Dairy Crest Limited

DAVIDSTOW ENVIRONMENTAL PERMIT VARIATION APPLICATION

Wastewater Best Available Techniques (BAT) Options Appraisal

70083590/BAT
MARCH 2022

INTERNAL

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1 BACKGROUND INFORMATION

1.1 INTRODUCTION

This Best Available Techniques (BAT) Options Appraisal report has been compiled in support of an environmental permit variation application for Davidstow Creamery (Creamery) which is operated by Dairy Crest Limited (Dairy Crest).

An environmental permit variation is being applied for in order to reflect a number of changes at the site, many of which have already been implemented (and the Environment Agency is aware of) in order to drive operational improvements since the last operator initiated permit variation was granted in 2014. The changes include six Creamery projects, with the key aim of maximising the utilisation of the main raw material (milk), thus increasing the hourly (t/hr) production capacity for cheese, as well as several changes as part of the redevelopment of the onsite Water Processing Facility (WPF). The changes will also seek to improve resource efficiency, waste generation and the energy profile for the site. For further details of the changes being applied for, the main environmental permit variation application report should be referred to.

The objective of this report is to provide the Environment Agency with the necessary information to demonstrate that the treatment of process effluent (at the WPF) and emissions to water (of that treated effluent) from the installation comply with BAT and, therefore, achieve a high level of protection of the environment taken as a whole. In undertaking the options appraisal, the requirements of the environmental permitting regulatory system have been taken into account, which stipulate that an integrated approach to control the environmental impacts from industrial activities should be employed. With this in mind, the report aims to demonstrate that:

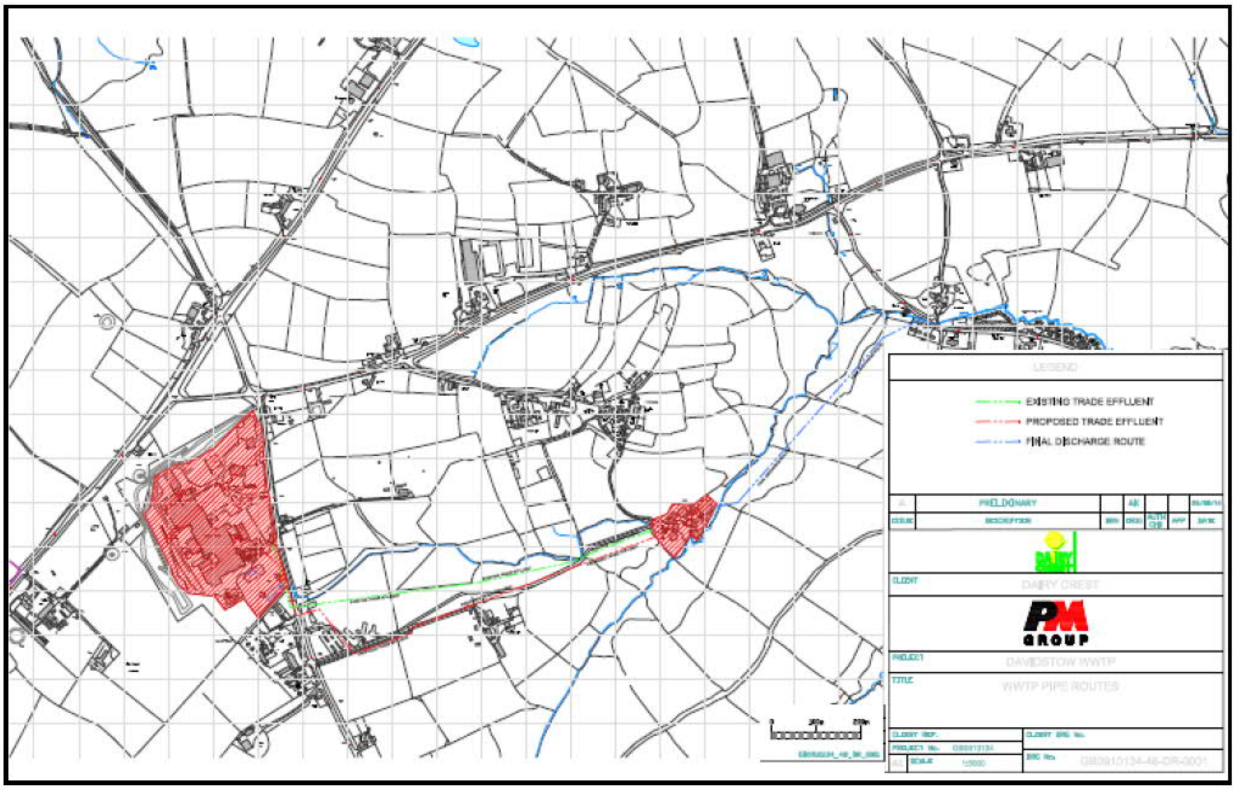
- BAT has been applied to the design and operation of the redeveloped WPF, taking into account relevant local factors; and
- The receiving environment will be protected.

During development of the environmental permit variation application, enhanced pre-application advice was sought from the Environment Agency and a number of meetings were held in addition to email and telephone correspondence. With regards to wastewater management / BAT, the Environment Agency requested that certain information be provided within the application. This is detailed in Section 1.4 below, which also confirms how and where in the application the relevant information is considered.

1.2 SITE DETAILS

The site is located in Camelford, Cornwall; it is situated approximately 88 km to the west of Exeter and 56 km to the north of Plymouth. The National Grid Reference (NGR) of the approximate centre of the Creamery facility is SX13825 86588. The installation boundary, shown in red in Figure 1-1 below, includes the main Creamery facility and the onsite WPF, which is located approximately 1 km to the east of the Creamery and is connected by pipelines.

Figure 1-1 - Site Location and Installation Boundary



(Note: The installation boundary is being modified as part of the permit variation being applied for, to incorporate a small area of land adjacent to the WPF, on which a raw material store is located. The main environmental permit variation application report should be referred to for further details, however, the change will not impact this BAT Options Appraisal).

The site manufactures a number of products comprising cheese, whey cream, demineralised whey powder (Demin) and galacto-oligosaccharide (GOS), which is a prebiotic syrup. Process effluent which is generated during the manufacturing processes at the Creamery is transported by two gravity fed pipelines and treated at the onsite WPF, which incorporates primary, secondary and tertiary treatment techniques. A proportion of the treated effluent is recycled back to the Creamery for re-use via the Water Recovery Plant (WRP) and the remainder is discharged to the River Inny.

As detailed above, a number of changes have been implemented at the site over recent years; this includes redevelopment of the WPF and enhancement of the WRP, which has included the following changes and improvements:

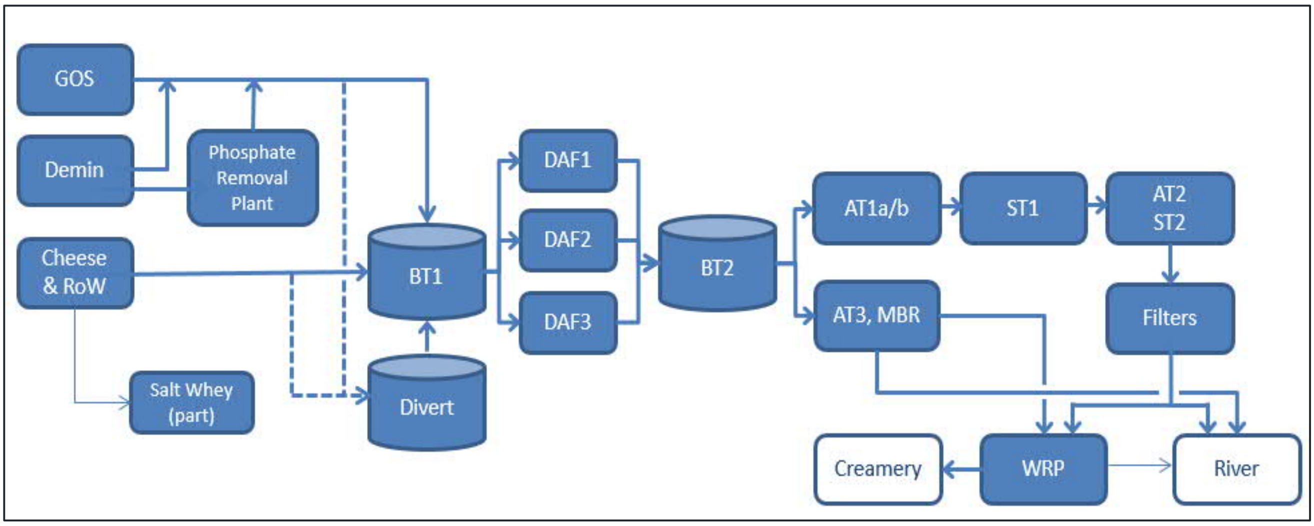
- New contingency lagoon with extraction to an odour control unit (OCU) (note this is physically located at the Creamery but has been developed as part of the redevelopment of the WPF);
- Two new dissolved air flotation (DAF) units;
- Covering and extraction of existing Balance Tank (BT1) and Divert Tank to a new OCU;
- New raw material(s) store;
- New aeration pumps for BT1 and Divert Tank;
- Installation of acoustic fencing;
- Installation of noise monitoring equipment;
- Provision of floating discs on Balance Tank 2 (BT2);

- Upgrade to activated filter media (AFM) filtration tanks;
- Installation of a perimeter containment wall to the downgradient portion of the WPF;
- Upgraded outfall pipework from the WPF to the River Inny;
- Installation of a third reverse osmosis (RO) plant;
- Installation of a fourth membrane bioreactor (MBR) loop;
- Installation of an ultrafiltration (UF) / RO flow attenuation tank;
- Replacement of W2 v notch sampling point with a MCERTs flume;
- Implementation of tertiary filters downstream of tank ST2 and prior to W2;
- Enclosure of sludge centrifuges and trailer; and
- Installation of an automated forward / divert solution for both cheese / whey and Demin / GOS.

Whilst not all of the above changes would warrant a permit variation in their own right, reference is made to them all in the current application in order to give a full picture of the significant investment and improvements made at the site since 2014. The changes at the WPF / WRP have driven operational improvements, enhanced the approach to general management and monitoring and, therefore, increased the efficiency and resilience of the overall wastewater treatment process. Furthermore, the changes will also seek to improve resource efficiency, waste generation and the energy profile for the site.

An overview of the wastewater treatment processes performed at the WPF and the latest configuration is provided in Figure 1-2 below. This configuration has been designed and implemented following various trials and modifications to the plant since the full commissioning of the Demin and GOS processes at the Creamery in 2016. It has been determined to provide the best treatment capacity and control on the final effluent discharged to the River Inny. A more detailed description of the WPF / WRP and the changes implemented are provided in Section 4 of the main environmental permit variation application report. Report Section 3 below reviews the specific treatment technologies implemented against BAT requirements.

Figure 1-2 - Summary of WPF Process



Note:- BT: Balance Tank, DAF: Dissolved Air Flotation, AT: Aeration Tank, ST: Settlement Tank MBR: Membrane Bio Reactor, WRP: Water Recovery Plant

1.3 DEFINITION AND APPLICATION OF BAT

The activities undertaken at both the Creamery and the WPF are prescribed activities falling under Sections 6 (milk / food products) and 5 (waste management) of Annex I to the Industrial Emissions Directive (IED). Therefore, the site is regulated as an installation and the application of BAT is required in order to prevent or minimise emissions and reduce impacts on the environment. Industrial process operators and environmental regulators are required to consider all the factors that influence BAT when determining and issuing permits and when regulating industrial sites (installations).

BAT is defined in Article 3(10) of the IED as follows:

'best available techniques' means the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole:

(a) 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;

(b) 'available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;

(c) 'best' means most effective in achieving a high general level of protection of the environment as a whole.

The European Commission produces best available technique reference documents, or BREF notes, which contain BAT for installations falling within specific sectors. The relevant BREF notes for the activities undertaken at the Davidstow installation are:

- Creamery operations – Food Drink and Milk BREF (2019) and associated BAT Conclusions; and
- WPF operations - Waste Treatment BREF (2018) and associated BAT Conclusions.

The BAT Conclusions include a number of individual conclusions that indicate which techniques or combinations of techniques are BAT for achieving a specific environmental objective and the emission levels ('BAT-AELs') and performance levels ('BAT-EPLs') associated with BAT. These must be complied with (unless the Environment Agency agrees that certain criteria have been met). Dairy Crest, as the operator of the installation, has a duty to determine which operational options and techniques constitute BAT when applying for a permit or variation. Where there is a choice, the technique that is best overall will be accepted as BAT, unless it is not an available technique. The BAT approach also ensures that the cost of applying techniques is not excessive in relation to the environmental protection they provide, i.e. the balance of costs and advantages means that a technique may be rejected as BAT if its costs would far outweigh its environmental benefits.

In many cases, the requirements may be demonstrated simply by implementing BAT as specified in the relevant BAT Conclusions. Provided that the environmental impact that results from the application of such BAT is acceptable, there should be no need for further appraisal of BAT at the installation level. However, there are often circumstances where an Operator needs to provide an installation-specific assessment to justify that BAT is being implemented. This is the case at the Davidstow installation as the Environment Agency has requested additional information to demonstrate that the receiving watercourse (the River Inny) will be protected.

When environmental regulators determine BAT for permit applications or variations, and subsequently issue permits or variation notices, Annex III of the IED requires them to take account of several environmental areas. These are:

- Low-waste technologies and techniques;
- Substances that have lower hazardous properties;
- The recovery and recycling of waste substances generated in an activity;
- Technological precedence, i.e. comparable methods and processes which have been applied successfully on an industrial scale;
- Technological advances and changes in scientific knowledge and understanding;
- The nature, volume and effects of releases to the environment;
- The commissioning dates for new or existing installations;
- The time that would be required to introduce BAT;
- The nature and consumption of raw materials used in the process, energy efficiency and water-use efficiency;
- The need to eliminate or minimise the overall impact of releases to the environment, based on the environmental risks posed;
- The need to prevent accidents and so minimise the consequences for the environment; and
- The information that the European Commission publishes on BAT.

In addition to the above environmental topics, there is a requirement to consider socio-economic factors, as detailed further in Section1.4 below.

Article 14 of the IED describes what environmental regulators have to do when determining permits and writing permit conditions. It states that the BAT Conclusions serve as a benchmark reference for permitting; at the same time, regulators can go further in terms of specifying controls, if the environmental risks justify this. On the other hand, if a regulator sees a case for applying conditions which are below those required by the BAT Conclusions, then the regulator must justify any derogations.

Whilst the UK left the EU on 31 January 2020, it is committed to maintaining environmental standards and the EU Withdrawal Act 2018 maintains established environmental principles and ensures that existing EU environmental law will continue to have effect in UK law. This includes the IED and BAT Conclusion Implementing Decision made under it. The UK government will put in place a process for determining BAT Conclusions for industrial emissions and it recently consulted on a future regime for developing BAT within the UK. Details of the new BAT regime were due to be published at the end of 2021 although nothing has been announced to date. Therefore, this BAT Options Appraisal has been undertaken with reference to the existing EU BREF notes referenced above.

1.4 BAT APPRAISAL OBJECTIVES AND METHODOLOGY

Whilst the permit variation being applied for will not introduce the manufacture of any new products at the Creamery, generate any new effluent streams requiring treatment at the WPF, limit or increase the volume of effluent discharged to the River Inny, the Environment Agency has conveyed its intention to review the Emission Limit Values (ELVs) for point source emissions to water during the permit variation determination process. This will include additional parameters being specified in the monitoring regime in the permit and lower ELVs for some parameters already listed in the permit. In some cases, the ELVs are for parameters which do not have BAT-Associated Emission Levels (AELs) or Environmental Quality Standards (EQSs) and are not priority substances under the Water Framework Directive (WFD). For these parameters the Environment Agency will need to consider the overall impact of releases to the environment, based on the environmental risks posed, when setting the ELVs.

During the pre-application process, the Environment Agency provided indicative ELVs for the continued discharge of treated effluent to the River Inny. The latest indicative ELVs (refer to Appendix A), provided in November 2020, were based on a modelling exercise performed by the Environment Agency. The model used an agreed Q95 flow rate for the River Inny of 0.061 m^3/s (5,270 m^3/day), which was calculated based on twelve months of site specific flow data collected by Dairy Crest. Whilst the indicative ELVs calculated for most of the parameters were deemed by Dairy Crest to be practical considering the site's operations, and the rationale as to how they were derived is understood, this was not considered to be the case for the following:

- Total phosphorus (P);
- Ammoniacal nitrogen (NH_3-N);
- Sodium (Na); and
- Potassium (K).

Accordingly, the rest of this BAT Options Appraisal report focuses on the above key parameters, which largely arise in the effluent from the Demin manufacturing process on site (with the exception of NH_3-N which arises from operational processes at the WPF, e.g. linked to organic load and aeration).

The Environment Agency acknowledged that the indicative ELVs provided during the pre-application advice stage were simplistic based solely on its internal Monte Carlo model outputs (that take into consideration the upstream / downstream river quality and flow and the effluent quality and flow). It confirmed that no further discussions could be held at this stage as to what 'reasonable' ELVs to both parties might look like, but that once a permit variation application had been submitted and duly made, it would consider a number of additional factors when determining the final ELVs. In particular, the Environment Agency has a duty to use a proportionate risk-based approach that also takes into consideration local site specific factors and permit history, what can be achieved using BAT, wider implications to the environment as a whole, the business and the local economy. Furthermore, the Environment Agency confirmed (as documented in meeting minutes from 24/11/2020) that it is not its intention to set ELVs that Dairy Crest cannot achieve.

In relation to wastewater management / BAT, the Environment Agency requested that the information detailed in Table 1.1. below specifically be considered in the application.

