Bourne Valley Associates Ltd

Phosphorus Mitigation Plan

for

Development of an AD Plant & Grain Store

For

STL Energy

At

Whitwick Manor Farm, Lower Eggleton, Ledbury, Herefordshire. HR8 2UE

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Table of Contents

1. *Introduction*

Planning application number 222728 was submitted to Herefordshire Council. The work relates to the construction at Whitwick Manor of an Anaerobic Digester (AD) plant, and associated facilities, such as Feedstock Storage Clamps, Lagoons and Wetland Filtration System. The works also includes the installation of photovoltaic panels and the construction of a grain dryer and store, and for the construction of a new vehicular access to the A417. The works will also incorporate a link with the nearby high pressure gas mains operated by the National Grid.

A request for further information pursuant to regulation 25 of the town and country planning (environmental impact assessment) regulations 2017, as amended, was received on the 14th February 2023. Part of this request related to drainage and water discharge from the development site. This report aims to address the water discharge and mitigate any phosphorus present.

2. *Phosphorus Removal*

One of the principal benefits of the AD Plant proposed is that nutrients within the feedstocks are to be stripped from the digestate so that clean water can be discharged to a water course adjacent to the site. This removes the requirement to spread digestate to land as an agricultural fertiliser, which in turn prevents phosphorus run off within the river Wye catchment.

Phosphorus removal involves four key steps, centrifuge, soluble phosphorus recovery, centrifuge 2 & phosphorus filters. Details of which can be found in appendix 1.

The calculations demonstrate that <4.5kg of phosphorus per annum that will remain in the treated water and discharged from the site.

3. *Treatment Plants*

It is proposed to install two sewage treatment plants to serve staff toilets and welfare facilities. These are to be located to the south of the AD Plant serving the office and to the east of the grain store serving the office. Treated effluent from the sewage treatment plants will discharge to the ditch system through a network wholly separated from the surface water network and under its own Ordinary Watercourse Consent.

The site will employ four full time staff. However, due to the nature of the work, that being agricultural in nature and low skilled, it is anticipated that all employees will come from within the river Wye catchment area. Therefore, discharges from the treatment plants have not been included in our phosphorus calculations as doing so would be considered double counting given the employees homes would be within the catchment area.

The welfare facilities would also be used by visitors and delivery drivers, though again including these figures would be considered double counting.

4. *The Development Site*

The development site includes three fields within Whitwick Manor Farm that are currently used for arable farming. The total area of agricultural land to be lost, or taken out of agricultural production, will be 18.432 hectares (Ha). Details of the agricultural land can be found in appendix 2.

5. *Proposed Land Use*

The proposed land use has been split into three types; Greenspace, Water and Commercial urban land for the purpose of inputting data into the Nutrient Budget Calculator.

Greenspace includes grass land, wildflower and tree planting. These have been grouped together as the values within the Nutrient Budget Calculator are the same for each type.

Water includes all the reed beds and the final water storage lagoon, as these will not only serve the processing of water within the site prior to discharge they will also provide significant biodiversity gain.

Commercial Urban Land includes all development land, ie. buildings, plant and hard surfaced areas. The area also includes the dirty water lagoon as this does not contribute to biodiversity gain.

Details of the proposed land use can be found in appendix 3.

6. *Nutrient Budget Calculator*

The development site lies within the river Lugg catchment, therefore the Herefordshire Councils River Lugg Nutrient Budget Calculator has been used to calculate the amount of phosphorus produced by arable agricultural land. The figures from our phosphorus stripping calculations have also been inputted. These figures have been inputted into stage 1, whereby we have included a value of 102.6mg TP/litre Phosphorus, this provides a value of 4.5kg TP/year phosphorus. The calculator then confirms the total annual phosphorus load that requires mitigation.

The completed budget calculator can be found in appendix 4. A summary of the report is below.

	Hectares (Ha)	Annual phosphorus export Kg TP/year
Land no longer in Agricultural Use	18.432	-16.56
Phosphorus discharge to water course		4.5
Commercial Urban Land	5.398	6.13
Greenspace	8.599	0.17
Water	4.435	0.0
Total annual phosphorus export		**-5.76**

The calculator demonstrates that there will be a nett decrease in phosphorus of 5.76 kg per year as a result of this development.

The request from the Local Planning Authority asked us to consider the Farmscoper assessment to calculate phosphorus budgets. However, this method was dismissed due to the Farmscoper survey being a very technical document that allows for the creation of unique farming systems, based on livestock, cropping and manure management, and the assessment of the cost and effect. We were not convinced this is applicable for a waste AD Plant of the scale proposed. After seeking advice from ADAS the Lugg Nutrient Budget Calculator was deemed to be the most appropriate tool.

