GOOD PRACTICE: Proven technology and techniques for profitable environmental improvement
REDUCING WASTE FOR PROFIT IN THE DAIRY INDUSTRY

This Good Practice Guide was produced by the Environmental Technology Best Practice Programme

Prepared with assistance from:

Entec UK Limited
Dairies use large amounts of water, generating high volume and high strength effluents. Water and effluent charges are a major operating cost for dairies, which face the prospect of an increase in trade effluent charges of 200 - 600% as sewage treatment works are upgraded to meet EC legislation. Implementation of the Integrated Pollution Prevention and Control (IPPC) Directive will also increase the pressure on dairy companies to reduce both water use and the generation of effluent and other wastes.

Dairies that take action to reduce waste will benefit from:

- reduced water supply and effluent charges;
- savings from reduced loss of valuable product and value gained from wastes;
- improved production efficiency.

This Good Practice Guide describes a range of techniques to help dairies of all sizes to reduce water use, effluent generation and product loss. As well as reducing their water and effluent costs, following the advice given in the Guide will help many dairies to make substantial savings by recovering product from their waste streams. Dairies that have not already implemented a systematic waste minimisation programme could reduce their water and effluent charges by at least 50% by implementing the measures outlined in this Guide.

The Guide provides a framework to enable dairies to take action based on their individual procedures. The advice is applicable to all processes in the dairy industry, including milk processing, cheesemaking, ice-cream making, yogurt production and fats/spreads production. The Guide Structure diagram opposite and the decision tree at the end of Section 1 will help companies to identify opportunities to reduce waste and save money.

All the techniques outlined in the Guide can be implemented without compromising the strict hygiene standards demanded by the dairy industry. In addition, many of the techniques require little or no capital investment.

Industry Examples throughout the Guide describe the cost savings and other benefits already achieved by different types of dairy.
Minimising water use, effluent generation and product loss

The greatest savings are made by minimising water use and effluent generation at source. Section 2 outlines the overall approach to help you do this. Specific guidance on cleaning is given in Section 3 and on reducing product loss in Section 4.

Re-using water

Once you have considered minimising waste at source, consider opportunities to re-use water back into your process or elsewhere on your site.

Gaining value from by-products

If you have not considered the potential value of your by-products, you could be missing out on sales opportunities.

Effluent strategies

Once you have reduced water and effluent as far as possible, careful consideration of effluent treatment strategies will save you money.

The way forward

This provides an Action Plan to help you make savings by reducing water use and effluent generation in your dairy.
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Dairies use large amounts of water, mainly for cleaning. The resulting wastewaters combine with wasted product to form high strength and high volume effluents. Water supply costs and trade effluent charges are therefore high.

Effluent charges are expected to increase still further as water companies seek to recoup the investment needed to upgrade their sewage treatment plants to meet the requirements of the Urban Waste Water Treatment Directive (UWWTD). Many dairies face an increase in trade effluent charges of 200 - 600%.

Implementation of the Integrated Pollution Prevention and Control (IPPC) Directive will also increase the pressure on dairy companies to reduce both water use and the generation of effluent and other wastes.

This Good Practice Guide is intended to help dairies save money by reducing water use, effluent generation and product loss. The Guide, which is applicable to all sizes of company, provides a framework to enable dairies to take action based on their individual procedures.

All of the techniques outlined in the Guide can be implemented without compromising the strict hygiene standards demanded by the dairy industry. In addition, many of the techniques require little or no capital investment.

1.1 THE BENEFITS OF REDUCING WASTE

Significant cost savings can be achieved by taking action to reduce waste in dairies, including:

- reduced water supply costs;
- reduced effluent charges;
- savings from reduced loss of valuable products;
- savings from improved production efficiency;
- revenue obtained by gaining value from by-products.

Using the measures outlined in this Guide, dairies that have not already implemented a systematic waste minimisation programme could reduce their water and effluent charges by at least 50%.

A systematic approach that reduces waste at source is the most effective approach to take and will also add to your company's bottom line. If you would like to know more about saving money through waste minimisation, there is a wealth of free material available from the Government's Environmental Technology Best Practice Programme. Contact the Environment and Energy Helpline free of charge on freephone 0800 585794.
1.1.1 Industry Examples

Many companies have already achieved worthwhile cost savings and have not compromised hygiene standards. Table 1 shows examples of successful projects, more details of which are given later in the Guide.

<table>
<thead>
<tr>
<th>Company</th>
<th>Techniques used</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Savings of £7,000/year. Payback of just over one year.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Savings of £13,500/year. Immediate payback.</td>
</tr>
<tr>
<td>Express Dairies – two sites:</td>
<td>Reducing the amount of product left in process equipment prior to cleaning, by using turbidity meters and increased visual inspection. At the Frome site, conductivity meters control the addition of CIP rinse water.</td>
<td>40% reduction in effluent COD.</td>
</tr>
<tr>
<td>Direct Service Division (Ruislip)</td>
<td></td>
<td>50% reduction in effluent COD.</td>
</tr>
<tr>
<td>Added Value Division (Frome)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taw Valley Creamery</td>
<td>Reducing the amount of product left in process equipment prior to cleaning.</td>
<td>65% reduction in effluent COD. Avoided the need to expand the effluent treatment plant at an anticipated cost of £2 million. Waste minimisation measures have resulted in a total of £3.5 million savings since 1994.</td>
</tr>
</tbody>
</table>

Table 1 Examples of cost savings achieved by UK dairies

You too can achieve attractive cost savings using the techniques outlined in this Guide.