Table 1-1 – Environment Agency Requirements for Wastewater Management / BAT

Information Required	Summary Details & Where in the Application this Information is Considered Further
Identification and exploration of all potential options for reducing the impact of SDUK's emissions on the River Inny, including (but not limited to) the following:	

▪ Changes in operation to reduce the quantity and quality (strength) of effluent arising from the production processes requiring subsequent treatment and discharge	Dairy Crest has explored, trialled, and based on the results, implemented a number of operational changes with the effect of reducing the quantity and improving the quality of effluent requiring treatment at the WPF. The options considered and changes implemented are described in detail in the main environmental permit variation application report and in Section 2 below and include:
	- Exploration of a wide range of opportunities for the prevention / minimisation of salt whey generation and / or removal of salt whey from site for treatment, use or disposal by others. These options have identified significant challenges. However, Dairy Crest now exports ~50 % of salt whey generated off site rather than sending it to the on-site WPF, which is estimated to reduce the Cl and K load in the final treated effluent discharged to the River Inny by 1,868 kg/day and 40 kg/day, respectively. Full details of the options considered are provided in Section 3.4 of the main environmental permit application report.
	- Changing the portfolio of products manufactured at the Creamery; including the manufacture of Sweet Whey Powder (SWP) rather than Demin (which contributes a significant proportion of the Na, K, Cl and P present in the final treated effluent discharged to the River Inny). This scenario comprises Option F which is considered in further detail in report Section 2.6 below.
	- Consideration of use of alternative chemicals to ferric chloride, which is used to control P in final treated effluent discharged to river. Further details are provided in Section 3.3 of the main environmental permit application report.
	- Cessation of discharge of whey buttermilk to the process drains and subsequently the WPF; whey cream is now exported from site rather than producing whey butter.
	- Redevelopment of the WPF in terms of new plant and equipment and its configuration means that there is now more control over the quantity and quality of effluent delivered to the WPF for treatment. Full details are provided in Section 4 of the main environmental permit application report, including:
	    - Implementation of a contingency lagoon
	    - Reinstatement of the Divert Tank at the WPF
	    - Avoidance of peak loading in BT1 due to the above two measures, plus automated dosing of pH correction in BT1 (reduces need for dosing and prevents potential overdosing of caustic and hence reduces Na)
	    - Installation of an automated forward / divert solution for both cheese / whey and Demin / GOS
	- Dairy Crest has undertaken a significant amount of research, with a number of partner organisations (e.g. WRAP and industrial

	companies that could potentially make use of salt whey as an ingredient, for example in animal feed), exploring alternative options for the potential offsite industrial use of salt whey and for onsite treatment options for salt whey and Demin effluent. However, no viable solutions have been identified to date. Further details of the options identified and considered for onsite treatment are provided in report Section 2.7 below.
▪ Changes to on-site effluent treatment	In addition to the operational changes summarised above, Dairy Crest has also implemented a number of changes to the on-site treatment of effluent, as part of the redevelopment of the WPF / enhancement of the WRP, with the aim and benefit of reducing the impact of emissions on the River Inny. These changes are described in detail in Section 4 of the main environmental permit variation application report and include: - Two new DAF units - Upgrade to AFM filtration tanks - Installation of a third RO plant - Installation of a fourth MBR loop - Implementation of tertiary filters For each change, Section 4 of the main environmental permit variation application report provides a process description, details of any new equipment and / or infrastructure installed and the key benefits introduced. With regards to potential alternative options for effluent treatment on-site, these are considered in report Section 3 below, which provides a review and comparison of treatment techniques identified as BAT in the BREF for each of the key parameters being considered. Where the parameters do not have BAT-AELs or treatment techniques identified in the BREF, BAT is justified based on a consideration of other relevant local factors, including emissions to water and protection of the receiving environment.
▪ Alternatives to discharging into the River Inny	A number of different options, both for the management and treatment of effluent from the Creamery and as alternatives to the continued discharge of treated process effluent into the River Inny, are reviewed and assessed in report Section 2 below. The options considered include: - Option A: Maintain 2015 as-built situation (baseline scenario) - Option B: Redevelop the WPF (with enhanced WRP) - Option C: Discharge to alternative water body - Option D: Constructive wetland - Option E: Discharge to sewer - Option F: Change portfolio of products manufactured - Option G: Effluent desalination The feasibility of each option is considered with reference to the practicalities, cost to implement and impacts (positive and negative) to the River Inny, the business and the wider environment as a whole.
A BAT review of the best available economically and technically viable options currently on the market for	Option G, as detailed above, considers the potential techniques specifically for treating demineralised whey effluent. In addition, report Section 3 below provides a review and comparison of treatment techniques identified as BAT in the BREF for each of the key

treating demineralised whey effluent	parameters being considered. Where the parameters do not have BAT-AELs or treatment techniques identified in the BREF, BAT is justified based on a consideration of other relevant local factors, including emissions to water and protection of the receiving environment.
An appraisal of the capability of the various technology options (or potential combination of technologies) for reducing the concentration of substances in the effluent for which indicative Emission Limit Values (ELVs) have been derived. This should confirm whether the indicative ELVs can be achieved	As detailed above, this information is presented in Section 3 of this report which provides a BAT review of the technology options that are available.
The proposed wastewater management strategy, to include details of the following:	
▪ Any on-site operational changes that you propose to implement in order to bring about reductions in the quantity and quality (strength) of wastewater requiring treatment	As detailed above in Row 2 of this table; 'Changes in operation to reduce the quantity and quality (strength) of effluent arising from the production processes requiring subsequent treatment and discharge'. These changes are described in detail in Section 4 of the main environmental permit variation application report.
▪ A full technical / process description of your proposed effluent treatment plant, indicating the lowest effluent quality values that can reliably and consistently be achieved (for substances with indicative ELVs in Annex 1), backed up by manufacturer's literature, process diagrams, etc, and any performance guarantees (as appropriate)	A process description for the WPF, including the changes being applied for, is provided in Section 4 of the main environmental permit variation application report. The selected solution at the redeveloped WPF comprises a bespoke combination of techniques which together offer the highest removal efficiency for the parameters in the effluent, rather than a single off the shelf technology package. Therefore, there is not a manufacturer's manual or guarantee for the whole WPF, although various information is available for the individual components, such as design specifications, as-built records, operating procedures, process flow diagrams etc. Example information for each of the changes at the WPF is provided in Section 4 of the main environmental permit variation application report. Full Piping and Instrumentation Diagrams (P&IDs) for the whole treatment process have not been included in this application due to the large number of documents, however, if the Environment Agency requires this information for specific parts of the process this can be provided upon request.
▪ Any other associated changes	All changes at both the Creamery and the WPF are detailed in Section 4 of the main environmental permit variation application report.

This BAT Options Appraisal has been developed to evaluate the options available to Dairy Crest for the abatement of four key parameters which are discharged in the final treated effluent from the

Davidstow installation to the riverine environment (the River Inny). The purpose of the assessment is to define BAT for the management and treatment of the key parameters and to assess the site's performance associated with the implementation of BAT.

The assessment has been undertaken using the following steps:

1) Consideration of different options, both for the management and treatment of effluent from the Creamery and as alternatives to the continued discharge of treated effluent into the River Inny:

    A. Maintain 2015 as-built situation (note: this is the baseline scenario against which the other options can be compared. In this scenario the design and operation of the WPF is considered as it was operating following the installation of the Demin and GOS processes in 2015, without the redevelopment works which form the basis of the environmental permit variation being applied for);

    B. Redevelop the WPF;

    C. Discharge to alternative waterbody;

    D. Constructed wetland;

    E. Discharge to sewer;

    F. Change portfolio of products manufactured;

    G. Separate and treat Demin effluent and salt whey via desalination.

2) BAT justification for pre-treatment techniques – operational controls at the Creamery including flow, effluent concentration and mass load reduction, to reduce the quantity and strength of effluent requiring treatment at the WPF; and

3) BAT justification for effluent treatment techniques – identification of management and treatment options for the key parameters of concern and / or justification of BAT based on consideration of other relevant local factors, including emissions to water and protection of the receiving environment.

2 CONSIDERATION OF ALTERNATIVE OPTIONS

2.1 OPTION A: MAINTAIN 2015 AS-BUILT SITUATION

DESCRIPTION

This option is the baseline scenario in which the design and operation of the Creamery and WPF would remain as they were following installation of the Demin and GOS processes in 2015. Whilst the Environment Agency approved the permit variation in 2014 based on the design of the WPF at that time, it is acknowledged that the site has had a variable history with regards to meeting the ELVs for emissions to water set within the existing permit. Therefore, this option of maintaining the 2015 as-built situation is not considered to be acceptable and, as explained in the main environmental permit variation application report, Dairy Crest has implemented a number of improvements at the installation (at both the Creamery and the WPF) since this time to improve compliance, which have reduced the impact of the discharge of final treated effluent on the River Inny. These include both operational changes, to reduce the quantity and quality (strength) of the effluent arising from the production processes requiring subsequent treatment and discharge, and technical changes to on-site effluent treatment process provided at the WPF, to improve abatement efficiency, resilience and redundancy. The latter incorporates redevelopment of the WPF and enhancement of the WRP; these are considered further in the appraisal of Option B below.

In addition to the environmental permit variation being applied for, the Environment Agency will be undertaking a sector permit review to implement the revised BAT Conclusions outlined in the new Food, Drink and Milk BREF. Whilst the permit review process has been delayed, due to the impacts of Covid-19, it is understood that it remains the Environment Agency's intention to complete all reviews before the end of 2023 and the end of the four year deadline from issue of the BREF as outlined in the IED. Therefore, to maintain the 2015 as-built situation would only have had a limited time period prior to the Environment Agency addressing the requirements of the BREF through a Regulation 61 Notice and Regulator initiated permit variation. In this instance, even without Dairy Crest applying for a permit variation, it would be required to comply with any BAT-AELs / ELVs specified in the Environment Agency initiated varied permit by 03 December 2023. With this in mind, Dairy Crest has addressed future BAT requirements with regards to wastewater management and treatment, and provided supporting evidence to the Environment Agency to demonstrate this as part of the current permit variation application.

EFFECT ON TREATED EFFLUENT CONCENTRATION, CROSS MEDIA IMPACTS AND ECONOMIC IMPACTS

This option comprises the baseline scenario against which all of the other options are compared to and, therefore, it would not have any effect on the treated effluent concentration discharged to the River Inny. Likewise, there would be no change to the cross media impacts; the raw material and water use, energy consumption (with associated carbon emissions) and waste generation would remain as they were in 2015 following the introduction of the Demin process. In terms of economic impacts, there would be no new capex costs as the WPF would remain as it was originally designed, installed and commissioned and there would just be the ongoing annual opex costs for running the plant.

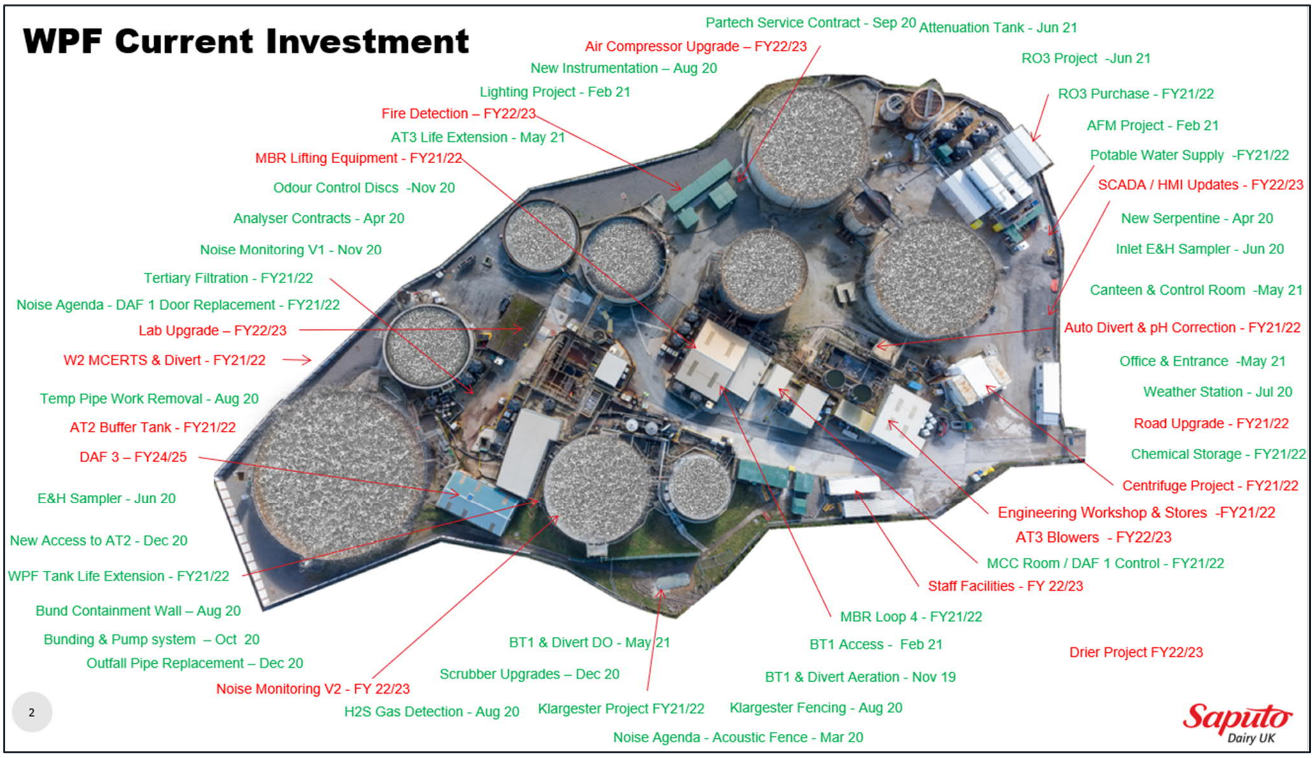
2.2 OPTION B: REDEVELOP THE WATER PROCESSING FACILITY

DESCRIPTION

Due to the variability in the efficiency of the treatment provided at the WPF following the installation and commissioning of the Demin process, Dairy Crest has implemented a number of changes leading to the redevelopment of the WPF and enhancement of the WRP. The changes are described in detail in Section 4 of the main environmental permit variation application report as they are the subject of the variation being applied for. However, in summary, the changes include a range of measures to improve the management, monitoring, operation / treatment, efficiency, resilience and redundancy of the existing WPF. The individual changes comprising the redevelopment works are also listed in Section 1.2 above; hence they are not repeated here.

The overall solution at the redeveloped WPF comprises a bespoke combination of techniques, which together are considered to offer the highest removal efficiency for the parameters present in the effluent; further information on how this combination of techniques meets BAT is provided in Section 3 below. A visual overview of the changes at the WPF is provided in Figure 2-1 below.

Figure 2-1 – Overview of WPF Redevelopment Works



Note:- Green text = complete, Red text = work in progress

EFFECT ON TREATED EFFLUENT CONCENTRATION

The changes implemented at the site have been designed with the aim of providing improved and more reliable treatment of the effluent, reducing the concentration and mass emissions of the key parameters in the effluent compared to previous / historical emissions from the site and thus protecting the River Inny.

As an example, Figure 2-2 below shows the improvement in phosphorus treatment at the WPF since 2015. The changes implemented at the WPF have increased the reliability of the treatment process and reduced the average phosphorus concentration in the final treated effluent to a level of 0.4 mg/l (2021 average). There is a clear trend of reduced emissions and improved compliance since 2016 (when full commissioning of the Demin process took place).

Taking the average (albeit from a non-compliant baseline) phosphorus concentration in the final treated effluent in 2016 (17.2 mg/l) and comparing it to the average in 2021 (0.4 mg/l), it can be seen that the improvements implemented on site have resulted in a 98 % reduction in the average concentration discharged to the River Inny and the site is currently discharging at levels significantly below the permitted limit. The benefits in terms of the reduction in mass emissions to the River Inny are shown in Table 2-1 below.