7. Monitoring

7.1. Laboratory and Release Testing Proposal

To test treated water prior to release, there are several key equipment and tests that are needed. These can include physical tests, chemical tests, and bacteriological tests.

- Physical tests include measuring colour, turbidity, total solids, dissolved solids, suspended solids, odour and taste.
- Chemical tests determine the amounts of mineral and organic substances that affect water quality.
- Bacteriological tests show the presence of bacteria characteristic such as faecal pollution.

Digital instruments such as lightweight and portable digital meters, colorimeters, and spectrophotometers are available. These provide the most accurate and repeatable results compared to traditional manual lab testing methods. The Output requirements and suggested equipment are listed below:

7.2. Output release requirements

The compliance release limits identified in the H1 Water Risk Assessment will be tested weekly in house will include:

Components	Output limit	Units
Maximum flow	5.53	l/s
pH	6 - 9	pH
BOD	6.5	mg/l(O)
Total phosphorous, as P	0.05	mg/l (P)
Ammoniacal nitrogen, as N	0.13	mg/l
Chloride	30	mg/l

In addition, a monthly sample will be sent to a third party lab for bacteriological testing along with periodic calibration tests samples. Sodium may also be tested externally as the process is quite intricate.

A wider range of tests will be performed at least weekly for internal quality controls most importantly on the input to the release buffer lagoon so that any deviation away from limits can be corrected prior to release or release stopped in the interim.

Final output limits and sampling frequency will be agreed with the EA as part of the permit.

7.3. Process Testing

As part of the normal operations regular process testing will be done on input materials, anaerobic digesters, tests before and after various pieces of nutrient recovery equipment and filters to check performance of the equipment or saturation of filters.

7.4. Laboratory Setup

In addition to the process control testing of the AD plant the proposed setup for internal quality and final release water in house will include:

Tests / equipment	**Typical manufacturers**	**Comment**
Fridge for sample storage	Cooled incubators TC 140 G 140l with glass door	
BOD testing	BD600 BOD measurement system 6 place	
Spectrophotometers	Hach DR3900 Spectrophotometer with RFID technology for 13mm Vials	Can also do many other tests such as other metals etc.
DM and COD testing	High Temperature HT200S Thermostat Digester	
COD testing	LT 200-1 Dry Thermostat COD Reactor 1 Block 9 x 13mm & 2 x 20mm Tubes	
	Hach LCK314 13mm COD Vials 15-150mg/l	
Phosphate testing	Phosphate (ortho/tot) trace cuvette test 0.01-0.5 PO_4-P mg/ L	
Nitrite testing	Hach LCK341 Nitrite Cuvette Test 0.015-0.6mg/l	
Ammonium testing	Hach LCK304 Ammonium Test 0.015-2mg/l	Store refrigerated
Chloride testing	Hach LCK311 Chloride Test 1-70 mg/l	Store refrigerated
pH testing	Model 3540 pH/conductivity meter with dual display graphics	
Sample preparation	Vacuum Filtration and Desiccation Apparatus Kit including vacuum compressor	
Glassware and standard equipment	Typical beakers, measuring cylinders, stands	
Consumables	Filter papers, cuvettes, reagents and calibration liquids etc.	
Heated stirrers, scales etc.	Cgoldenwall HJ-2A, Kern KB or similar	

Note These are examples of equipment available subject to final selection. Some tests will also have to go to third party laboratories.

8. *Conclusion*

The calculator demonstrates that there will be a nett decrease in phosphorus of 5.76 kg per year as a result of this development.

