WWOE (2) 01 – Welsh Water Organic Energy Cardiff

PAS 110 Digestate

Quality Management System Description

Table of Contents

1. Record of Change

Issue Number & Date	Date	Details of Change
Issue 1	8th November 2018	Issue of procedure
Issue 2	3rd January 2019	Update of procedure references and review of the HACCP.
Issue 3	1st March 2019	Section 3 – updated with job titles rather than persons names. Section 3.1 – updated the organogram with contractor support. Section 6.5 – Macerator separated as a CCP in the HACCP.
Issue 4	11th March 2019	Section 3.1 – updated the organogram to include scientific support role.
Issue 5	28th February 2020	Update to format and procedure. Section 3- Change of quality manager Section 3, 1.2- updated the organogram Section 4- Update of date of REAL Certification Scheme Rules, PAS110 and AD Quality Protocol. Update section 8 – CCP CAR actions

Issue 6	20 January 2021	Section 2.2 – updated to include Senior Management commitment to deliver and communicate the policy.
Issue 7	28th January 2021	Update to section 2 Quality manager change from Bleddyn Escott to Stephen Morton
Issue 8	1st March 2021	Update to Organisation chart (organogram)
Issue 9	24th March 2021	Update to organisation chart & update to section 9.2 on the frequency of sampling required changed from monthly to in accordance with WWOEF 078 – Sampling Schedule.
Issue 10	24th April 2021	Update to section 2.1 to the organisation chart to reflect the New starters and staff that have left the company. Updated section 18 updated to reflect the use of DPM on site.
Issue 11	10th August 2021	Page Up is now SuccessFactors, 8.3.3. has been amended to reduce urgency of FOS/TAC exceedances and show daily corrections in DPM – Consistent exceedances are still to be recorded in CAR.
Issue 11.1	21st September 2021	Addition of sign-on sheet on final page.
Issue 11.2	2nd February 2022	Update to REA Scheme Rules Version (Section 3)
Issue 11.3	30th January 2023	3.1 Staff roles and responsibilities updated. Flow charts amended to reflect new end. Doc. Ref. updated. 8.3 updated in relation to CAR register.

1. Overview

This Digestate Quality Management System (DQMS) is established and maintained by:

Welsh Water Organic Energy

1.1 Scope

This Digestate Quality Management System applies to the separated liquor digestate arising from:

Mesophilic Anaerobic Digestion with post-digestion pasteurisation and separation to produce a separated liquor digestate. The process accepts a maximum of 35,000 tonnes of feedstock per year.

At **Tremorfa Anaerobic Digestion Plant, Tides Field Road, Tremorfa, Cardiff, CF24 5SB.**

This QMS controls all operations and activities necessary to produce digestate compliant with the requirements of the Biofertiliser Certification Scheme (BCS).

2. Senior management responsibilities

[PAS110 clause 4.1.3]

The senior management responsible for this organisation's Digestate Quality Management System includes the Managing Director, the Plant Manager, Contract Manager and the Team Leaders.

The senior managers are responsible for:

- ensuring sufficient resources (people, infrastructure, equipment, work environment) for the establishment, implementation, maintenance and improvement of the QMS;
- ensure responsibilities and authorities are defined and communicated within the organisation;
- establishing a quality policy for digested material produced under this QMS;
- communicate that digested material must be fit for purpose;
- establish appropriate communication processes within the organisation and ensure communication takes place regarding effectiveness of QMS; and
- Conducting management reviews.

Mark Perry has been appointed the quality manager. This role has the responsibility and authority to:

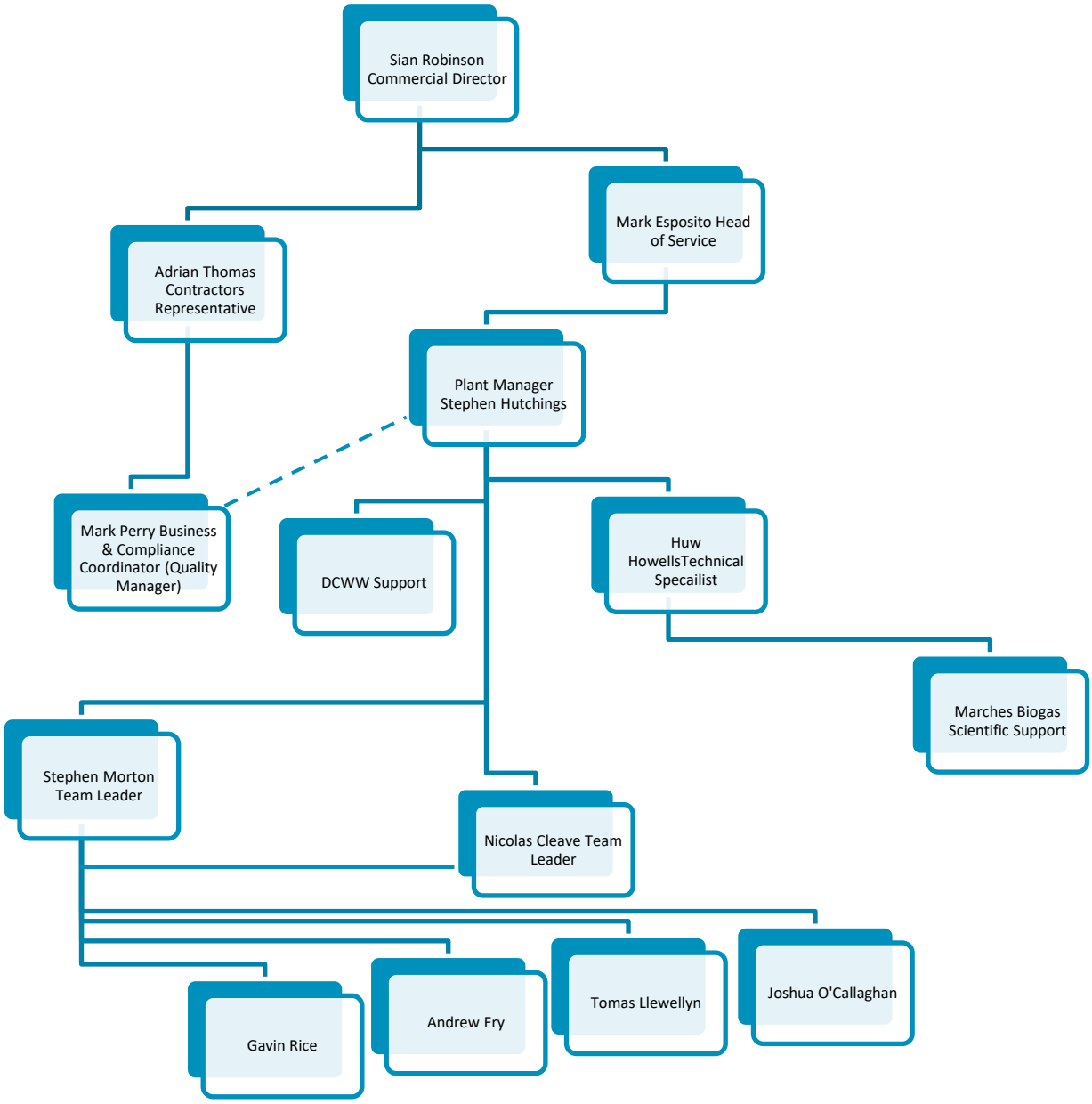
a) ensure that the QMS processes are established, implemented and maintained;
b) report on performance of QMS and any need for its improvement; and
c) ensure that awareness of digestate customers' requirements is promoted throughout the organisation.

This person is referred to in brief as the 'PAS 110 responsible person' and their responsibilities a) to c) above apply irrespective of any other responsibilities they have.

2.1 Staff roles and responsibilities

[PAS110 clause 4.3.2]

Roles and responsibilities are detailed in job descriptions and supported via the corporate HR system, SuccessFactors.


Sian Robinson
Commercial Director
Mark Esposito Head of Service
Adrian Thomas Contractors Representative
Plant Manager Stephen Hutchings
Mark Perry Business & Compliance Coordinator (Quality Manager)
DCWW Support
Huw HowellsTechnical Specailist
Marches Biogas Scientific Support
Stephen Morton Team Leader
Nicolas Cleave Team Leader
Gavin Rice
Andrew Fry
Tomas Llewellyn
Joshua O'Callaghan

2.2 Communication and training

[PAS110 clause 4.3.1]

Senior management are committed to the delivery and communication of the policy.

A training event was held on date 09/11/2018 by David Tompkins to explain the principles of PAS110 and digestate quality management.

PAS110 Awareness is part of the training requirements for all staff in line with the Training matrix

As part of their induction process, new staff have access to a copy of this quality policy and the importance of their role with respect to operations and digestate quality is communicated by the quality manager. The Quality Policy is also briefed to colleagues in light of any changes, this is recorded on their personal Procedure Briefing Forms.

3. Digestate quality policy

[PAS110 clause 4.2.2]

Policy statement:

- Welsh Water Organic Energy is committed to the production of high quality separated liquor digestate that is safe to use and fit for purpose, meeting – as a minimum – the quality as specified in PAS110:2014 Sections 11.2 and 12.2, in addition to customers' specific requirements regarding quality and fitness-for-purpose.
- The digestate will be produced at the AD facility located at Tides Field Road, Tremorfa, Cardiff

Vehicle to Achieving the Policy:

In order to comply with the above statement, the digestate production system will be established in such a way as to comply with all the requirements of:

- BSI PAS110:2014; Second Edition July 2014.
- Anaerobic Digestate Quality Protocol. Issued January 2014; and
- REAL Certification Scheme Rules. Issued 1st March 2021, version 6.
- Specific customers.

Digestate is produced at the Tremorfa facility by means of mesophilic anaerobic digestion in stirred tank reactors, after which it is pasteurised in a batch process. Pasteurised digestate is then separated into liquor and fibre fractions, with the liquor fraction stored in a covered, stirred tank on site prior to despatch. The fibre fraction is not currently deemed suitable for the requirements of the Biofertiliser Certification Scheme. The liquor fraction is the focus of this quality policy.

3.1 Digestate Product

3.1.1 Separated Liquor

This product will be used as a biofertiliser on agricultural land in accordance with the relevant codes of practice and in compliance with the Quality Protocol for Anaerobic Digestate.

3.1.2 Customer-specific requirements

Digestate is marketed and supplied to customers by a third-party provider. They have confirmed that their customers have no quality requirements beyond those specified by PAS110:2014 Sections 11.2 and 12.2. The separated liquor digestate meeting these quality requirements is fit for the intended purpose, which is use on agricultural land as a biofertiliser.

3.1.3 Quantity of digestate produced per calendar year

[PAS110 clause 7.3.1t]

The permitted capacity of the site, in terms of wastes that can be accepted, is 35,000 tonnes (fresh weight). With a proportion of this material converted to biogas, and a proportion removed as 'contamination' before and after anaerobic digestion it is estimated that annual production of liquor digestate will be around 24,000 tonnes.

4. Anaerobic Digestion Process

Process Flow

Summary

Source-segregated biowastes can be received from two different sources:

1. Local authority 'contract' waste
2. Commercial waste

Biowastes are inspected upon arrival, and when accepted for processing are passed forwards to de-packaging, which removes the bulk of the non-target (non-biodegradable) material. The biodegradable fraction is then subjected to mesophilic anaerobic digestion at a temperature of 38°C - 40°C for a minimum period of 32 days in two fermenters that can be operated in series or parallel. During digestion, biogas is produced that is captured, cleaned and combusted in combined heat and power units – generating renewable electricity for export and heat for use in the AD and pasteurisation processes. Digested material is passed through a macerator, reducing particle size to less than 12mm, before it is pasteurised up to >70°C for one hour in one of three parallel pasteurisation units. After pasteurisation, the digestate is separated through a strain press into liquor and fibre fractions. The liquor fraction is stored on site before despatch to market as a biofertilizer. The fibre fraction is discarded as waste.

Detail

Appropriately qualified and trained staff are employed to operate the anaerobic digestion facility at Tremorfa. These operations include waste reception, acceptance, de-packaging, anaerobic digestion, pasteurisation, and separation. They also include site hygiene, gas monitoring and clean-up, liaison with commercial customers, waste disposal and digestate off-take by a third-party contractor. The whole process is managed according to a set of written procedures, many of which are relevant to the production of quality digestate. Where required, these procedures include critical limits and

associated performance checks. Compliance is ensured through maintenance of written and computer records – the Quality Management System being subjected to periodic review to ensure that it remains fit-for-purpose. Site resourcing and staff competence / training needs form part of these reviews.