Figure 2-2 - Improvement in Phosphorus Emissions Jan 2015 – Dec 2021

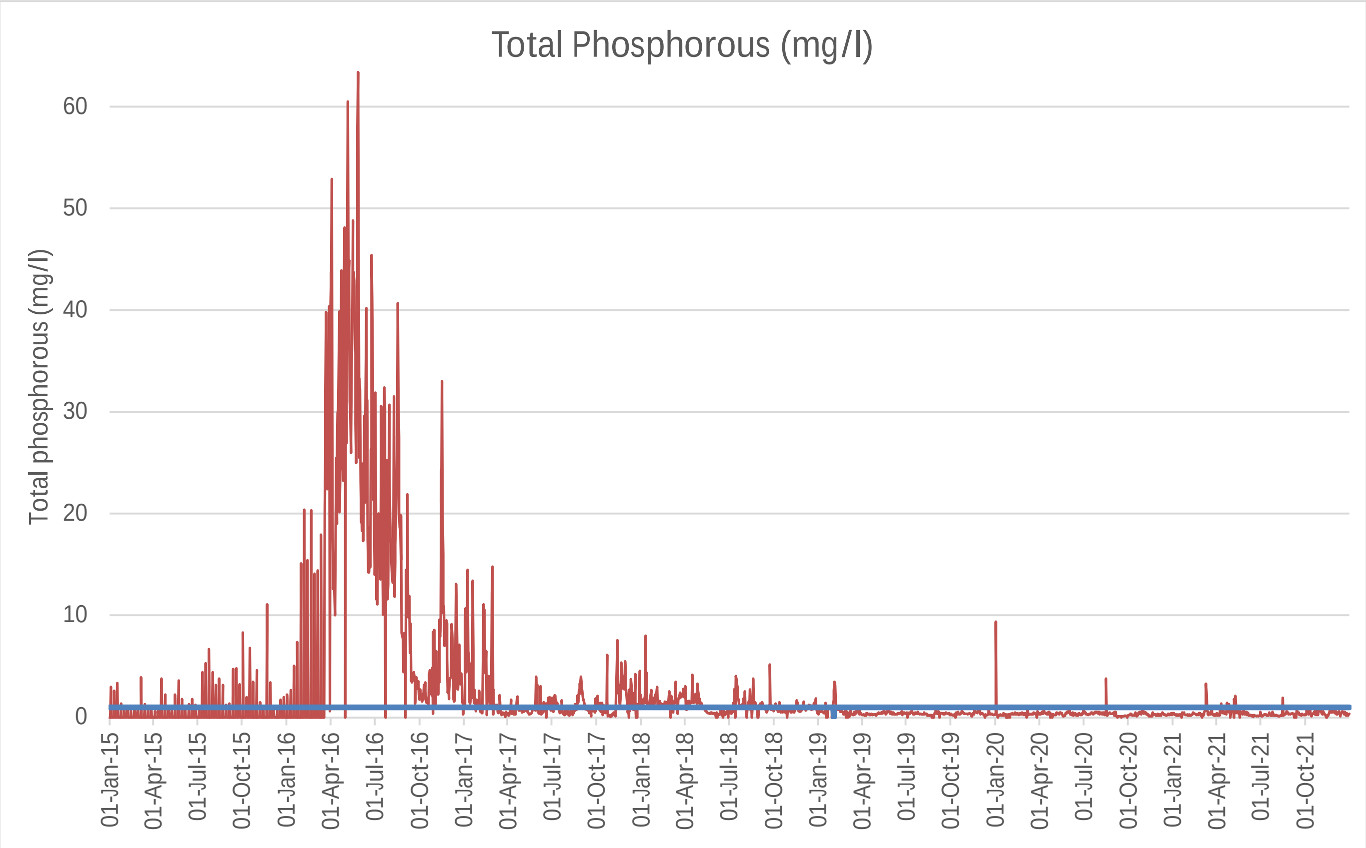


Table 2-1 – Reduction in Mass Emissions of P to the River Inny 2016 – 2022

Year	Mass Emissions of P (kg)*	% Reduction from 2017 Emissions (%)
2017	1,107	-
2018	809	26.9
2019	253	77.1
2020	191	82.7
2021	224	79.8

* Mass emissions have been calculated by multiplying the daily Total-P concentration by the daily flow discharged. The results are approximate as some days in each year do not have either concentration or flow data and these day have been excluded from the calculations.

When considering the potential impact of phosphorus from the Davidstow site on the River Inny, it is important to bear in mind that there are other sources of phosphorus in the area. In particular, the Environment Agency's latest WFD information for the Upper River Inny cites other Reasons for Not Achieving Good Status (RFNAGS) for phosphorus; 50 % of the source apportionment data is attributed to agriculture compared to 44 % from industry. Further details and the relevance to the setting of site specific ELVs are provided in report Section 3.3 below.

Significant improvements in the concentrations discharged to the River Inny for the other key parameters of concern, which are the subject of this BAT Options Appraisal, have also been demonstrated. However, routine monitoring of the other key inorganic parameters only commenced in May 2020 and was not required by the environmental permit until November 2020 (following an Environment Agency initiated variation). Even in the relatively short time period between these dates, a reduction in the concentrations discharged can be seen, as demonstrated by the data in Table 2-2 below.

Table 2-2 – Na and K: Average and Maximum Concentrations in 2020 and 2021

Parameter	2020 Average (mg/l)	2020 Maximum (mg/l)	2021 Average (mg/l)	2021 Maximum (mg/l)
Sodium	2,885	5,530	2,138	3,660
Potassium	973	1,770	820	1,360

Whilst this report focuses on phosphorus, ammoniacal nitrogen, sodium and potassium, which are the parameters requiring further discussion with the Environment Agency to determine BAT and appropriate ELVs, it should be noted that the WPF also provides effective treatment and removal of a number of other parameters, such as Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS) prior to discharge to the River Inny. The techniques and removal efficiencies for these parameters are included in Section 4 of the main environmental permit variation application report.

CROSS MEDIA IMPACTS

The changes implemented on site, i.e. the redevelopment of the WPF which is the subject of the current environmental permit variation application, have had a minor influence on cross media impacts. Further details are provided in the main environmental permit variation application, but in summary, no new waste streams will be generated and no new raw materials will be required. However, there will be a minor increase in raw material use (predominantly ferric chloride and cleaning chemicals) and energy use at the WPF (electricity).

ECONOMIC IMPACTS

Since 2015/16 Dairy Crest has spent approximately £12 million over last 5/6 years (in addition to the ~£10 million invested in 2014/15 for Option A) on the redevelopment works at the WPF. As detailed above, this has provided improved and more reliable treatment of the effluent, reducing the concentration and mass emissions of the key parameters of concern from the site and thus protecting the River Inny.

CONCLUSION

This is considered to be a viable option as it is technically available and, whilst it has required a significant financial investment from Dairy Crest, the techniques employed at the redeveloped WPF are based on BAT as specified in the BREF (BAT 12 and Table 17.1) and result in an improvement in emissions to the River Inny. Furthermore, there are no significant negative cross media impacts associated with this option. With regards to the environmental impacts, the results of an ecological assessment undertaken have shown that there is no significant change in the invertebrate population as a whole downstream of Dairy Crest's discharge into the River Inny compared to upstream. Similarly, there are significant fish numbers and a diverse range of fish species present. This supports the conclusion that the emissions from the WPF are not having a negative environmental impact on the River Inny. Whilst this BAT Options Appraisal report focuses on wastewater management and emissions to water, there are a number of other environmental improvements and benefits which have been introduced as part of the WPF redevelopment works; these are detailed in the main environmental permit variation application report and include enhanced mitigation and reduced emissions of noise and odour.

Further details on determination of BAT for the management and treatment of each of the key parameters of concern is provided in report Section 3 below.

Refer to Section 2.8 below for an overview of this option compared to the baseline case (Option A) and the other alternatives considered in this BAT Options Appraisal.

2.3 OPTION C: DISCHARGE TO ALTERNATIVE WATER BODY

DESCRIPTION

Recognising that the River Inny is a relatively small watercourse and taking into account the composition of the treated effluent discharged from the WPF, an additional option to consider is the discharge of the effluent to an alternative water body. From an initial desk based review it is deemed that, whilst there are other rivers in the area with potentially higher flow rates (and therefore more dilution available), discharge to these water bodies would most likely raise similar concerns to the Regulator. Therefore, rather than discharge to an alternative freshwater body, discharge to sea is considered as a potential alternative.

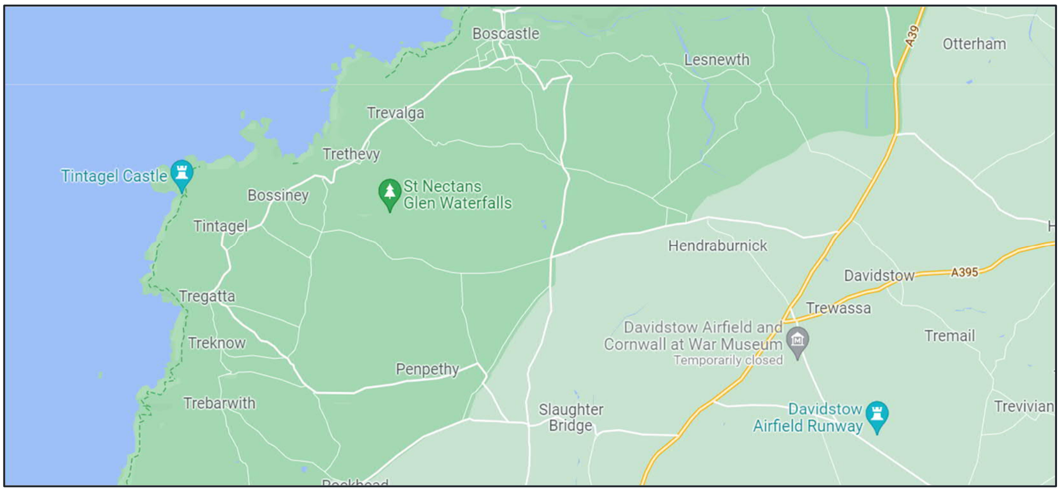
Constructing a pipeline to take the treated effluent from the WPF and discharge it to sea would reduce the Davidstow site's reliance on the River Inny, other than for surface water abstraction and discharge of surface water (emission point W1 in the environmental permit), and hence reduce the potential environmental impact associated with the discharge of treated effluent to surface water. With more dilution being available and the composition of sea water containing dissolved salts, including Na, K and Cl, the receiving marine environment would be more tolerant to the key parameters of concern found in the treated effluent from the Creamery (Davidstow's current treated effluent has around one fifth of the salinity of sea water). This option would also have the benefit of being more resilient to future climate change compared to the continued discharge to the River Inny (or other local rivers); the UK is likely to experience hotter drier summers which could reduce river flow and, therefore, increase the potential impact of the treated effluent discharge on the River Inny during these times.

Other benefits to this option are that it would protect the River Inny from potential pollution associated with any instabilities in WPF performance, it would benefit other stakeholders with an interest in the River Inny and it would also provide a long-term sustainable disposal route for treated effluent. Consequently, it would protect the future operation of the Creamery and also offer the potential for future growth, whilst reducing the long-term risk of discharge to river.

However, whilst this option is considered to be technically achievable, it also has a number of substantial challenges that would need to be overcome. Therefore, further detailed investigations are required to determine if it is in fact available and viable within the context of BAT. Such investigations are likely to require a significant amount of time and it is therefore not considered to be an immediate option, even if the required investigations ultimately suggest that it is deliverable and viable.

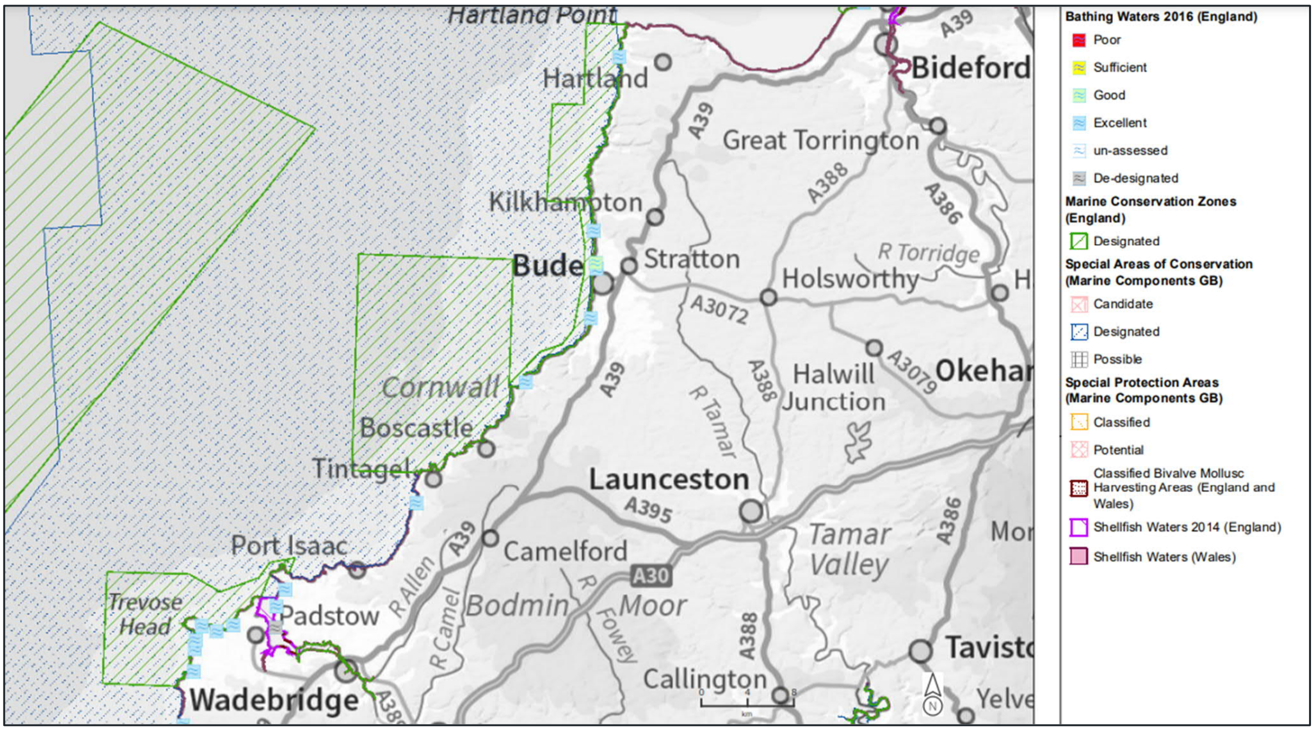
The Davidstow site is located 7-8 miles inland from the north Cornwall coast, depending on the point of discharge to the sea, as shown in Figure 2-3 below. The route of the pipeline would need to pass through multiple land owners; an initial search performed by Dairy Crest has identified over fifteen land owners just to get half way to the sea. Of these, half of the landowners are unregistered as the land has been handed down over generations. Therefore, in addition to the normal planning requirements for such a pipeline, there would also be legal complexities, costs and challenges associated with the necessary aligned wayleaves / easements.

Figure 2-3 – Location of Davidstow Creamery in Relation to North Cornwall Coast



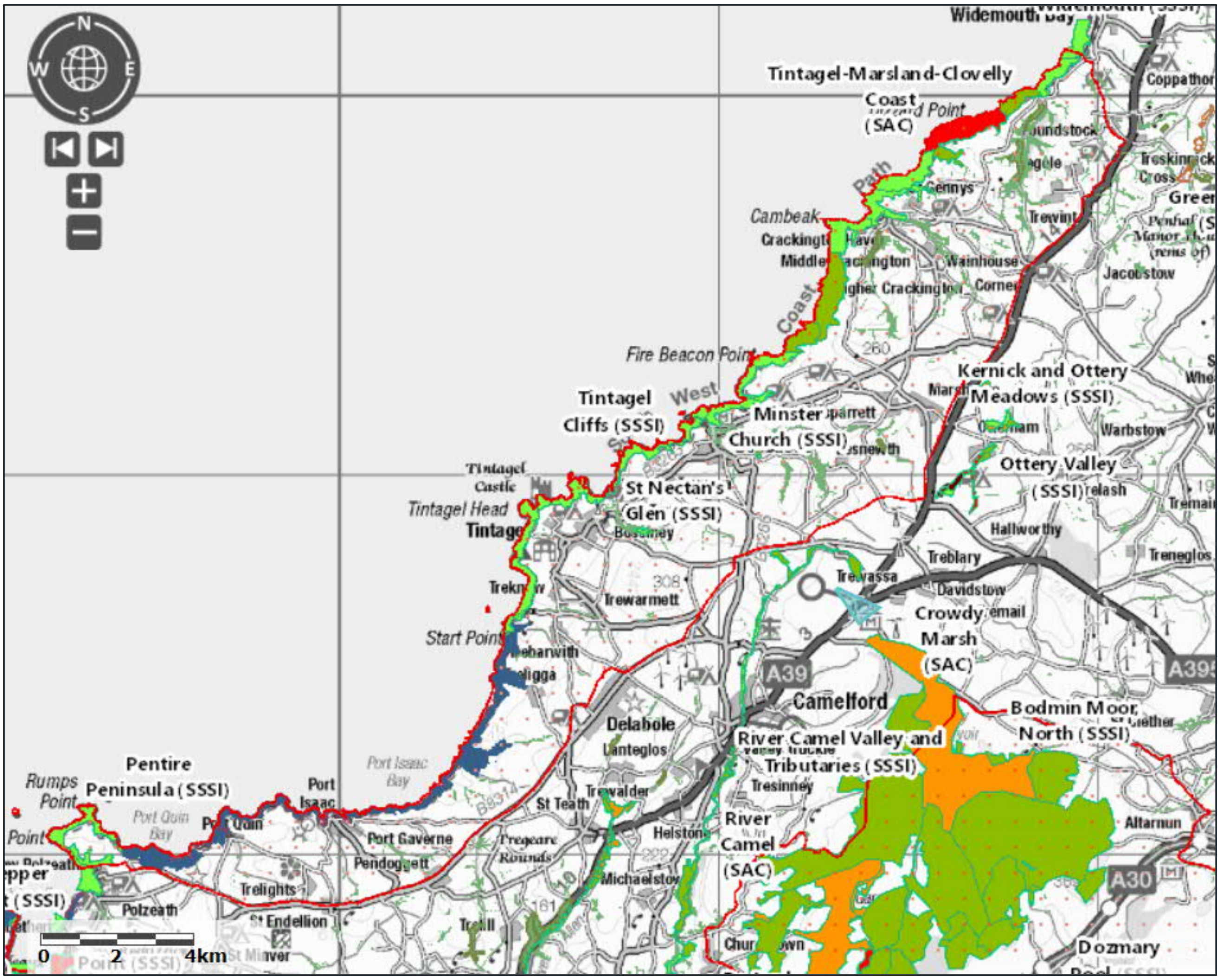
Furthermore, the north Cornwall coastline has a number of statutory designations, including Bathing Waters, Marine Conservation Areas and other onshore ecologically protected areas (refer to Figure 2-4 and Figure 2-5 below), plus sensitive areas such as the coastal path which owned by the National Trust. A key part of any feasibility study for this option would be to identify appropriate discharge location(s) (with the added consideration of how far offshore any discharge would need to be made) and it would be critical to consult and engage with all of the appropriate stakeholders, from Regulators, land owners, local interest groups and the public.

Figure 2-4 – Statutory Designations along the North Cornwall Coast



Note: As shown in the above figure, the whole coastline is designated as a Marine Special Area of Conservation (blue dashed hatching), there are large areas designated as Marine Conservation Zones (green hatching) and numerous Bathing Waters designated as Excellent (small blue squares).

Figure 2-5 - Onshore Ecological Designations



Note: The above figure shows a number of onshore statutory designated areas, including Sites of Special Scientific Interest, Special Areas of Conservation, Areas of Natural Beauty and Priority Habitat Inventory – Maritime Cliffs and Slopes, which are located primarily along the coastline but also between the Creamery (indicated by the light blue triangle) and the coastline.

