ENVIRONMENTAL
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EG69
GUIDE

WATER USE IN UK PAPER AND BOARD MANUFACTURE

AN ENVIRONMENTAL PERFORMANCE GUIDE: The benchmark for profitable environmental improvement

WATER USE IN UK PAPER AND BOARD MANUFACTURE

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

Prepared with assistance from:

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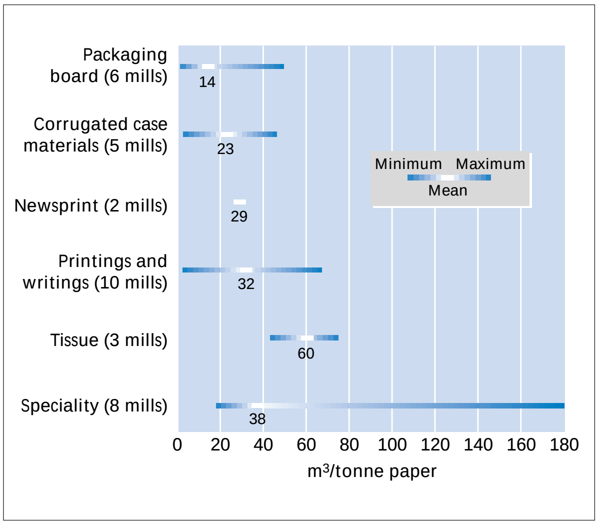
RECYCLED

SUMMARY

Water is essential to the manufacture of paper and board and, in volume terms, is the most significant material involved in the manufacturing process. In some regions of the UK, the industry makes considerable demands on water resources. Furthermore, only a small proportion of the water used is actually removed from the water cycle with the finished product, while the remaining water is discharged as an effluent that requires expensive final treatment to reduce its polluting impact.

Over the years, the industry has worked to reduce its specific water consumption - the volume of water required to produce a single tonne of paper. Much has been achieved through capital investment, with each new generation of papermaking plant incorporating more sophisticated water minimisation measures. However, environmental and regulatory pressures are increasing the cost burden associated with high volumes of water consumption, and recent guidance from the regulatory bodies has directly encouraged mills to consider further water minimisation measures.

As the Figure shows, there are significant variations in specific water consumption within each of the major industry sectors. This Environmental Performance Guide illustrates how costs of water supply, use and discharge vary enormously between those mills manufacturing similar products. For example, in mills manufacturing printings and writings grades the costs of supply vary from 22 pence to £6.92 for each tonne of paper produced, while the costs of effluent discharge vary from one penny to £7.18 per tonne of paper. Reducing rates of consumption can control these variable production costs and help to improve profitability within a highly competitive market.



Specific water consumption range per sector

The Guide is designed to assist those paper mills that are seeking to control their water use. It is based on data provided by The Paper Federation of Great Britain, which have been updated through a telephone survey, and provides information on:

- water sources and discharge routes;
- rates of specific water consumption and how these vary within and between the different industry sectors;
- the costs of water supply and discharge and how these vary within and between the different industry sectors;
- practices commonly adopted to restrict water consumption, notably water management techniques, good housekeeping measures and plant and process modifications;
- barriers to further improvement.

Using the information contained within this Guide and the Action Plan provided, each mill will be able to assess its own performance in relation to that of other comparable mills. Each mill should also be able to reach a fuller understanding of the costs inherent in its current level of water use. In addition, this Guide will help mills to assess the scope for cost savings arising out of water minimisation measures, and some of the technologies and techniques are highlighted that can deliver these savings as part of an improvement plan.

CONTENTS

1 WHY WORRY ABOUT WATER?

Water is essential to the manufacture of paper and board and has traditionally been supplied at low or zero cost. As a result, and particularly in view of the financial and manpower resources required to improve the efficiency with which water is used, there have been few incentives to control the industry's consumption.