Appendix 1 – Phosphorus Removal

STL2 Whitwick AD

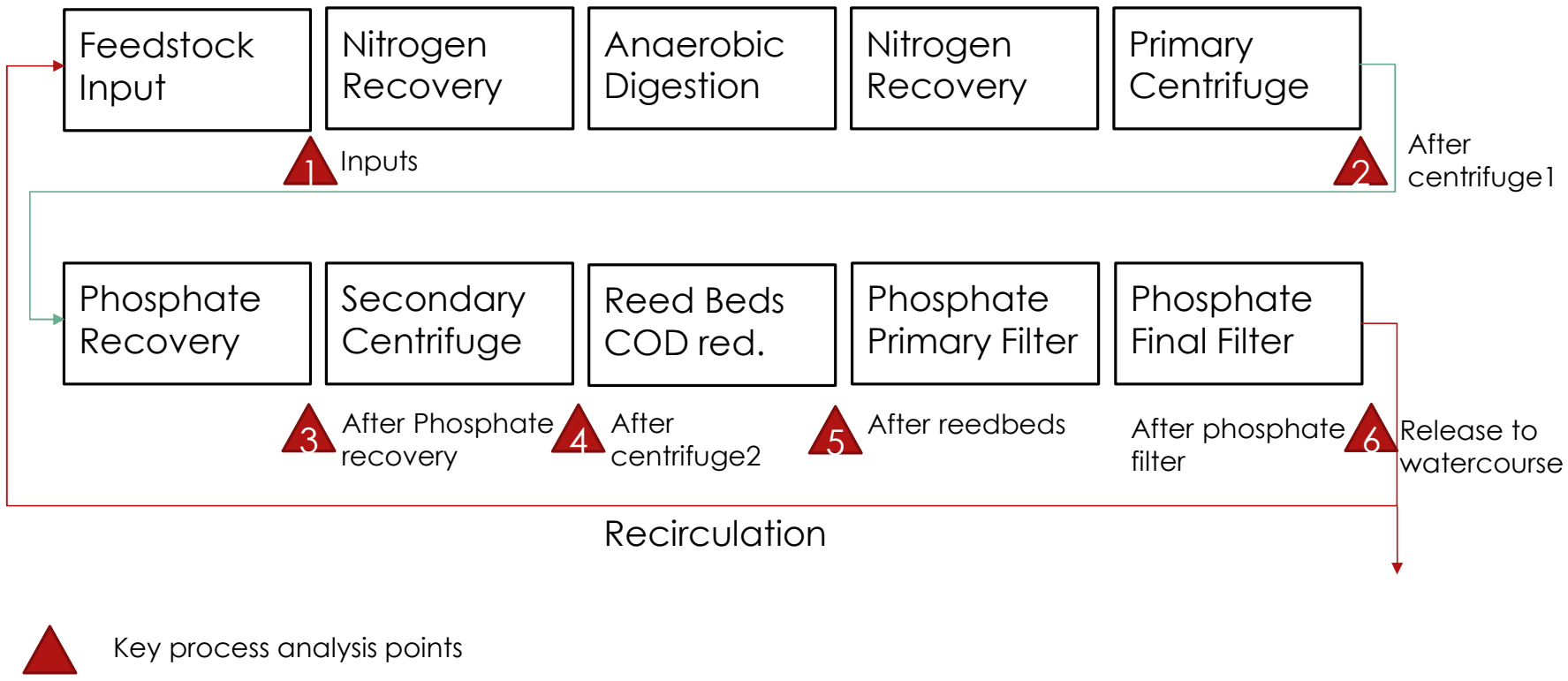
PHOSPHATE RECOVERY AND TREATMENT PROCESS
JANUARY 2023

Phosphate in Agriculture

- Phosphate is one of the three essential plant nutrients ("N**P**K") used as fertiliser in agriculture
- Poultry manure contains significant quantities of this valuable resource
- Historically the application of poultry manure to land has resulted in too much Phosphate (P_2O_5) being applied relative to the other plant nutrients especially Nitrogen ("N")
- This excess Phosphate has resulted in pollution of watercourses such as the River Wye

The solution is to remove Phosphate from poultry manure and transform it into products that can be appropriately and safely used as fertiliser in agriculture.

STL2 Whitwick Phosphate Recovery Process Flow



1 – Total Plant Inputs

Total Feedstock Inputs

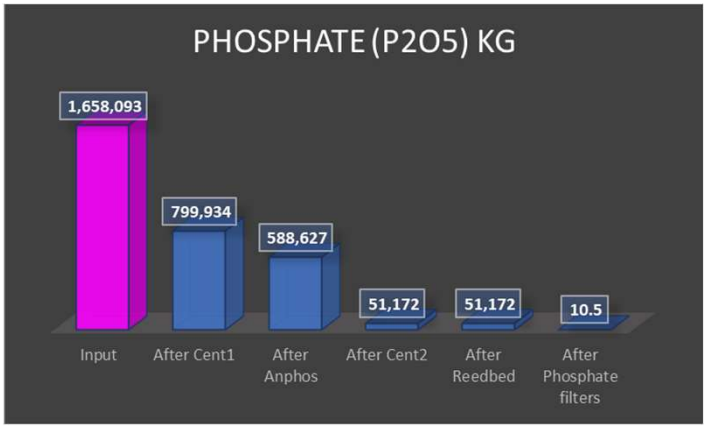
- 100,000 tpa* Poultry manure delivered by covered truck, stored under cover and fed quickly to plant
- 16,000 tpa Apple pomace transported locally by lorry and stored in clamp; then fed over 12 months to balance feedstock mix. Runoff captured and fed directly into digester
- 25,000 tpa Digestate from Hampton Bishop delivered daily and fed directly into sealed tanks
- 35,000 tpa Liquid waste delivered daily and fed directly into sealed tanks
- 170,000 tpa Recirculated water from end of process avoids water extraction