EFFECT ON TREATED EFFLUENT CONCENTRATIONS, CROSS MEDIA IMPACTS AND ECONOMIC IMPACTS

This option would not treat the effluent from the Creamery to a higher standard, but it would protect the River Inny as it would no longer receive treated effluent from Davidstow. There would not be a significant effect on cross media impacts; no new waste streams would be generated and no new raw materials would be required. There would likely be a minor increase in energy use associated with the pumping requirements to transport the treated effluent to the discharge location at sea.

Whilst this option would reduce the Davidstow site's reliance on the River Inny and hence the potential environmental impact to this water body, due to the requirement to continue to treat effluent to a very high standard to enable recovery of significant quantities required for reuse at the Creamery, there would still be a necessity to run all effluent through the WPF. Therefore, in addition to the capex for installation of the pipeline, which is expected to be in the region of £5-10 million, plus the cost for access across land in the ownership of multiple land owners and the operating expenses (opex) for pumping the effluent to sea, there would still be the ongoing opex associated with running the WPF to achieve and deliver water quality suitable for recycling to the Creamery.

CONCLUSION

This option has not been ruled out and is determined to be a potential longer-term consideration for the Davidstow site. Dairy Crest is committed to undertaking the necessary investigations and a feasibility study in order to consider this option further. However, bearing in mind the length of time required for and the complexities involved in undertaking the feasibility study, it is recommended that this action is secured via an improvement condition in the varied permit. It is anticipated that it would take two years in order to undertake all of the necessary work for the feasibility study; the exact requirements and scope of the study would be agreed in advance with the Environment Agency and Dairy Crest would provide six monthly progress reports to the Regulator during this delivery period.

Refer to Section 2.8 below for an overview of this option compared to the baseline case (Option A) and the other alternatives considered in this BAT Options Appraisal.

2.4 OPTION D: CONSTRUCTED WETLAND

DESCRIPTION

This option would add an additional ‘natural’ treatment stage to the integrated treatment process performed at the WPF in the form of a constructed wetland (or lagoon system) with reed beds (or other suitable vegetation). The treated effluent from the WPF would pass through the wetland, which would act as a final polishing stage, before discharge to the River Inny. The wetland would require planting with macrophytic vegetation species which have the potential to form a variety of functions. Their primary function is the support of biofilms (slime layers), which carry out the principal cleansing functions of the wetland. They also facilitate the sorption of nutrients and act as a filter medium, and, through the use of appropriate emergent vegetation, can also help to control odours and pathogens. Whilst the vegetation has the capacity to filter suspended solids, it also increases the hydraulic resistance, thus increasing the residence time.

In addition to providing further removal of some of the parameters found in the effluent from the Creamery, the wetland would also accommodate any short-term variability in effluent concentration and thus prevent spikes in the final discharge to the River Inny. Furthermore, if designed suitably to facilitate the ecological conditions found in natural wetlands, it could also achieve habitat creation into its design and provide an ecologically beneficial habitat, e.g. for bird and invertebrate species.

Whether or not this option is considered to be technically achievable at the Davidstow site, have a beneficial impact on the treated effluent concentration, and therefore be viable within the context of BAT, would depend on the outcome of a detailed feasibility study. Such a study would be required to look at the design (including space) requirements and involve a literature review / desk based study followed by pilot scale field trials with sufficient time factored in to evaluate the results. With respect to the design and area of land required for the constructed wetland, the relationship of the volume of waste water to the area of wetland generally determines the outflowing water quality. The land requirement associated with constructed wetlands, which is generally dependent on the volume and composition of effluent, can restrict their application. There is no spare land within the current installation boundary on which to construct a wetland and, therefore, Dairy Crest would need to investigate land availability local to the site, to rent or purchase, as part of the feasibility study. Another key factor would be to consider groundwater as a potential receptor and the need to line the lagoon(s) and, were that necessary, how this could affect the growing media.

As for Option C, a key requirement of any feasibility study for this option would also be to consult and engage with all of the appropriate stakeholders, including Regulators, Natural England, land owners, local interest groups and the public. Such investigations and consultations are likely to require a significant amount of time and it is therefore not considered to be an immediate option, even if the required investigations ultimately suggest that it is viable.

EFFECT ON TREATED EFFLUENT CONCENTRATIONS, CROSS MEDIA IMPACTS AND ECONOMIC IMPACTS

This option has the possibility to treat the effluent from the Creamery to a higher standard, but it is only likely to achieve a modest reduction in P and the extent of uptake for K, Na and Cl is not currently known (but again expected to be modest). However, it has the potential to protect the River Inny by providing a buffer to short-term peaks in effluent concentration. It is also possible that the shade provided by reeds could further reduce the temperature of the effluent before it is discharged to the River Inny.

In terms of cross media impacts, this option would not require any energy or chemicals and it would not generate any new wastes (other than as part of routine maintenance of the wetland). Constructed wetlands do, however, require regular inspection and ongoing monitoring and maintenance to ensure their continued function. The capex associated with this option would include that required for additional land purchase plus the cost of the wetland construction. These figures are not yet known and would be required to be fully investigated as part of the detailed feasibility study, however, the costs could be in the region of £2-3 million. The opex costs are expected to be low with a low level of operational support required, associated with inspection, monitoring and maintenance, e.g. reed cropping, water quality monitoring etc.

CONCLUSION

This option has not been ruled out and is determined to be a potential longer-term consideration for the Davidstow site. Dairy Crest is committed to undertaking the necessary investigations and a feasibility study in order to consider this option further. However, bearing in mind the length of time required for and the complexities involved in undertaking the feasibility study, it is recommended that this action is secured via an improvement condition in the varied permit. It is anticipated that it would take at least two years in order to undertake all of the necessary work for the feasibility study; the exact requirements and scope of the study would be agreed in advance with the Environment Agency and Dairy Crest would provide six monthly progress reports to the Regulator during this delivery period.

Refer to Section 2.8 below for an overview of this option compared to the baseline case (Option A) and the other alternatives considered in this BAT Options Appraisal.

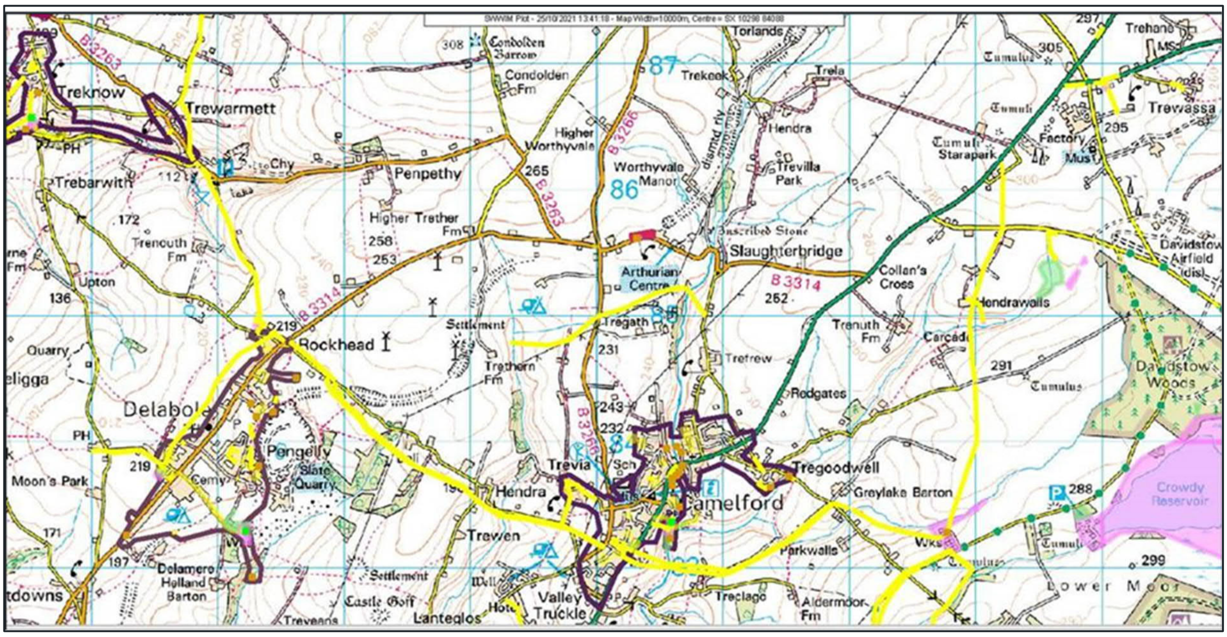
2.5 OPTION E: DISCHARGE TO SEWER

DESCRIPTION

It is acknowledged that the preferred option and best practice is for the discharge of wastewater to foul sewer whenever it's reasonable to do so. However, there is no foul sewer to connect to in the area local to the Davidstow installation; hence why domestic effluent from the Creamery is treated in a package treatment plant and process effluent is treated at the WPF before being discharged to the River Inny. This has always been the case since the site was first developed in the 1950s.

South West Water (SWW) has been contacted in order to obtain an up to date understanding of its assets (sewer networks and Sewage Treatment Works (STW)) in the local and wider area around Davidstow Creamery. As shown in Figure 2-6 below the Creamery is located approximately 3 miles away from the Camelford STW network. This STW is designed to treat approximately 330 m^3/day for a population (with tourists) of less than 3,500 people.

Figure 2-6 - SWW Assets: Closest STWs and their Catchments Served by Public Sewers



As can be demonstrated by the above example, the STWs in the area serve rural communities and are of limited capacity. Therefore, they would not be able to handle the circa 2,000 m^3/day from the Creamery.

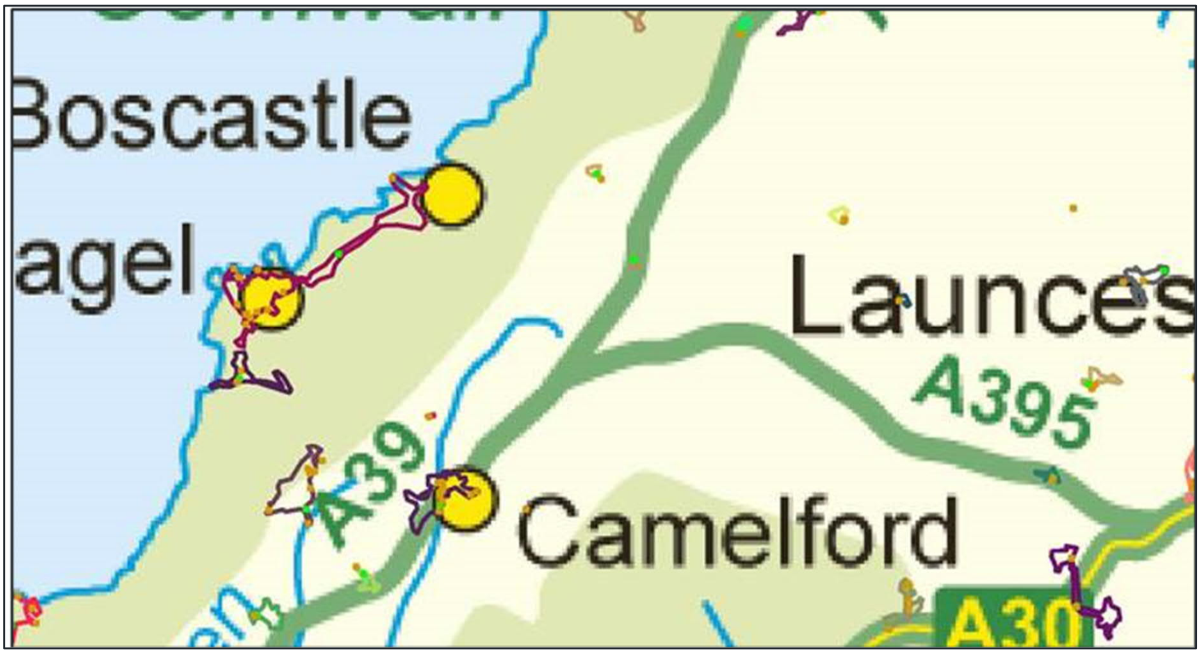
Other STWs in the wider area include:

- Boscastle – 4 miles away – serves a population (with tourists) of 3,500 people and the daily flows are ~280 m^3/day;
- Launceston - 12 miles away – the closest 'large' STW but this still only treats 2,000 m^3/day; and
- Other 'considerable' STWs include Scarlett Well / Nunstallon (treats <2,800 m^3/day) and Holsworthy (treats <500 m^3/day).

It is clear that there are no STWs of suitable scale in the regional area. SWW has advised that the issue is not only the volume of effluent but the load; these small rural STWs are not designed to accept significant quantities of industrial trade effluent (with elevated COD, BOD etc.), such as that from the Creamery. By way of example, the COD in the effluent from the Creamery would relate to a population equivalent of over 100,000 people. If any STWs were to accept the effluent they would need to upgrade / extend the works (and most likely buy additional land for the extension) and apply for a new permit from the Environment Agency, which due to the increased flows, would most likely be more stringent than their current authorisations. It would also take a significant amount of time to obtain such authorisations from the Environment Agency and construct the upgraded / extended STW as necessary.

Figure 2-7 below shows STWs located in the wider area; the yellow dots represent standard STWs whereas the small green dots represent descriptive sites which treat <50 m^3/day.

Figure 2-7 – SWW Assets Located in the Wider Area



EFFECT ON TREATED EFFLUENT CONCENTRATIONS, CROSS MEDIA IMPACTS AND ECONOMIC IMPACTS

Based on the information provided by SWW and reviewed above, discharge to sewer is not considered to be a viable option for the site. If it were a feasible option, it would reduce the Davidstow site's reliance on the River Inny, other than for surface water abstraction, and hence reduce the potential environmental impact associated with the discharge of treated effluent to surface water. However, the STW would not have technology in place to remove Cl, K and Na and so they would still be transferred to river, although potentially a larger water body with more dilution available. SWW would most likely request a significant financial contribution from Dairy Crest to support upgrade / expansion of the works and the ongoing opex for use of SWW assets would be prohibitive at circa £10k+ per day which would equate to £3.7 million per annum

CONCLUSION

This option is, therefore, not considered any further as it is not deemed to meet the requirements of BAT with regards to availability and economic feasibility.

Refer to Section 2.8 below for an overview of this option compared to the baseline case (Option A) and the other alternatives considered in this BAT Options Appraisal.

2.6 OPTION F: CHANGE PORTFOLIO OF PRODUCTS MANUFACTURED

DESCRIPTION

The mass balance calculations conducted to date indicate that the Demin whey effluent and salt whey provide significant contributions to the Na, K, Cl and P present in the final treated effluent discharged to the River Inny. Consequently, if Dairy Crest were to change the products it manufactures, including the manufacture of Sweet Whey Powder (SWP) rather than Demin, this would reduce the concentration of these parameters in the process effluent delivered to the WPF from the Creamery.

In order to change over from the manufacture of Demin to SWP the following would be required:

- Reconfiguration of the multi-stage whey evaporator so that whey from cheese production is routed directly to the evaporator as opposed to being demineralised and stored in intermediary holding tanks.
- During the changeover, continued milk reception and cheese making would require circa one million litres of whey to be disposed of, most likely via land application given the finite capacity of alternatives such as accessible anaerobic digestion facilities.
- The whey processing capacity during SWP production is lower than when producing Demin. This is due to the Demin process reducing the mass of whey solids by around 15 %. The associated surplus whey of 205 kl/ day would require disposal in order to maintain current levels of milk reception, during SWP production, which could be difficult to achieve. Considering the pressure and uncertainty for the UK agricultural sector as a whole with (i) rising input costs and (ii) changes post Brexit with regards to farming incentives including those related to other environmental priorities for farmers, the Environment Agency should be aware of and take into account the current pressures on the UK dairy supply chain.
- In order to service the SWP market a different product format is required and it would be necessary to reinstate 25 kg bagging capability at the site.

Other short-term options have been considered, such as the temporary cessation of Demin production in summer periods when the river flow is typically lowest and, therefore, the potential impact of the treated effluent discharge on the River Inny is greatest. However, this is not considered to be feasible for the following reasons:

- The manufacture of Demin whey powder was introduced at the end of 2015. Over the six years since, the level of technical experience within the Creamery operations team of changeover between Demin and SWP is very low.

- In order to achieve the very high product quality standards required by infant formula markets, which utilise Demin whey powder, it would be necessary to remove all residual traces of SWP.
- This entails a wet wash of the spray dryer requiring around one day of production downtime. During this time, continued milk reception and cheese making would require circa 1 million litres of whey to be disposed of, again most likely via land application given the finite capacity of alternatives such as accessible anaerobic digestion facilities.
- Removing residual SWP fines from whey powder handling systems is more challenging and potentially entails wet washing of powder storage silos. This activity has previously resulted in microbiological contamination and extensive product disposal. Regardless, as a minimum, the first three batches of Demin whey powder production (circa 240 tonnes) and up to seven batches (circa 560 tonnes) would need to be downgraded depending on microbiological results. In practice it is likely that the microbiological contamination will be greater than the estimated 500 tonnes which will lead to increased levels of downgrade products for which alternative outlets will have to be found.
- During the production of SWP it would be necessary to maintain the same very high hygiene standards that are applied during the production of Demin in order to prevent any environmental contamination which could compromise subsequent Demin product quality. This would require plant improvements to address the prior fugitive emissions of powder fines in 'high care' areas (i.e. the most critical production area for hygiene standards) experienced when producing SWP.