Worthwhile savings can be obtained in all areas covered by the Guide, but the most effective way of cutting effluent costs is to reduce water use and product losses at source.

Most of the Industry Examples are applicable to all dairy processes, however, they are coded according to their origin as follows:

- **Milk processing**
- **Cheesemaking**
- **Other processes, including ice-cream making, yogurt production and fats/spreads production**

Fig 1 contains a decision tree to help you identify opportunities to achieve cost savings at your site.
An Action Plan in Section 8 summarises the steps you need to take to reduce water use and effluent production and thus increase your profits. Further details of the free help and advice available from the Environmental Technology Best Practice Programme is also given in Section 8, along with a publications list.
The most effective way of cutting effluent costs is to reduce water use and product losses at source. Simple measures to reduce the amount of water used will decrease the volume of effluent produced, while dairy products such as milk and whey have a high chemical oxygen demand (COD) and thus increase effluent strength considerably. Reducing the volume and strength of your effluent will reduce your trade effluent charges. Alternatively, if you treat your effluent on-site, this will reduce the load on the effluent treatment plant (ETP), thus minimising capital and operating costs.

Minimising water use and product loss will:

- reduce water purchase costs;
- reduce the costs of effluent treatment or disposal;
- reduce waste of valuable product.

These cost savings are illustrated in Fig 2, which highlights the true cost of dairy wastes rather than just the costs of effluent.

**Fig 2** The true cost of dairy wastes

Reducing water use and effluent generation will make your process more efficient.

### 2.1 IDENTIFYING CURRENT WATER USE AND EFFLUENT GENERATION

Understanding how water is used and product is wasted in your process is an essential first step to making cost savings.

Fig 3 shows water, effluent and product flows in a typical dairy process. Constructing a similar diagram for your plant will help you to:

- identify information gaps;
- focus your efforts to reduce waste.

Calculating a ‘water balance’ showing all uses and losses will help you to identify opportunities to save money by reducing water use and effluent generation.
2.2 THE SCOPE FOR SAVINGS

Knowing what can be achieved and what others have achieved, will help you to set improvement targets for your company. Performance benchmarks relate effluent parameters to a unit of production and are thus independent of the volume of production. They provide a useful indication of how well you are performing.

Use the benchmarks given overleaf to assess your performance and to identify the scope for further improvements. These benchmarks are not necessarily the best performance achievable - you may be able to make even greater improvements.

**Dairy reduces effluent COD/tonne of milk processed by 65%**

Many dairies monitor the amount of biodegradable material in their effluent per tonne of milk processed. For example, over the last five years Taw Valley Creamery has reduced this 'effluent to milk factor' from 7.9 kg COD/tonne of milk processed to 2.5 kg COD/tonne of milk. This reduction has been achieved by decreasing product loss and improving the CIP system.

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**Fig 3 Typical water uses and effluent sources in a dairy**

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**Good Practice Guide (GG152) Tracking Water Use to Cut Costs** describes how to develop and use a water balance. GG152 is available free of charge through the Environment and Energy Helpline on freephone 0800 585794.
2.2.1 Effluent benchmarks

Reducing the flow and strength of your final effluent will help you to reduce your trade effluent charges. The following benchmarks should be achievable using the techniques outlined in this Guide.

- At the ETP intake or discharge point, the flow of milk-processing effluent should be less than 1 m³/tonne of milk processed.
- Effluent COD levels should be less than 3.8 kg/tonne of milk processed. Levels of 1.5 kg of COD/tonne of milk can be achieved. (NB COD is normally about 1.5 times biochemical oxygen demand (BOD)).
- Effluents from cheese and butter production plants should contain less than 3 kg of COD/tonne of product.

2.2.2 Product loss benchmarks

Table 2 shows achievable limits on the amount of product loss for dairies expressed as a percentage of the volume of milk, fat or whey processed.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Milk (%)</th>
<th>Fat (%)</th>
<th>Whey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer milk</td>
<td>1.90</td>
<td>0.70</td>
<td>N/A</td>
</tr>
<tr>
<td>Butter (with skimmed milk transported off-site)</td>
<td>0.17</td>
<td>0.14</td>
<td>N/A</td>
</tr>
<tr>
<td>Butter and skimmed milk powder</td>
<td>0.60</td>
<td>0.20</td>
<td>N/A</td>
</tr>
<tr>
<td>Cheese</td>
<td>0.20</td>
<td>0.10</td>
<td>1.6</td>
</tr>
<tr>
<td>Cheese and whey</td>
<td>0.20</td>
<td>0.10</td>
<td>2.3</td>
</tr>
<tr>
<td>Full cream milk powder</td>
<td>0.64</td>
<td>0.22</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 2 Product loss benchmarks

2.3 SETTING TARGETS

To set appropriate and realistic targets for your dairy, you first need to quantify your current performance. This also acts as a base-line for measuring savings.