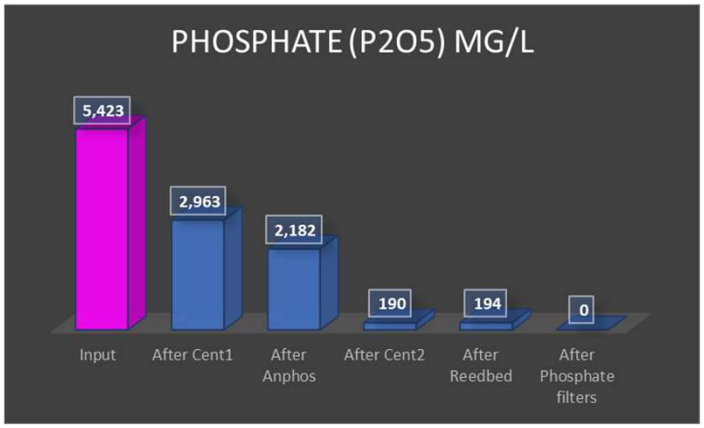
* tpa = tonnes per annum

Whitwick Process

- The feedstock mix is kept as stable as possible to promote a consistent biological process
- Due to pre-digestion Nitrogen stripping, liquid inputs are reduced by around 100,000 tpa
- Liquid inputs are pumped directly into sealed storage tanks from sealed delivery vehicles
- Solid inputs are fed into feed hoppers and incorporated into the sealed anaerobic (i.e. without air) digestion process
- Total Phosphate Input:

  1,658,093 kgs Phosphate per year





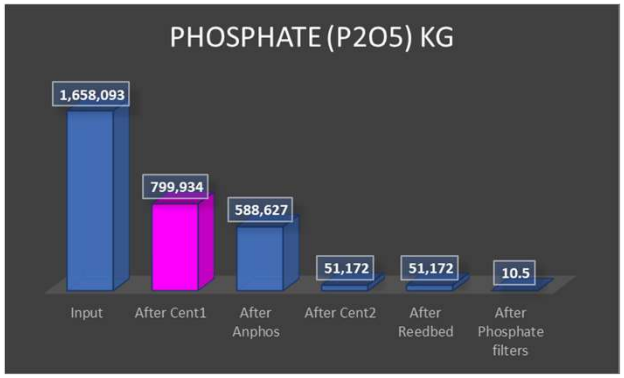
2 – Post Digestion and Centrifuge1

Typical AD Process

- Most AD plants use a single stage screw separator to remove a small proportion of solids to facilitate spreading of liquids to land
- The solid fraction is typically only 22% dry matter and contains significant soluble Phosphate and is also subject to leaching and runoff during field storage
- Both the solid and liquid including all the Phosphate are then spread to land

Whitwick Process

- The first Decanter Centrifuge produces a high quality soil improver with dry matter between 40-45%
- Approximately 35,000 tpa of this soil improver captures 858 t of mostly slow release insoluble, mineral Phosphate
- The balance of Phosphate remaining in the liquid fraction is: 799,934 kgs Phosphate per year



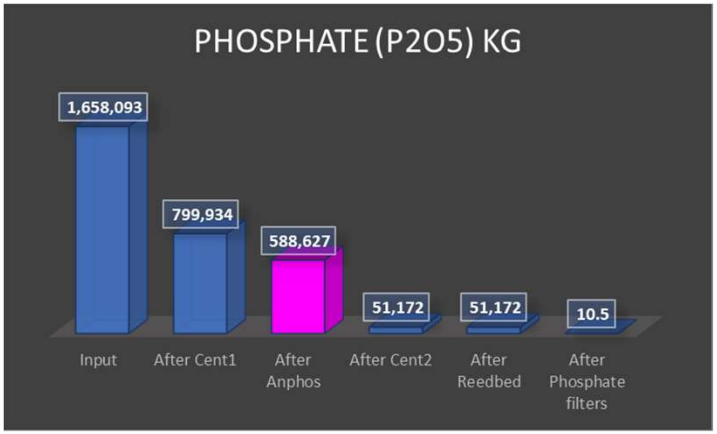
3 – Soluble Phosphate Recovery

Struvite Recovery System

- This technology is not usually deployed at AD plants and has been developed primarily for the sewage treatment industry

Whitwick Process

- Proven Struvite recovery technology uses Magnesium Hydroxide to make Struvite (Magnesium Ammonium Phosphate)
- This process captures Ammoniacal Nitrogen and 90% of the remaining soluble Phosphate for use as a fertiliser
- Remaining Phosphate: 588,627 kgs Phosphate per year