EFFECT ON TREATED EFFLUENT CONCENTRATION

Based on a review of previously prepared mass balances, the effect on the concentration of pollutants in the final treated effluent would be in the order of:

Sodium (Na):

- The mass balance indicates that around one third of Na originates from the Demin department comprising Na from demineralisation of sweet whey (20 %), CIP processes (20 %) and regeneration of anionic columns (60 %).
- The manufacture of SWP would reduce the contribution of Na from demineralisation of sweet whey and the caustic used for anionic column regeneration.
- A reduction in CIP of the core demineralisation plant would be offset by increased requirements for CIP of evaporators. Consequently, the net contribution of caustic used for CIP would remain unchanged during SWP production.
- As a result of the above, changing to the manufacture of SWP would not remove all of the one third Na in the final treated effluent originating from Demin. It would achieve an approximate 23 % reduction in Na in the final treated effluent only.
- Some further reduction, albeit to a lesser extent, may be achieved through reduced use of caustic in the reception tanks of the WPF, which is used to increase the pH of the predominantly acidic effluent received from Demin in order to minimise emissions of odour.

Potassium (K):

- The mass balance indicates that around 80 % of K originates from the Demin department and, therefore, changing to the manufacture of SWP would also reduce the amount of K in the final treated effluent by approximately 80 %.

Chlorides (Cl):

- The mass balance indicates that around 60 % of Cl originates from the Demin department and, therefore, changing to the manufacture of SWP would also reduce the amount of Cl in the final treated effluent by approximately 60 %.
- Some further reduction, albeit to a lesser extent, may also be achieved through reduced use of ferric chloride at the WPF given the reduction in phosphorus loading on the WPF of which a significant proportion is present in the pre-treated effluent from the phosphate removal plant.

It should be noted that the scale of reduction described above resulting from the manufacture of SWP alone, would not be sufficient to achieve all of the indicative future ELVs for inorganics in the final effluent quality previously advised by the Environment Agency (refer to Appendix A).

Flow:

- Process condensate produced by the whey evaporators during manufacture of SWP is of a lower quality than that produced during manufacture of Demin. Historically, process condensate from SWP was treated in a Reverse Osmosis (RO) plant to enable its reuse in the process water system. This RO plant has since been repurposed; as such, condensate produced during the manufacture of SWP would have to be discharged to drain adding to WPF influent flow.
- The net effect of changing to SWP production would be a reduction of flow received by the WWTP of circa 8%.

Organic Load – Chemical Oxygen Demand (COD):

- There would be an approximate 25 % reduction in COD at the influent to the WPF based on recent plant loadings.
- This percentage reduction does not reflect the recent reduction in COD base load resulting from (i) cessation of discharge of whey buttermilk to the WPF and (ii) the recently instigated export of one tanker load per day of salt whey. In combination, these changes have already reduced the COD base load by circa 20 %.

Total Phosphorus (P):

- Total P would theoretically be reduced given the reduced quantity of P received from the pre-treated effluent from the phosphate removal plant which originates from Demin production. However, it should be noted that current emissions of Total P are generally compliant with the maximum concentration specified in the environmental permit and significantly lower than those achieved historically during the production of SWP (refer to Figure 2-2 in report Section 2.2 above).

Total Suspended Solids (TSS):

- Operational experience of the WPF has shown that maintaining stable operation in the aeration systems of the WPF (most notably Aeration Tank 2) is key to achieving compliance with the maximum consented emissions concentration for TSS, i.e. maintaining optimum and stable levels of organic loading and sludge mass (measured as Mixed Liquor Suspended Solids) is essential for effective gravity settlement of biological solids in downstream Settlement Tanks.
- Changes in COD loading resulting from changing to/from Demin powder and SWP production described above, which would come into effect in a very short period of time, would require very careful management of loading on biological systems in order to maintain effective gravity solids separation.
- Given that the biological processes of the WPF have been conditioned over the last six plus years to operate in the presence of inorganics such as chlorides, it is not known whether short term changes in Cl loading would have any detrimental effect on efficacy of the biological processes of the WPF.

Biological Oxygen Demand (BOD) and Ammoniacal Nitrogen (NH3-N):

- Changing to the manufacture of SWP is not expected to materially affect the concentration of these parameters in the effluent quality and they are generally well below maximum consented emissions concentrations in the current environmental permit.

CROSS MEDIA IMPACTS

As described above, Davidstow's whey processing capacity is lower during the production of SWP than for Demin powder. Maintaining current levels of milk reception would therefore necessitate the disposal of circa 200 kl per day of surplus whey. Whilst this could be managed in the short term it could not be sustained for anything other than a very short period. Considering the pressure and uncertainty for the UK agricultural sector as a whole with (i) rising input costs and (ii) changes post Brexit with regards to farming incentives, including those related to other environmental priorities for farmers, the Environment Agency should be aware of and take into account the current pressures on the UK dairy supply chain.

This option is not considered to have a negative effect on other cross media impacts, such as raw material and energy use. However, as explained above, any longer term cessation of Demin production would lead to Dairy Crest having to review and potentially reduce its milk supply requirements so as to avoid the problem of the need to dispose of significant volumes of excess whey associated with the manufacture of SWP as opposed to DWP. This would have serious economic consequences in the south west with the potential for the termination of milk supply contracts with local farmers, as well as potential negative impacts on milk pricing. For further details refer to report section below on Economic Impacts.

ECONOMIC IMPACTS

The cessation of Demin production would have significant financial impacts for Dairy Crest, the local community / businesses and the wider south west region for the following reasons.

Employment:

The introduction of Demin production at the end of 2015 entailed the creation of a significant number of high quality, highly technical roles. Changing to SWP production, on either a temporary or longer term basis, would directly impact at least 40-50 of those roles which would not be required for the production of SWP.

It would be critical to retain the skills of these personnel which have been developed over the last six plus years. During any temporary (up to 4 weeks) change to SWP production it may be possible to redeploy some personnel and/ or potentially make use of annual leave allowances. However, this could not be sustained for anything other than a very short period without serious consequence on local employment.

SWP and Demin Markets:

Since Davidstow ceased SWP production at the end of 2015, there have been fluctuations in both the SWP and Demin markets, caused by a number of external factors but, in particular, the Chinese infant formula market (China represents approximately 65 % of the infant formula market). However, the longer term trend is that sustained economic growth as well as socio-demographic changes, will continue to increase the global demand for infant formula and, therefore, demineralised whey powder and milk supply. Contrary to this market pattern, a number of former customers (e.g. confectionery manufacturers) have reduced or ceased their use of SWP in their product formulations. Consequently, the scale of the UK market for the SWP previously manufactured at Davidstow has significantly reduced, with limited opportunities for new customers. If customers cannot be found the SWP will be sold on the spot market. Introducing circa 25,000 - 30,000 tonnes of SWP to the spot market will inevitably reduce market pricing in what is already an uneconomical and commoditised price level. As a result of the reduced returns, the milk price paid to local farmers may be adversely impacted. In summary, if the site was to change to SWP production, Dairy Crest would no longer be able recover the capital it has invested in the plant and equipment (see report section below) or share the extra value that Demin allows (having a higher market value than SWP) with the stakeholders of its supply chain.

Since the introduction of Demin powder manufacture, Dairy Crest has secured new international customers in the infant formula sector for its portfolio of high quality infant grade products which are highly sought after. Securing such customers has required contractual commitments for minimum quantities of Demin whey powder supplies for agreed time periods.

Changing to SWP production, depending on the duration, could result in failure to meet such contractual obligations. Failure to maintain minimum levels of supply could result in the loss of the current Demin whey powder customer base, fines and penalties as well as the inability to secure and maintain new longer term customer relationships.

Dairy Crest's Investment in Demin Powder Production

The introduction of Demin production in 2015 entailed substantial financial expenditure to achieve a structural change to the business, which was intended to secure the longer term sustainability of Davidstow and its associated farmer supply chain. On changing to SWP production, this investment, which has already been committed to by Dairy Crest, would need to be written off.

The Demin facility is a unique investment in the UK. It produces local, traceable demineralised whey from milk supplied by a dedicated supply chain. All of the demineralised whey is sold to customers in New Zealand/Australia, the Far East and Europe, predominantly for use in infant formula products and it contributes over £25 million of exports to the UK economy. The investment in Demin also created 40-50 new jobs and cemented Davidstow's position as the largest employer in North Cornwall.

A change to SWP production rather than Demin production would require Dairy Crest to write off the residual £65 million invested to create this unique facility. When the project was being planned it was assumed that the Demin facility would be operational for at least 20 years to make the project economically feasible. Following approval of the proposed project by the Environment Agency in 2014, the project was accepted for funding by Dairy Crest's Board and it was designed and installed on this basis. Furthermore, following a change to SWP, Dairy Crest's revenue would be substantially reduced. In order to mitigate this, Dairy Crest would have to reduce employment at Davidstow (40-50 full time jobs would become redundant) and potentially reduce the price it pays its farmers for milk (which could put local farms out of business). Therefore, the damage to the local economy would be severe and, once mothballed for more than a temporary period, it is highly unlikely that the Demin plant would be able to reopen. These factors could have a greater impact in Cornwall compared to other locations in the UK as Cornwall's economy is dominated by agriculture and tourism.

Whilst the Environment Agency's role is to protect the environment and human health, it also has a duty to have regard to economic growth. The economic growth duty came into force in 2017 (under the Deregulation Act 2015) and requires regulators, including the Environment Agency, to have regard to the 'desirability of promoting economic growth', alongside the delivery of protections set out in relevant environmental legislation.

CONCLUSION

This option is not deemed to be economically viable given the site's standing in the local community and economy and the fact that Dairy Crest wants to ensure a sustainable long-term future for the site, delivered through the significant investment and continued improvements it has both implemented and committed to. Such investments will ensure that the incomes and revenues detailed above to staff and local businesses remain within the region, but this would not be the case if this option was progressed and Dairy Crest was obliged to change the portfolio of products it manufactures.

This option is, therefore, not considered any further as it is not deemed to meet the requirements of BAT with regards to economic impact.

Refer to Section 2.8 below for an overview of this option compared to the baseline case (Option A) and the other alternatives considered in this BAT Options Appraisal.

2.7 OPTION G: EFFLUENT DESALINATION

DESCRIPTION

An alternative option considered, rather than changing the portfolio of products manufactured as detailed above, is the segregation and separate treatment of the effluent stream that arises from the Demin process (~500 m^3/day) along with the salt whey from the cheese manufacturing process (~50 m^3/day). These two effluent streams combined contain a large proportion of the inorganic salts (sodium, potassium and chlorides) that are currently delivered in the effluent from the Creamery to the WPF for treatment. This option would, therefore, reduce the loading on the WPF in terms of both the quantity and quality of effluent received for treatment.

Dairy Crest has undertaken a significant amount of research (including internationally) in an attempt to identify a technology that can deliver such a solution, however, the conclusion at this current time is that there is no supplier that can provide an available and proven technology. The closest to a solution that has been identified is a potential technology that could remove a proportion of the inorganic salts from this high strength effluent stream. However, the technology presents a number of significant challenges. Further details on the process technology, effect on treated effluent concentration, cross media impacts and economic impacts are provided below.

The potential technology involves a combination of the following techniques, detailed in Table 2-3 below, to deliver a five-stage treatment process. A process flow diagram of the treatment stages is provided In Appendix B. Such a technology would require a minimum of four years to implement at Davidstow and most likely considerably longer.

Table 2-3 – Description of Potential Process Technology

Stage	Description	Purpose
1	**Physico-chemical Pre-treatment (chemical precipitation):** ▪ Chemical mixing and reaction system – reagents dosage, coagulation and pH adjustment; ▪ Clarifier system – flocculation and decanting; ▪ Sludge treatment – press filter; and ▪ Recirculation of filtered water.	Stage 1 comprises a physical and chemical pre-treatment system that provides chemical softening in order to precipitate the calcium present in the Demin effluent and therefore avoid its precipitation in the subsequent electrodialysis reversal (EDR) system (Stage 3 below).
2	**Ultrafiltration (UF):** UF is a type of membrane filtration in which hydrostatic pressure forces water against semi-permeable membranes. UF removes suspended solids and compounds of high molecular weight (retentate or concentrate), while water and compounds of low molecular weight pass through the membrane (permeate).	Stage 2 comprises a UF system to remove suspended solids and turbidity.
3	**Electrodialysis Reversal (EDR):** Electrodialysis (ED) is a separation technique performed by ion-selective membranes. The treatment process requires several cells, each comprising a cationic membrane and an anionic membrane. EDR is an evolution of the ED process in which the polarity of the membranes is periodically changed in order to reduce fouling problems and cleaning operations.	Stage 3 comprises an EDR system which treats the wastewater desalination in order to obtain a diluted liquid that can be sent to the WPF and a reject fraction that will be treated in the crystallisation equipment (Step 4 below). The cation exchange membrane has a negative charge and is permeable to cations such as NA+, K+ and Ca2+, while the anion exchange membrane is positively charged and is permeable for anions. A series of these cells is placed in the electrolyte to be purified,

		so that by placing a pair of electrodes in it and applying an electric current, the anions and cations present as solute will migrate to the anode and cathode respectively, crossing the membranes and become part of a more concentrated electrolyte. This results in a product of lower mineralisation water and a saline concentrate.
4	**Vacuum Crystallisation:** The equipment operates using saturated steam for heating and cooling water for condensing. The process incorporates the following systems: ▪ Evaporation system; ▪ Vacuum generation system; ▪ Steam condensation system; ▪ Concentrate discharge system; and ▪ Cleaning system.	Stage 4 comprises a thermal vacuum crystalliser to concentrate the reject generated by the EDR system and generate a distillate water and a saline slurry.
5	**Salts Dewatering:** Pusher centrifuge for salts dewatering	Stage 5 comprises a pusher centrifuge for salts dewatering in order to obtain a mixture of salts with a 5 % moisture content which would need to be sent off site for disposal plus a liquor which would be recirculated to the crystalliser inlet.

It is relevant to note that this potential option comprises a number of individual technologies that have been combined to provide an integrated treatment process. However, the technology has not been proven in this format and it has not been previously employed for an application of the type and scale relevant to Davidstow. Therefore, it is not considered to be technically 'available' within the definition of BAT. That is, there is no known successful implementation of the technology within the food and drink / dairy sector. This is further supported by the fact that there is no mention of such a process or combination of techniques within the Food, Drink and Milk BREF; either within Section 2.3.6 'Techniques to Consider in the Determination of BAT across the FDM Sector – Waste Water Treatment Techniques' or in Section 5.4 'Dairies – Techniques to Consider in the Determination of BAT'. The BREF does include membrane filtration as a technique for final solids removal in the treatment of waste water. This technique has been implemented recently on site and comprises one of the changes to the WPF being applied for in the permit variation application; downstream tertiary filters replace the previous gravity Settlement Tanks in order to reduce the concentration of suspended solids in the final treated effluent.

As detailed above, this option would require the installation of a significant amount of additional plant and equipment to perform the five-stage process, plus additional equipment to provide the necessary thermal power and cooling systems required. The technology would require a substantial increase in energy use at the installation and generate significant quantities of a difficult waste stream that would require disposal. These issues are considered further in the section on cross-media impacts below, but suggest that the technology is not 'best' within the definition of BAT as, whilst it could reduce certain emissions to the River Inny, it is not considered to achieve a high general level of protection of the environment as a whole.

EFFECT ON TREATED EFFLUENT CONCENTRATION

The technology described above could theoretically achieve a circa 86 % reduction in the mass of inorganics in the combined Demin effluent and salt whey streams.

Based on lab scale tests, the effect on inorganics in the final treated effluent could be:

- Potassium: ~75 % reduction;
- Sodium: ~54 % reduction, however, this does not reflect the additional sodium in caustic required for cleaning of the treatment plant, and
- Chlorides: ~72 % reduction.

However, the technology provider was not able to provide any guarantee as to the ELVs that could be achieved. Furthermore, whilst the technology appears to be potentially capable of removing a significant proportion of K, Na and Cl, it still would not achieve the indicative ELVs provided by the Environment Agency (provided in Appendix A).

It should be noted that the efficacy of the technology in removing phosphorus from the Demin effluent would be circa 86 %. This is significantly lower than the current removal efficiency for phosphorus (>95 %) achieved by the existing phosphate removal plant. This option would, therefore, result in an increased mass of phosphorus required to be removed by the downstream WPF.

CROSS MEDIA IMPACTS

As detailed above, this option would demand a substantial increase in energy use, require ancillary consumables / raw materials and generate additional waste streams.

The technology requires a substantial increase in utilities, placing significant load on local power infrastructure, considerably increasing steam generation and resulting in other significant direct and indirect environmental impacts e.g. increased Green House Gas (GHG) emissions. The projected utility requirements are shown in Table 2-4 below.

Table 2-4 - Demin and Salt Whey Treatment – Utility Requirements

Utility	Quantity and Environmental Impacts
Electricity	350 kWh (300 kWh main plant + 50 kWh ancillary) or 3,100 MWh per year (delivered energy consumption). This is equal to 7,440 MWh per year primary energy consumption. This represents >70 % increase on the WPF's current electricity use and ~8 % increase on the total electricity use at the installation (including the Creamery). The site's Specific Energy Consumption (SEC) per tonne of raw material (milk) processed would also increase significantly, exceeding both the indicative environmental performance levels for SEC from the BREF and the Dairy UK Environmental Benchmarking Report energy efficiency levels. Refer to Section 3.2 of the main environmental permit variation application report for further details of the installation's energy consumption and energy efficiency figures. The resultant Scope 2 GHG emissions would be circa 700 tonnes CO2e based on DEFRA's latest (2021) carbon emissions factor for UK grid electricity.

Steam / fuel	10 tonnes per hour of 3 barg steam. As insufficient capacity is available in the existing biomass boilers, steam would need to be generated in the site's kerosene fired boilers, requiring an additional 6 million litres per year of kerosene. Therefore, combustion of the additional fuel required would generate an increase in nitrogen oxides (NOx), sulphur dioxide (SO_2), particulate matter and carbon emissions to the local area. In addition to having potential impacts on human health and ecological receptors, such emissions would hinder Dairy Crest's wider industrial decarbonisation plans in the south west region and progress towards net zero. The resultant Scope 1 GHG emissions would be circa 14,000 tonnes CO2e based on DEFRA's latest (2021) carbon emissions factors, an increase of 200 % in Davidstow's current Scope 1 emissions. Scope 1 emissions fall under the remit of the European Union Emission Trading Scheme (EU ETS), now replaced by the UK-ETS. Given that the maximum consented flow rate for local water abstraction is already fully utilised, the additional water demand would need to be satisfied from potable water, placing additional pressure on the South West Water potable water infrastructure.
Cooling	6.5 MW of cooling would be required to reduce the temperature of the outputs from vacuum crystallisation delivered from 1,080 m^3/hr cooling @27 °C (6,300 kWh) and 30 m^3/hr cooling @15 °C (175 kWh).