- Review the processes that use water, starting with the ones that have the highest consumption. Establish the minimum amount of water required for a given job by talking to production staff, checking equipment specifications and holding discussions with suppliers. Any use greater than the minimum is waste.
- Review the processes that generate effluent, starting with those that generate high strength and/or high volume flows. Identify potential opportunities for reducing the concentration and volume of the effluent, thus reducing the load on your ETP or reducing your trade effluent charges.
- Compare your dairy’s performance with the benchmarks given above. Find further examples of good practice by talking to other dairies and your trade association.
- Having identified the scope for improvement, estimate the potential improvement from the range of measures you plan to apply to your site. Possible measures you can take are described in subsequent Sections of this Guide.

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2.4 MAKING SAVINGS

Techniques to reduce water use and effluent generation in dairies include:

- no-cost measures, eg turning off taps or hoses when not in use;
- low-cost measures, eg installing level-gauges in tanks;
- high-cost measures, eg the redesign of pipework.

No-cost measures, eg good housekeeping measures, should be introduced immediately. Low-cost and high-cost measures may require more consideration, eg assessment of the payback period, before you decide to implement them.

For dairies, the most important techniques for reducing water use, effluent and waste are concerned with:

- minimising water used in cleaning (see Section 3);
- minimising product losses (see Section 4).

Fig 4 summarises the steps you need to take to make savings.

2.4.1 The importance of training

Educating and training staff in water and waste minimisation techniques is vital to the success of your improvement programme. Without the co-operation and commitment of staff, you will not achieve the full potential savings. In addition, many no-cost improvements can be achieved by increasing staff awareness and explaining the reasons for new procedures.

You will find it helpful to:

- Raise the awareness of the true cost of water and effluent at your dairy. Relate this figure to the sales of product needed to offset these costs.
- Encourage staff to suggest ideas to save water or reduce product loss. Acknowledge all ideas and recognise good ones.
Provide regular information on water use and effluent generation to reinforce the message that people can make a difference. Each month, display a simple graph or chart of water and effluent cost trends on notice-boards.

Raise staff awareness of water and effluent issues by showing them round the site’s water and effluent treatment facilities. Explain the consequences of increased product loss on the performance of the effluent treatment plant.

People issues are discussed in more detail in Good Practice Guide (GG27) *Saving Money Through Waste Minimisation: Teams and Champions*. GG27 is available free of charge through the Environment and Energy Helpline on freephone 0800 585794.
In the dairy industry, cleaning water can account for 50 - 90% of the site’s water consumption. Optimising the use of water and cleaning chemicals can significantly reduce costs without compromising cleaning efficiency.

Cleaning is a vital part of your process. It ensures that hygiene standards are met and minimises the risk of contamination. However, meeting hygiene requirements does not rule out the potential for minimising water use and effluent generation.

This Section outlines practical ideas for minimising water use in both automatic and manual cleaning systems. Detailed advice is given in Good Practice Guide (GG154) Reducing the Cost of Cleaning in the Food and Drink Industry, available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

### 3.1 AUTOMATIC CLEANING SYSTEMS

Cleaning-in-place (CIP) systems clean equipment automatically to a high standard. CIP systems typically start with a pre-rinse to remove solids, followed by a chemical wash with caustic and acid solutions, and finish with a rinse using a sterilising solution to remove the wash chemicals.

**Major benefits from new detergent system**

The acid solution used by an Australian dairy in its CIP system contained nitrates and phosphates that had implications for its effluent. The dairy examined alternatives and introduced a new detergent, a mixture of cleaning activators, wetting agents and anti-foaming agents. When used in conjunction with caustic soda, the detergent eliminates the need for an acid cleaning stage. The new detergent system uses 25% less water and reduces the cleaning time by 25%, thus decreasing production downtime.

With CIP systems, water use and effluent generation can be minimised in a number of ways, including:

- Removing as much product as possible before the pre-rinse (eg by using a pigging system, see Section 4.2) to reduce water use for flushing out solids and residues. Chemical use and effluent concentration will also be reduced. In addition:
  - check that vessels, tanks and pipes have been drained as fully as possible;
  - install collection trays or containers that can be removed before running the CIP cycle.

- Optimising the amount of water used in the pre-rinse by shutting off the water supply as soon as the solids have been flushed through. A pre-rinse controlled by a timer may use unnecessary amounts of water. If your process is consistent and reliable, timing devices can be set to provide the optimum rinse. Otherwise, consider visual inspection or use of turbidity meters.

- Optimising CIP controls to ensure that the optimum amount of water is used. Individual CIP programmes should also be tailored to avoid excessive use of chemicals and energy.