4 – Centrifuge 2

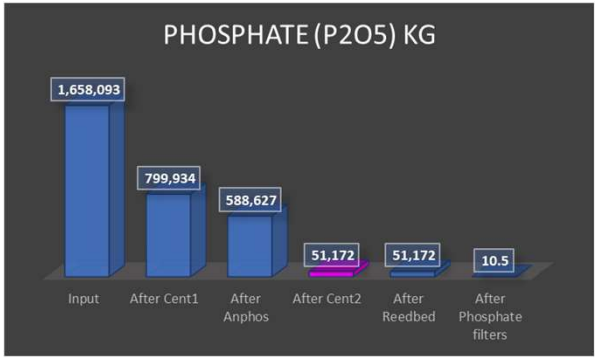
Centrifuge Stage 2

- During trials at STL1* the second stage centrifuge achieved a significant total Phosphate reduction (the results of the trials showed a 99% capture rate)

*STL1 – STL Energy's existing AD plant at Hampton Bishop

Whitwick Process

- At STL2 this process is split into three steps to optimise Phosphate recovery.
- Centrifuge2 is the third step prior to the reed beds. The design has been based on 95% Phosphate removal whereas in STL1 trials 99% was achieved.
- Approximately 1,300 tpa of solids are produced for use as fertiliser
- Phosphate remaining after Centrifuge2:
  51,172 kgs Phosphate per year



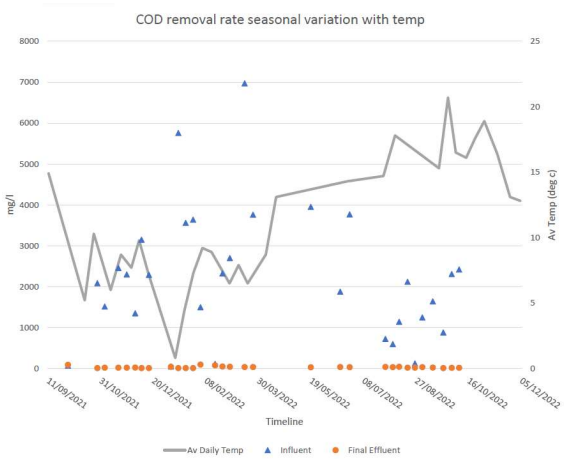
Further processing of liquid to allow discharge to watercourse

- The intensive Phosphate capture processes will remove in excess of 99% of the Phosphate from the input materials (including poultry manure)
- The remaining liquid stream coming from Centrifuge 2 still contains small concentrations of Phosphate, organic matter, plant nutrients and trace elements
- The remaining processes to treat these consist of:
  - Reed beds to remove organic matter, measured as Chemical Oxygen Demand (COD) potential
  - Phosphate filters in series, after the reed bed to reduce the Phosphate concentration to minimal levels allowing the treated water to be discharged to the watercourse

5 – Reed Beds COD reduction

Typical Reed Bed

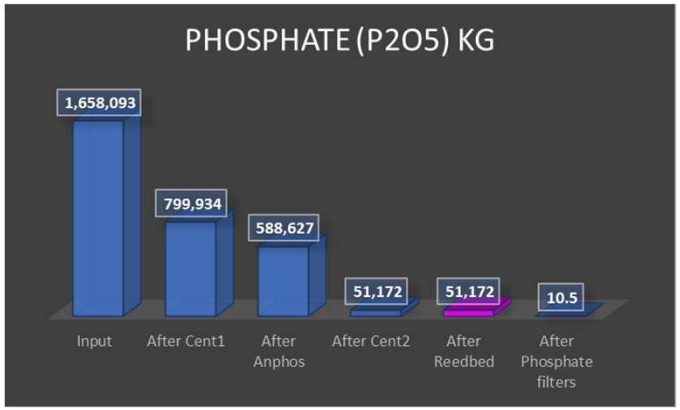
- Reed beds COD* removal efficiency over the year