The technology would also require additional raw materials for use in the process and it would yield large quantities of additional waste streams, including a 'difficult' mineral rich waste stream for which no recovery or disposal route in the UK has yet been identified. The generation of this waste, which arises from Stage 5 (salts dewatering) of the treatment process, poses a major challenge and significant negative environmental impact for the project. Due to the high concentration of mixed chloride salts it contains, no recovery routes have been identified and even considering disposal, it is not suitable for landfill or incineration.

Table 2-5 below details the additional raw materials and, assuming that the technology is used to treat ~550 m^3/day of effluent from Demin and salt whey, the projected wastes and the quantities that would be generated are detailed in Table 2-6 below.

Table 2-5 - Demin and Salt Whey Treatment – Raw Material Use

Raw Material	Use of Material	Risk / Impact
Sodium bicarbonate	Stage 1 – chemical precipitation – pH adjustment	The product is water soluble, and may spread in water systems. Will likely be mobile in the environment due to its water solubility. Highly mobile in soils.
Caustic	Stage 1 – chemical precipitation – pH adjustment	R35 causes severe burns. Changes in pH / acidity in small water systems which could impact aquatic organisms.
Coagulant	Stage 1 – chemical precipitation – coagulation	No details available on specific coagulant at present, but likely to be harmful to aquatic life.
Polyelectrolyte	Stage 1 – chemical precipitation – flocculation	No details available on specific flocculant at present, but likely to be harmful to aquatic life.

Table 2-6 - Demin and Salt Whey Treatment – Waste Generation

Process Stage Generating Waste	Waste Description	Daily Quantity	Annual Quantity	Destination (Recovery / Disposal)
Stage 1: Chemical precipitation	Calcium carbonate sludge	10 tonnes	3,500 tonnes	Potentially recovered e.g. land spreading
Stage 4: Vacuum crystallisation	Distillate	156 m^3	56,940 m^3	Used for cleaning the equipment
Stage 5: Salts dewatering	Treated waste water 95 % dry solids containing mixed chloride salts (including Na, K & P)	330 m^3 26 tonnes	120,450 m^3 9,490 tonnes	Routed to WPF Export off-site, however, no viable disposal option has been identified to date

ECONOMIC IMPACTS

The estimated cost of implementing the technology required for this option includes capital expenditure in the region of £7-8 million and an operating cost of circa £4-5 million per year (note these figures are based on 2020 energy prices and so would now be subject to significant energy price increases). The operating costs are those associated with the additional utility requirements for power, steam and cooling, as detailed in Table 2-4 above.

CONCLUSION

This option is not technically proven as an integrated treatment process, nor has it been employed for similar applications in the dairy (or wider food and drink) sectors. It has significant negative cross media impacts (environmental costs) and the capex and opex costs are not economically viable. This option is, therefore, not considered any further as it is not deemed to meet the requirements of BAT.

It should be noted that, in addition to the desalination process detailed above, Dairy Crest has also explored the potential option for partial-desalination of a proportion of the effluent (30-40 m^3/hr) at the WPF. Bearing in mind that approximately one third of the minerals arise from the RO retentate, Dairy Crest has investigated the possibility of using forward osmosis to remove these inorganics. However, as was the case for full desalination, the technology, which is a new and novel technique, was found not be commercially available or proven. Furthermore, the process would still generate a concentrated process sludge for which no recovery or disposal options in the UK have been identified.

Refer to Section 2.8 below for an overview of this option compared to the baseline case (Option A) and the other alternatives considered in this BAT Options Appraisal.

2.8 SUMMARY OF OPTIONS CONSIDERED

Table 2-7 below provides an overview of the outcomes from the assessment of Options A-G considered above. For each option, it summarises whether it is technically and economically viable and whether, overall, the cross media impacts are considered to be positive or negative. It then provides a qualitative assessment (low / medium / high) of the tonnage of each parameter that would be avoided from entering the River Inny and the associated cost per tonne of parameter removed. Finally, each option has been ranked from 1 to 6 indicating which are most and least feasible within the context of BAT.

The key for Table 2-7 is provided below:

Annual tonnes of parameter avoided	H	High tonnage of parameter avoided compared to baseline (Option A)
	M	Medium tonnage of parameter avoided compared to baseline (Option A)
	L	Low tonnage of parameter avoided compared to baseline (Option A)
Cost per tonne of parameter avoided	H	High cost per tonne of parameter avoided compared to baseline (Option A)
	M	Medium cost per tonne of parameter avoided compared to baseline (Option A)
	L	Low cost per tonne of parameter avoided compared to baseline (Option A)

Table 2-7 – Wastewater Management / Treatment BAT Options Appraisal – Summary Table

Option	Technically Available	Economically Viable	Overall Cross Media Impacts	Annual Tonnes of Parameter Avoided (in River Inny)				Cost per Tonne of Parameter Avoided	Ranking	Considered Further	Comments
				P	NH3-N	Na	K				
A: 2015 As-Built	✓	✓	-	-	-	-	-	-	-	-	This is the baseline scenario against which all other options are compared
B: Redeveloped WPF	✓	✓	Positive	H	H	M	L	M	1	✓	Achievable and meets BAT; refer to report Section 3 below for further BAT justification
C: Discharge to alternative waterbody	✓	✓	Positive	H	H	H	H	H	2	✓	Potential longer term consideration – suggested permit Improvement condition[1]
D: Constructed wetland	✓	✓	Positive	L	L	L	L	M	3	✓	Potential longer term consideration – suggested permit Improvement condition[1]
E: Discharge to Sewer	×	×	Positive	H	H	H	H	H	4	×	Not considered further based on technical availability and economic viability
F: Change portfolio of products	✓	×	Negative	M	M	M	M	H	5	×	Not considered further based on cross media impacts and economic viability
G: Desalination	×	×	Negative	L	L	H	H	H	6	×	Not considered further based on technical availability, cross media impacts and economic viability

1 These options are considered to comprise potential longer-term considerations for which Dairy Crest will commit to undertaking more detailed feasibility studies. Due to the significant amount of work required it is suggested that improvement conditions are included in the varied permit, to be completed within 2 years, and with Dairy Crest providing 6-monthly progress reports to the Environment Agency.

3 APPLIED TECHNIQUES BAT JUSTIFICATION

3.1 BAT OVERVIEW

As detailed in report Section 2 above, a number of different options have been considered (compared to the 2015 as-built baseline), both for the management and treatment of effluent from the Creamery and as alternatives to the continued discharge of treated process effluent into the River Inny. Each of the options has been reviewed and assessed and, as summarised in Table 2-7 above, redevelopment of the WPF (Option A) has been ranked first (most favourable) when considering the technical availability, economic viability, cross media impacts and quantity of parameters removed from the effluent (or River Inny). Notwithstanding this, two additional options have been identified for further consideration in the longer-term, subject to the outcome of detailed feasibility studies.

The aim of this section of the report is to consider redevelopment of the WPF (Option A) further in terms of BAT requirements and to review the treatment / removal techniques provided by the redeveloped WPF against the techniques and BAT-AELs identified in the Food, Drink and Milk BREF. This includes consideration of general pre-treatment techniques and specific effluent treatment techniques for the removal of the key parameters of concern in the effluent. Where the parameters do not have treatment techniques or BAT-AELs identified in the BREF, BAT is justified based on a consideration of other relevant local factors, including emissions to water and the requirement for protection of the receiving environment.

As detailed previously, the changes implemented as part of the redeveloped WPF are the subject of the current environmental permit variation application. Therefore, the main environmental permit variation application report should be referred to for full details of each of the changes and a review of the installation as a whole against BAT requirements, e.g. for energy efficiency, raw materials and water, waste management, emissions and monitoring etc.

3.2 BAT JUSTIFICATION: PRE-TREATMENT TECHNIQUES

The site adopts a number of measures which are deemed to be BAT prior to the main treatment of effluent at the WPF. This includes the techniques listed in BAT 7 and BAT 12 from the Food, Drink and Milk BREF, as detailed in Table 3-1 below. The techniques listed in BAT 7 aim to reduce the water consumption and volume of waste water discharged and, therefore, the quantity of water requiring treatment at the WPF, whereas the techniques listed in BAT 12 comprise the initial or preliminary techniques performed at the WPF.

Table 3-1 – Pre-treatment Techniques from the BREF

BREF Requirements	Davidstow Arrangements to Meet BAT Requirements
BAT 7: Common techniques (water consumption and discharge): A. Water recycling and/or reuse	The WRP treats a portion of the final effluent at the WPF for reuse back at the factory. As part of the redevelopment works at the WPF, the WRP has been enhanced which enables the amount of water recovered and recycled on site to be maximised and increased considerably (by ~30%).

B. Optimisation of water flow C. Optimisation of water nozzles and hoses D. Segregation of water streams	The control of water flow and the use of water nozzles and hoses are optimised on site, e.g. by the use of devices to automatically adjust water flow, using the correct number and position of nozzles and adjusting water pressure. Water streams that do not need treatment, such as uncontaminated surface water runoff at the main Creamery, are segregated and managed separately from process waste water that has to undergo treatment at the WPF. Further information on other techniques to reduce water consumption and discharge, including techniques relating to cleaning operations are provided in Section 3.3 of the main environmental permit variation application report.
BAT 12: Preliminary, primary and general treatment (emissions to water): a. Equalisation b. Neutralisation c. Physical separation e.g. screens, sieves, grit separators, oil/fat separators, or primary settlement tanks	There are two discharge pipes which transfer crude effluent to the WPF via gravity lines. The cheese and whey line discharges into an open channel whereby there is a 10 mm aperture channel screen for gross solids removal. From here the effluent is discharged into an inlet sump before being pumped to BT1 (or transferred to the Divert Tank if required). The Demin and GOS line does not require screening and is discharged directly into BT1 (or can also be transferred to the Divert Tank if required). The phosphorus rich waste stream from the Demin process is also pre-treated at the phosphate removal plant located at the Creamery before it arrives at the WPF; further consideration of BAT for phosphate removal techniques is provided in Table 3-2 below. Approximately 50 % of the salt whey generated is now exported off site rather than being sent to the WPF. This reduces the loading of Cl and K on the WPF (and ultimately the River Inny). The Balance Tanks aid in the equalisation of the wastewater by combining wastewater of different loadings and pH adjustment also takes place here. Redevelopment of the WPF in terms of new plant and equipment and its configuration means that there is now more control over the quantity and quality of effluent delivered to the WPF for treatment. In particular: - Implementation of a contingency lagoon (located at the Creamery) - Reinstatement of the Divert Tank (located at the WPF) with automated divert functionality - Avoidance of peak loading in BT1 due to the above two measures, plus automated dosing of pH correction in BT1 (reduces need for dosing and prevents potential overdosing of caustic and hence reduces Na) - Installation of an automated forward / divert solution for both cheese / whey and Demin / GOS After balancing the effluent is treated via three DAF plants for solids, COD and phosphorus removal before passing to the biological treatment stage.

3.3 BAT JUSTIFICATION: EFFLUENT TREATMENT TECHNQIUES

PHOSPHORUS REMOVAL

The techniques for the treatment and removal of phosphorous considered are:

- Precipitation as struvite;
- Chemical precipitation;
- Enhanced biological phosphorous removal;
- Coagulation and flocculation;
- Dissolved Air Flotation (DAF);
- Membrane filtration; and
- Integrated constructed wetland.

Each of these are reviewed for a range of criteria in in Table 3-2 below in order to demonstrate their suitability for treating the wastewater from the Creamery along with determining which of the techniques can be considered to be BAT.

It is noted that, whilst all of the techniques are referred to in the BREF, only three of the techniques are specifically listed as BAT for phosphorus removal in the BAT Conclusions (BAT 12), as detailed below.

Figure 3-1 - BAT for Phosphorus Removal as Defined by the FDM BREF (BAT 12)

Phosphorus recovery and/or removal			
g	Phosphorus recovery as struvite	Total phosphorus	Only applicable to waste water streams with a high total phosphorus content (e.g. above 50 mg/l) and a significant flow.
h	Precipitation		Generally applicable.
i	Enhanced biological phosphorus removal		

Total phosphorus (TP)	0.2–2 mg/l ([9])

[9] The upper end of the range is 4 mg/l for dairies

Table 3-2 – Comparison of Techniques for Phosphorus Removal

Technique	Removal Efficiency	Achievable emissions	Cross media impacts	Cost	Conclusions for Davidstow Site
Precipitation as struvite (magnesium ammonium phosphate)	Average removal efficiencies of 80–90 %	The effluent concentration that can be reached is no lower than 10–20 mg $P\text{-}PO_4$/l	Reduced total phosphorus in emissions Reduction of sludge production Recovery as phosphorous (e.g. as fertiliser) Only applicable to wastewater streams with a high total phosphorus content (e.g. above 50 mg/l) and a significant flow The EU depends on imports for >90 % of its phosphorus. Phosphate rock and white phosphorous are on the EU list of critical raw materials	From BREF: EUR 983,000 for the treatment of 120 m^3/h of wastewater has been reported, for achieving an outlet $P\text{-}PO^4$ concentration of 20 ppm (inlet $P\text{-}PO^4$ concentration around 150 ppm). The cost would be EUR 1,126,354 based upon 3,300 m^3 day of wastewater treatment (average input to WPF).	This technique is not known to have been implemented at any dairy installations in the food, drink and milk sector. Based on the information provided in the BREF, it would not come close to achieving the phosphorus ELV in the current permit for Davidstow or the Environment Agency's indicative future ELV (refer to Appendix A). Therefore, it is not considered to be an appropriate technique for the site.
Chemical precipitation	Dairy installation with demineralised whey powder production - a reduction of 90 % in the total phosphorus	<u>Dairy example:</u> Total P concentration in the effluent of 1.8 mg/l as a yearly average <u>Potato starch example:</u> Total P concentration in the effluent of 1-2 mg/l	Reduced total phosphorus in emissions Chemical consumption Greater sludge generation Iron or aluminium salts not likely to be used for fertiliser	From BREF: A total cost of around EUR 2,700,000 for the phosphorus precipitation plant in an existing dairy installation processing around 100,000 t of raw materials/year and average operating costs of around	The BREF notes that this technique is widely used at food, drink and milk installations and it is known to have been implemented at nine dairy installations. This technique is employed at Davidstow as part of the integrated treatment process at the WPF; the Davidstow site is referenced as an example installation in the BREF. Since its original installation, Dairy Crest has further invested in the phosphate removal

	can be achieved			EUR 0.45 per m^3 of treated wastewater.	plant to reduce the entrainment of calcium phosphate precipitate fines that would otherwise re-solubilise at the WPF adding to the phosphorus load. Current monitoring data shows that the phosphate removal plant achieves >95 % removal efficiency, which is now higher than the removal efficiency stated in the BREF.
Enhanced biological phosphorous removal (EBPR)	70-90 %	2-3 mg/l	Reduced total phosphorus in emissions Also reduces BOD and TOC or COD emission levels Avoidance of chemicals required for precipitation Difficult to manage - sludge age should be less than 7 days and residence time less than 1 hour Additional pumping required to send the waste water to further aerobic treatment	From BREF: An investment cost of around EUR 160,000 was reported for a wastewater flow rate of 300 m^3/h in a brewery. This would equate to EUR 73,333 for a plant capable of treating 3,300m^3/day (average input to WPF).	The BREF notes that this technique is widely used at food, drink and milk installations and it is known to have been implemented at thirteen dairy installations. Whilst the technique could in theory be applied at Davidstow, it achieves a lower removal efficiency (%) and results in higher emissions compared to chemical precipitation which is performed at the existing phosphate removal plant. Based on the information provided in the BREF, this technique would not be able to achieve the phosphorus ELV in the current permit for Davidstow or the Environment Agency's indicative future ELV (refer to Appendix A).
Coagulation and flocculation	- No data provided in BREF	- No data provided in BREF	Reduced suspended solids, fat, oils and grease and phosphorus in emissions Energy consumption (mixing) Chemical use Solid waste generation	- No data provided in BREF	The BREF notes that this technique is applied in several installations in the food, drink and milk sector, including at dairies. Whilst it is primarily aimed at separating and removing suspended solids, it can also help to reduce phosphorus. This technique is employed at Davidstow as part of the integrated treatment process at

			The dissolved solids/salt content may increase significantly and the solid waste produced might be difficult to reuse or dispose of.		the WPF. In addition to chemical precipitation at the phosphate removal plant, ferric chloride and polymer are dosed at the DAF plant and again at Settlement Tank ST3 to aid further phosphorus precipitation.
Dissolved Air Flotation (DAF)	- No data provided in BREF	- No data provided in BREF	Nitrogen and phosphorus emission levels are reduced. The sludge can also be used for biogas production. The system is kept aerobic, so the risk of odour problems is low. BOD/COD, suspended solids and fat oils and greases also reduced. Energy consumption for compressed air and, depending on the amount of protein in the wastewater, addition of flocculant.	- No data provided in BREF	The BREF notes that this technique is widely used in food, drink and milk installations. This technique is employed at Davidstow as part of the integrated treatment process at the WPF. Dairy Crest has invested in two additional DAF units at the WPF for physico-chemical removal of phosphorus. Refer to Section 4 of the main environmental permit variation application report for further details on the DAF units.
Membrane Filtration	Using UF, up to 90–95 % of the feed can be recovered as product water. Phosphorus removal efficiencies of 90–100 % have been	- No data provided in BREF	RO product streams are normally of very high quality and suitable for reuse in the manufacturing process. Additional wastewater may be produced. Use of chemicals for cleaning the membranes. Energy consumption	From BREF: The operating cost associated with the use and cleaning of membranes can be very high. There are also high energy costs. A total cost of around EUR 3, 600,000 has been reported for the installation of a RO plant in a dairy, for recycling	The BREF notes that this technique is used at several food, drink and milk installations, including within the dairy sector. Membrane filtration is employed at Davidstow as part of the integrated treatment process at the WPF; membrane bioreactors are used, which combine membrane filtration with biological treatment. Dairy Crest has invested in a fourth MBR loop as part of the WPF redevelopment works.

	reported using RO.			~130,000 m^3 wastewater/year. This would equate to EUR 33,355,387 for a plant capable of treating 3,300m^3/day (average input to WPF).	The WRP includes treatment via UF and RO to treat a portion of the effluent for reuse back at the Creamery. The RO concentrate (reject) and UF backwash water from the WRP are then treated in AFM tanks (after the effluent has passed through ST3) prior to discharge to the River Inny. Dairy Crest has invested in a third RO plant and four new AFM vessels as part of the WPF redevelopment works. Refer to Section 4 of the main environmental permit variation application report for further details on the MBR, RO and AFM units.
Integrated constructed wetland (ICW)	- No data provided in BREF (bud adjacent example suggests >99 %)	212 mg/l inlet 0.5 mg/l outlet	TSS, BOD and TOC or COD, nitrogen and phosphorus emission levels are reduced No (or very low) energy and chemical use No sludge disposal required Groundwater beneath wetlands may have lower nutrient levels that surrounding terrestrial sites Phosphorus is retained in the soil An ICW can provide suitable effluent to be used for irrigation of crops and pasture	From BREF: The example dairy installation in Ireland reported that its ICW system cost EUR 120,000, which is comparable to EUR 3.175 million reported for a conventional WWTP. The example ICW treated 1,100 m^3/day and so this would equate to EUR 360,000 for a plant capable of treating 3,300m^3/day (average input to WPF).	The BREF notes that this technique is used at least one installation in the dairy sector. It is not currently employed at Davidstow, however, it has been identified for further consideration in the longer-term, subject to the outcome of a detailed feasibility study.

