the atmosphere via the individual exhaust stack.

The biological activity of organisms within the primary biofilter stage (OS14) allows for the removal of a wide range of chemical components present in the incoming airstream (organic and inorganic) which are perceived as odorous by the human sense of smell. This stage consists of porous rock media which is wetted with either final effluent or potable water (as back-up) to ensure that the biological population is kept viable and highly active while the airborne odours are being solubilised within the contact media. The supplier has indicated a minimum media life guarantee of 20 years.

The remaining odorous components are presented to the final dry polishing stage (OS15) which consists of a layered activated carbon. This media has a large surface area which physically traps and reacts the chemical odours within its structure as they pass through the final stage of treatment. Although the system has been sized for a guaranteed minimum media life of 5 years at the expected loads, this will depend on how often the biological stage is bypassed for maintenance or the number of peak loads generated by the process.

To prevent any period of downtime of the OCU during planned media changes, a bypass system is provided around the biological stage and two second stage units are provided to ensure secondary treatment is always available during media change.

Figure 1 below indicates the extent of the odour ducting and extraction points.

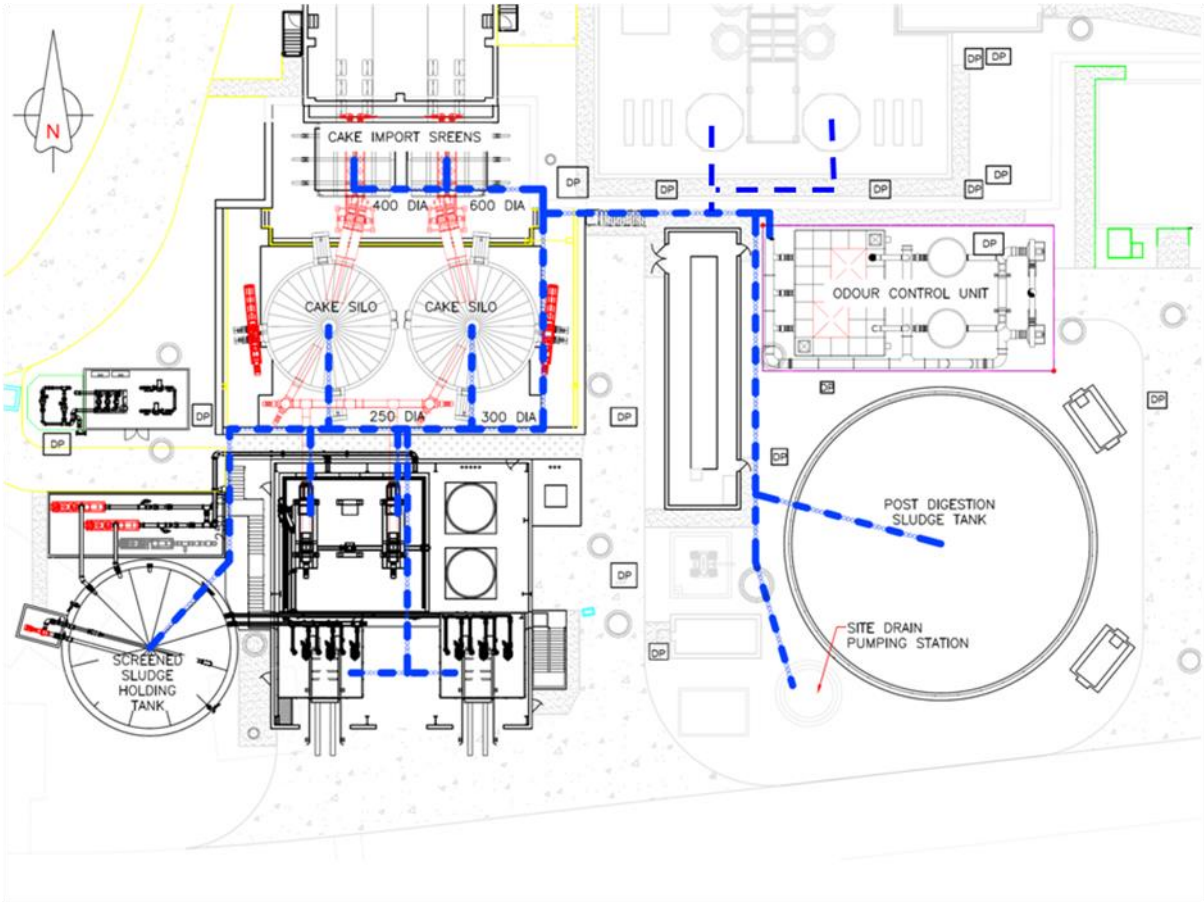


Figure 1: Odour Ductwork Layout

The following additional process requirements have been provided for odour mitigation for Howdon AD OCU unit:

- Extended residence time (RT of 45sec, normally 35sec) trickling biofilter with Lavarock media and FE irrigation – media life of 20years
    - Low maintenance and operating cost, no chemical requirement.
    - Overall low carbon foot print.
    - Extended RT to allow treatment of ammonia.
    - Stable and inert – for long life (20 years).
    - Light and strong – ideal for deep bed
    - High porosity and surface area – ideal for biological growth
    - Stone voidage allows continual irrigation ensuring biomass thoroughly wetted for peak performance
    - 99% H_2S removals at steady loadings, stable process.

- Dual Dry scrubber units (Total RT of 5sec, normally 2 to 3 sec) with a combined media life of 5 years (normally 3 years), containing layers of carbon media:

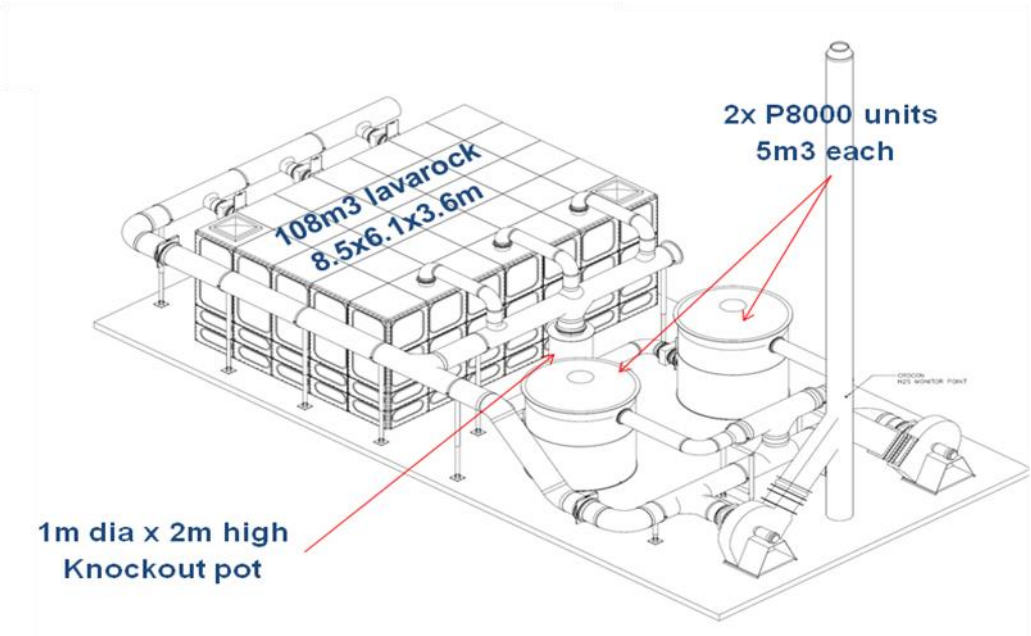


Figure 2: Howdon OCU

Process Commissioning (details on plant start up)

OS14/15:

Biofilter will require a 2 to 3 week start-up period. However, this will be reduced to 2 to 3 days by seeding with Activated Sludge from STW (appr. 1000l) or inoculation with appropriate bacteria. To facilitate the start-up period, the OCU will be brought online 1 week before importing sludge to seed digestion process. To further facilitate the start up period, the media has been impregnated to allow for some adsorption removal on start up.

Start up prior to seeding with digested cake will allow a gradual acclimatisation of the process with a slow build up loads on the system as the digester seeding process will take approximately 14 days. Towards the middle of this period, the first flow of indigenous sludge will be fed to the sludge screens, allowing an increase in loads to the OCU. This then followed by the operation of the centrifuges and discharge of cake into the cake silos.

During this start-up process, the secondary stage on the OCU will be by-passed. The odour will be monitored, and any increase in odour discharge from the stack, will result in the secondary process being brought online. It is a passive unit, and does not require a start up period.

Fugitive Emissions:

The plant has been designed to minimise potential fugitive emissions. The individual areas of plant (Area 1 – 13) will be monitored and improvements (design or operational) made as required.

During the early stage of commissioning, some venting of digester head space through the whessoe valves will be required to allow concentrating of the biogas in the head space. This will be relieved at the highest point on the digesters (25m high). Once the methane concentration has increased to combustible levels, the waste gas burner will be brought online, reducing the requirement to vent the digesters head space. Impact on odour is not anticipated from this activity; but this will be monitored.