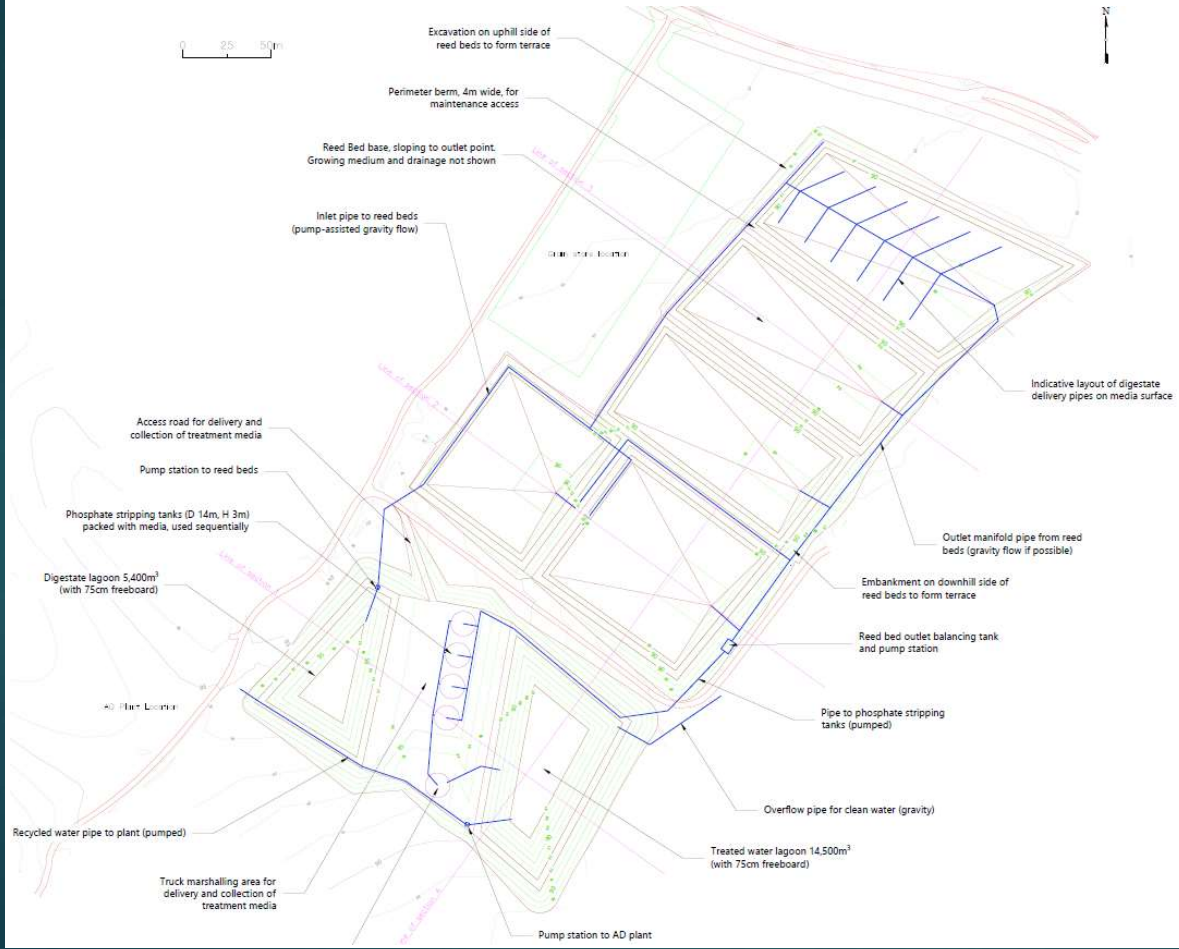
*COD – Chemical Oxygen Demand

Whitwick Process

- Nitrogen and Phosphorus recovery and organic solids separation in previous processes minimises the COD loading on the reed beds.
- The reed beds are primarily designed to remove the remaining COD
- Phosphate remaining after the reed bed: 51,172 kgs Phosphate per year



5 (cont.) - Reed bed layout



Whitwick Process

- There are five vertically fed reed beds in parallel to cope with the hydrological water loading.
- This allows for one red bed to be taken out of service in turn, for cleaning or replanting as necessary
- Treatment area is: 3.5 ha
- Phosphate remaining after the reed bed: 51,172 kgs of Phosphate per year

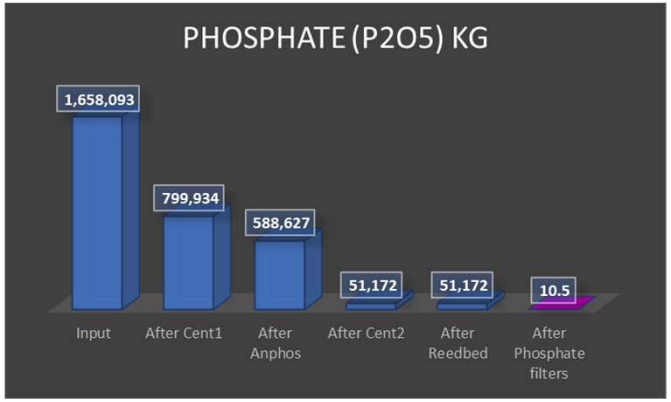
6 – Phosphate Filters

Phosphate Filters

- The filters are a simple up-flow adsorption filter with the ability to bypass or add units in series
- The Phosphate levels will be monitored both before and after each unit to detect when the media is becoming saturated
- When a filter becomes saturated it will be bypassed emptied and refilled with new media
- The specific media has been developed and then tested with the Environment Agency