This situation is now changing. The large-scale use of water is imposing increasing financial burdens on the user and this, together with various other 'drivers' (Fig 1), is encouraging the paper and board industry to give greater priority to more efficient water use. At the same time, technological advances and improvements in manufacturing practice are demonstrating that water consumption, like the consumption of other raw materials, can be effectively controlled to achieve efficient use.

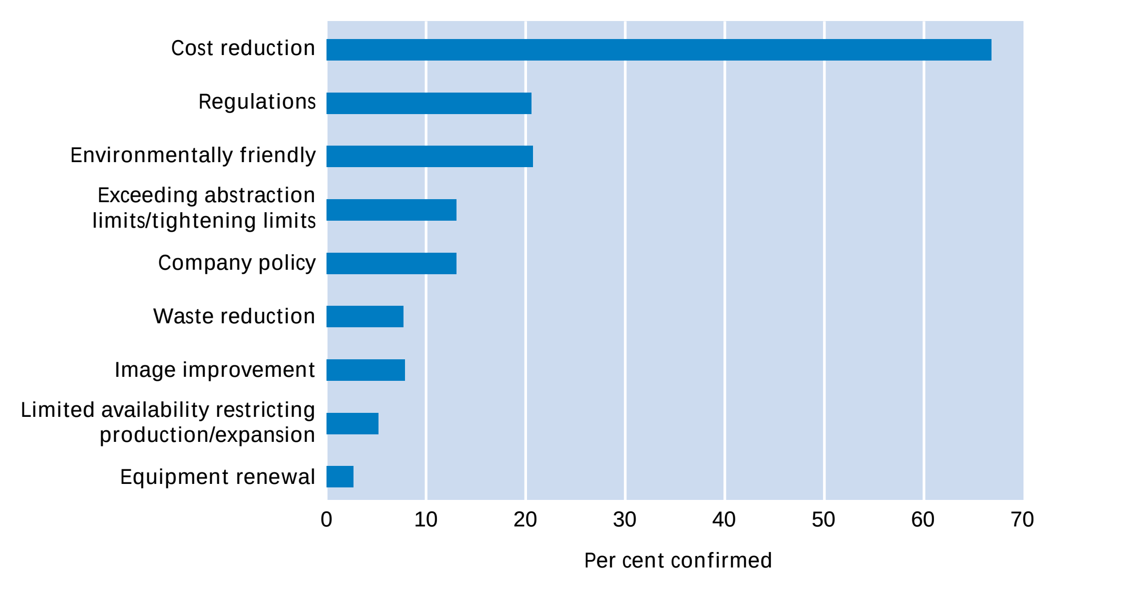


Fig 1 The paper and board industry's response to various 'drivers' for more efficient water use

1.1 THE COST INCENTIVE

Cost reduction is the key concern of every mill, and it is now widely recognised that minimising water use provides significant cost-saving opportunities and can help to improve profitability.

Mills that use large volumes of mains water and discharge significant quantities of waste to sewer are having to pay ever-increasing water supply and effluent disposal charges. This reflects the efforts of the water companies to control demand and to cover their investment costs for the improved treatment plant required to meet tougher discharge consent limits.

Where mills operate their own effluent treatment plant, minimising water use and thereby reducing the hydraulic load on that plant may help to improve effluent treatment, reduce operating costs and, where subsequent disposal is to sewer, minimise effluent disposal charges.

Where a mill is planning to expand its output, an overall reduction in specific water consumption (consumption per tonne of product) can sometimes remove the need for additional effluent treatment capacity. This will reduce capital expenditure and eliminate an additional ongoing operating cost.

1.2 ENVIRONMENTAL AND LEGISLATIVE PRESSURES

Environmental concern and its associated legislation are other compelling reasons for minimising water use.

Recent drought conditions have led regulators and water companies to place greater emphasis on the conservation of scarce water resources. Large water users such as papermakers should therefore consider the impact on their business of any potential tightening of abstraction limits or restrictions on water use. This is an issue of particular concern for those operating at the limits of their abstraction licence or considering an increase in production capacity.