The AD site is in contract with local authorities in Cardiff and the Vale of Glamorgan to process kerbside-collected household food waste ('contract waste'). There is potential that separate contracts can be put in place to process source-segregated biowastes collected by commercial waste management companies ('third party waste'). The wastes are processed in the following steps:

1. Third party wastes are subjected to pre-acceptance checks, to satisfy the AD plant operators that the material is likely to be suitable for processing. These checks can include: walkarounds of manufacturing facilities; testing of material for its biogas potential; testing of material for its content of potentially toxic elements (PTEs). These pre-acceptance checks are not applied to the contract waste.
2. Contract waste, and third-party waste when a contract is in place, is weighed into the AD site using the weighbridge, the delivery vehicle passes over the weighbridge before and after delivery, and a record kept of the quantity of material delivered is kept on the weighbridge system. Consignments of contract waste are received under a waste transfer note 'season ticket', whilst consignments of third-party waste would be accompanied by an individual waste transfer note – copies of which would be retained on site.
3. As mentioned, currently only Local Authority waste is taken on site. Waste is tipped into the reception building in bay 1. Visual inspections are undertaken against written criteria as the waste is tipped. Where unacceptable physical contamination is identified, tipping is stopped and all or part of the load may be rejected, according to a written procedure, WWOE (3) 07 and WWOE (3) 06.
4. Waste is loaded into the hopper of the waste food de-packer. Waste now has the physical appearance of a soup or slurry and is pumped into a reception tank. Rejects – comprising a mixture of plastics, metals and other non-target materials – are collected in via the rejects screw conveyor and their weight recorded.
5. Liquid is added to the reception tank to dilute material to the desired solids' content before further processing. Liquid may be introduced from the (potable) main water supply, collected rainwater or condensates from the biogas chiller / odour control units / liquid digestate.
6. Ferric chloride may be dosed into this tank to reduce H_2S formation, while micronutrients are traced to stabilise biological activity during subsequent anaerobic digestion. The maximum residence time in the reception tank will normally be four days, during which the waste begins to hydrolyse (break down) and become more acidic. Periodic sampling and testing of the de-packaged waste is undertaken according to written procedures, WWOE (3) 21 Routine Sampling Procedure, to determine the total dry solid, volatile solid, total nitrogen, carbon, sulphur content and PTE concentrations of the material. This is to ensure that the implemented control measures are maintaining PTE concentrations at or below critical limits.
7. According to a pre-set feeding schedule based on organic loading rate, the desired volume of waste is pumped either into Fermenter 1 and/or Fermenter 2, where it will remain for a minimum period of 32 days and undergo anaerobic digestion. Under normal operations, partially digested material is passed from Fermenter 1 to Fermenter 2, where digestion is

completed. Where operational constraints mean this is not possible, then the fermenters are operated in parallel. In all cases the absolute minimum retention time is 32 days, and the digestate quality management system has been validated on this basis. Where the retention time is longer, this is expected to improve digestate quality over and above the validated baseline. A single central pump is used to move liquid between the fermenters.

8. During anaerobic digestion, the fermenter contents are periodically agitated with shaft-mounted propeller mixers. These help to mix incoming waste with the fermenter contents, as well as reducing the potential for material to form layers that could impede the generation of biogas ('stratification'). Biogas is generated during this stage, is collected and combusted in a combined heat and power unit. Electricity from this unit is exported to Dwr Cyrmu Welsh Water's Cardiff East Wastewater Treatment Works. Heat is recovered for two purposes: principally to operate the pasteuriser units, but also to ensure that the fermenters are maintained at the correct operating temperature of 36°C – 40°C.
9. Routine sampling and testing is undertaken for each fermenter, to ensure that the anaerobic digestion process is stable and functioning within defined limits. Anti-foam agent (vegetable oil) can also be injected into the top of the fermenters, when required. Each fermenter is fitted with a biological desulphurisation system in which very small quantities of air are injected into the headspace between the fermenting contents and fermenter roof.
10. To maintain headroom within each fermenter, a pre-set quantity of digested material is passed forwards for maceration and pasteurisation before each addition of 'new' waste from the reception tank. Maceration is designed to reduce the particle size of the digested material to a maximum of 12mm (in any one plane) in accordance with the requirements of the Animal By-Products Regulations. The macerator is subjected to frequent inspections against a written procedure, to verify its performance.
11. Macerated digestate is passed into one of three pasteuriser units, where it is heated to a temperature of 70°C. It is held at this temperature for a minimum of 60 minutes. The control system for this step does not permit by-pass – meaning that material must comply with the time/temperature requirements or be fed back into a fermenter.
12. Samples of pasteurised digestate are collected according to a written procedure and tested for *E. coli* and Salmonella in accordance with the requirements of an APHA (Animal and Plant Health Agency) approval. The results from this testing are also used to demonstrate conformance with control measures intended to reduce biological hazards (pathogens) to below critical limits.
13. Pasteurised digestate is separated through a strain press into fibre and liquor fractions. This step removes residual plastics and other non-target material, partitioning it into the fibre fraction. Samples of liquor are periodically sampled and tested to ensure that the physical hazards have been reduced to below critical limits. Fibre digestate is removed from the site for disposal by incineration.
14. Liquor digestate is pumped into a digestate storage tank, where it is held at ambient temperatures until portions are removed by the digestate offtake contractor. The tank is covered, and biogas collected for combustion in the CHP unit in combination with biogas from the fermenters. The storage tank is mixed on a cycle.
15. Samples of liquor digestate are periodically collected from the digestate storage tank and tested according to written procedures to check that the digestate meets the requirements

of the digestate Quality Management System. In particular, samples are tested for physical contaminants, PTEs and stability.

16. In the future, a return line may be installed that allows liquor digestate to be passed back to the dilution tank. This is intended to reduce reliance on potable water.
17. Providing that all control measures operate within their intended boundaries, and that all samples conform to their critical limits – digestate is periodically removed from site for recycling to agricultural land as a biofertilizer.

The site process flow from waste arrival to digestate offtake is summarised in **Error! Reference source not found.**.

Figure 4.1 Overall process flow

Accepted input materials

[PAS110 Section 6]

The principle feedstock is local authority (household) food waste, supplied to site in biobags. The site also has capacity to accept third party (commercial / industrial) wastes. Only source-segregated, biodegradable wastes are accepted into the site – some of which are also classified as Animal By-Products. The types of waste that can be accepted for processing by the AD facility are restricted by:

1. The Environmental Permit
2. The APHA Permit
3. The Anaerobic Digestate Quality Protocol

Having reviewed these documents, it is evident that the Environmental Permit allows a smaller range of waste types than would otherwise be permitted by the Quality Protocol. The list of wastes presented in Table 4-1 should therefore be regarded as definitive, in conjunction with the types of Animal By-Product listed in Section 4.1.2.

No sludges from sewage treatment processes can be accepted for processing at this site.

The process by which incoming wastes are checked against the list of acceptable inputs is described in WWOE (3) 05 - Weighbridge Procedure. Commercial / industrial wastes are also subject to pre-acceptance checks (i.e. checks that take place before delivery of the first consignment of such wastes to the AD site); these are descried in WWOE (3) 06 – Waste Acceptance and WWOE (3) 07 – Waste Acceptance Criteria.

4.1.1 ADQP

Compliance with the requirements of the Biofertiliser Certification Scheme and designation of waste-derived digestate as product restricts inputs to specific types of waste. These are listed in Table 4-1.

Table 4-1 Types of waste that can accepted for processing at Tremorfa

Wastes from agriculture, horticulture, hunting, fishing and aquaculture primary production, food preparation and processing	**Specific sub codes permitted**
Wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing	02 01
Sludges from washing and cleaning	***02 01 01***
Restriction: Food processing waste and food washing waste only.	
Animal tissue waste	***02 01 02***
Plant tissue waste	***02 01 03***
Including husks, cereal dust, waste animal feeds, off-cuts from vegetable and fruit and other vegetation waste.	
Animal faeces, urine and manure (including spoiled straw[1]), effluent, collected separately and treated off site	***02 01 06***

[1] Including poultry litter

Wastes from forestry	***02 01 07***
Restriction: Plant tissue waste only.	
Wastes not otherwise specified	**02 01 99**
Restriction: Spent mushroom compost or discarded mushrooms from commercial mushroom cultivation only	
Wastes from preparation and processing of meat, fish and other foods of animal origin	02 02
Sludges from washing and cleaning	***02 02 01***
Restriction: Process water and food washing waste only	
Animal tissue waste	***02 02 02***
Including blood, animal flesh, fish processing waste, fish carcasses and poultry waste.	
Materials unsuitable for consumption or processing	***02 02 03***
Wastes not otherwise specified	***02 02 99***
Restriction: Sludges from gelatine production and animal gut contents only.	
Wastes from fruit, vegetables, cereals, edible oils, cocoa, coffee, tea and tobacco preparation and processing; conserve production, yeast and yeast extract production, molasses preparation and fermentation	02 03
Sludges from washing, cleaning, peeling, centrifuging and separation	***02 03 01***
Materials unsuitable for consumption or processing	***02 03 04***
Sludges from on-site effluent treatment	***02 03 05***
Wastes from sugar processing	02 04
Sludges from on-site effluent treatment	***02 04 03***
Restriction: Biological sludge only	
Other biodegradable wastes	***02 04 99***
Wastes from dairy products industry	02 05
Materials unsuitable for consumption or processing	***02 05 01***
Including solid and liquid dairy products, milk, food processing wastes, yoghurt, and whey.	
Sludges from on-site effluent treatment Restriction: Biological sludge only	***02 05 02***
Wastes from the baking and confectionary industry	02 06
Materials unsuitable for consumption or processing	***02 06 01***
Including condemned food, food processing wastes, biscuits, chocolate, yeast, bread, bakery wastes.	
Sludges from on-site effluent treatment Restriction: Biological sludge only	***02 06 03***
Wastes from production of alcoholic and non-alcoholic beverages (except tea, coffee and cocoa)	02 07
Wastes from washing, cleaning and mechanical reduction of raw materials	***02 07 01***

– Including brewing waste, food processing waste, fermentation waste	
Wastes from spirits distillation	***02 07 02***
Restriction only: – Spent grains, fruit and potato pulp – Sludge from distilleries	
Materials unsuitable for consumption or processing	***02 07 04***
Including brewing waste, food processing waste, fermentation waste, beer, alcoholic drinks and fruit juice	
Wastes not otherwise specified	***02 07 99***
Restriction Only: – Malt husks, malt sprouts, malt dust – Spent grains – Hops – Yeast and yeast like residues – Sludges from the production process	
Wastes from waste management facilities, off-site waste water treatment plants and the preparation of water intended for human consumption and water for industrial use	**Specific sub codes permitted**
Wastes from the anaerobic treatment of wastes	19 06
Liquor from anaerobic treatment of municipal waste	***19 06 03***
Restriction: Acceptable only if derived solely from input types listed in this table and remains segregated from, and uncontaminated by, any other waste type.	
Digestate from anaerobic treatment of municipal waste	***19 06 04***
Restriction: Acceptable only if derived solely from input types listed in this table and remains segregated from, and uncontaminated by, any other waste type.	
Liquor from anaerobic treatment of animal and vegetable waste	***19 06 05***
Restriction: Acceptable only if derived solely from input types listed in this table and remains segregated from, and uncontaminated by, any other waste type.	
Digestate from anaerobic treatment of animal and vegetable waste	***19 06 06***
Restriction: Acceptable only if derived solely from input types listed in this table and remains segregated from, and uncontaminated by, any other waste type.	
Wastes from wastewater treatment plants not otherwise specified	19 08
Grease and oil mixture from oil/water separation containing edible oils and fats	***19 08 09***
Restriction: Grease and oil mixture containing only edible oils and fats only.	
Municipal wastes and similar commercial, industrial and institutional wastes including separately collected fractions	**Specific sub codes permitted**
Separately collected fractions	20 01
Biodegradable kitchen and canteen waste	***20 01 08***
Edible oil and fat	***20 01 25***

Other municipal wastes	20 03
Mixed municipal waste	***20 03 01***
Restriction: Allowed only if separately collected biodegradable wastes listed in this table. If former foodstuffs are packaged, the restrictions given above on packaging wastes apply.	
Waste from markets	***20 03 02***
– Restriction: Allowed only if source segregated biodegradable fractions. Examples are plant material, fruit and vegetables – Restriction: Packaging waste from a market source is allowed only if it is of a type that is listed in this table	

4.1.2 APHA approval

The site operates under APHA permit number: 57/072/8045 ABP/BIO. This only allows certain categories of Animal By-Product (ABP) to be accepted for processing:

- Category 3 ABP material and specified Category 2 ABP (manure, digestive tract and its content, milk, milk based products, colostrum, eggs, and egg products).

All consignments of ABP material received at the site must be accompanied by documentation that states their ABP category alongside a brief description. Only Category 3 and the specified Category 2 ABP can be accepted.

4.1.3 Environmental Permit

The site's Environmental Permit (issued by Natural Resources Wales) allows only specified wastes to be accepted. These are listed in Table 4-2.