Monitoring

Throughout the first two months of commissioning the plant shall be monitored on a daily basis, for:

- Odour checks from the stack of OS14/15 using on line monitor
- Random odour sampling for H_2S (fugitive emissions) using Jerome meter

In addition this there will be more detailed testing to demonstrate the performance of the plant:

- Olfactometry and other species from the stack of OS14/15
- Smoke tests
- More detailed odour sampling for other components (fugitive emissions)

Dispersion Model

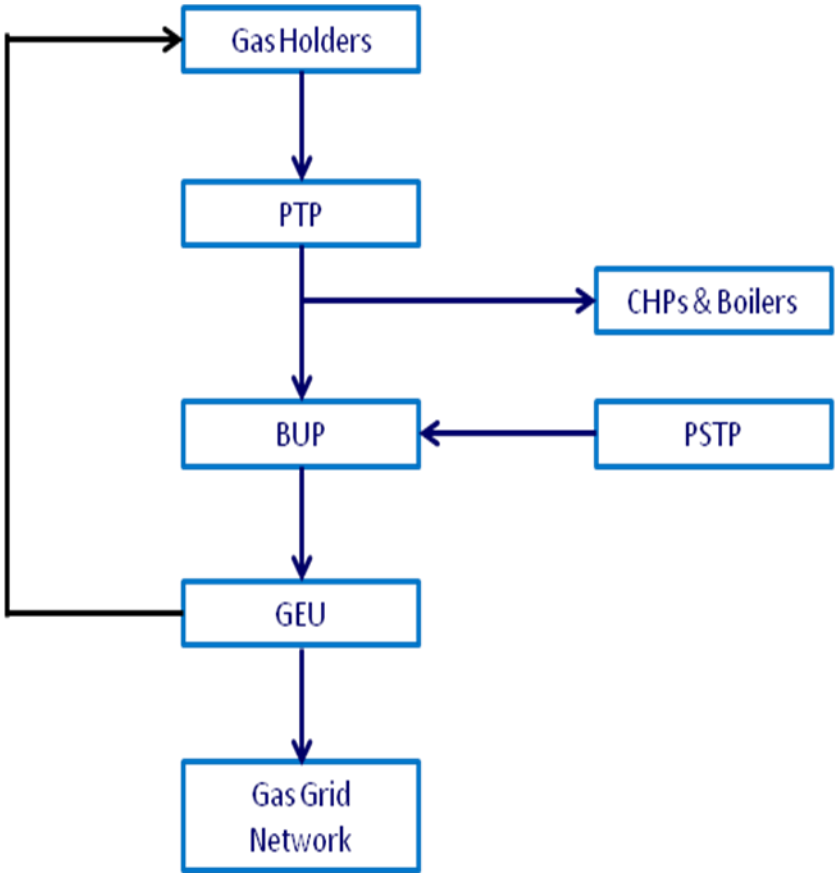
NWL has prepared and maintains an odour dispersion model for Howdon Sewage Treatment Works (STW). This odour dispersion model now includes the AD plant based on odour mitigation measures (OS14/15), so that the odour limit at the site boundary is <=5 OU_E/m_3. Using this model, it has been demonstrated that OS14/15 is required to achieve the objective of <1000OU_E/m_3 at the stack outlet.

Relevant data will be collected from OS14/15 and other odours stacks at Howdon STW and used to validate this model once the AD process has reached full throughput.

Appendix 6.0 Howdon Odour Management Plan – G2G Plant

Process Overview

The G2G installation consists of the Biomethane Upgrade Plant (BUP), Pre-Treatment Plant (PTP), Grid Entry Unit (GEU) and Propane Storage and Transfer Plant (PSTP)



The BUP, PTP and GEU each have their own dedicated PLC based control system and each package control PLC is linked to the overall site SCADA. In addition, the control system for each of these package plants allows an operator to safely start up, run, monitor and shut down the relevant plant from its own control panel in the absence of connection to the site SCADA system.

Process Objectives

Under normal operation the G2G (biomethane injection plant) provides:

- Upgrade of all available biogas to biomethane through a fully automated process stream;
- Injection to the UK gas distribution network of enriched biomethane meeting the requirements of the Network Entry Agreement (NEA), Gas Safety (Management) Regulations (GS(M)R) and OFGEM requirements.