Many paper and board mills have been, or are likely to be, authorised as Part A processes under the Integrated Pollution Control (IPC) regime established by the Environmental Protection Act 1990. Such processes will be required to demonstrate that they employ Best Available Techniques Not Entailing Excessive Cost (BATNEEC) in preventing the release of prescribed substances or, where this is not practicable, that they are minimising their releases and rendering them harmless. The Process Guidance Note IPR6/9 for papermaking and related processes recognises that water minimisation is a key technique for controlling the polluting impacts of the process and strongly encourages mills to adopt appropriate measures. Although there is no such requirement for mills outside IPC, water minimisation may still be a cost-effective way of limiting their environmental impact. Water conservation is, in itself, an important aspect of regulation, with the Environment Act 1995 placing a duty on the Environment Agency in England and Wales to secure the proper use of water resources.

There is a growing need for companies to be perceived by their customers and other stakeholders as environmentally friendly, and several mills have a company policy that involves the setting up of environmental management systems as a means of managing the environmental effects and liabilities of their operations. As these systems become more widely established, data relating to environmental parameters such as water consumption should be more readily available. Once water use is accurately measured it can be more readily controlled. Indeed, reducing specific water consumption could become an integral component of each company's drive for continuous environmental improvement.

1.3 HOW THIS GUIDE CAN HELP

This Environmental Performance Guide allows those responsible for water consumption in paper and board mills to assess the efficiency of their water use in relation to the industry as a whole and to their particular sub-sector. It also assesses the extent to which the various water minimisation technologies and techniques currently available to the industry have been adopted, and examines the barriers to take-up that remain. Finally, it sets out a water minimisation Action Plan.

The questions at the end of the various Sections or sub-sections are designed to promote investigation and, ultimately, action.

- To what extent do regulatory issues already affect your company's use of water? To what extent are they likely to do so in the future?
- Do resource limitations represent a threat to your company's business?
- Does your company fully understand the cost implications of its water use, and can these costs be controlled?

2 SURVEY METHODOLOGY AND RESPONSE PROFILE

This Environmental Performance Guide has been prepared with the close co-operation of the paper and board industry. It is based on the findings of two surveys and is the most complete picture of water use within the industry to date.

2.1 SURVEY METHODOLOGY

Several surveys of water use within the paper and board industry have been conducted in recent years. The information on which this Guide is based came from three main sources:

- the water and effluent sections of an environmental survey of members carried out in 1996 by The Paper Federation of Great Britain (The Federation);
- water and effluent details obtained by The Federation from UK tissue manufacturers (non-members);
- confidential telephone interviews carried out for the Environmental Technology Best Practice Programme in 1996 specifically to obtain up-to-date information for the Guide.

All those responding to The Federation's survey were subsequently contacted for a telephone interview. A questionnaire was used in pilot interviews of eight mills, and this was then modified slightly for the full telephone survey.

Further information and data from other sources is included to enhance the value of this Guide as a water management tool for the industry.

2.2 SURVEY RESPONSE PROFILE

Responses were received from all industry sectors, allowing data for each sector to be presented in the Guide. The response rate for both surveys is shown in Table 1.

Industry sector	Number of mills in sector*	Mills responding to The Federation's survey		Mills responding to the telephone survey	
		Number	%	Number	%
Packaging board	30	14	46.7	12	40.0
Newsprint	3	2	66.7	1	33.3
Printings and writings	30	12	40.0	11	36.7
Tissue	15	3	20.0	2	13.3
Other	17	11	64.7	9	52.9
Total	95	42	44.2	35	36.8

* Source: The Paper Federation of Great Britain, 1996

Table 1 Rates of response to surveys

The response to The Federation's 1996 survey shows a good representation of UK paper mill output capacities, as shown in Table 2.