As detailed in Table 3-2 above, the Davidstow site implements four of the techniques listed in the BREF for phosphorus removal as part of the integrated treatment process at the WPF. The treatment process is considered to meet BAT and the phosphate removal plant achieves >95 % removal efficiency with further removal at the main WPF.

Additional measures implemented as part of the WPF redevelopment woks and taken to reduce P emissions from the site to date include:

- Further investment in the phosphate removal plant to reduce entrainment of calcium phosphate precipitate fines that would otherwise re-solubilise in the WPF adding to P load;
- Investment in two additional DAF units at the WPF for physico-chemical removal of P; and
- Optimisation of aerobic biological processes for increased biological removal of P in combination with optimised use of ferric chloride.

These measures have helped to deliver improved and sustained compliance with the current permit limit as shown in Figure 2-2 in report Section 2.2 above. As a direct impact, they will have ensured no deterioration in the River Inny (due to the Davidstow site) and, in fact, would be expected to contribute to an improved situation. Whilst the Upper River Inny is rated as ‘poor’ for phosphorus under the 2019 WFD classification, this classification is based on Environment Agency monitoring data from the period after initial commissioning of Demin when emissions were known to be higher (as shown by Figure 2-2).

Any updated ELVs included in the permit should be risk based and proportionate to the current performance of the site and river quality and not based on historic issues. Furthermore, P source apportionment data from the Environment Agency suggests that 50 % of the source in the River Inny is attributable to agriculture (livestock and arable combined) and 44 % from industry. Therefore, Dairy Crest would expect a fair and proportionate approach to be used for P reduction rather than to place all of the obligation on them alone to achieve ‘Good’ status in the River Inny. Furthermore, it is noted that the Environment Agency’s Catchment Data Explorer reports that the objective for phosphate is to achieve ‘Good’ status by 2027 with the reason stated as ‘disproportionate burdens’; This acknowledges that it would be disproportionately expensive to expect the water body to achieve good status before this date.

Bearing all of the above factors in mind it is considered that the site is applying BAT with respect to phosphorus removal and that emissions have been reduced as far as practicable.

3.4 AMMONIACAL NITROGEN REMOVAL

The techniques for the treatment and removal of nitrogen considered are:

- Nitrification and denitrification;
- Partial nitritation-anaerobic ammonium oxidation; and
- Ammonia stripping.

Each of these are reviewed for a range of criteria in Table 3-3 below in order to demonstrate their suitability for treating the wastewater from the Creamery along with determining which of the techniques can be considered to be BAT.

It is noted that only two of the techniques are specifically listed as BAT for nitrogen removal in the BAT Conclusions (BAT 12), as detailed below.

Figure 3-2 - BAT for Nitrogen Removal as Defined by the FDM BREF (BAT 12)

Nitrogen removal			
e	Nitrification and/or denitrification	Total nitrogen, ammonium/ammonia	Nitrification may not be applicable in the case of high chloride concentrations (e.g. above 10 g/l). Nitrification may not be applicable when the temperature of the waste water is low (e.g. below 12 °C).
f	Partial nitritation - Anaerobic ammonium oxidation		May not be applicable when the temperature of the waste water is low.

Total nitrogen (TN)	2–20 mg/l (7) (8)

7 The upper end of the range is 30 mg/l as a daily average only if the abatement efficiency is >80 % as a yearly average or as an average over the production period.

8 The BAT-AEL may not apply when the temperature of the water is low (e.g. below 12 °C) for prolonged periods.

Review of total nitrogen monitoring data from Tank BT1 (input to the WPF) and W2 outfall (output from WPF) for 2021 shows that the site has an average removal efficiency of 87.7 % and, therefore, Footnote 7 from BAT 12 the BREF applies and the upper end of the BAT-AEL range is taken to be 30 mg/l for the Davidstow site.

Table 3-3 – Comparison of Techniques for Nitrogen Removal

Technique	Removal Efficiency	Achievable emissions	Cross media impacts	Cost	Conclusions for Davidstow Site
Nitrification and denitrification	- No data provided in BREF (but specifies this process has a potential to achieve a high removal efficiency)	- No data provided in BREF	Reduced nitrogen in emissions In some cases an external carbon source needs to be added Nitrification may not be applicable in the case of high chloride concentrations Nitrification may not be applicable when the temperature of the waste water is low This technique is not applicable when the final treatment does not include a biological treatment	From BREF: EUR 1,300,000 for an aerobic treatment step for nitrification and denitrification treating around 1,500 m3/day (with a COD load of ~1.0 t/COD/day and total nitrogen load of 150 t/TN/day) The cost would be EUR 2,860,000 based upon 3,300 m3 day of wastewater treatment (average input to WPF)	The BREF notes that this technique is widely used at food, drink and milk installations. Nitrification and denitrification is employed at Davidstow as part of the integrated treatment process at the WPF. Nitrification takes place in the Aeration Tanks where ammonia is oxidised to nitrate; the nitrate is then converted to nitrogen gas in the Anoxic Tanks. No changes to this part of the process have been made as part of the recent redevelopment works that form the current environmental permit variation application. The 2014 permit variation included new Balance Tanks, an Anoxic Tank, two Aeration Tanks and a Settlement Tank. The existing integrated treatment process performed at the WPF achieves a removal efficiency of ~90 %. Refer to Section 4 of the main environmental permit variation application report for an overview of the current WPF.
Partial nitritation	Potato processing installation	- No data provided in BREF	Reduced nitrogen in emissions	No data on capex provided in BREF	The BREF notes that this technique is applied to various food and drink

(anaerobic ammonium oxidation)	achieved total nitrogen removal efficiency of around 90 %		Energy savings Lower amounts of sludge generated (compared to classic nitrification – denitrification) This technique is not applicable when the final treatment does not include a biological treatment May not be applicable when the temperature of the waste water is low	Opex costs can be reduced compared to a conventional nitrification / denitrification step	manufacturing installations although there are no dairy examples cited. This technique is not employed at Davidstow, however, it would be an alternative to the conventional nitrification / denitrification step which is employed. As detailed above, the existing integrated treatment process performed at the WPF achieves a removal efficiency of >90 %.
Ammonia stripping	Approximately 99 %	Ammonium concentrations <2 mg/l	Reduced nitrogen in emissions Less waste created Ammonium sulphate solution created can be used as a liquid fertiliser or non-protein source of nitrogen for feeding ruminants Cleansed water can be used as service water Energy consumption required	- No data provided in BREF	The BREF notes that this technique has been reported at one food, drink and milk installation. This technique is used to treat condensate that contains high concentrations of ammonia, e.g. the example in the BREF was proven treating condensate from the sugar sector with an ammonia concentration in the input of 150 mg/l. The integrated treatment process at the WPF achieved an average ammoniacal nitrogen concentration of 0.9 mg/l in 2021 (compared to an average inlet concentration of 30.4 mg/l). This equates to a removal efficiency of 97 %. This technique is not considered to be suitable for implementation at Davidstow.

As detailed in Table 3-3 above, the Davidstow site implements one of techniques listed in the BREF for nitrogen removal as part of the integrated treatment process at the WPF. The treatment process is considered to meet BAT and the WPF achieves >87 % removal efficiency for total nitrogen and >95 % removal efficiency for ammoniacal nitrogen.

With respect to total nitrogen, the site complies with the BAT-AEL of 30 mg/l as specified in the BREF. The BREF does not include a BAT-AEL for ammoniacal nitrogen in emissions to water. However, it is understood that the Environment Agency intends to review the ELV for this parameter in the varied permit in order to ensure protection of the River Inny.

Determination of BAT for ammoniacal nitrogen emissions is, therefore, based on consideration of relevant local factors, including actual emissions to water and protection of the receiving environment. As stated in Article 14 of the IED, regulators can go further than BAT controls specified in the BREF, or in this case where there are no relevant BAT-AELs to serve as a benchmark reference for permitting, if the environmental risks justify this.

The 2019 WFD status for ammonia in the Upper River Inny is currently ‘high’ as it has been since 2009. More recent Environment Agency monitoring data has been requested and reviewed and demonstrates that, based on the classifications used, for 2020 the WFD status would remain as ‘high’ (acknowledging that this is based on a limited data set). This suggests that the current limit for ammoniacal nitrogen of 5 mg/l, as set in the existing permit, is adequate to ensure no deterioration from the ‘high’ status of the Upper River Inny and meets the definition of BAT.

Bearing all of the above factors in mind it is considered that the site is applying BAT with respect to total nitrogen / ammoniacal nitrogen removal and that emissions have been reduced as far as practicable.

3.5 SODIUM REMOVAL

The BREF does not include any treatment techniques for the removal of sodium from wastewater, nor does it contain a BAT-AEL for emissions to water for this parameter. However, it is understood that the Environment Agency intends to set an ELV for sodium in the varied permit in order to ensure protection of the River Inny. In addition to reviewing the treatment techniques in the BREF, Dairy Crest has undertaken a significant amount of research, including internationally, however, no feasible treatment technique for sodium has been identified to date (refer to Section 2.7 – Option G: desalination above for further details).

Determination of BAT for sodium emissions is, therefore, based on consideration of relevant local factors, including actual emissions to water and protection of the receiving environment. As stated in Article 14 of the IED, regulators can go further than BAT controls specified in the BREF, or in this case where there are no relevant BAT Conclusions to serve as a benchmark reference for permitting, if the environmental risks justify this.

Table 3-4 – Considerations in Defining BAT for WPF Na Emissions

- The BREF makes no reference to an ELV for Na.
- Na is not a priority substance under the WFD and it does not have a statutory EQS.
- Accordingly, no treatment techniques for Na removal are provided in the BREF.
- In view of the above and as detailed previously, Dairy Crest has undertaken its own extensive research (including internationally), but the conclusion at this current time is that there is no supplier that can provide an available and proven technology.
- The Environment Agency had previously advised Dairy Crest that an ELV for Na was not required as impacts associated with Na are typically controlled through regulation of Cl, as Na is typically present as salt (NaCl).
- However, the Environment Agency later advised that a limit for Na is required for Davidstow to control Na associated with the use of caustic.
- One key use of caustic is for pH correction in the WPF reception tanks for odour control which (based on previous mass balance) accounts for around 20 % of Na present in the outfall.
- Davidstow has significantly reduced caustic use since 2019 through influent control and aeration of reception tanks. 2020 Q4 caustic use at the WPF was 25 % lower than same period in 2019 which is indicative of the future caustic usage trend and delivering a 5-10 % reduction in Na in the outfall. Additionally, the new auto pH control of BT1 should further reduce caustic use as it will avoid potential manual overdosing. Whilst caustic use could theoretically be reduced even further, this could lead to odour problems and so a balanced approach to overall environmental management is required.
- This is considered to be the best technique available at the current time for reducing Na emissions to the River Inny, however, it is considered that incentivising reduction in Na through reduction in caustic does not require a permit limit.
- It is acknowledged that there may be circumstances where the Regulator sets ELVs for substances which do not have BAT-AELs in the relevant BREF due to installation specific reasons and that in these circumstances the ELVs will be set at levels determined to protect the receiving environment and prevent deterioration.
- It is understood that harm resulting from elevated emissions of Na would be evident as an adverse effect on invertebrates in the River Inny. However, the WFD status for invertebrates for the Upper River Inny is currently 'high' as it has been since 2009 and as substantiated by the work of the University of Plymouth.
- Therefore, the redeveloped WPF in combination with the reduction in caustic use is considered to meet the definition of BAT with regards to Na emissions, i.e. it will protect the receiving environment and not cause deterioration.
- Furthermore, were emissions of Na to be controlled in line with Cl (based on the presumption that Na is typically present as salt, NaCl), then Dairy Crest's proposed mean ELV for Na of 3,000 mg/l is consistent with the EA's proposed ELV for Cl of 4,600 mg/l based on molecular weights (refer to Appendix A).

3.6 POTASSIUM REMOVAL

The BREF does not include any treatment techniques for the removal of potassium from wastewater, nor does it contain a BAT-AEL for emissions to water for this parameter. However, it is understood that the Environment Agency intends to set an ELV for potassium in the varied permit in order to ensure protection of the River Inny. In addition to reviewing the treatment techniques in the BREF, Dairy Crest has undertaken a significant amount of research, including internationally, however, no feasible treatment technique for potassium has been identified to date (refer to Section 2.7 – Option G: desalination above for further details).

Determination of BAT for potassium emissions is, therefore, based on consideration of relevant local factors, including actual emissions to water and protection of the receiving environment. As stated in Article 14 of the IED, regulators can go further than BAT controls specified in the BREF, or in this case where there are no relevant BAT Conclusions to serve as a benchmark reference for permitting, if the environmental risks justify this.

Table 3-5 - Considerations in Defining BAT for WPF K Emissions

▪ The BREF makes no reference to an ELV for K. ▪ K is not a priority substance under the WFD and it does not have a statutory EQS. ▪ Accordingly, no treatment techniques for K removal are provided in the BREF. ▪ In view of the above and as detailed in Section 2.7, Dairy Crest has undertaken its own extensive research (including internationally), but the conclusion at this current time is that there is no supplier that can provide an available and proven technology. ▪ It is acknowledged that there may be circumstances where the Regulator sets ELVs for substances which do not have BAT-AELs in the relevant BREF due to installation specific reasons and that in these circumstances the ELVs will be set at levels determined to protect the receiving environment and prevent deterioration. ▪ It is understood that harm resulting from elevated emissions of K would be evident as an adverse effect on invertebrates. However, the WFD status for invertebrates for the Upper River Inny is currently 'high' as it has been since 2009, i.e. there has been no change in status pre/post introduction of Demin in early 2016 which accounts for the majority of K present in the outfall. ▪ The University of Plymouth's work reinforces the 'high' status and does not show a significant difference in invertebrate biodiversity downstream vs upstream of the outfall. ▪ Dairy Crest is not aware of other WFD ecological indicators that show that current emissions of K are having a detrimental effect on the Upper Inny and therefore the redeveloped WPF is considered to meet the definition of BAT with regards to K emissions, i.e. it will protect the receiving environment and not cause deterioration.

4 CONCLUSIONS

A BAT Options Appraisal for wastewater management and treatment has been undertaken in support of an environmental permit variation application for Davidstow Creamery. Whilst the permit variation being applied for will not introduce the manufacture of any new products at the Creamery, generate any new effluent streams requiring treatment at the WPF, limit or increase the volume of effluent discharged to the River Inny, the Environment Agency has conveyed its intention to review the ELVs for point source emissions to water during the permit variation determination process. This will include additional parameters being specified in the monitoring regime in the permit and lower ELVs for some parameters already listed in the permit. In some cases, the ELVs are for parameters which do not have BAT-AELs or EQSs and are not priority substances under the WFD. For these parameters the Environment Agency will need to consider the overall impact of releases to the environment, based on the environmental risks posed, when setting the ELVs.

During the pre-application process, the Environment Agency provided indicative ELVs for the continued discharge of treated effluent to the River Inny (refer to Appendix A). Whilst the indicative ELVs calculated for most of the parameters were deemed by Dairy Crest to be practical considering the site's operations, and the rationale as to how they were derived is understood, this was not considered to be the case for the following:

- Total phosphorus (P);
- Ammoniacal nitrogen (NH_3-N);
- Sodium (Na); and
- Potassium (K).

Accordingly, the BAT Options Appraisal focused on the above key parameters, which largely arise in the effluent from the Demin manufacturing process on site (with the exception of NH_3-N which arises from operational processes at the WPF, e.g. linked to organic load and aeration).