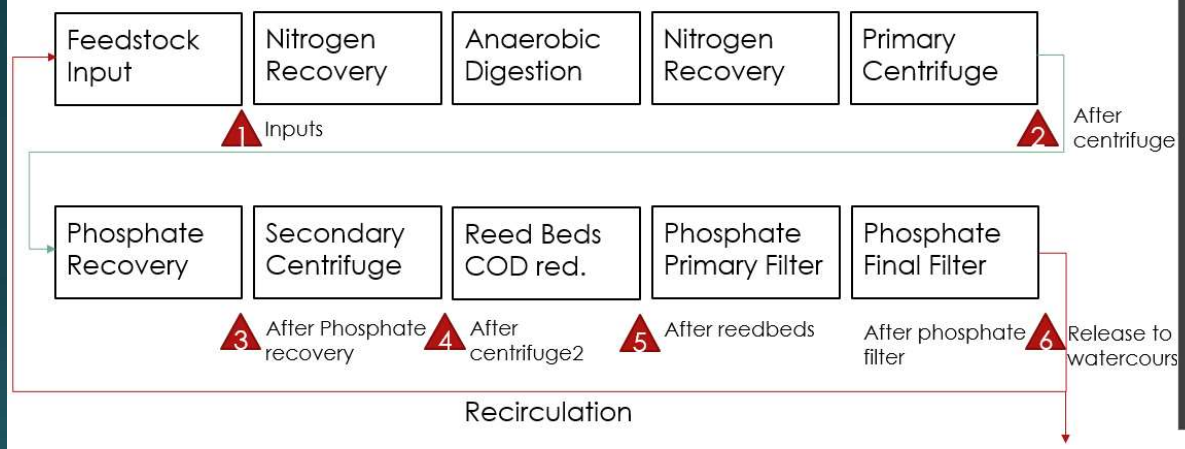
Whitwick Process

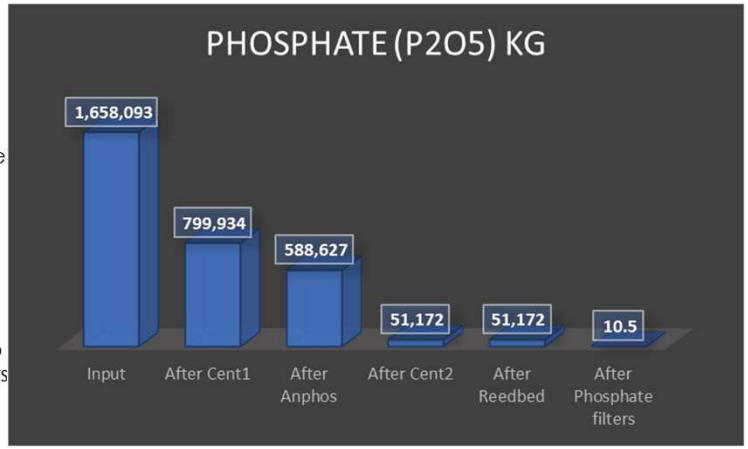
- The system has four main processing filters and a spare, to allow for cleaning and refilling or to provide extra protection if one of the upstream processes is undergoing maintenance
- When saturated, the Phosphate saturated media may be used as a slow release fertiliser
- The STL2 plant design allows for the additional final filter, to have a very low loading
- Phosphate remaining for release to watercourse: <10.5 kg of Phosphate per year or <0.05mg Phosphorus/litre

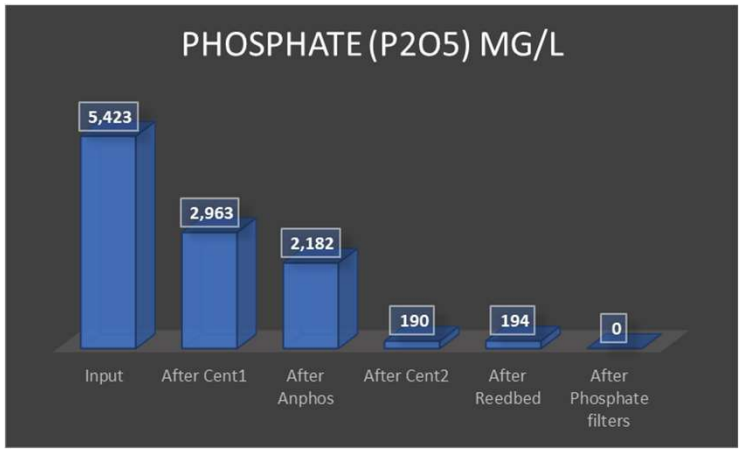


NOTE – Due to different molecular weights one mole of Phosphorus weighs 0.43 X one mole of Phosphorus measured as P205 Phosphate