Mill output categories (tonnes)	Mills in each category*	Respondents from each category	
		Number	% of category
Less than 10 000	24	5	20.8
10 001 - 25 000	22	7	31.8
25 001 - 50 000	19	10	52.6
50 001 - 100 000	17	5	29.4
100 001 - 250 000	14	10	71.4
250 001 and above	3	1	33.3
Unconfirmed	-	4	-

* Source: The Paper Federation of Great Britain, 1994

Table 2 Survey response according to mill output

3 SPECIFIC WATER CONSUMPTION

Although local conditions dictate that minimising water use may not always be an environmental objective in itself, the Environment Agency's Process Guidance Notes advocate water minimisation as a key technique in controlling the polluting impacts of a process.

Specific water consumption (SWC) is primarily a measure of the efficiency of water use. It can also be a valuable indicator of the extent to which a mill is controlling its releases and is particularly useful as a measure against which an individual mill can chart its own improvement.

Given the enormous variation in processes, plant and materials employed by the UK paper and board industry, it is difficult to compare the polluting impacts of different mills by reference to their water consumption alone. This Guide therefore presents its findings on a sector-by-sector basis for each grade of paper or board. However, even within the individual sectors, variations may exist that do not necessarily reflect the efforts of an individual mill to control its own environmental impact. The comparisons made should therefore be regarded as indicative only and should not be interpreted as representing an absolute standard for that particular sector.

3.1 KEY PERFORMANCE INDICATORS

For the purposes of this Guide specific water consumption (SWC) is defined as the amount of water used by a mill (m^3) to produce one air-dried tonne (ADt) of paper.

Two measures of specific water consumption are used in the following figures:

- SWC_s has been calculated from production and total water consumption data provided by mill respondents (ie calculated from survey data);
- SWC_m is the estimate of specific water consumption provided by the mills themselves (ie estimated by the mills).

Some mills draw cooling water directly from surface water (ie rivers, lakes, canals and reservoirs) or ground water sources (ie boreholes) and discharge directly to surface water immediately after the cooling process. Flow rates in these instances are generally high to ensure a low temperature rise between supply and discharge. In other cases (about 21% of mills included in the survey) mills re-use some or all of the cooling water for process purposes.

To include cooling-only flows with process water requirements when assessing the efficiency of process water use would be misleading, and an attempt has been made to distinguish between the volumes of water involved in each case. The measures calculated from survey data (SWC_s) and used in the following figures are for process water applications only.

3.2 PERFORMANCE COMPARISONS

Survey respondents have been classified into six main groups according to the grade of paper or board that they produce:

- packaging board;
- corrugated case materials;
- newsprint;
- printings and writings;

- tissue;
- speciality.

Fig 2 indicates the range of specific water consumptions (SWC_s) observed within each sector, together with the calculated mean value. Since fewer than three mills in the newsprint sector have provided data, only the mean value is shown to ensure confidentiality.