Table 4-2 Types of waste that the facility can accept under Environmental Permit EPR/AB3093CA

Maximum quantity	The total annual throughput must not exceed 35,000 tonnes per annum.
Waste code	**Description**
02	**WASTES FROM AGRICULTURE, HORTICULTURE, AQUACULTURE, FORESTRY, HUNTING AND FISHING, FOOD PREPARATIONAND PROCESSING**
02 01	**Wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing**
02 01 01	Sludges from washing and cleaning
02 01 02	Animal-tissue waste
02 01 03	Plant-tissue waste
02 01 06	Animal faeces, urine and manure (including spoiled straw), effluent, collected separately and treated off-site
02 01 99	Wastes not otherwise specified – residues from commercial mushroom cultivation
02 02	**Wastes from the preparation and processing of meat, fish and other food from animal origin**
02 02 01	Sludges from washing and cleaning
02 02 02	Animal-tissue waste
02 02 03	Materials unsuitable for consumption or processing

02 02 99	Wastes not otherwise specified – sludges from gelatine production and animal gut contents
02 03	**Wastes from fruit, vegetables, cereals, edible oils, cocoa, coffee, tea and tobacco preparation and processing; conserve production; yeast and yeast extract production, molasses preparation and fermentation**
02 03 01	Sludges from washing, cleaning, peeling, centrifuging and separation
02 03 02	Wastes from preserving agents
02 03 04	Materials unsuitable for consumption or processing
02 03 05	Sludges from on-site effluent treatment
02 04	**Wastes from sugar processing**
02 04 03	Sludges from on-site effluent treatment
02 04 99	Wastes not otherwise specified – other biodegradable wastes
02 05	**Wastes from the dairy product industry**
02 05 01	Materials unsuitable for consumption or processing
02 05 02	Sludges from on-site effluent treatment
02 06	**Wastes from the baking and confectionary industry**
02 06 01	Materials unsuitable for consumption or processing
02 06 02	Wastes from preserving agents
02 06 03	Sludges from on-site effluent treatment
02 07	**Wastes from the production of alcoholic and non-alcoholic beverages (except tea, coffee and cocoa)**
02 07 01	Wastes from washing, cleaning and mechanical reduction of raw materials
02 07 02	Wastes from spirits distillation
02 07 04	Materials unsuitable for consumption of processing
02 07 05	Sludges from on-site effluent treatment
02 07 99	Wastes not otherwise specified (malt husks, malt sprouts, malt dust, spent and sludge from breweries, sludge from wine making, yeast and yeast-like residues)
19	**WASTES FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTE WATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE**
19 06	**Wastes from anaerobic treatment of waste (source separated)**
19 06 03	Liquor from anaerobic treatment of municipal waste
19 06 04	Digestate from anaerobic treatment of municipal waste
19 06 05	Liquor from anaerobic treatment of animal and vegetable waste
19 06 06	Digestate from anaerobic treatment of animal and vegetable waste
19 08	**Wastes from wastewater treatment plant not otherwise specified**
19 08 09	Grease and oil mixture from oil/water separation containing edible oils and fats
20	**MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL, AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS**
20 01	**Separately collected fractions (except 15 01)**
20 01 08	Biodegradable kitchen and canteen waste
20 01 25	Edible oil and fat

20 03	Other municipal waste
20 03 01	Mixed municipal waste
20 03 02	Wastes from markets – allowed only if source segregated biodegradable fractions e.g. plant material, fruit and vegetables

4.2 Input material rejection criteria

Criteria to trigger rejection
Contract waste can be rejected if: • It is kerbside food waste and contains more than 7% contamination by weight; • It is commercial food waste and contains more than 10% contamination by weight.
Third party waste can be rejected if: • It contains more than 10% contamination by weight; and/or • It contains more than 10% by weight of ragwort or yew plant material.

5. HACCP planning

[PAS110 Section 5]

5.1 Principles of HACCP

5.1.1 Introduction to Hazard Analysis and Critical Control Point Planning (HACCP)

Hazards are substances or organisms that have the potential to cause harm. They can be present in feedstocks and/or introduced during the anaerobic digestion process. The core requirement is that hazards are managed down through defined and managed steps that ensure they only remain at acceptable levels in the digestate product.

Hazards can normally be classified as either biological, chemical or physical, and tend to be controlled in different ways:

- Biological hazards include crop pests and diseases, as well as animal and human diseases. They are normally killed by pasteurisation or other thermal sanitation step;
- Chemical hazards include pesticides, herbicides, disinfectants and potentially toxic elements such as mercury and chromium. Most of these hazards are not broken-down during processing, so their presence in AD systems is controlled by exclusion (high risk feedstocks are not accepted);
- Physical hazards include stones, metal fragments, glass and plastic. Plastic residues from packing are commonly associated with food waste, and this can be removed by screening before, during or after AD. Grit traps and other systems are available to remove stones and other heavy fragments.

AD systems can include multiple control points to manage the same types of hazard – for example, physical contaminants can be excluded by rejection of heavily-contaminated material and/or de-bagging or de-packaging before AD and/or screening of the final digestate product. The Critical Control Point (CCP) is the last step in any process chain that can reduce the identified hazard to the desired level. For physical contaminants this is normally a screen after AD. This does not mean that the other control processes are ignored, but the CCPs receive focus because of their critical link to digestate quality – if they fail, the digestate will fail the requirements of PAS110. CCPs are identified

for each hazard that a hazard analysis considers is relevant to the feedstocks, process and product under study.

Once identified, Critical Limits are established for each CCP – usually concentrations or loadings of hazard above which digestate would fail PAS110 or be at risk of failure. These critical limits (CLs) must be regularly monitored for non-conformance, the aim being to ensure that the hazard always remains within its CLs at the relevant CCP. This is the strength of HACCP approaches – if the CCPs are retained within their CLs, then the final digestate product should always pass PAS110. Tests of the final digestate are performed occasionally to check that the Quality Management System is operating as it should.

This HACCP plan has been compiled in accordance with the Codex Alimentarius Commission's seven "Principles of the HACCP System":

1. Conduct a hazard analysis
2. Determine the Critical Control Points (CCPs)
3. Establish critical limit(s) (CLs)
4. Establish a system to monitor control of the CCPs
5. Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control [i.e. is outside its CL(s)
6. Establish procedures for verification to confirm that the HACCP system is working effectively
7. Establish documentation concerning all procedures and records appropriate to these principles and their application

5.1.2 The HACCP Team

The HACCP team comprises:

Name and job title	HACCP expertise	Role at AD plant
Dr David Tompkins, Bioresources Development Manager (Aqua Enviro)	Level 2 certificate in HACCP planning	Advisor
Stephen Morton, Team Leader	Introduction to HACCP principles from David Tompkins	Team Leader

5.1.3 The digestate product

	Comments
General description	Separated digestate liquor from mesophilic anaerobic digestion with post-digestion pasteurisation at 70°C for 60 minutes
Feedstocks	Source-segregated biodegradable wastes from local authority and commercial sources
Storage	Digestate is stored prior to despatch in a stirred tank
Intended use	As a biofertiliser on agricultural land where crops are grown for human / livestock consumption and/or where livestock are grazed
Intended users	Farmers and growers
Intended application methods	Digestate shall be applied using low trajectory / high precision slurry-spreading apparatus (such as trailing hose, dribble-bar and shallow injection).

Hazard categories to consider	Chemical hazards that might harm crops or the wider environment or accumulate in crops and cause harm to their consumers. Hazards may also affect soils and watercourses; Biological hazards that might harm crops or the wider environment, or be encapsulated within / be present on the surface of crops and cause harm to their consumers; Physical hazards that might result in visual dis-amenity to soils or cause harm to the consumers of crops grown on treated soils.

5.1.4 Digestate markets

4R Recycling have been contractually and exclusively engaged to manage digestate off-take. They intend to supply digestate for use on all (suitable) types of agricultural land in Wales and England, including cropped and grazed land. This QMS does not cover digestate intended for supply to Scotland.

5.1.5 Market-specific quality constraints

The process from waste (pre)acceptance to anaerobic digestion and digestate despatch is described below. The overview is shown on Figure 5.1 on page 11.

4R Recycling have confirmed that their current and intended customers have no requirements for digestate quality beyond the baseline requirements of BSI PAS 110:2014.

5.2 HACCP pre-requisites

This section lists several underlying requirements (or 'pre-requisites') that are outside the scope of the HACCP plan, but which are assumed to be in place for the purposes of HACCP planning.

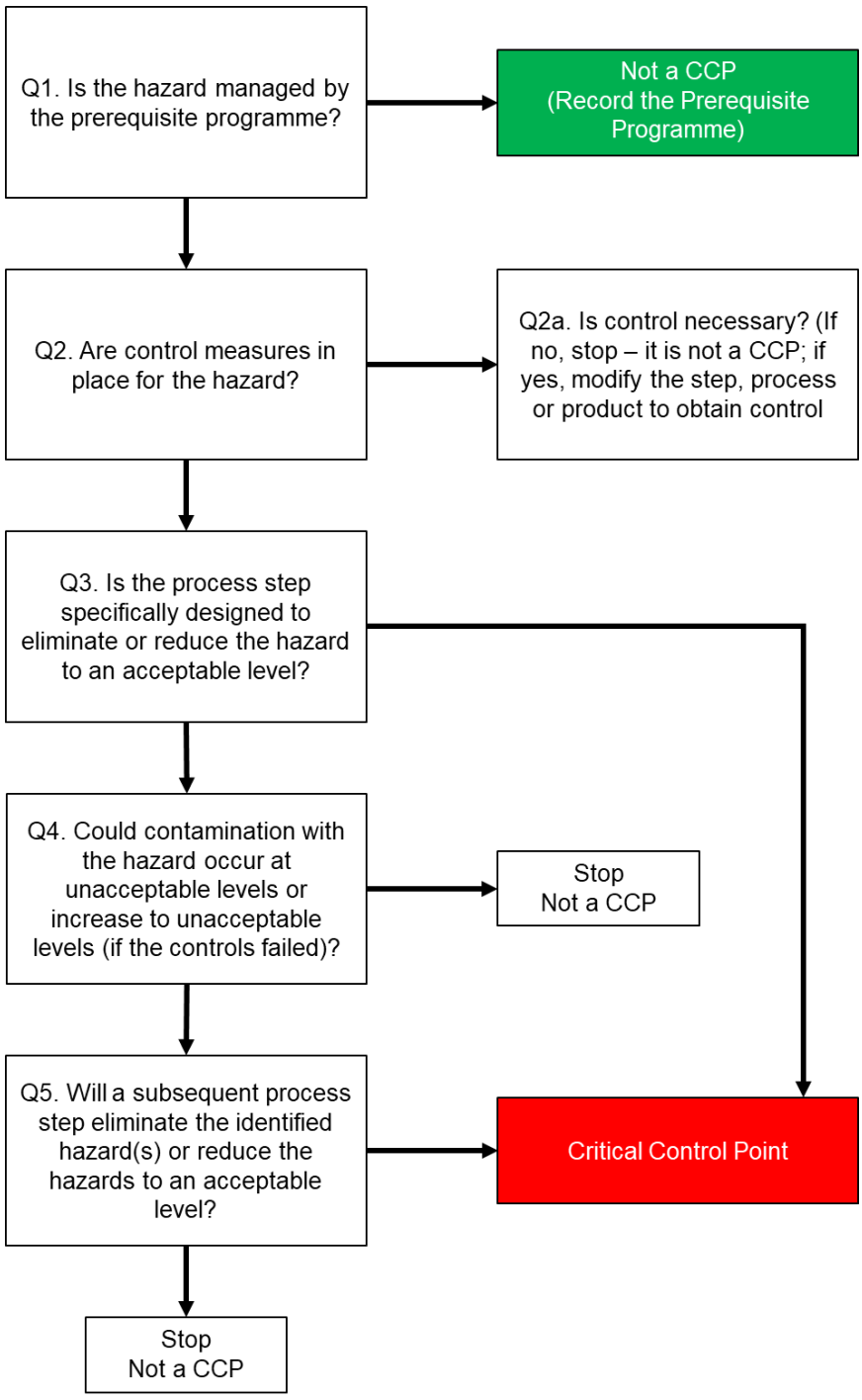
1. The digestate is intended for use on agricultural land only, it is not intended for domestic (household) use.
2. An approval from APHA is in place to allow this anaerobic digestion process to accept Category 3 animal by-products (ABP) and specified Category 2 ABP. The terms of this approval mean that all feedstocks are reduced to a specific particle size, that the pasteurisation process guarantees that all material meets specified time and temperature requirements, and that site hygiene is strictly observed.
3. Since the digestate is derived from inputs that include approved ABP, statutory grazing and harvest intervals apply when the digestate is used in its intended markets. These intervals are: two months for pigs, three weeks for all other livestock. Digestate users must be notified of these restrictions (and their associated record-keeping requirements) by the digestate supplier.
4. The site accepts source-segregated biodegradable wastes only.
5. No sludges from sewage treatment processes are accepted for processing at this site.
6. No crop / vegetable processing residues will be accepted for processing where they are subject to statutory quarantine control – which should be stated on any waste transfer note for such materials.
7. All feedstocks accepted for processing meet the requirements of the site's Waste Acceptance Criteria, listed in each feedstock supply agreement.

5.3 Determining whether control points are CCPs

When considering the potential presence and passage of hazards through the anaerobic digestion process, there may be multiple points at which those hazards can be attenuated. Not all of these will be critical control points. The flowchart illustrated in Figure 5-1 was used to determine whether each control point was critical for each hazard considered. Potential hazards are listed in Section 5.4, together with their potential control points. Critical Control Points, Critical Limits and Monitoring process are listed in Section 5.5.