- Using cleaning chemicals, eg foaming chemicals and gels, to reduce the amount of cleaning water required. Consult chemicals suppliers to assess the costs and benefits of such chemicals.
Modifications to the set-up of a CIP system can be carried out during plant shutdown periods. Any major alterations should be performed by qualified engineers.

### 3.1.1 Optimising CIP control

Dairies often find considerable potential for water savings through optimising the control of their CIP system. Review your CIP system to establish cleaning requirements and then calculate the optimum conditions.

When optimising a CIP system, ensure that cleaning always meets hygiene requirements. Any changes in CIP control should be monitored closely. Look at the cleaning efficiency as well as the effect on effluent production and quality.

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**New CIP controls save £7 000/year**

Dansco Dairy Products installed new programmable logic controllers on its milk intake CIP system (see below). The new controls allow Dansco to optimise CIP water use by adjusting the time settings. Water consumption has fallen by 24 m³/day - a saving worth £7 000/year. The new controls cost £8 000, giving a payback period of just over a year.

Plans to make similar changes to Dansco’s larger CIP systems are expected to produce even greater savings.
If your CIP system involves pH control, it is also important to optimise chemical additions to minimise pH fluctuations in the effluent. Otherwise, excessive amounts of chemicals will be needed to control the pH of the effluent.

**pH control produces significant savings**

At Dansco Dairy Products, careful control of the CIP chemical dosing system maintains the pH of the effluent entering the ETP in the range pH 5 - 7. Improved control has reduced the amount of balancing chemicals required, saving an estimated £17 000/year compared to previous performance. After allowing for the costs of extra sampling, net savings are estimated at £15 000/year.

Information on optimising CIP systems is given in Good Practice Guide (GG154) *Reducing the Cost of Cleaning in the Food and Drink Industry* and Good Practice Guide (GG220) *Low-cost Process Control in Food and Drink Processing*. Both Guides are available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

### 3.2 MANUAL CLEANING

Manual cleaning is still common in dairies and can offer scope for significant water savings. Methods include the use of hoses, pressure washers and conventional bucket techniques.

Ways of reducing water use and effluent strength include:

- Dry cleaning waste on floors, eg with a rubber blade wiper, before hosing down areas.
- Placing trays and containers under machines or within a process to catch solid wastes prior to washing down. Ensure that trays are emptied regularly so that you avoid overfilling.
- Fitting trigger-action guns to hoses (see below).
- Using low-cost screens to prevent solids entering the wastewater stream and increasing the effluent load. This is particularly effective in creameries where solids are often washed down the drain.
The advantages and disadvantages of manual cleaning are summarised in Table 3.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>A good method for unusually shaped and inaccessible machinery.</td>
<td>Labour-intensive and so normally the most expensive cleaning technique.</td>
</tr>
<tr>
<td>Often the only method for water-sensitive machinery.</td>
<td>Can present a potential hazard to employees when cleaning complex equipment.</td>
</tr>
<tr>
<td>Can be used on its own or for initial cleaning prior to another method.</td>
<td>Water and chemicals can be wasted through poor operating practices.</td>
</tr>
<tr>
<td>Can be efficient in terms of overall water consumption and effluent costs.</td>
<td></td>
</tr>
</tbody>
</table>

Table 3  Advantages and disadvantages of manual cleaning

If employees are provided with appropriate training, the right equipment and are well-managed, then manual cleaning can be an efficient and cost-effective process. Improvements include:

- Consider whether the need for cleaning can be prevented or reduced, eg:
  - improve waste collection systems, eg trays to collect waste as it falls;
  - improve product scheduling;
  - cleaning-as-you-go, ie cleaning as soon as possible after use and not leaving equipment until wastes have hardened;
  - ensure equipment is well-maintained, eg leaks and spillages can often be avoided by ensuring that bolts and couplings are tightened properly and are in good repair.
- Fit automatic shut-off taps.
- Ensure the correct cleaning aids are used and that they are in good condition.
- Check cleaning equipment is being operated properly.
- Use a chemical dosing system to ensure the concentrations are correct.
- Investigate alternative equipment and methods.

Good Practice Guide (GG154) Reducing the Cost of Cleaning in the Food and Drink Industry\(^2\) includes a good housekeeping checklist and a dryclean-up checklist in addition to detailed advice on all types of cleaning.

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\(^2\) Available free of charge through the Environment and Energy Helpline on freephone 0800 585794.
Reducing product loss from your process not only avoids wasting valuable product but will reduce effluent treatment costs.

**Waste minimisation programme saves £3.5 million in four years**

In 1994, Taw Valley Creamery was advised that increased production would necessitate expansion of its ETP. This would have cost around £2 million. Instead, the Company decided to implement a waste minimisation programme. This proved very successful, with a 65% reduction in effluent COD over a four-year period. This was achieved through minimising the product left in the process equipment prior to cleaning, and training staff in the importance of reducing product waste.

As well as avoiding the need for capital investment of £2 million, Taw Valley Creamery has saved a total of £3.5 million since 1994 through measures to minimise water use, waste generation and energy consumption. These are net savings after accounting for all project costs.