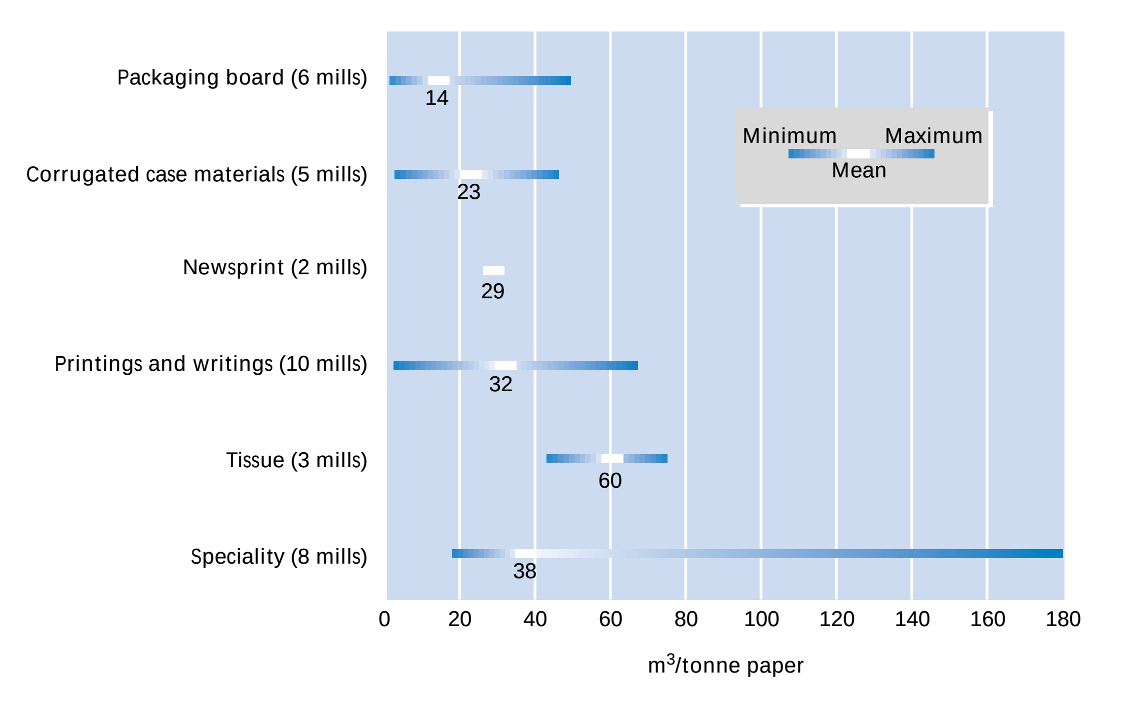


Fig 2 Specific water consumption range per sector

Figs 3 and 4 compare specific water consumption in each sector using the estimates supplied by the mills (SWC_m). Any mill can use these figures to compare its performance with that of other mills performing similar operations.