Phosphate reduction







- A typical house in the Wye catchment area produces around 0.5 kgs Phosphate per year or an acre of farmland 0.9 kg per annum.
- The STL2 plant will release less than 4.5 kgs per year of Phosphorus to the watercourse, less than the amount of Phosphate produced by 5 hectares of farmland
- The phosphate release to the watercourse will be less than 0.05mg/l of Phosphorus the minimum level detected at the nearest River Lugg measuring station
- The balance of Phosphate remaining in the liquid fraction released to the watercourse is: <4.5 kg of Phosphorus (<10.5kg Phosphate P205) per year
- The phosphate removed during the whole STL2 process will be in formats suitable for transport and use as fertiliser or for further processing in fertiliser manufacturing plants
- The concentration of Phosphate released to the lagoon will be: <0.05 mg/l of Phosphorus where it will be then further diluted by rainwater from the catchment

Appendix 2 – The Site

Agricultural Arable Production Land

5.911 Ha

8.028 Ha

4.493 Ha

Track

Drain

Def

CD

0.91m RH

95.2m

A 417

Lay-by

89.9m

87.9m

Drive Cottages

The Managers House

Whitwick Manor

Stable Cottage

Garden Bungalow

The Cottage

Pond

Cow

Rev No.	Revision Note.	Date	Drawn	Checked
A	Pre App Drawings	12.11.19	AW	AW
B	Wetlands system added to the site	01.04.20	AW	AW
C	Grain Store updated	02.10.20	CJB	AW
D	Red line site amended	07.09.22	AW	AW
E	Grain store and storage building revised	28.03.23	AW	AW

NUMBER - REV - CLIENT - PROJECT

01113-00 - E - N Layton - Whitwick Manor

TITLE

Agricultural Land

DATE	SHEET	SCALE
30.05.23	14	1:2500
DRN BY: AW	CHK BY: AW	PAPER SIZE: A3

BOURNE VALLEY ASSOCIATES
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FABERSTOWN
ANDOVER
HAMPSHIRE
SP11 9PE
Tel: 01264 850159
Email: info@bournevalley.co.uk

Appendix 3 – Proposed Land Use

Green Space	8.599 Ha
Water	4.435 Ha
Commercial Urban Development	5.398 Ha

1.338 Ha

3.843 Ha

3.294 Ha

0.431 Ha

0.335 Ha

0.592 Ha

Cow

0.91m RH

95.2m

A 417

Lay-by

Def

Track

89.9m

Drive Cottages

The Managers House

87.9m

Drain

Pond

Whitwick Manor

Stable Cottage

Garden Bungalow

The Cottage

Pond

Pond

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NUMBER - REV - CLIENT - PROJECT

01113-00 - E - N Layton - Whitwick Manor

TITLE

Proposed Land Use

DATE	SHEET	SCALE
30.05.23	15	1:2500
DRN BY: AW	CHK BY: AW	PAPER SIZE: A3

BOURNE VALLEY ASSOCIATES
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Tel: 01264 850159
Email: info@bournevalley.co.uk

Appendix 4 – Nutrient Budget Calculator

Development site details

Date (dd/mm/yyyy):	27/07/2023
Site Name:	Whitwick Manor Farm
Planning Application number:	222728
Site Address:	Whitwick Manor Farm, Lower Eggleton, Ledbury, Herefordshire, HR8 2UE

Stage 1

User Inputs

Date of first occupancy:		
Average occupancy rate:	1.00	
Water usage (litres/person/day)**:**	120	
Development Proposal (dwellings/units)**:**	1	
Wastewater treatment works:	Package Treatment Plant user defined	
Wastewater treatment works P permit (mg TP/litre)**:**	Please enter value in cell to the right:	102.6

Stage 1 Calculated Loading

Additional population	1	people
Wastewater by development	120	litres/day
Annual wastewater TP load	**4.50**	**kg TP/yr**

Stage 2

User Inputs

Catchment:	Arrow, Lugg and Frome
Soil drainage type:	Impeded drainage
Annual average rainfall (mm)**:**	750.1 - 800
Within Nitrate Vulnerable Zone (NVZ):	Yes

Existing land use type(s)	**Area** (ha)	**Annual phosphorus nutrient export** (kg TP)
Cereals	18.43	16.56
Total:	**18.432**	**16.56**

Stage 3

User Inputs

New land use type(s)	**Area** (ha)	**Annual phosphorus nutrient export** (kg TP)
Commercial/industrial urban land	5.40	6.13
Greenspace	8.60	0.17
Water	4.44	0.00
Total:	**18.432**	**6.30**

Stage 4

Calculated Outputs

The total annual phosphorus load to mitigate is:	**0 kg TP/year**