The process stream as a whole is based around a Biomethane Upgrade Plant (BUP) fed by the biogas stored at the existing site biogas gas holders.
In general the process stream sequence is:

- Biogas is fed to the PTP;
- Biogas is boosted and dried at the PTP;
- Biogas is fed to the BUP;
- Biogas is upgraded in the BUP to biomethane;
- Biomethane is enriched with propane from the PSTP;
- Enriched Biomethane leaves the BUP;
- Enriched Biomethane is monitored at the GEU;
- Enriched biomethane is injected to the gas distribution network;
- The GEU controls injection to gas distribution network.

General Process Description

- The Advanced Anaerobic Digestion (AAD) plant produces 1,700 Nm^3/hr of raw biogas at nominally 60% Methane. The raw biogas contains contaminants such as siloxanes and hydrogen sulphide.

- The biogas produced by the AAD plant is stored in two gas holders each having a capacity of 1,150 Nm^3. The gas holders operate in parallel and are interlinked. Normal operating pressure is 23 mbarg. Mechanical over pressure relief valves discharging to atmosphere are fitted.

- The raw biogas from the gas holders is piped to the PTP. The main function of the PTP is to remove excess moisture from the biogas and boost its pressure to allow it to be distributed to the site consumers. The primary consumer will be the BUP however the pipework is configured to allow the dry biogas to be fed to the existing CHP engines and boilers should the BUP be unable to process all of the produced gas. The PTP plant boosts the gas pressure to nominally 80 mbar prior entering the dryer unit. The condensation process in the dryer also reduces the levels of H_2S and siloxanes in the dry biogas.

- From the outlet of the PTP the dry biogas is piped to the site gas consumers. Under normal circumstances all dry biogas is fed to the BUP. However in some circumstances, such as reduced grid gas demand or the BUP being unavailable, some or all of the biogas can be used in the CHP engines.

- The BUP plant uses a water scrubbing process to clean the biogas of contaminants deemed harmful to the natural gas grid and remove carbon dioxide thereby increasing the calorific value of the gas so that it can be designated as biomethane. The analysed ‘off gas’ which is predominantly Carbon dioxide is connected to odour ductwork which is odour controlled at OS10 -12

- The BUP carries out the analysis necessary to ensure that the produced biomethane is of an acceptable quality. The upgrade plant incorporates a recirculation facility so that out of specification biomethane can be returned to the inlet of the upgrade plant for further treatment.

- Biomethane of the correct specification needs to be further enriched with propane to meet the calorific value (CV) and Wobbe Index values required to comply with the gas Network Entry Agreement (NEA) between the NWL and Northern Gas Networks (NGN). The propane injection and mixing system forms part of the BUP

- The enriched biomethane leaving the BUP is analysed and monitored at the GEU. The GEU contains high grade analysers, certified by OFGEM, which continuously monitor the quality of the enriched biomethane to confirm compliance with the NEA, GS(M)R and OFGEM requirements.

- The GEU has a gatekeeper role and controls the admission of enriched biomethane injected to the gas grid. The GEU contains equipment to add odorant to the exported gas as required by gas safety legislation.

Safety Advice for Odorant Spills and leaks
Appropriate safety precautions and measures to clean up odorant spills can be found in the material
Safety data sheet of the odorant, which should be provided by your odorant supplier.
All major odorant spills that could result in false gas leak reports should immediately be reported to the local grid operator and emergency call centre.
After cleaning up odorant spills, clean all surfaces that have come into contact with the odorant with a neutralising liquid to get rid of the strong odorant smell. Suitable neutralising liquids are:
*CHRISAL CMF-240;
*6% bleach (sodium hypochlorite);
*Hydrogen peroxide.
Refer to the supplier's manual for the proper use of these products.
Lingering odorant smells can be neutralised with anti-odorant aerosol sprays.
Suitable anti odorants include: O-Scent from Technic Systems International.

Small spills
During maintenance it is always possible that a few drops of odorant are spilled when a fitting is opened. These will be caught in the drip tray underneath the odorisation system. If this happens, wipe up the odorant with a cloth or paper towel drenched in neutralising liquid, or pour a little neutralising liquid on the odorant and then wipe it up. Spray anti-odorant to combat strong odorant smells.

- Gas quality and flow metering data is continually transmitted to the gas network operator (NGN), in the event that the gas quality deviates outside of acceptable limits a remotely operated valve, under the control of NGN, is closed to prevent export of gas. This valve cannot be opened remotely; reset requires a site visit by NGN personnel.

- In the event that the enriched biomethane approaches the limits for compliance with the Network Entry Agreement (NEA) a divert valve, located within the GEU kiosk, will automatically open to recycle any out of spec Biomethane to the AAD plant.