**4.1 IDENTIFYING SOURCES OF LOSS**

The first step is to identify the areas where product loss occurs. Walking around your processing area and talking to operators should help you to identify the main points at which product is lost.

Examples of how product loss occurs include:

- product left in tanks and pipes which is not recovered;
- fittings and couplings that leak;
- vessels that overflow, eg vessels that are filled before mixing may overflow when mixing starts;
- loss of product onto the floor during handling and transfer.

Fig 5 shows key areas to check for product loss.
Having identified sources of product loss, start by tackling the areas with the greatest loss.

### Improved control reduces product loss and effluent strength

Over the last five to six years, two Express Dairies sites have adopted improved control techniques to identify and reduce product loss - improving yield while also reducing effluent strength and treatment/disposal costs. These techniques include visual checks and the installation of turbidity meters to ensure that excessive COD is not being generated. At Frome, conductivity meters are also used to control the product/rinse water interface so as to ensure the maximum amount of product is recovered and the minimum left to be flushed to drain during the CIP. This reduction in product loss will significantly lower COD in the wastewater from the CIP.

As a result, significant reductions in the levels of COD in wastewater have been achieved - 40% at the Direct Service Division site in Ruislip, and 50% at the Added Value Division site in Frome.

### 4.2 REMOVING PRODUCT BEFORE CLEANING

To improve the efficiency of your process ensure that, wherever possible, product is removed from tanks, vessels and pipes prior to cleaning. This will also reduce the strength of the effluent from the cleaning process.

A ‘pigging’ system is the most effective method of purging a pipe. Such systems remove product from a line using a ‘ram’ (or pig) and without using any water. Pigging systems can be used in most processes and offer good paybacks.

When investigating pigging systems, compare the cost of the investment against the savings in recovered product, reduced water use (if you currently use a water purge) and lower effluent treatment costs.

Where pigging is unsuitable, alternative methods of purging pipes include the use of water or air. If water is used, ensure that controls are in place to minimise water carryover into your process.

If the collected material cannot be directly recovered into your process, consider diverting it to a holding tank and selling it as a by-product (see Section 6). Even if you do not obtain any money for the material, you will save in effluent treatment and/or waste disposal costs.

Good Practice Guide (GG220) Low-cost Process Control in Food and Drink Processing describes suitable measurement and control devices to help you minimise product losses. GG220 is available free of charge through the Environment and Energy Helpline on freephone 0800 585794.
Once you have investigated ways of minimising water use and effluent generation at source, consider opportunities to re-use wastewater back into the process or elsewhere on-site.

Wastewater from each process should be regarded as used water with the potential for re-use, until it is too contaminated for any further use. For example, using mains water or softened water for pre-rinsing is inefficient if used water could be utilised instead.

Identifying opportunities for re-using water requires a good understanding of both your site water use and your processes. Good Practice Guide (GG152) Tracking Water Use to Cut Costs\(^3\) will help you to identify opportunities for re-using water.

To assess the potential for re-using water on your site:

- produce a flow diagram showing all water uses and wastewater flows;
- look for water uses that do not require mains or softened water;
- where the quality of the used water is not good enough, consider diluting it with mains water or employing techniques such as screening or filtering.

The matrix in Table 4 summarises water re-use opportunities in dairies.

<table>
<thead>
<tr>
<th>Wastewater</th>
<th>Vehicle washing</th>
<th>Crate washing</th>
<th>Manual cleaning of equipment</th>
<th>CIP pre-rinse</th>
<th>CIP main wash supply</th>
<th>CIP final rinse</th>
<th>Water purge of product lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIP-used cleaning solution</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CIP final rinse</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Condensate</td>
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<td>2</td>
<td>1</td>
<td>2/3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Permeate from reverse osmosis plant</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Key:  
1. Direct re-use.  
2. Some screening of solids required.  
3. Re-use after suitable membrane separation (see Section 7.2.3).  

Table 4 Water re-use opportunities at a dairy

\(^3\) Available free of charge through the Environment and Energy Helpline on freephone 0800 585794.
5.1 EXAMPLES

5.1.1 CIP liquids
CIP systems provide excellent opportunities to re-use the final rinse water as a pre-rinse. Although the final rinse may contain cleaning solution, high quality water is not required for the pre-rinse (designed to remove solids before the main cleaning cycle). To evaluate the potential benefits of re-using final rinse water, compare the cost of installing the necessary pipework and a holding tank to the anticipated savings in water and effluent costs. Don’t forget to allow for possible forthcoming increases.

Re-using water to wash crates helps reduce effluent costs
A dairy has implemented a series of measures to minimise effluent, including reducing product waste and re-using lightly soiled water for washing bottle crates. Effluent costs have been reduced by 50%, saving £35,000/year.

Caustic and acid solutions from CIP of operations, such as the evaporation and drying of milk, can be re-used following the removal of fine particles, colour and BOD/COD using nanofiltration membranes.