The first stage of the assessment was to consider a number of different options, both for the management and treatment of effluent from the Creamery and as alternatives to the continued discharge of treated effluent into the River Inny. The options considered comprised:

A. Maintain 2015 as-built situation (baseline);

B. Redevelop the WPF;

C. Discharge to alternative waterbody;

D. Constructed wetland;

E. Discharge to sewer;

F. Change portfolio of products manufactured;

G. Separate and treat Demin effluent and salt whey via desalination.

For each option, the assessment determined whether it is technically and economically viable and whether, overall, the cross media and environmental impacts are considered to be positive, neutral or negative. A qualitative appraisal (low / medium / high) of the tonnage of each parameter that would be avoided from entering the River Inny and the associated cost per tonne of parameter removed was then performed. Finally, each option was ranked from 1 to 6 indicating which are most and least feasible within the context of BAT.

The assessment determined that three of the above options (E, F and G) are not technically and / or economically viable and, therefore, these options do not meet the requirements of BAT and were not considered further. Two of the options (C and D) were determined to be potentially viable and they would most likely deliver positive cross media impacts, however, feasibility studies would be required to confirm this. Therefore, for these options Dairy Crest has committed to undertaking more detailed feasibility studies and, due to the significant amount of work required (and potential challenges already identified), it is recommended that improvement conditions are included in the varied permit to secure this work.

Option B (redevelopment of the WPF) was ranked number 1 and determined to be achievable, deliver positive cross media impacts and meet the requirements of BAT. This option was subject to further assessment comprising a review of pre-treatment techniques and effluent treatment techniques applied at the redeveloped WPF against the relevant BAT Conclusions and BAT-AELs in the Food, Drink and milk BREF. The assessment concluded that BAT is being applied in line with the BREF for phosphorus and ammoniacal nitrogen removal and, furthermore, emissions of these parameters from the site are unlikely to cause deterioration of the River Inny. For sodium and potassium, which are not covered by treatment techniques or BAT-AELs in the BREF, the assessment of BAT was based on consideration of relevant local factors, including actual emissions to water and protection of the receiving environment. It was determined that the redeveloped WPF (considering both the techniques applied and the management / operational controls) meets the definition of BAT with regards to these parameters, i.e. emissions from the site are unlikely to cause deterioration of the River Inny.

With regards to the environmental impacts, the results of an ecological assessment undertaken have shown that there is no significant change in the invertebrate population as a whole downstream of Dairy Crest's discharge into the River Inny compared to upstream. Similarly, there are significant fish numbers and a diverse range of fish species present. This supports the conclusion that the emissions from the WPF are not having a negative environmental impact on the River Inny. Whilst this BAT Options Appraisal report focuses on wastewater management and emissions to water, there are a number of other environmental improvements and benefits which have been introduced as part of the WPF redevelopment works; these are detailed in the main environmental permit variation application report and include enhanced mitigation and reduced emissions of noise and odour.

The overall conclusion from the Wastewater BAT Options Appraisal is that the assessment demonstrates that the techniques implemented by Dairy Crest as part of the redevelopment of the WPF meet BAT and will achieve the lowest possible emissions using the technologies that are currently available on the market. For further details of the changes on site comprising the redevelopment works at the WPF, the main environmental permit variation application report should be referred to. This report also details other relevant BAT requirements for the installation as a whole and how they will be met, including management system requirements, energy efficiency, raw materials and water, waste management and monitoring.

It is understood that the Environment Agency has a duty to both protect the environment and promote sustainable economic growth and this assessment has demonstrated that, with the improvements to the site, both of these objectives will be delivered. The projects being delivered at both the Creamery and WPF will deliver a reduction in emissions to the River Inny (compared to the 2015 baseline) whilst ensuring the continued success of the site and benefits to the local community and economy.

Appendix A

INDICATIVE ELVS FROM EA (NOVEMBER 2020)

Saputo Dairy UK enhanced pre-application

Environment Agency indicative ELVs (updated Nov 20) for treated effluent discharge from Davidstow Creamery to the River Inny

Pre-app ref. EPR/BN6137IK/V010

Parameter	Current Permit ELV	Current Emissions May-July 20	EA Jun 19 Indicative ELV	SDUK Jul 20 Proposed ELV	SDUK Nov 20 interpretation of ELVs (post Q95 flow agreement)	SDUK Nov 20 Proposed ELV	SDUK Nov 20 Commentary (prior to receipt of EA ELVs)	EA Nov 20 (re-modelling post Q95 river flow agreement)	
								Indicative ELV	Commentary
Daily Flow	2,600-m3/day	1,749 m3/day (670-3,339)	2,600 m3/day	2,600 m3/day	2,600 m^3/day	2,600 m^3/day	Achievable	2,600 m3/day	Operator defined effluent flow. No change to existing permit limit
pH	6-9	8.2 (6.0-8.4)	6-9	6-9	6-9	6-9	Achievable	6-9	Not subject to modelling. No change to existing permit limit
Temperature	N/A	27.7°C (24-34)	31°C	31°C	31°C	31°C	Achievable	31 °C	New permit limit. No change from earlier advised ELV
BOD	13 mg/l	<2 mg/l (1.6-7.9)	13 mg/l	13 mg/l	13 mg/l	13 mg/l	Achievable	13 mg/l	No change to existing permit limit
COD	N/A	42 mg/l (11-120)	N/A	N/A (BRef 25-100)	N/A (BRef 25-125) Prefer TOC measurement value	N/A (BRef 25-125)	Achievable noting that Davidstow's COD:BOD ratio is atypical hence any future ELV for COD should be based at the upper end of the quoted BRef range. SDUK would prefer TOC value as it can be	120 mg/l OR 125 mg/l (only if the abatement efficiency is ≥ 95 % as a yearly average or as an average over the production period)	New permit limit from FD&M BAT Conclusions (BAT 12). ELV set at the upper end of BAT-AEL range in accordance with Defra advice. BATc state that COD may be replaced by TOC and that the correlation between COD and TOC is determined on a case-by-case basis. Setting a BAT-AEL for TOC is the preferred option because TOC monitoring does not rely on the use of very toxic compounds.

Parameter	Current Permit ELV	Current Emissions May-July 20	EA Jun 19 Indicative ELV	SDUK Jul 20 Proposed ELV	SDUK Nov 20 interpretation of ELVs (post Q95 flow agreement)	SDUK Nov 20 Proposed ELV	SDUK Nov 20 Commentary (prior to receipt of EA ELVs)	EA Nov 20 (re-modelling post Q95 river flow agreement)	
								Indicative ELV	Commentary
							continuously measured and trended		EA default position is that the COD BAT-AEL will be used unless the operator requests otherwise. If so, they will be required to produce (in their application) a site specific assessment to satisfactorily demonstrate the relationship between COD and TOC for their particular effluent.
Total Soluble Solids	20 mg/l	13 mg/l (5-30)	20 mg/l	20 mg/l (BRef 4-50)	20 mg/l	20 mg/l (BRef 4-50)	Achievable	20 mg/l	No change from existing permit limit. ELV is set tighter than the upper limit of the BRef range to protect downstream water quality
Phosphorous	1.0 mg/l	0.3 mg/l (0.085-0.86)	0.1 mg/l	1 mg/l (BRef 0.2-4.0)	1 mg/l (BRef 0.2-4.0)	1 mg/l (BRef 0.2-4.0)	EA to describe rationale for reduction from current level	0.3 mg/l	Rationale for reduction from current permit limit to be explained at meeting on 24/11/20. ELV is set tighter than the upper limit of the BRef range to protect downstream water quality. Note that the BRef indicates that 0.2 mg/l is technically achievable

Parameter	Current Permit ELV	Current Emissions May-July 20	EA Jun 19 Indicative ELV	SDUK Jul 20 Proposed ELV	SDUK Nov 20 interpretation of ELVs (post Q95 flow agreement)	SDUK Nov 20 Proposed ELV	SDUK Nov 20 Commentary (prior to receipt of EA ELVs)	EA Nov 20 (re-modelling post Q95 river flow agreement)	
								Indicative ELV	Commentary
Total Nitrogen	N/A	5 mg/l (1-16)	N/A	20 mg/l (BRef 2-20)	20 mg/l (BRef 2-30)	20 mg/l (BRef 2-30)	If required SDUK can achieve the upper end of the BRef range	20 mg/l OR 30 mg/l (only if the abatement efficiency is ≥ 80 % as a yearly average or as an average over the production period)	New permit limit from FD&M BAT Conclusions (BAT 12). ELV set at the upper end of BAT-AEL range in accordance with Defra advice
Ammoniacal Nitrogen	5 mg/l	0.3 mg/l (0.02-3)	1 mg/l	5 mg/l	5 mg/l	5 mg/l	EA to describe rationale for reduction from current level as the current limit is considered adequate to protect the river	1.4 mg/l	Rationale for reduction from current permit limit to be explained at meeting on 24/11/20.
Sulphate	N/A	1,222 mg/l (784-1,890)	900 mg/l	900 mg/l	1,800 mg/l	900 mg/l	Achievable if Calcium Phosphate operational trials prove successful	4,300 mg/l	New permit limit

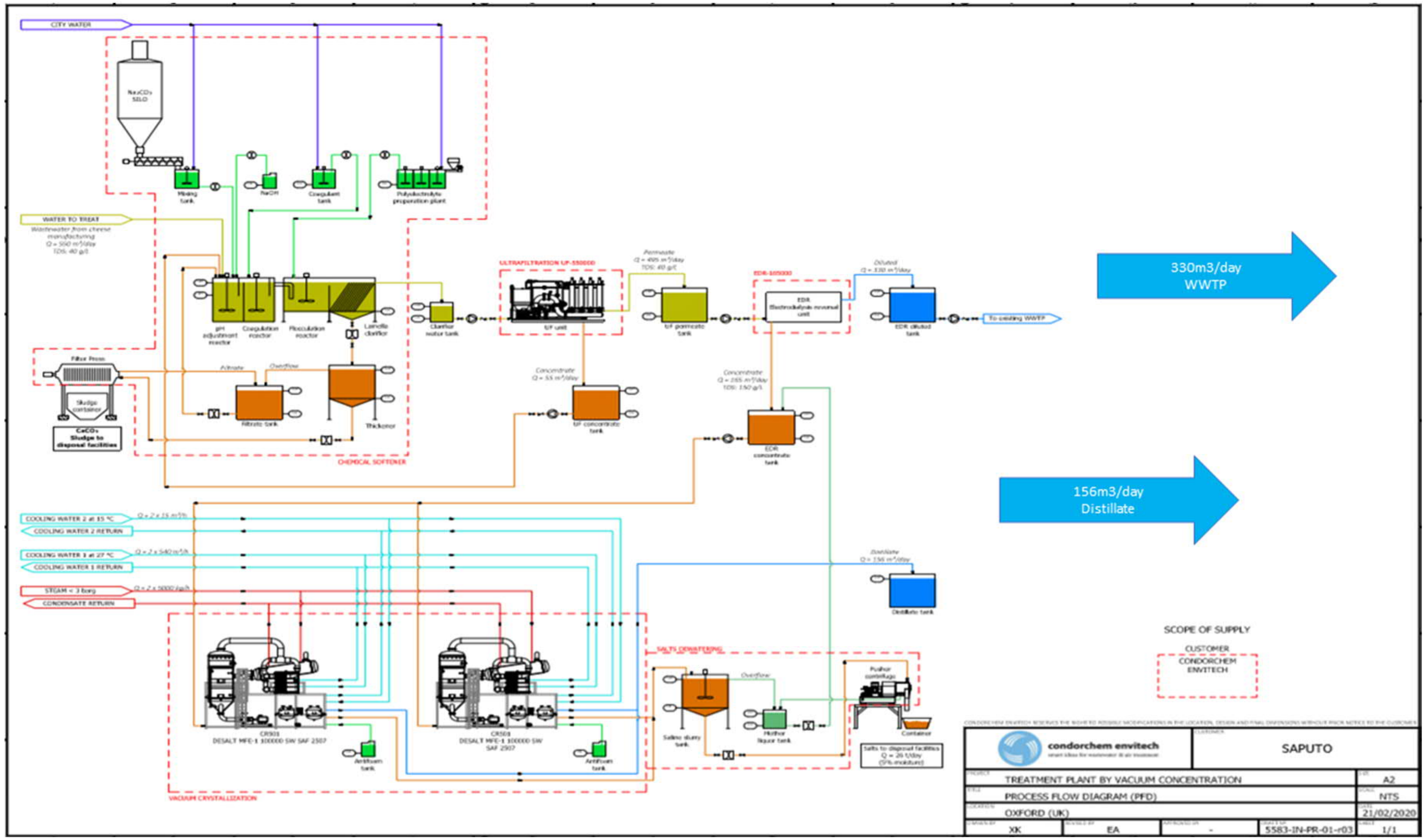
Parameter	Current Permit ELV	Current Emissions May-July 20	EA Jun 19 Indicative ELV	SDUK Jul 20 Proposed ELV	SDUK Nov 20 interpretation of ELVs (post Q95 flow agreement)	SDUK Nov 20 Proposed ELV	SDUK Nov 20 Commentary (prior to receipt of EA ELVs)	EA Nov 20 (re-modelling post Q95 river flow agreement)	
								Indicative ELV	Commentary
Chloride	N/A	3,993 mg/l (2,670-6,010)	700 mg/l	4,000 mg/l	1,400 mg/l	4,000 mg/l	EA proposed ELV is not currently achievable with BAT	4,600 mg/l	New permit limit
Potassium	N/A	1,112 mg/l (615-1,820)	17 mg/l	1,200 mg/l	34 mg/l	1,200 mg/l	EA proposed ELV is not currently achievable with BAT. Subject to derivation of EA assessment criteria	40 mg/l	New permit limit
Sodium	N/A	3,343 mg/l (2,360-5,190)	No value yet	4,000 mg/l	N/A	N/A	EA stated that is was unlikely to set an ELV for sodium in Sept 20	2,700 mg/l	New permit limit. SDUK stated in Jul 20 that the "EA has not yet advised an indicative ELV however if the scale of reduction is comparable to other inorganics is required, then this is unlikely to be achievable with BAT".
Iron	N/A	0.58 mg/l (0.18-2.52)	5 mg/l	5 mg/l	5 mg/l	5 mg/l	Achievable	5 mg/l	New permit limit. No change from earlier advised ELV

Parameter	Current Permit ELV	Current Emissions May-July 20	EA Jun 19 Indicative ELV	SDUK Jul 20 Proposed ELV	SDUK Nov 20 interpretation of ELVs (post Q95 flow agreement)	SDUK Nov 20 Proposed ELV	SDUK Nov 20 Commentary (prior to receipt of EA ELVs)	EA Nov 20 (re-modelling post Q95 river flow agreement)	
								Indicative ELV	Commentary
Mercury	0.6 µg/l	<0.02 µg/l (0.01-0.02)	<0.6 µg/l/ or Remove	N/A	-	N/A	EA and SDUK intention is to remove limit	-	EA intention is to remove limit for consistency with proposed position under forthcoming FD&M sector review
Cadmium	0.01 µg/l	<0.07µg/l (0.07)	<0.01µg/l or remove	N/A	-	N/A	EA and SDUK intention is to remove limit	-	EA intention is to remove limit for consistency with proposed position under forthcoming FD&M sector review

Appendix B

OPTION G - DESALINATION PROCESS FLOW DIAGRAM

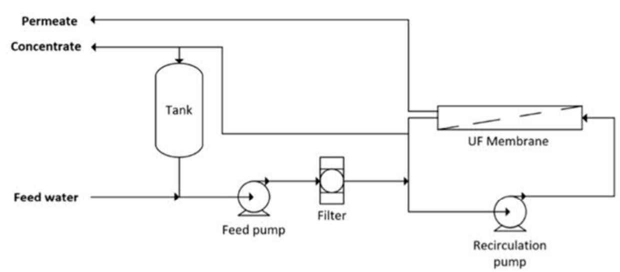
Demin & Salt Whey – Waste Treatment



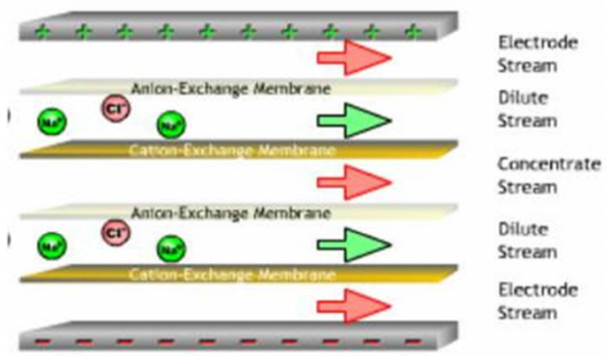
Demin & Salt Whey – Waste Treatment

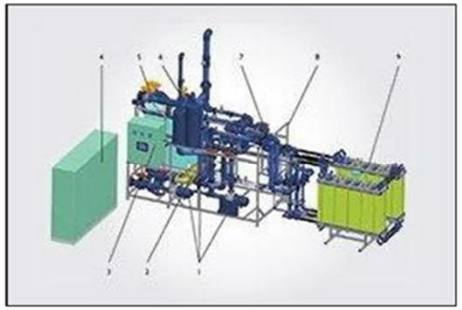
Ultra-Filtration

Process diagram

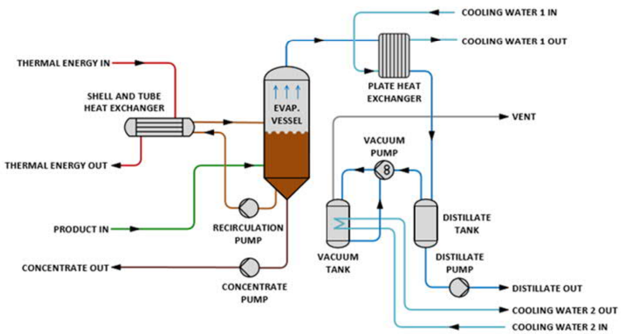


Functional principle





Vacuum Crystalisation



Electro-Dialysis Reversal

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