Figure 5-1 Decision tree for identifying CCPs.

From:
https://myhaccp.food.gov.uk/sites/default/files/resources/campdenbri_guidline42page41.pdf



5.4 Hazard identification

Applying expert knowledge, several hazards potentially present in feedstocks intended for anaerobic digestion are listed below.

Hazard	Risk of presence in feedstocks?	Notes	Process points that may offer control	CCP?
Human pathogens and parasites				
E. coli	H	Likely to be present in many feedstocks, particularly those including livestock manures or soil	Size reduction Pasteurisation	Y Y
E. coli O157	M	Potentially present in some food wastes.	Size reduction Pasteurisation	Y Y
Salmonella spp	M	Potentially present in some food wastes.	Size reduction Pasteurisation	Y Y
Listeria monocytogenes	M	Potentially present in some food wastes.	Size reduction Pasteurisation	Y Y
Campylobacter	H	Likely to be present in some food wastes.	Size reduction Pasteurisation	Y Y
Cryptosporidium parvum	M	Potentially present in some food wastes.	Size reduction Pasteurisation	Y Y
Clostridium botulinum	M	Widespread in soil and therefore potentially present in some food wastes. Only vegetative phase is considered a risk	Size reduction Pasteurisation	Y Y
Clostridium perfringens	M	Widespread in soil and therefore potentially present in some food wastes. Only vegetative phase is considered a risk	Size reduction Pasteurisation	Y Y
Staphylococcus aureus	L	May be present in some food wastes	Size reduction Pasteurisation	Y Y
Taenia saginata	L	May be present in some food wastes	Size reduction Pasteurisation	Y Y

Hazard	Risk of presence in feedstocks?	Notes	Process points that may offer control	CCP?
NOTE: Hygiene control at the digestate separator must be carefully managed to prevent re-contamination with pathogens (particularly *E. coli* and *Salmonella*) through use of dirty equipment. Separator inspection is WWOE (4) 02 and WWOE (3) 22.				
Note: Whilst animal pathogens and parasites are relevant hazards, they are expected to be managed under Pre-requisites 2 and 3 (Section 5.2). Size reduction and pasteurisation are the Critical Control Points necessary to attenuate animal pathogens and parasites to an acceptable degree.				
Plant pests and diseases				
Potato Cyst Nematodes	M	Could be present in potato processing residues (domestic or commercial)	Size reduction Pasteurisation	Y Y
Powdery and Common Scab	M	Could be present in potato processing residues (domestic or commercial)	Size reduction Pasteurisation	Y Y
Phytophthora infestans	M	Could be present in potato processing residues (domestic or commercial)	Size reduction Pasteurisation	Y Y
Rhizoctonia solanii	M	Could be present in a range of crop processing residues	Size reduction Pasteurisation	Y Y
Plasmodiophora brassicae	L	Could be present in brassica (cabbage, broccoli etc) processing residues, particularly where any soil is present	Size reduction Pasteurisation	Y Y
Fusarium spp	M	May be present in a range of crop residues, and could result in mycotoxin production if it infected digestate-treated crops.	Size reduction Pasteurisation	Y Y
Inorganic chemicals				
As, Cd, Cr, Cu, Hg, Pb, Ni, Zn	M	Expected to be present at low concentrations in source-segregated biowastes. No mixed waste accepted. Low risk of accidental inclusion of batteries	Supply agreement Weighbridge procedure	N Y
Organic compound contaminants				

Hazard	Risk of presence in feedstocks?	Notes	Process points that may offer control	CCP?
Mycotoxins	M	Could be present in a number of food wastes and crop processing residues. Degraded by anaerobic digestion	Anaerobic digestion	Y
Disinfectants	L	Could be present at low concentrations in a number of food processing residues, and would be more likely to impact on the digestion process than the quality of the digestate product. Risks minimised through exclusion of mixed wastes (black bag wastes). New feedstocks subjected to biological testing prior to first acceptance, and periodically thereafter	Supply agreement Weighbridge procedure	N Y
PAHs and other organic compound contaminants	L	Expected to be present at low concentrations in source-segregated biowastes. No mixed waste accepted	Supply agreement Weighbridge procedure	N Y
Pesticides	L	Expected to be present at low concentrations in source-segregated biowastes. No mixed waste accepted	Supply agreement Weighbridge procedure	N Y
Synthetic auxin herbicides	M	Compounds such as clopyralid and aminopyralid may be associated with livestock slurries or crop residues. They will not adequately degrade during AD and should be excluded at source	Supply agreement Weighbridge procedure	N Y
Shellfish toxins	L	Normally expected to be absent from shellfish waste. Shellfish found to be contaminated would not be considered suitable for human consumption and should not therefore be submitted for processing via AD	Supply agreement Weighbridge procedure	N Y
Plant Protection Products	L	Expected to be present at low concentrations in source-segregated biowastes. No mixed waste accepted	Supply agreement Weighbridge procedure	N Y
Toxic plants				

Hazard	Risk of presence in feedstocks?	Notes	Process points that may offer control	CCP?
Ragwort	L	Unlikely to be present in feedstocks, and heavily contaminated loads should be rejected	Weighbridge procedure Waste acceptance procedure	N Y
Yew	L	Unlikely to be present in feedstocks, and heavily contaminated loads should be rejected	Weighbridge procedure Waste acceptance procedure	N Y
Invasive weeds				
Giant Hogweed	L	Unlikely to be present in feedstocks, and propagules would be killed by pasteurisation	Size reduction Pasteurisation	Y Y
Japanese Knotweed	L	Unlikely to be present in feedstocks, and propagules would be killed by pasteurisation	Size reduction Pasteurisation	Y Y
Himalayan Balsam	L	Unlikely to be present in feedstocks, and propagules would be killed by pasteurisation	Size reduction Pasteurisation	Y Y
Physical contaminants				
Treated wood	M	May be present in contaminated packaging. Exclude at source	Weighbridge procedure Waste acceptance procedure	N Y
Large metal, stone or other non-target materials	M	Such materials could damage de-packaging equipment	Weighbridge procedure Waste acceptance procedure	N Y
Stones	L	Unlikely to be present in food waste and commercial feedstocks – gross contamination would be identified in the reception hall, and minor contamination removed during feedstock preparation or final digestate screen	Press operation procedure Digestate separation procedure	N Y

Hazard	Risk of presence in feedstocks?	Notes	Process points that may offer control	CCP?
Concrete / other man-made conglomerates	L	Unlikely to be present in food waste and commercial feedstocks – gross contamination would be identified in the reception hall, and minor contamination removed during feedstock preparation or final digestate screen	Press operation procedure Digestate separation procedure	N Y
Glass	M	Potentially present in food waste, particularly when delivered packaged	Press operation procedure Digestate separation procedure	N Y
Hard plastic	H	Potentially present in food waste, from domestic or commercial sources	Press operation procedure Digestate separation procedure	N Y
Sharps	L	Unlikely to be present in food wastes, although could be caused by the process of de-packaging	Press operation procedure Digestate separation procedure	N Y
Metal fragments (foil etc)	M	Potentially associated with foil-wrapped foods	Press operation procedure Digestate separation procedure	N Y
Bones	M	Potentially present in food waste, from domestic or commercial sources	Press operation procedure Digestate separation procedure	N Y
Eggshells / nut shells	M	Potentially present in food waste, from domestic or commercial sources	Press operation procedure Digestate separation procedure	N Y
Cardboard	H	Likely to be present in food waste, from domestic or commercial sources	Press operation procedure Digestate separation procedure	N Y
Paper	H	Likely to be present in food waste, from domestic or commercial sources	Press operation procedure	N Y

Hazard	Risk of presence in feedstocks?	Notes	Process points that may offer control	CCP?
			Digestate separation procedure	
Film plastic	H	Likely to be present in food waste, from domestic or commercial sources	Press operation procedure Digestate separation procedure	N Y
Other				
Allergens	H	Very likely to be present in food wastes, but there is no known evidence of their survival and subsequent risk during digestate use	-	-
Flavour and odour taints	H	Highly flavoured / odorous materials are very likely to be present in food wastes, but there is no known evidence of their survival and subsequent risk during digestate use	-	-
Digestate odour: H_2S	L	Hydrogen sulphide (H_2S) is often produced during anaerobic digestion, and is controlled through the addition of air to the fermenters.	Anaerobic Digestion, including air injection and micronutrient supplementation	Y
Digestate odour: VFAs	L	A range of potentially odorous gases are produced during anaerobic digestion, including Volatile Fatty Acids (VFAs). VFAs are pre-cursors to biomethane, and their presence in digestate should be low. Since the process is contained, odours are not expected to represent a hazard on site. Residual odours off site will be managed through use of covered storage and low-emission / precision digestate application to soil	Anaerobic Digestion, including air injection and micronutrient supplementation	Y
Digestate odour: other organic compounds	L	Gases such as skatole and indole may be produced during the anaerobic digestion process, but are minimised during digestate storage. Since the process is contained, odours are not expected to represent a hazard on site.	Anaerobic Digestion, including air injection and micronutrient supplementation	Y

Hazard	Risk of presence in feedstocks?	Notes	Process points that may offer control	CCP?
		Hydraulic retention time is defined, and achieved through a controlled feeding regime		
Digestate odour: ammonia	L	Ammonia (NH_s) is normally produced during anaerobic digestion, and when dissolved (and ionised – as ammonium), comprises a useful agronomic property of digestate. Since the process is contained, ammoniacal odours are not expected to represent a hazard on site. Excess concentrations are detrimental to plant operation. Operating NH_4 limit is 5500mg/l	Anaerobic Digestion, including air injection and micronutrient supplementation	Y
Potential for introduction of hazards other than in feedstocks				
Biological	M	After pasteurisation, digestate is passed forwards to a separator, where the final digestate liquor product is generated. It is then passed into a digestate storage tank before collection by the off-take contractor. The post-pasteurisation steps are all covered / enclosed with little potential for accidental recontamination. However, when inspecting the integrity of the separator screen it is important that clean gloves and clean equipment are used.		
Chemical hazards	M	Chemical hazards are largely controlled by exclusion (in which only acceptable low risk wastes are accepted into the site). Clean water in the outdoor bunded area is retained for use as dilution water in the reception tank, while leachate generated in the reception building is passed into the reception tank. Spillages (for example, of disinfectant or fuel oil) in either the reception building or bunded area could represent a risk to digestate quality. Emergency plans are in place (WWOE (3) 15) to contain and manage any such spillage.		
Physical hazards	L	Residual physical hazards are removed by the digestate separator, after pasteurisation. Subsequent process steps are covered / enclosed and it is not physically possible to introduce plastic or glass contaminants. Metal contaminants could be introduced during maintenance of the separator screen, but would remain in the buffer tank and not pass forward into the digestate storage tank.		

5.5 HACCP plan: hazard controls and monitoring

Process step	Hazard	CCP name and number	Control measure	Frequency	Critical Limit	Corrective action	Confirmation
Weighbridge	Ring Rot (*Clavibacter michiganensis* ssp. *Sepedonicus*) and Brown Rot (*Ralstonia solanacearum*)	Weighbridge procedure	Check each load against site acceptance criteria	Every load	Zero loads of quarantine plant material accepted	Load rejected – follow procedure WWOE (3) 05 - Weighbridge	Electronic record of acceptance / rejection
Weighbridge	Inorganic chemicals (Cd, Cr, Cu, Hg, Pb, Ni, Zn)	Weighbridge procedure	Check each load against site acceptance criteria	Every load	Zero loads of non-source-segregated material accepted	Load rejected – follow procedure WWOE (3) 05 - Weighbridge	Electronic record of acceptance / rejection
Weighbridge	Organic chemicals: Disinfectants, PAHs, PCBs, PCDD/Fs, Pesticides, Synthetic auxin herbicides, Personal Hygiene Products, Plant Protection Products	Weighbridge procedure	Check each load against site acceptance criteria	Every load	Zero loads of non-source-segregated material accepted	Load rejected – follow procedure WWOE (3) 05 - Weighbridge	Electronic record of acceptance / rejection

Process step	Hazard	CCP name and number	Control measure	Frequency	Critical Limit	Corrective action	Confirmation
Weighbridge	Shellfish toxins	1. Weighbridge procedure	Check each load against site acceptance criteria	Every load	Zero Cat 1 or Cat2 ABP	Load rejected – follow procedure WWOE (3) 05 - Weighbridge	Electronic record of acceptance / rejection
Reception Hall	Toxins (such as arsenic) in treated wood	2. Reception Hall	Check each load against procedure	Every load	Zero (not acceptable inputs).	Load rejected – follow procedure WWOE (3) 06 & 07 – Waste acceptance	Electronic record of acceptance / rejection
Reception Hall	Gross physical contaminants (eg large pieces of metal)	2. Reception Hall	Check each load against procedure	Every load	Zero (not acceptable inputs).	Load rejected – follow procedure WWOE (3) 06 & 07 – Waste acceptance	Electronic record of acceptance / rejection
Reception Hall	Plant toxins (ragwort and yew)	2. Reception Hall	Check each load against procedure	Every load	10% of load, based on visual inspection	Load rejected – follow procedure WWOE (3) 06 & 07 – Waste acceptance	Electronic record of acceptance / rejection
Fermenters	H_2S generated by sulphurous feedstocks	3. Primary and Secondary fermenters	Air injection into digester head space	Continuous	H_2S concentration in biogas below 600ppm	Ensure injection equipment is within specification	Maintenance record