5.1.2 Reverse osmosis permeate
Reverse osmosis, which is used primarily to concentrate whey from creameries, generates a high quality permeate that can have a number of uses on site.

Use of reverse osmosis permeate saves £13,500/year
Dansco Dairy Products uses water from a reverse osmosis plant to feed its hose network. This reduces the site’s demand for mains water by an estimated 50 m³/day, saving £13,500/year.

5.1.3 Steam condensate
Steam condensate is often considered as a waste by dairies and discharged to drain with the loss of valuable heat. However, it can be used for pre-heating, thus reducing energy costs. A good example is for pre-heating milk prior to pasteurisation in older equipment where pre-heating is not already a feature. After the heat has been removed, the water can be re-used in low-grade applications, eg pre-rinsing or crate washing.

Heat recovery from steam condensate saves dairy £12,000/year
An Australian dairy used to send steam condensate to drain. Installing new equipment to use the condensate to pre-heat milk prior to pasteurisation and then re-using the water in a CIP system, saved the company £12,000/year. With an initial investment of £6,500, the payback period for the project was 6.5 months.

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4 Good Practice Guide (GG54) Cost-effective Membrane Technologies for Minimising Wastes and Effluents provides further details of nanofiltration and other membrane technologies. GG54 is available free of charge through the Environment and Energy Helpline on freephone 0800 585794.
Section 4 looked at minimising product loss, and Section 5 looked at ways of re-using wastewater. Some of these techniques, eg reverse osmosis, have the added benefit of recovering valuable by-products and other materials. Most dairy wastes can be re-used, either in your own process, or as a by-product that can be sold. Therefore, it is important to consider any waste or by-product as potentially valuable. For example, the treatment system used by Joseph Heler Ltd not only produced demineralised water but also recovered whey protein and lactose. The separated whey products are sold, providing important income (see Section 6.2).

This Section outlines some of the techniques for gaining value from common dairy wastes or by-products, eg:

- customer returns and dairy by-products from the process;
- whey from creameries;
- sludge from effluent treatment plants.

Mixing your process and foul waste streams makes it impossible to gain value from by-products. Cost benefits from the collection, treatment and re-use or sale of dairy by-products may justify changes to your sewerage network to keep process by-product and foul waste streams separate. Such changes may also make effluent treatment easier (see Section 7).

If you haven't considered the potential by-products in your wastes, you could be missing out on revenue opportunities.

### 6.1 RE-USE OF DAIRY BY-PRODUCTS

#### 6.1.1 Utilising dairy by-products on-site

In certain cases, dairy wastes and by-products can be re-used on-site. Where dairy solids have been collected to reduce the effluent load (see Section 4), these solids can sometimes be re-used in the production process. This reduces raw material requirements and saves disposal costs. Careful evaluation of these opportunities is required to ensure that quality and hygiene standards are met.

**Product recovery pays off**

A milk and ice-cream producer in the USA recovers product from the product filler systems, initial rinses and ice-cream remelt. The company recovers 11 000 litres/day of product by careful control of the process and ensuring, where possible, that product does not remain in vessels or transfer pipes. The payback period for the project was less than one year.

#### 6.1.2 Other uses of dairy by-products

Dairy by-products can sometimes be used in other manufacturing processes. Although these opportunities are less easy to investigate, they can produce some good returns.

**Milk fat production waste may become soap**

An Australian dairy had never considered a by-product of anhydrous milk fat production (a mixture of caustic soda and free fatty acids with 5% solids) to have a use. The company is now investigating the opportunity for selling this material to commercial soap manufacturers.
By-products from your process that cannot be re-used can be sold as an animal feed. Many dairies have tanks in which to store suitable by-products and customer returns for use as pig feed. Although the price paid for such material is low, the amount of effluent requiring treatment and other waste disposal costs are less - resulting in useful cost savings.

6.2 WHEY RECOVERY

Whey is classed as sweet (typically pH 5.8 - 6.6), medium acid (typically pH 5 - 5.8) and acid (typically pH less than 5). Whey from cheeses coagulated with rennet has low levels of acidity, whereas production of fresh acid cheeses such as cottage cheese produces a more acidic whey.

**Whey recovery raises £685 000/year for Cheshire creamery**

Joseph Heler Ltd recovers whey from its cheesemaking process using membrane technology. Whey protein and lactose recovered by the three-stage process (ultrafiltration, nanofiltration and reverse osmosis) are sold as high-quality products, while demineralised water recovered from the process at a rate of 150 m³/day is used as boiler feedwater.

Net cost savings of £685 000/year have been achieved, giving a payback period of 1.5 years on capital costs of £1.02 million.

Full details are given in Good Practice Case Study (GC150) *Turning Waste into Profit*, available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

Cost-effective opportunities exist to recover whey from dairy waste. Whey can be used in animal feeds, eg in calf milk replacement, while powdered whey serves as a natural ingredient in a number of applications, eg:

- food supplements;
- human milk substitutes;
- infant formulas;
- diet preparations.

Reverse osmosis is commonly used to increase whey concentrations from typically 6% to around 25%. Increasing the concentration reduces the transport costs of removing whey from the site. Provided sufficient quantities of whey are produced, the payback period for whey recovery is normally acceptable. The whey can sometimes be concentrated further by external contractors using conventional drying methods.

Whey drying in spray or roller dryers increases the concentration beyond the levels produced by reverse osmosis. However, these drying systems are not economical for most dairies.
6.3 SLUDGE UTILISATION

Effluent treatment plants at dairies produce large amounts of sludge, which has value due to its high nutrient content. Your sludge could be sold for use as a fertiliser without further treatment - with a potential value of up to £100/tonne. Sludge thickening will increase the concentration and thus reduce transport requirements. However, before investing in sludge thickening equipment, check your customers’ requirements, as some outlets prefer sludge that has not undergone too much thickening.

Its high organic content also makes the sludge a useful compost or soil conditioner. However, the cost of drying the sludge to reduce its water content for this application is a major barrier. More efficient technologies are now available that use superheated steam rather than hot air to dry the sludge. These new technologies can recover up to 80% of the heat used in drying. When considering this option, it is important to compare the costs of installing and operating a drying system with the potential revenue from compost sales.

The environmental impact of landspreading industrial sludges (including dairy sludges), either directly or after composting, is coming under increasing scrutiny.

For advice on the latest rules governing the landspreading of industrial wastes, contact your trade association, local MAFF office or waste regulator (Environment Agency, Scottish Environment Protection Agency or Northern Ireland Environment and Heritage Service).
Depending on the size of your operations, on-site effluent treatment may not be feasible. In such cases, discharge to the local sewage treatment works as trade effluent will often be the solution. However, trade effluent charges are rising steeply as water companies upgrade their plants to comply with the Urban Waste Water Treatment Directive and some sewage works are refusing to accept high strength dairy effluents.

Producing less effluent in the first place will save money by either reducing trade effluent charges or reducing the demands on your effluent treatment plant (ETP). When all possibilities for minimising the amount and strength of your effluents have been investigated, effluent treatment techniques should be reviewed and optimised.

Your effluent treatment plant will cost less to build and run if the dairy produces less effluent in the first place. Significant cost savings can be achieved by reducing both the amount and strength of raw effluent entering the ETP.

7.1 THE IMPORTANCE OF SEGREGATION

To assess your effluent treatment options, carry out a survey of your process to identify the characteristics of your effluent. Draw a map of the different waste streams and determine the flow rates, strengths and compositions of these streams.

Keeping different waste streams separate will allow you to adopt the most cost-effective option for each waste. Consider the following points.

- Are foul waste streams included in your effluent? Keeping process waste separate from foul wastes could enable you to recover value from your effluent.
- Is rainwater included? Uncontaminated rainwater does not require treatment and is charged by water companies at the lower domestic sewage rate. However, if rainwater is not segregated from your process effluent, you are likely to be paying trade effluent charges for its disposal.
- Dilute process effluents may not require treatment and could potentially be re-used or discharged directly to sewer. Segregating your more concentrated process effluents may allow you to recover value or adopt a more cost-effective treatment option.

7.2 TREATMENT TECHNIQUES

Treatment of dairy effluents involves primary treatment by a physical separation method and sometimes secondary biological treatment. Tertiary treatment, eg reverse osmosis, can be used to produce a high purity water suitable for a wide range of re-use applications. It is also used for whey recovery (see Section 6.2). These treatment processes are described briefly opposite.

A detailed, step-by-step approach to selecting and implementing the most suitable effluent treatment system for your site is described in Good Practice Guide (GG109) Choosing Cost-effective Pollution Control. Worksheets and matrix tables are provided to help you characterise your effluents and evaluate your options.

Available free of charge through the Environment and Energy Helpline on freephone 0800 585794.
7.2.1 Primary treatment

Primary treatment normally consists of screening, flow equalisation, neutralisation and dissolved air flotation (DAF)\(^6\) to remove fats and suspended solids. Solids removal not only helps the sewage treatment plant to run more efficiently, but also helps to reduce the effluent load.

DAF units (see below) are popular in the dairy industry because they can remove solids efficiently. The solids adhere to gas bubbles generated within the wastewater or sludge and float to the surface, where they are scraped off.

![DAF unit at Dansco Dairy Products](image)

Effluents that have undergone primary treatment can generally be discharged as trade effluent. Alternatively, you may wish to consider secondary treatment to reduce your trade effluent charges.

7.2.2 Secondary treatment

Secondary treatment methods use the biological action of micro-organisms to reduce effluent BOD. If sufficient space is available, land treatment or stabilisation pond systems are potentially cost-effective. Other options include conventional aerobic biological treatment processes such as activated sludge, trickling filters and rotating biological contactors.

7.2.3 Tertiary treatment

This type of treatment has become increasingly popular for recovering valuable wastes and/or purifying effluents to make them suitable for re-use in the process.