Process step	Hazard	CCP name and number	Control measure	Frequency	Critical Limit	Corrective action	Confirmation
Fermenters	VFAs generated by process instability	3. Primary and Secondary fermenters	FOS/TAC measurement VFA speciation Micronutrient addition	Daily FOS/TAC Fortnightly VFA speciation Monthly micronutrient testing	Operating FOS/TAC limit is 0.45 Operating acetic acid limit is 1000mg/l Operating propionic acid limit is 1000mg/l Micronutrients tested by manufacturer	Reduce or stop feeding if: FOS / TAC >0.45 Acetic acid >500mg/l Propionic acid >200mg/l	Electronic records of digestate test results Daily log recording corrective actions
Fermenters	NH_3 generated by high nitrogen feedstocks	3. Primary and Secondary fermenters	Monitoring of NH_4 in fermenters	Fortnightly NH_4 testing	Operating NH_4 limit is 5500mg/l	Reduce or stop feeding if NH_4 exceeds 5000mg/l	Electronic records of digestate test results Daily log recording corrective actions
Maceration	Human and animal pathogens and parasites; Plant pests and diseases; Invasive weeds	CCP 4 Particle Size Reduction	Particle size is reduced by a macerator with fixed apertures.	Weekly – log any ABPR	12mm	Inspection and replacement of screen if required.	Written records confirming macerator screen checks (WWOE (3) 11 & 12)

Process step	Hazard	CCP name and number	Control measure	Frequency	Critical Limit	Corrective action	Confirmation
Pasteurisation	Human and animal pathogens and parasites; Plant pests and diseases; Invasive weeds	5. Pasteurisation	Pasteurisation is achieved by heating batches of material to >70°C and holding it at that temperature for over one hour. The pasteurisation process is automated and managed via the SCADA system. It is not designed to be by-passed	Daily – log any ABPR Records for each batch pasteurised Annually calibration	70°C for one hour	Each batch identified and any non-compliances will be re-processed through the pasteuriser	SCADA records for pasteurisation Calibration logs for pasteuriser temperature probes E. coli and Salmonella test results on file
Digestate separation	Physical Contaminants, including stones	6. Digestate separation	Separator screen operating within manufacturer's tolerance	Daily log Weekly screen check Scheduled maintenance	BSI PAS 110: 2014 limits	Replace screen. Digestate in store must be re-screened on site before despatch or despatched as waste	Re-start and test performance (WWOE (2) 06 – Corrective Action Register)). The corrective action register is filled in using the SP(2) 03 Corrective Action Procedure, see section 6.

6. Validation of Critical Control Points

6.1.1 Overview

Six Critical Control Points have been identified:

1. Weighbridge
2. Reception hall
3. Anaerobic digestion, including retention time, air injection and micronutrient supplementation
4. Particle size reduction
5. Pasteurisation
6. Digestate separation

The location of these CCPs is presented in Figure 6.1.

Figure 6.1: Location of CCPs


LA food waste
Supply agreement
Pre-acceptance checks
C & I waste
Supply agreement
CCP2 Reception Hall procedures
CCP1 Weighbridge procedures
Reception Hall
Weighbridge
Sump
Hopper
Dilution tank
Mill (Waste food de packer
Compactor
Biomass screw
Micronutrient dosing
Rejects screw conveyor
Macerator
Rejects
Biogas chiller condensate
EMS Ram pump
Water
Reception tank
Ferric dosing
Odour control condensate
Pump
Anti-foam
Anti-foam
CCP3 Fermentor managing prcedures.
Air
Fermenter 1
Fermenter 2
Air
Grinder
CCP4 ABP macerator procedures
ABP macerator
Pasteurisation
CCP5 Pasturaisation procedures
CCP6 digestate seperaton procedures
Separator
Fibre digestate
Air
Buffer tank
Digestate storage
Liquid digestate

CCP validation is only required once, prior to initial certification by the Biofertiliser Certification Scheme. However, if any non-temporary changes occur that affects the digestate quality, or if a non-temporary change in the required quality of digestate occurs, the production process must be re-validated. In the event of temporary change(s) of this kind, then the sampling and testing procedures as described in Section 6.1.9 must be undertaken to confirm that the change has not impacted on the required digestate quality.

6.1.2 Weighbridge procedure (CCP1)

Only source-segregated biodegradable wastes and non-waste materials are accepted as inputs into the process, and only certain categories of animal by-product (ABP) are acceptable. All other potential inputs are to be rejected, and the first opportunity for rejection is at the weighbridge. The weighbridge procedure, WWOE (3) 05, comprises a simple decision tree. Anything that passes this can be delivered to site and tipped in the reception hall. Records kept on the weighbridge system confirm that only acceptable inputs have been delivered, and the effectiveness of this procedure is confirmed through testing of actual material accepted. Daily reconciliation checks are made (for waste transfer notes and other records of received wastes) to confirm that they comply with this procedure. Confirmation that the accepted materials are (actually) suitable for processing is addressed in CCP2.

6.1.3 Waste acceptance (reception hall) procedure (CCP2)

This procedure rejects unacceptably contaminated or otherwise inappropriate materials using WWOE (3) 06 & 07 Waste acceptance procedure. Since it is difficult to representatively sample and test materials as received, the CCP validation procedure involves sampling and testing from the reception tank.

Representative samples must be collected from the reception tank on a fortnightly basis until the completion of overall QMS validation (Section 6.1.9). Thereafter, sampling and testing should reduce to monthly intervals. Samples must be tested for total nitrogen, and a range of potentially toxic elements (PTEs). Results must be compared with the table below – the principle is that higher nitrogen feedstocks can contain higher concentrations of PTEs, since the resulting digestates will be applied to land at lower rates. Actions in the event of a failure are outlined in Section 8.3.2.

Table 6.1 PTE limits for feedstocks with different nitrogen contents, on a fresh weight basis

Total nitrogen (N)	kg/t	Less than 1	1 to 1.9	2 to 2.9	3 to 3.9	4 to 4.9	5 to 5.9	6 to 6.9	7 to 7.9	8 to 8.9	9 or more
Cadmium (Cd)	mg/kg	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.2
Chromium (Cr)	mg/kg	8	16	24	32	40	48	56	64	72	80
Copper (Cu)	mg/kg	16	32	48	64	80	96	112	128	144	160
Mercury (Hg)	mg/kg	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80
Nickel (Ni)	mg/kg	4	8	12	16	20	24	28	32	36	40
Lead (Pb)	mg/kg	16	32	48	64	80	96	112	128	144	160
Zinc (Zn)	mg/kg	32	64	96	128	160	192	224	256	288	320

6.1.4 Anaerobic Digestion process (CCP3)

Representative samples must be collected from each fermenter on a fortnightly basis until the completion of overall QMS validation (Section 6.1.9). Thereafter, sampling and testing should reduce to monthly intervals. Samples must be tested for FOS/TAC, ammonium and volatile fatty acids. Biogas should be monitored on a continuous basis, and daily averages recorded. All limits can be found on the WWOEF 008 Critical Parameter Board. Actions in the event of a failure are outlined in Section 8.3.3.

6.1.5 Particle size reduction (CCP4)

ABP macerator must be checked as per WWOE (3) 11 and performance must be checked as per WWOE (3) 12. Critical and operational limit is a maximum of 12mm (in any one dimension) for all particles exiting the macerator. Checks must be made monthly, using WWOEF 012 ABPR Particle Size Validation. Actions in the event of a failure are outlined in Section 8.3.4.

6.1.6 Pasteuriser (CCP5)

For APHA approval, material must be reduced to a specific particle size and heated to a defined temperature for a defined period. Populations of *E. coli* and Salmonella are determined in the output from the pasteurisers.

Samples must be collected once per month. Since there are three pasteurisation units on site, at least one sample must be collected from the outlet of each unit during CCP validation. Each sample must be tested for the following organisms, which have the following upper limits. Critical limits can be found on the WWOEF 008 Critical Parameter Board. Actions in the event of a failure are outlined in Section 08.3.3.

6.1.7 Digestate separation (CCP6)

Physical contaminants that make it through the digestion process will be removed at this point. It is important to understand the operational tolerance of this control by taking samples throughout the validation period, which is intended to encompass typical operational variation.

Liquor samples must be collected on a fortnightly basis until the completion of overall QMS validation (Section 6.1.9). Samples must be tested for total nitrogen and physical contaminants, and the results compared with the table below. Actions in the event of a failure are outlined in Section 8.3.6.

Total nitrogen (N)	kg/t	Less than 1	1 to 1.9	2 to 2.9	3 to 3.9	4 to 4.9	5 to 5.9	6 to 6.9	7 to 7.9	8 to 8.9	9 or more
Total stones	kg/t	3.2	6.4	9.6	12.8	16	19.2	22.4	25.6	28.8	32
Total physical contaminants (excluding stones)	kg/t	0.04	0.07	0.11	0.14	0.18	0.22	0.25	0.29	0.32	0.36

6.1.8 QMS validation checklist

Table 6.2 Validation checklist

	Yes	No	Notes
Does the flow chart correctly identify each step in the process?	✓		
Are all significant hazards correctly identified and addressed?	✓		
Have the CCPs been correctly identified / justified? Are the critical/legal limits acceptable?	✓		
Has the performance of the CCPs been checked to confirm that control measures are adequate?	✓		
Are there procedures in place for monitoring?	✓		
Are corrective actions in place and understood by relevant staff?	✓		
Is there adequate record-keeping in place?	✓		

	Yes	No	Notes
Will the plan control all the significant hazards if followed correctly?	✓		
Validation Record Validation carried out by: S. Churches Validation signed-off by: B. Escott			**Date** 1St November 2018 8th November 2018

6.1.9 Review of HACCP plan

The HACCP plan is reviewed as part of the annual management review, covering all requirements of clause 4.8 of the standard.

The checklist below is to support the HACCP review, but is optional to use.

Table 6.3 HACCP review checklist

	Yes	No	Detail of required amendment:	Confirm that the amendment has been made
Are the descriptions of the digestate product, digestate markets and market-specific quality requirements still valid?				
Is the process flow diagram still correct?				
Have the hazards changed, or have you received any feedback from customers / regulators / auditors etc to suggest that your approach to hazard management needs to change?				

Are the Critical Control Points still correct for each hazard, or do process changes mean that the CCPs need to move?				
Are the Critical Limits, Control Measures and Corrective Actions still appropriate for the hazards? Have you received customer complaints?				
Are your daily records for (overall) process operation up to standard?				
Has a walk-through of the production process from feedstock reception to digestate despatch shown that the procedures are being followed, including record-keeping?				
Review carried out by: Position: Signed: Date: Date of next review:				

6.1.10 Significant change and process re-validation

[PAS110 clause 4.8]

Following certification, various changes may take place on site that have the potential to impact on digestate quality. These include:

1. Temporary, non-temporary and significant changes to input materials (where those materials are significantly different to those accepted by the site when this Quality Management System was originally validated);
2. Temporary, non-temporary and significant changes to the AD process (such as changes in de-packaging equipment, macerators or screens);
3. Significant changes in required digestate quality as a result of customer interaction.

A record must be kept for any such changes in Table 6.4, and the PAS responsible person should note whether these changes warrant process re-validation or not. Any decision not to revalidate – where significant non-temporary changes are made – must be justified. Where significant changes are temporary, then digestate must be tested to confirm that there has been no impact on intended digestate quality.

Table 6.4 Change record form

Change that has taken place	Significant or non-significant? Temporary or non-temporary?	Process re-validation triggered?	Justify any decision not to re-validate

7. Validation of digestate Quality Management System

[PAS110 Section 11]

7.1 Sampling and testing to validate digestate QMS

Several CCPs are required to manage the range of potential hazards associated with this process, so it is important to validate both the individual CCPs and digestate QMS.

The minimum hydraulic retention time (HRT) of the overall anaerobic digestion process is 32 days. To encompass typical variations in feedstock and process performance, a cycle of three 32-day retention times is required to demonstrate that digestate of the required quality is consistently produced.

Representative samples must be collected from the digestate store at three occasions, separated by intervals of 32 days. They must be tested against the full suite of quality parameters as specified in PAS110:2014 and the Anaerobic Digestate Quality Protocol. These are listed in Table 7.1.