Membrane technologies are the most common tertiary treatment in dairies. The main types are ultrafiltration, nanofiltration, microfiltration and reverse osmosis. Of these technologies, reverse osmosis achieves the highest level of pollutant removal. More information about membrane technologies is given in Good Practice Guide (GG54) *Cost-effective Membrane Technologies for Minimising Wastes and Effluents*, available free of charge through the Environment and Energy Helpline on 0800 585794.

For advice on treatment requirements for effluents, contact your local regulator (Environment Agency, Scottish Environment Protection Agency or Northern Ireland Environment and Heritage Service) and/or your local water company. For information about the latest environmental legislation, contact the Environment and Energy Helpline on freephone 0800 585794.

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\(^6\) For more information about the operation of a DAF unit, see Good Practice Guide (GG37) *Cost-effective Separation Technologies for Minimising Wastes and Effluents*. GG37 is available free of charge through the Environment and Energy Helpline on freephone 0800 585794.
This Guide provides you with a framework to help you achieve cost savings by reducing waste. Industry Examples throughout the Guide show how companies from all sectors of the dairy industry have used different methods to achieve worthwhile savings.

Consider the cost-saving measures suggested in the Guide. Review your process in conjunction with production and operational staff to identify the most cost-effective techniques for your circumstances.

Many measures require no capital expenditure - just a different way of doing things. These should be considered immediately.

Other opportunities to save money may involve buying low-cost devices, eg fitting trigger-action guns to hoses, or require more significant investment, eg new pipework runs. You may need to assess the payback before deciding whether to implement these projects. For detailed guidance on the financial appraisal of potential projects, see Good Practice Guide (GG82) Investing to Increase Profits and Reduce Wastes. GG82 is available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

Remember to establish a base-line against which to measure your first savings. This will help to maintain commitment from senior management and plant operators.

Fig 6 shows an Action Plan to guide you through the steps you need to take to reduce waste and increase profits in your dairy.

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If necessary, obtain help.
The Environment and Energy Helpline (0800 585794) can:

- Send you copies of relevant Environmental Technology Best Practice Programme publications, eg advice about implementing a systematic waste minimisation programme.
- Tell you about relevant environmental and other regulations that could affect your operations.
- Provide free, up-to-date information on environmental issues, equipment suppliers and technologies described in this Guide.
- Arrange for a specialist to contact your company if you employ fewer than 250 people, this is at the discretion of the Helpline Manager.
8.1 Free advice from the Environmental Technology Best Practice Programme

Many of the water and waste minimisation ideas described in the following free publications from the Environmental Technology Best Practice Programme can be applied to dairies.

- Good Practice Guide (GG26) Saving Money Through Waste Minimisation: Reducing Water Use;
- Good Practice Guide (GG67) Cost-effective Water Saving Devices and Practices;
- Good Practice Guide (GG120) Cost-effective Vessel Washing;
- Good Practice Guide (GG135) Reducing Water and Effluent Costs in Breweries;
- Good Practice Guide (GG152) Tracking Water Use to Cut Costs;
- Good Practice Guide (GG154) Reducing the Cost of Cleaning in the Food and Drink Industry;
- Good Practice Guide (GG157) Reducing the Cost of Packaging in the Food and Drink Industry;
- Good Practice Guide (GG220) Low-cost Process Control in Food and Drink Processing;
- Good Practice Guide (GG243) Packing Line Savings in the Food and Drink Industry;
- Environmental Performance Guide (EG126) Water Use in the Soft Drinks Industry;
- Good Practice Case Study (GC41) Family Brewery Makes Big Water Savings;
- Good Practice Case Study (GC150) Turning Waste into Profit;
- Good Practice Case Study (GC202) Cutting Water and Effluent Costs in Fish Processing;
- WMIT (Waste Minimisation Interactive Tools) (IT96) This PC-based software tool helps companies to identify the sources of their waste, calculate its true cost and take practical steps to reduce it.

All of these publications are available free of charge through the Environment and Energy Helpline on freephone 0800 585794.

Free advice on improving energy efficiency in dairies

Reducing Energy Costs in Dairies: A Guide to Improved Profitability (Good Practice Guide 209)

The Liquid Milk Sector of the Dairy Industry (Energy Consumption Guide 26)

Energy Monitoring and Target Setting at a Dairy (Good Practice Case Study 138)

These and other publications from the Energy Efficiency Best Practice Programme are available free of charge through the Environment and Energy Helpline on freephone 0800 585794.
The Environmental Technology Best Practice Programme is a Government programme managed by AEA Technology plc.

The Programme offers free advice and information for UK businesses and promotes environmental practices that:

- increase profits for UK industry and commerce;
- reduce waste and pollution at source.

To find out more about the Programme please call the Environment and Energy Helpline on freephone 0800 585794. As well as giving information about the Programme, the Helpline has access to a wide range of environmental information. It offers free advice to UK businesses on technical matters, environmental legislation, conferences and promotional seminars. For smaller companies, a free counselling service may be offered at the discretion of the Helpline Manager.

FOR FURTHER INFORMATION, PLEASE CONTACT THE ENVIRONMENT AND ENERGY HELPLINE

0800 585794

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