Table 7.1 Test parameters, upper limit values and declaration parameters for validation (all units on a fresh weight basis)

Parameter	Upper limit and unit									
E. coli	1,000 CFU/g fresh matter									
Salmonella	Absent in 25g fresh matter									
Total nitrogen (N)	**kg/t**	**Less than 1**	**1 to 1.9**	**2 to 2.9**	**3 to 3.9**	**4 to 4.9**	**5 to 5.9**	**6 to 6.9**	**7 to 7.9**	**8 to 8.9**	**9 or more**
Cadmium (Cd)	mg/kg	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.2
Chromium (Cr)	mg/kg	8	16	24	32	40	48	56	64	72	80
Copper (Cu)	mg/kg	16	32	48	64	80	96	112	128	144	160
Mercury (Hg)	mg/kg	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80
Nickel (Ni)	mg/kg	4	8	12	16	20	24	28	32	36	40
Lead (Pb)	mg/kg	16	32	48	64	80	96	112	128	144	160
Zinc (Zn)	mg/kg	32	64	96	128	160	192	224	256	288	320
Total stones	kg/t	3.2	6.4	9.6	12.8	16	19.2	22.4	25.6	28.8	32
Total physical contaminants (excluding stones)	kg/t	0.04	0.07	0.11	0.14	0.18	0.22	0.25	0.29	0.32	0.36
Parameter	**Upper limit and unit**									
Residual biogas potential	0.45 litres biogas / g volatile solids									

Parameter	Digestate must be tested for these and concentration noted – no upper or lower limit
pH value	
Total nitrogen (N)	

Total phosphorus (P)
Total potassium (K)
Total sulphur (S)
Ammoniacal nitrogen (NH4-N), extractable in potassium chloride
Dry matter (also referred to as “total solids”)
Loss on ignition (also referred to as “volatile solids” and a measure of organic matter)

7.2 Summary of QMS sampling and testing requirements

Table 7.2 Summary of sampling, testing and checks for digestate QMS validation

Sampling point	Tests required	Sampling frequency
n/a	Reconciliation of weighbridge records to confirm only acceptable wastes allowed on site	Daily
1 (Reception Tank)	ODM (%), Nitrogen, Carbon, Sulphur, PTEs (Cd, Cr, Cu, Hg, Ni, Pb, Zn); pH, Dry Matter	Fortnightly
2 (Fermenters)	ODM (%), VFA profile, NH4-N; pH, Dry Matter, FOS/TAC H_2S in biogas	Fortnightly; H_2S daily (average).
n/a	ABP macerator screen and particle size checks completed successfully	Monthly
3 (Post-pasteurisation)	*E. coli* and Salmonella	Monthly
4 (Post-separation)	Total nitrogen (N), Stones, Other physical contaminants	Fortnightly

5 (DST)	*E. coli*, Salmonella, pH; Total nitrogen (N); Total phosphorus; Total potassium; Total sulphur; NH4-N; PTEs (Cd, Cr, Cu, Hg, Ni, Pb, Zn); Stones & other physical contaminants; Residual biogas potential; pH; Total solids;	Every 32 days

Figure 7.2 Sampling points

7.3 Sampling and testing after QMS validation

[PAS110 Section 12]

Table 7.3.1 Summary of sampling and testing after QMS validation

Sampling point	Tests required	Sampling frequency
1 (Reception Tank)	Total nitrogen; Total PTEs (Cadmium (Cd); Chromium (Cr); Copper (Cu); Mercury (Hg); Nickel (Ni); Lead (Pb); Zinc (Zn)	Monthly
2 (Fermenters)	FOS/TAC in fermenters; H_2S in biogas Ammonia in fermenters; Acetic and propionic acid in fermenters; Micronutrients in fermenters	Daily: FOS/TAC and H_2S; Fortnightly: ammonia, acetic acid and propionic acid; Monthly: micronutrients
3 (Post-pasteurisation	*E. coli* and Salmonella	Monthly
4 (Post-separation)	Total nitrogen; Physical contaminants and stones	Monthly
5 (Digestate storage tank)	Refer to Table (7.3.2)	

Table 7.3.2 Required sampling frequency from sample point 5 (Digestate storage tank).

Parameter	Minimum frequencies for testing representative samples
Stability (Residual Biogas Potential)	2 per 12 months and not within 3 months of each other, or sooner when significant change occurs.
Potentially toxic elements (PTEs)	Once per month
Physical contaminants	
Total nitrogen (N), total phosphorus (P), total potassium (K) and total sulphur (S)	
Ammoniacal nitrogen (NH_4-N)	

Dry matter (total solids)	
Loss on ignition	

8. Process management

[PAS110 Section 7]

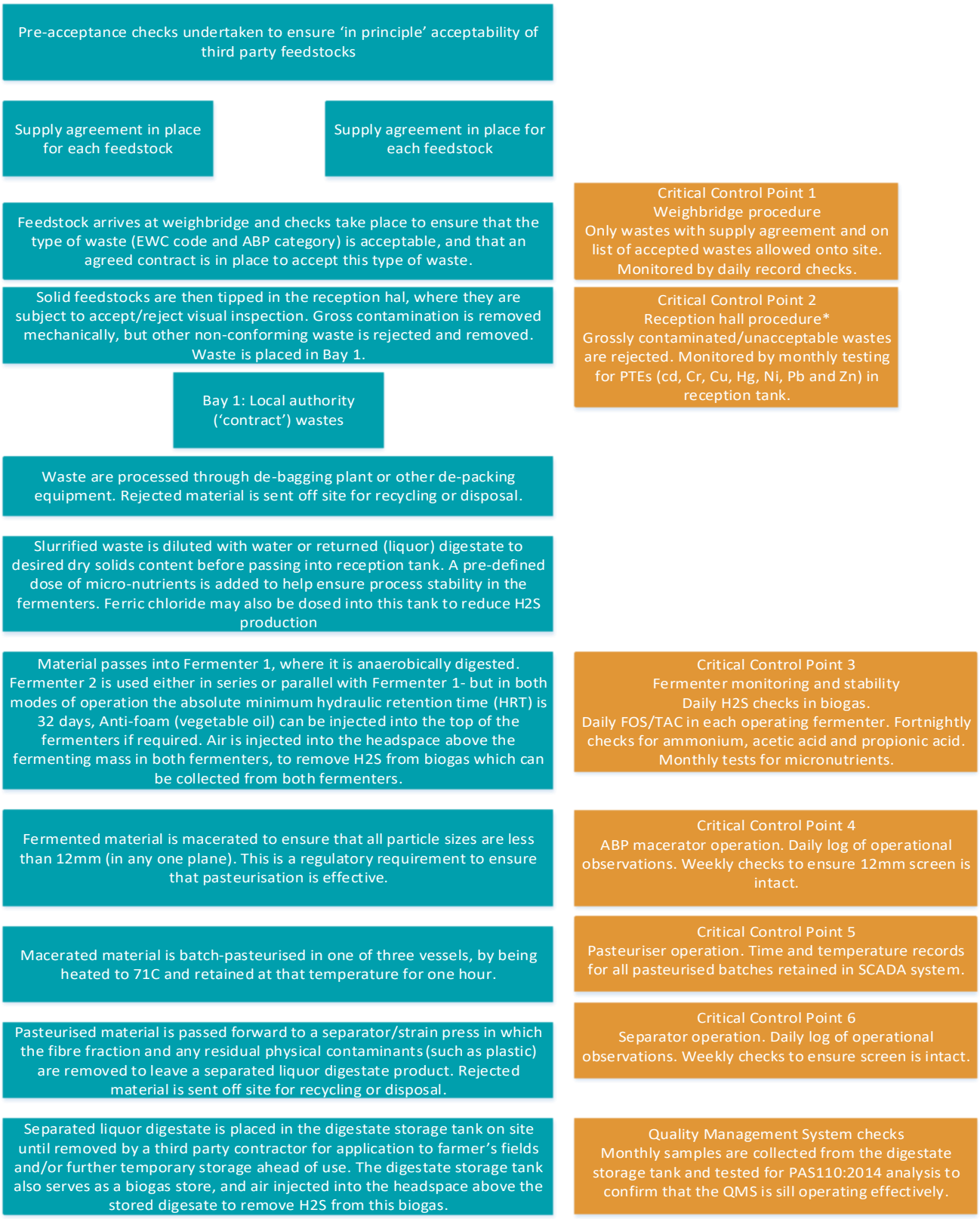
In accordance with PAS110, the process is managed and documented throughout to ensure a consistent and adequate quality of end product.

8.1 Process flow

The site process flow from waste arrival, to digestate offtake is summarised in Figure 8.1.1 and *Refers to WWOE (3) 06, 07, 08, 10, 11, 18, 20 and 23.

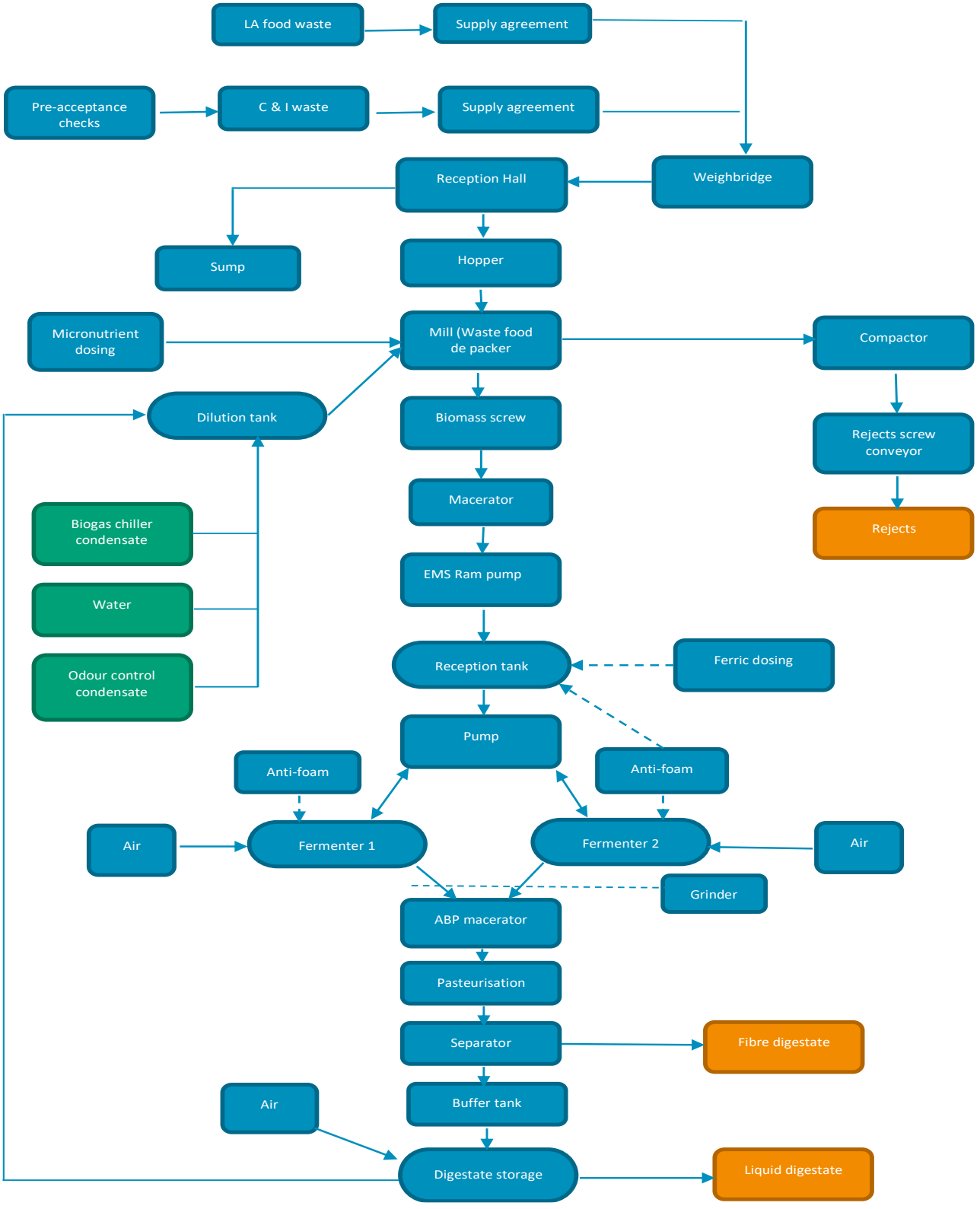
Figure 8.2. [PAS110 Section 7.3.1a; Section 7.3.1e]

Figure 8.1 Process flow (basic description)



*Refers to WWOE (3) 06, 07, 08, 10, 11, 18, 20 and 23.

Figure 8.2 Process flow (diagrammatic overview)



A list of procedures relevant to production of quality digestate is provided in Table 8.1.

Table 8.1 List of procedures, checks and records relevant to production of quality digestate, and associated housekeeping / pre-requisites

Document number	Description	PAS clause
WWOE (3) 06 & 07	Waste acceptance procedure for contract and third-party wastes, including accept/reject procedures and input storage	7.3.1b 7.3.1c
WWOE (3) 10	Waste Handling Bag opener procedure	7.3.1d
WWOE (4) 02	Separator inspection work instruction	7.3.1h
This document Section 4	Digestate storage procedure	7.3.1i
n/a	Digestate recirculation procedure (not currently in use)	7.3.1k
This document Section 10	Digestate despatch paperwork	7.3.1o
WWOE (3) 21	Sampling procedures, covering: Reception tank; Fermenter 1 and Fermenter 2; Pasteuriser outlets; Separated liquor digestate; Digestate storage tank	7.3.1l
Weekly checks and annual contracts	Vermin control	7.3.1s
WWOE (2) 01 section 8 WWOE (3) 27	Procedures to be followed in the event of: system or equipment failures relevant to digestate quality	7.3.1q
WWOE (2) 01 section 8 WWOE (2) 05	Procedures to be followed in the event of accidents or incidents relevant to digestate quality	7.3.1q
Suite of Procedures & forms	Process inspection and maintenance	7.3.1p
This document Section 8.2.8	Process management evaluation	7.3.1m
This document Section 8.3	Corrective actions	7.3.1n
This document Section 8.3.8	Corrective actions in the event of unforeseen failures	7.3.1r

8.2 Process Monitoring and Management

[PAS110 Section 9; clause 7.3.1f; clause 7.3.1g]

Requirements for routine monitoring checks are listed in this section.

8.2.1 CCP1

Daily. Only specific wastes are accepted for processing on site. These are defined according to EWC (European Waste Catalogue) code and/or ABP (Animal By-Products) category. Acceptable inputs are listed in Section 0. All data is sorted on the weighbridge system, for more information see the WWOE (3) 05 Weighbridge Procedure. Where it is found that unacceptable wastes have been accepted, go to Section 8.3.1.

8.2.2 CCP2

Reception Tank samples are taken monthly and sent to NRM for analysis, see the sample log sheets held on site and WWOE (3) 21 Routine Sampling Procedure. Operating Limits are as set out in the table below. Where PTE concentrations exceed limits (which vary according to total nitrogen content), then go to Section 8.3.2.

Total nitrogen (N)	kg/t	Less than 1	1 to 1.9	2 to 2.9	3 to 3.9	4 to 4.9	5 to 5.9	6 to 6.9	7 to 7.9	8 to 8.9	9 or more
Cadmium (Cd)	mg/kg	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.2
Chromium (Cr)	mg/kg	8	16	24	32	40	48	56	64	72	80
Copper (Cu)	mg/kg	16	32	48	64	80	96	112	128	144	160
Mercury (Hg)	mg/kg	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80
Nickel (Ni)	mg/kg	4	8	12	16	20	24	28	32	36	40
Lead (Pb)	mg/kg	16	32	48	64	80	96	112	128	144	160
Zinc (Zn)	mg/kg	32	64	96	128	160	192	224	256	288	320

8.2.3 CCP3

FOS/TAC samples are taken daily. Levels must be determined in each operating fermenter, and daily average H_2S concentration for biogas calculated. NH_4, acetic acid and propionic acid samples are taken fortnightly and must be determined in each operating fermenter. For operating limits of FOS/TAC, NH4, acetic acid and propionic acid see WWOEF 008 Critical Parameter boards. H_2S's critical limit is 500ppm.

In the case of exceedance(s), then actions must be taken as specified in Section 8.3.3.

Monthly samples from each operating fermenter must also be tested for micronutrient concentrations, and micronutrient supplementation altered according to the manufacturer's recommendations.

8.2.4 CCP4

Monthly

ABP macerator must be checked as per WWOE (3) 11 and its performance checked as per WWOE (3) 12. Samples are taken in line with WWOE (3) 21 and recorded via operational tasks on share point. The operational limit is a maximum of 12mm (in any one dimension) for all particles exiting the macerator. In the case of exceedance(s), then actions must be taken as specified in Section 8.3.4.

8.2.5 CCP5

Monthly samples from each pasteuriser should be collected and tested for *E. coli* and Salmonella. For the operational limits see WWOEF 008 Critical Parameter boards and follow Sampling Procedure WWOE (3) 21.

In the case of exceedance(s), then actions must be taken as specified in Section 8.3.5.

8.2.6 CCP6

Monthly operational limits for physical contaminant or stone concentration are as set out in the table below. When the limits exceed, vary according to total nitrogen content, then go to Section 8.3.6.

Total nitrogen (N)	kg/t	Less than 1	1 to 1.9	2 to 2.9	3 to 3.9	4 to 4.9	5 to 5.9	6 to 6.9	7 to 7.9	8 to 8.9	9 or more
Total stones	kg/t	3.2	6.4	9.6	12.8	16	19.2	22.4	25.6	28.8	32
Total physical contaminants (excluding stones)	kg/t	0.04	0.07	0.11	0.14	0.18	0.22	0.25	0.29	0.32	0.36

8.2.7 Digestate quality

Monthly operational limits for digestate quality are as set out in the table below. Where concentrations exceed limits, vary according to total nitrogen content, then go to Section 8.3.7.

Total nitrogen (N)	kg/t	Less than 1	1 to 1.9	2 to 2.9	3 to 3.9	4 to 4.9	5 to 5.9	6 to 6.9	7 to 7.9	8 to 8.9	9 or more
Cadmium (Cd)	mg/kg	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.2
Chromium (Cr)	mg/kg	8	16	24	32	40	48	56	64	72	80
Copper (Cu)	mg/kg	16	32	48	64	80	96	112	128	144	160
Mercury (Hg)	mg/kg	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80

Nickel (Ni)	mg/kg	4	8	12	16	20	24	28	32	36	40
Lead (Pb)	mg/kg	16	32	48	64	80	96	112	128	144	160
Zinc (Zn)	mg/kg	32	64	96	128	160	192	224	256	288	320
Total stones	kg/t	3.2	6.4	9.6	12.8	16	19.2	22.4	25.6	28.8	32
Total physical contaminants (excluding stones)	kg/t	0.04	0.07	0.11	0.14	0.18	0.22	0.25	0.29	0.32	0.36

Monthly samples must be test for the parameters set out below. There are no Operational Limits associated with these results.

Total nitrogen (N), total phosphorus (P), total potassium (K) and total sulphur (S)
Ammoniacal nitrogen (NH_4-N)
Dry matter (total solids)
Loss on ignition

Twice per year. Residual Biogas Potential must not exceed an operational limit of 0.45 litres biogas / g volatile solids. If it does so, corrective action as listed in Section 8.3 must be followed.

8.2.8 Process evaluation

Daily team meetings are held on site. During these meetings all aspects of site performance and activity are logged, including:

- Health and Safety;
- Process performance (fermenter stability, biogas production and quality);
- Laboratory results, including CCP monitoring data;
- Wastes received;
- Wastes rejected;
- Digestate despatched;
- Defects;
- Maintenance;
- Staff resources; and
- AOB

8.3 Actions in the event of a failure

[PAS110 Section 13]

Irrespective of whether Critical or Operational Limits are exceeded, the same approach should be taken to corrective action.

8.3.1 CCP1

1. Where it is found that waste has been accepted with an EWC code that is not on the site's Environmental Permit, then the AD plant operator must contact Natural Resources Wales immediately, and request advice.
2. Where it is found that waste has been accepted with an EWC that is on the site's Environmental Permit – but not on the list of approved inputs, then the AD plant operator must contact the REAL certification officer, and request advice.
3. Where it is found that ABP material has been accepted that is in a category not listed in the APHA approval, then the AD plant operator must immediately contact APHA, and request advice.
4. Any action must be recorded in the site diary and WWOEF 014 and for NRW a Schedule 5 Notification Form.

8.3.2 CCP2

1. Where any Potential Toxic Elements (PTE) is found to have exceeded the Critical Limit, then samples of each subsequent load of waste should be de-packaged separately and tested for the failed PTE(s) and total nitrogen. This will help to identify whether the failure is due to one or more sources of feedstock;
2. If the PTE failure can be linked to specific sources of feedstock, then those sources should no longer be accepted without: Discussion with the waste provider; Re-testing of future consignments to confirm that PTEs are within required limits;
3. If the PTE failure cannot be linked to specific sources of feedstock, then additional feedstock should be passed into the reception tank and samples again taken for PTE (and total nitrogen) testing;
    a. Where this does not remedy the failure, then samples should be tested within fermenter 1 and 2 for the failed PTE(s) and total nitrogen, and calculations made to determine whether the reception tank contents are likely to have a detrimental effect on fermenter PTE concentrations. If the feedstock is likely to elevate the failed PTE(s) to concentrations above the PTE critical limits within the fermenter, then the AD operator should either: Partially empty the reception tank, fill with fresh feedstock and re-test (for PTEs and total nitrogen); or closely monitor digestate quality test results to determine whether final product quality has been impacted (see Section 5).
4. Record any action in WWOE (2) 06 – Corrective Action Register.

It is possible that some PTEs (such as zinc, nickel and chromium) can arise from wear and tear to metallic components within the de-packaging system. Where it is not possible to identify a specific feedstock as a source for PTE failure, then a study should be undertaken in which feedstock is tested before and after de-packaging. If this shows that the de-packaging step is the cause of the failure, then the AD operator should discuss options with the technology supplier.

8.3.3 CCP3

Where Critical Limits are exceeded for NH_4, Acetic acid or Propionic acid the AD operator should:

1. Reduce feeding to the fermenter(s); and
2. Check that mixers / pumps within the AD system are operating as intended; and
3. Check that the correct micronutrient supplement has been used.
4. Record any action in WWOE (2) 06 – Corrective Action Register, as prompted on the bio monitoring spread sheet.

None of these steps should be taken without first consulting an appropriate process expert. After these actions (or the expert recommendations) have been implemented, FOS/TAC testing should be

undertaken on the following day, as normal – if results are below Critical Limits, then NH_4, acetic acid and propionic acid should be determined to verify that they too are within limits.

Where FOS/TAC is outside the Critical Limits the AD Operator should:

1. Reduce feeding to the fermenter(s); and
2. Check that mixers / pumps within the AD system are operating as intended; and
3. Check that the correct micronutrient supplement has been used.
4. Repeat sampling analysis & check equipment calibrations to ensure results are consistent.
5. Record any action in Daily Process Monitoring Log.

If FOS/TAC is still outside the required range, then the steps listed above should be repeated.

The Daily Process Monitoring (DPM) Log is reviewed at regular management meetings. IF FOS/TAC exceedance the critical failure range on the CPB for more than 3 consecutive days the actions should be recorded in the WWOE (2) 06 – Corrective Action Register and an appropriate process expert is to be consulted. As prompted on the DPM.

Where H_2S within the digestate storage tank in biogas exceeds the Critical Limit as indicated on the CPB, then the biogas should be diverted from the CHP engine and flared. The following actions should follow:

1. Ferric and air dosing systems should be checked to determine that they are operating within their design ranges. Remedial maintenance should be performed where necessary;
2. Reduce feeding to the fermenter(s); and
3. Check that mixers / pumps within the AD system are operating as intended.
4. Record any action in WWOE (2) 06 – Corrective Action Register, as prompted on the DPM.

None of these steps should be taken without first consulting an appropriate process expert.

8.3.4 CCP4

The macerator screen apertures are of fixed dimensions that ensure compliance with the Animal By-Products Regulations. Where macerator checks reveal excessive wear and tear, then the screen must be replaced. Likewise, where excessive wear and tear is evident on the blade that rotates against this screen, it must be replaced.

Record any action in WWOE (2) 06 – Corrective Action Register.

8.3.5 CCP5

Where critical limits are exceeded for *E. coli* or Salmonella, the following actions should follow:

1. Alert APHA and respond accordingly;
2. Check calibration records for temperature probes in pasteuriser units and verify conformance.

Record any action in WWOE (2) 06 – Corrective Action Register.

8.3.6 CCP6

Should stones and/or physical contaminants exceed their Critical Limits at this point, then the following actions should be taken:

1. The digestate separator should be checked to verify that pressure / screen settings are within the manufacturer's specification and operating as intended;
2. In-line pumps passing whole digestate from the pasteurisers to the separator should be checked to ensure that they are operating within their intended specification;
3. Components that are worn or otherwise out of specification should be replaced;

4. Once engineering checks are complete and components changed, liquor samples should be re-tested to ensure that they comply with the Critical Limits.
5. Record any action in WWOE (2) 06 – Corrective Action Register, review analysis results from approved external laboratories to ensure compliance, repeat above actions until compliance is achieved.

8.3.7 Digestate quality

Provided the prior CCPs are operating as intended, there should be no failures in digestate quality. Should any such failures occur, then the following two options are available:

1. Dispatch the sampled portion of production as non-conforming material ("waste"); or
2. Take appropriate corrective action and gain evidence of conformance before dispatching it for use.
3. Record any action in WWOE (2) 06 – Corrective Action Register.

Where tested digestate has been despatched for use before the test results were returned, then the relevant customers should be informed of the nature of any failure. NRW and/or APHA (as relevant to the nature of the failure) must be contacted to discuss options.

The following corrective actions are available, depending on the nature of the failure:

Table 8.3 Actions in the event of digestate quality failure

Nature of failure	Actions to be taken
E. coli and Salmonella	1. Check records for CCP4 and CCP5 to determine whether the particle size reduction and pasteurisation processes have been operated within their intended specification; 2. Check calibration records for temperature probes in pasteuriser units and verify conformance; 3. Where CCP4 and/or CCP5 can be identified as the cause of the failure – update and revalidate the CCPs; 4. Check maintenance records to determine whether there have been any mechanical interventions between the pasteuriser outlets and digestate storage tank – and whether these may have re-introduced the organisms to the pasteurised material; 5. Sample and test for *E. coli* and Salmonella at points before and after equipment in the line between the pasteurisers and digestate storage tank that might have undergone maintenance or change. This will determine whether these are acting as sources for the organisms; 6. Disinfect any contaminated equipment (where found); 7. Re-test digestate for *E. coli* and Salmonella
Potentially Toxic Elements	1. Check records for CCP2 to determine whether the failure can be tracked to a specific source of waste. Follow-up with the supplier accordingly; 2. Where CCP2 can be identified as the cause of the failure – update and revalidate the CCP; 3. 'Before and after' samples of material should be taken from digestion, maceration and screening stages to understand whether any failure is due to wear and tear of components in the AD process itself. Should the process be identified as the

	source of PTE contamination, then a resolution should be sought with the appropriate supplier; 4. Re-test digestate for the failed PTE(s).
Stones and physical contaminants	1. Check records for CCP6 to determine whether the failure can be tracked to digestate separator operating outside intended specification; 2. Where CCP6 can be identified as the cause of the failure – update and revalidate the CCP. This may require replacement of the digestate separator; 3. Re-test digestate for the failed parameter (stones and/or physical contaminants excluding stones)
Residual Biogas Potential	1. Check records for CCP3 to determine whether the failure can be tracked to AD process instability; 2. Where CCP3 can be identified as the cause of the failure – update and revalidate the CCP; 3. Re-test digestate for RBP.
Following implementation of the appropriate corrective action(s), an additional batch or portion of production of digestate that has completed its minimum necessary HRT in the digester may be pumped into the digestate storage tank. After thorough mixing, a sample representative of the tank's content may be sampled for testing against the relevant (failed) parameter	

8.3.8 Unforeseen digestate quality failures

[PAS110 clause 7.3.1r]

This digestate Quality Management System is designed around a series of Critical Control Points, intended to manage foreseeable hazards that are present in feedstocks (or could be introduced during the AD process) and are relevant to the quality and safety of the digestate product.

Where there are unforeseen failures in digestate quality, then a root cause analysis must be undertaken, and the relevant sections of Table 8.8.3 updated. Depending on the nature of the failure, it may be possible to re-process and re-sample digestate – but this should be discussed and agreed with an appropriate technical advisor.

8.4 System or equipment failure

[PAS110 clause 7.3.1q]

WWOE (3) 27 Escalation Procedure – Escalation procedure to be followed in the event of process or equipment failure that affect the digestion process or the quality of digestates

8.5 Process equipment checks

[PAS110 Section 8; clause 7.3.1p]

There is a suite of procedures and forms for the maintenance checks on site.

Relevant equipment includes:

Bag opener- WWOE (3) 10 Waste Handling- Bag Opener Procedure, WWOEF 005 Daily, weekly and monthly planned maintenance and WWOE 061 Plant Inspection Weekly checklist

Mixers in reception tank, fermenters and digestate storage tank- WWOEF 005 Daily, weekly and monthly planned maintenance

Temperature monitoring in fermenters- Scada System and WWOEF 0015 Scada Daily Check Sheet

FOS/TAC, pH probe and moisture balance- Scada System and WWOEF 0015 Scada Daily Check Sheet

ABP macerator & screen- WWOE (3) 11 Macerator Inspection and Maintenance Procedure, WWOEF 060 Plant Inspection Daily Checklist and 005 Daily, weekly and monthly planned maintenance

Pasteuriser units (temperature monitoring)- Scada System and WWOEF 0015 Scada Daily Check Sheet

Digestate separator- Scada System and WWOEF 0015 Scada Daily Check Sheet

9. Digestate sampling and testing

[PAS110 Section 10; clause 7.3.1j]

9.1 Portion of Production

The anaerobic digestion process is semi-continuous, from the point at which waste / feedstock is received, to the point at which digestate is removed for application to land or off-site storage. For the purposes of PAS110:2014, a portion of production is defined as the quantity of separated digestate liquor passed forward into the digestate storage tank (DST) in any given day. These portions can be traced back to the AD inputs through daily feeding and process records.

9.2 Sampling

All of feedstock processed at this facility is derived from local authority contracts (for kerbside collected, household food waste). Operational experience has shown that this material is of consistent quality through the year. Representative samples can therefore be obtained at any time, but for consistency are collected from the DST and samples are scheduled in accordance with the sample schedule WWOEF 078

10. Labelling, marking, dispatch and use of separate liquor

[PAS110 Section 14]

10.1 Dispatch

WWOEF 003 – Dispatch Note must be used when a consignment of digestate is dispatched from the AD Plant or storage facility to the user of the materials.

This digestate product:

- Is for use solely in agriculture and field horticulture;
- Must be used in accordance with good practice guidelines; and
- Must not be in any circumstances be blended with any waste material. If material is blended with waste, then the mixture becomes a waste and is regulated as such.

10.2 Information to accompany despatch note

Application and use of quality digestate: advice for users of digestate

- Seek advice on suitable applications for quality digestate from an advisor qualified under the Fertiliser Advisers Certification and Training Scheme (FACTS).
- Ensure any application of quality digestate conforms to the principles set out in *Code of Good Agricultural Practice to Protect Water, Soil and Air Quality* (CoGAP) (or subsequent guidance). This covers all aspects of agricultural activities including nutrient use. In particular, do not spread digestate on frozen, snow-covered or waterlogged ground, or within 10 metres of a watercourse.
- Spreading techniques and subsequent soil management that will minimise ammonia emissions should be adopted.
- Match quality digestate applications to crop nutrient requirement, growth stage and prevailing weather conditions. Apply in accordance with a Nutrient Management Plan for the farm; see *Fertiliser Recommendations for Agricultural and Horticultural Crops* (RB209).
- Adhere to the maximum permissible annual rate of PTE addition over a 10 year period as per the *Code of Practice for the Agricultural Use of Sewage Sludge* (the 'Sludge Code') .
- Follow Animal and Plant Health Agency guidance on the use of animal by-product derived organic fertilisers and soil improvers[2].
- In areas of England and Wales designated as Nitrate Vulnerable Zones (NVZs) (i.e. areas designated under legislation to implement the Nitrates Directive), applications of digestate must comply with the relevant mandatory Action Programme measures. These include various requirements for maximum rates of application and permitted application windows for different types of manures and quality digestate.

Soil sampling and analysis

- The land manager should arrange for the receiving soil to be analysed for PTEs (lead, cadmium, chromium, mercury, copper, zinc, nickel) to ensure that the limit values given by the Sludge Code[3] are not exceeded for the receiving soil.
- Soil analysis for PTEs should be carried out before the first application of digestate and again when any predicted soil PTE concentration becomes equal to or greater than 75 percent of its corresponding limit value set out in the Sludge Code.
- Soils should be sampled for major nutrients regularly in accordance with RB209.
- Ensure all chemical analysis is carried out by laboratories using appropriate methods that are accredited by UKAS to ISO/IEC 17025 for the chemical testing of soil.

11. Supply agreements

AD Facility Name:	**Welsh Water Organic Energy Cardiff**
Supplier Name:	
Supplier's Contact Name:	

About the waste to be supplied
EWC code:
ABP category (where applicable):
Source of waste: State address of commercial / industrial site if applicable. For waste collected in rounds, then state "dedicated collection for source-segregated food wastes from households and businesses"
Brief description of source type and any associated process from which it arose:
Brief description of its physical form (solid, liquid):

Acceptance criteria: Only types of waste that comply with the site's Environmental Permit, Animal & Plant Health Agency approval, the Anaerobic Digestate Quality Protocol and the following specific criteria can be accepted by the site:

1. All commercial / industrial wastes must have undergone pre-acceptance checks;
2. Levels of contamination must be below target thresholds;
3. The presence of the plants ragwort and yew must be below target thresholds.

Additional arrangements to remove or reduce physical contaminants/unsuitable content prior to shredding or digestion:

Where feasible, physical contamination is removed by litter picker or front-end loader.
Where gross physical contamination is identified by visual inspection, material will be back-loaded onto the delivery truck for disposal off site.

Input material rejection criteria and procedure:

Criteria to trigger rejection	Procedure to follow if rejection occurs
Contract waste can be rejected if: • It is kerbside food waste and contains more than 7% contamination by weight; • It is commercial food waste and contains more than 10% contamination by weight.	1. Pictures of the load are taken for evidence. 2. If it is possible the waste is loaded back to the vehicle it arrived in. 3. If this is not possible it is quarantined in Bay 1 until removal. 4. APHA, NRW, and customer / waste supplier (as appropriate) are notified immediately and further action agreed.
Third party waste can be rejected if: • It contains more than 10% contamination by weight; and/or • It contains more than 10% by weight of ragwort or yew plant material.	

The responsibility for the quality control of the waste supplied remains with the supplier. The plant operator reserves the right to reject any load or part load that fails to meet the agreed criteria. The supplier must inform the plant operator of any significant change in the quality of the input material, affecting the fitness for purpose, before delivery.

Suppliers' signature	Date
Suppliers' name and job title	
AD operator's signature	Date

11.1 Input materials delivery record

Input material is recorded via the weighbridge system.

11.2 Input material rejection record

This is recorded on WWOEF 004 – Input material rejection form.

12. Training and competence

[PAS110 clauses 4.3.3 and 4.3.4]

Training is recorded via Learning and Development in our corporate system SuccessFactors, a central function to support Welsh Water, WWOE also maintains a site Training Matrix.

Competency is monitored via job description, knowledge and skills frameworks, task assessment,development plans and CCP training records and reviewed via our corporate system SuccessFactors.

13. Document control

[PAS110 clause 4.4]

This managed via our corporate procedure SP (2) 04 – Document Control procedure.

14. Incidents and accidents

[PAS110 clause 4.5]

All accidents and incidents are recorded via our corporate system Assure.

14.1 Accidents or incidents that might affect the digestion process or digestate quality

- WWOE (2) 01 - Welsh Water Organic Energy Cardiff PAS 110 Management System Description section 8;
- WWOE (2) 04 – Cardiff AD Plant ABPH HACCP Plan;
- WWOE (2) 05 – Environmental Aspects and Impacts Register; and
- WWOEF 008 – Critical Parameter Board and the site diary.

15. Vermin control records

[PAS110 clause 7.3.1s]

Reference to vermin control contracts

16. Complaints and concerns

[PAS110 clause 4.6]

Refer to WWOE (2) 03 – Complaints and Enquiries Plan and WWOE (3) 24 – Complaints and Enquiries Procedure.

17. Internal audit of the digestate Quality Management System

[PAS110 clause 4.7]

At least once per year, senior management will appoint appropriate members of staff from with the Dwr Cymru Welsh Water Business Assurance and Internal Audit departments to conduct an internal audit of the Quality Management System.

18. Records

All records are to be retained for a minimum of two years.

All site information that is collected on daily basis is retained on the Daily Process Monitoring log for easy of use and so we can trend the site progress and compliance.

Record	Reference	Retained by
Weighbridge	Win Weigh IV	Weighbridge System
Daily Process Monitoring Log	DPM	SharePoint
Assure	Assure	Assure System
Input material rejection form	WWOEF 004	SharePoint
Scada System	Scada	Site/Scada System
Dispatch Notes	WWOEF 003	SharePoint
Daily, weekly and monthly check sheets	Daily Site Report	SharePoint
Escalation Procedure	WWOE (3) 27	SharePoint
ABPR Particle Size Validation	WWOEF 012	SharePoint
Shutdown Sheet	WWOEF 014	SharePoint

19. Reference Documents

Also see hyperlinked references in section 10.2.

Document	Document Reference
Biofertilizer Certification Scheme	Bio Cert. Scheme
Anaerobic Digestion Quality Protocol	AD Quality Protocol
PAS110:2014	PAS 110
WWOE ABPH HACCP Plan	WWOE (2) 04
Environmental Aspects and Impacts Register	WWOE (2) 05
Corrective Action Register	WWOE (2) 06
Corrective Action Procedure	SP (2) 03
Complaints and Enquiries Procedure	WWOE (3) 24
Weighbridge Procedure	WWOE (3) 05
Waste Acceptance Procedure	WWOE (3) 06
Waste Acceptance Criteria Procedure	WWOE (3) 07
Disinfection Procedure	WWOE (3) 08
Macerator Inspection and Maintenance Procedure	WWOE (3) 11
ABPR CCP Particle Size Validation	WWOE (3) 12
Rejects Management Procedure	WWOE (3) 18

Document	Document Reference
Reception Hall Drain Clean Out	WWOE (3) 20
Routine Sampling Procedure	WWOE (3) 21
Reception Sump Pump	WWOE (3) 23
Escalation Procedure	WWOE (3) 27
European Waste Catalogue	EWC
Cardiff Food AD ABPR HACCP	WWOE (2) 04
Critical Parameter Board	WWOEF 008
ABPR Particle Size Validation	WWOEF 012
Macerator Inspection and Maintenance	WWOE (3) 11
ABPR CCP Particle Size Validation	WWOE (3) 12
Training Matrix	WWOEF 085