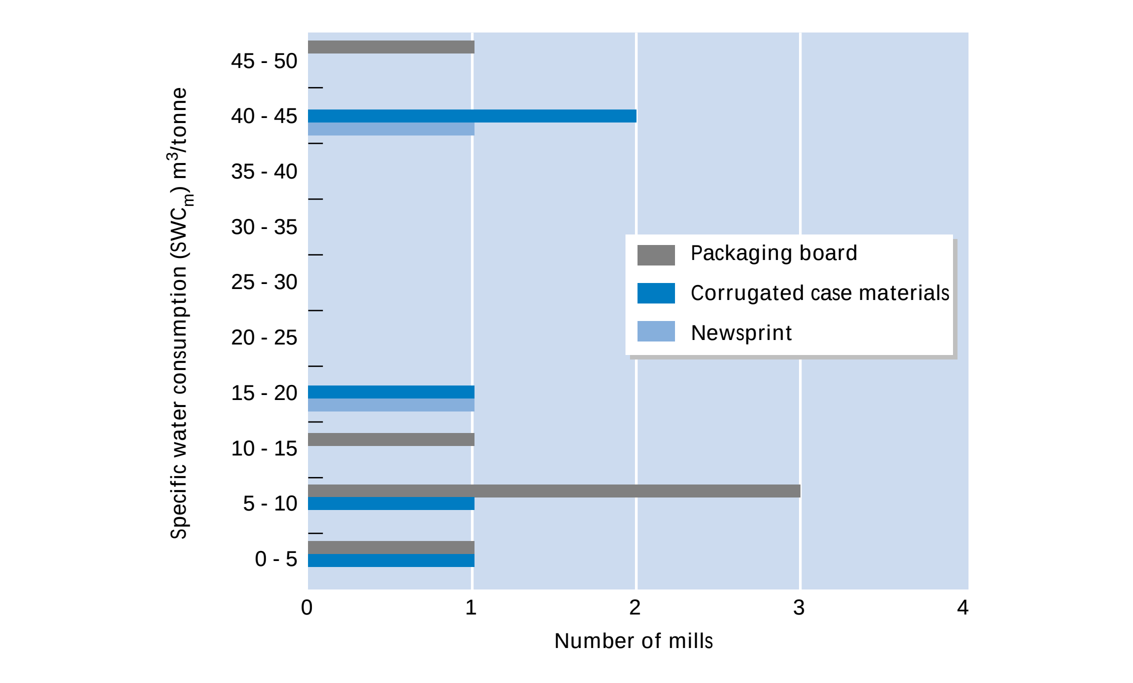


Fig 3 Specific water consumption: packaging, corrugated case and newsprint mills

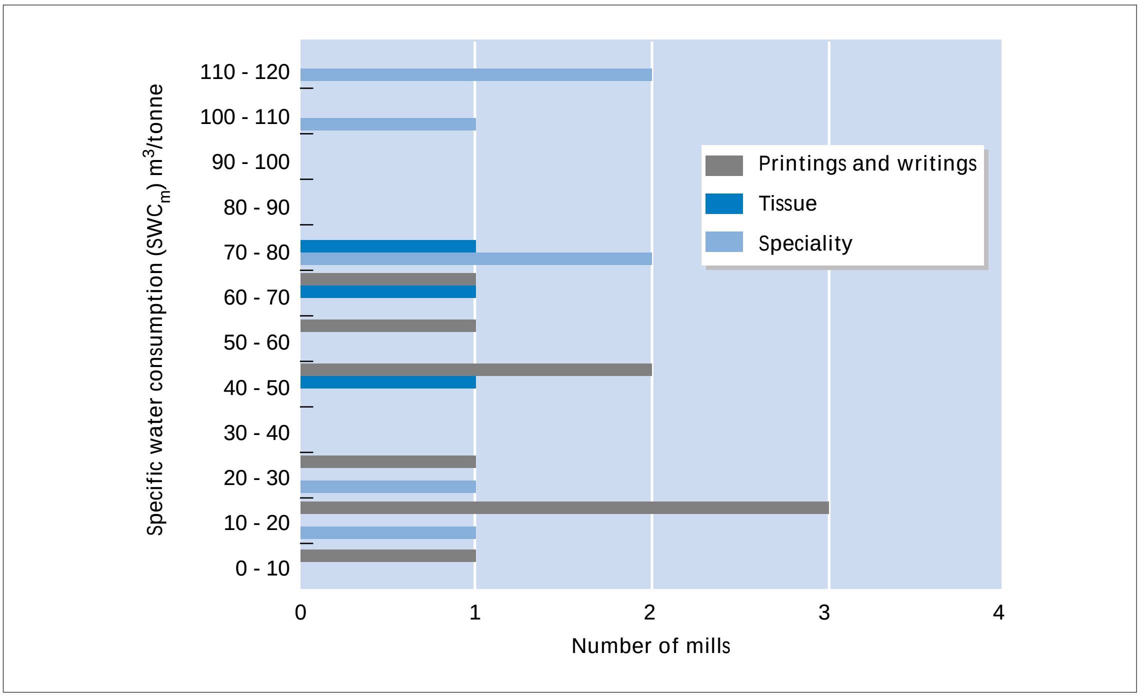


Fig 4 Specific water consumption: printings and writings, tissue and speciality mills

The data provided indicate that production process characteristics give rise to significant differences in specific water consumption between the various sectors of the industry. Several factors contribute to this and can be summarised as follows:

- Where sectors use predominantly recycled fibre (RCF) feedstock, RCF processing is nearly always integrated with paper mill processes. For some grades of product, the cleanliness of the white water is less critical than for others. Consequently, the mill can re-use white water at other locations. There may also be opportunities for using excess white water in the RCF processing plant.
- The same concept can be used to advantage in mills with ‘white’ machines and ‘brown’ machines. The combined operation can be ‘closed’ to a greater extent than in a white machine only mill.
- White water clarification systems currently in use cannot produce the quality of white water required for higher quality papers. Consequently more fresh water is required.
- Plant washdowns in mills producing high quality paper are more frequent because of colour changes and shorter production runs.
- Tissue manufacturers and some specialist mills produce lightweight papers. Consequently, comparisons made on the basis of m^3/tonne show them as poor performers compared with other industry sectors.

At the end of the production process, the water not consumed within the finished product or passing to atmosphere as steam is discharged as effluent. Fig 5 provides a comparison of specific effluent discharge, again by industry sector, and broadly reflects the consumption data presented in Fig 2.

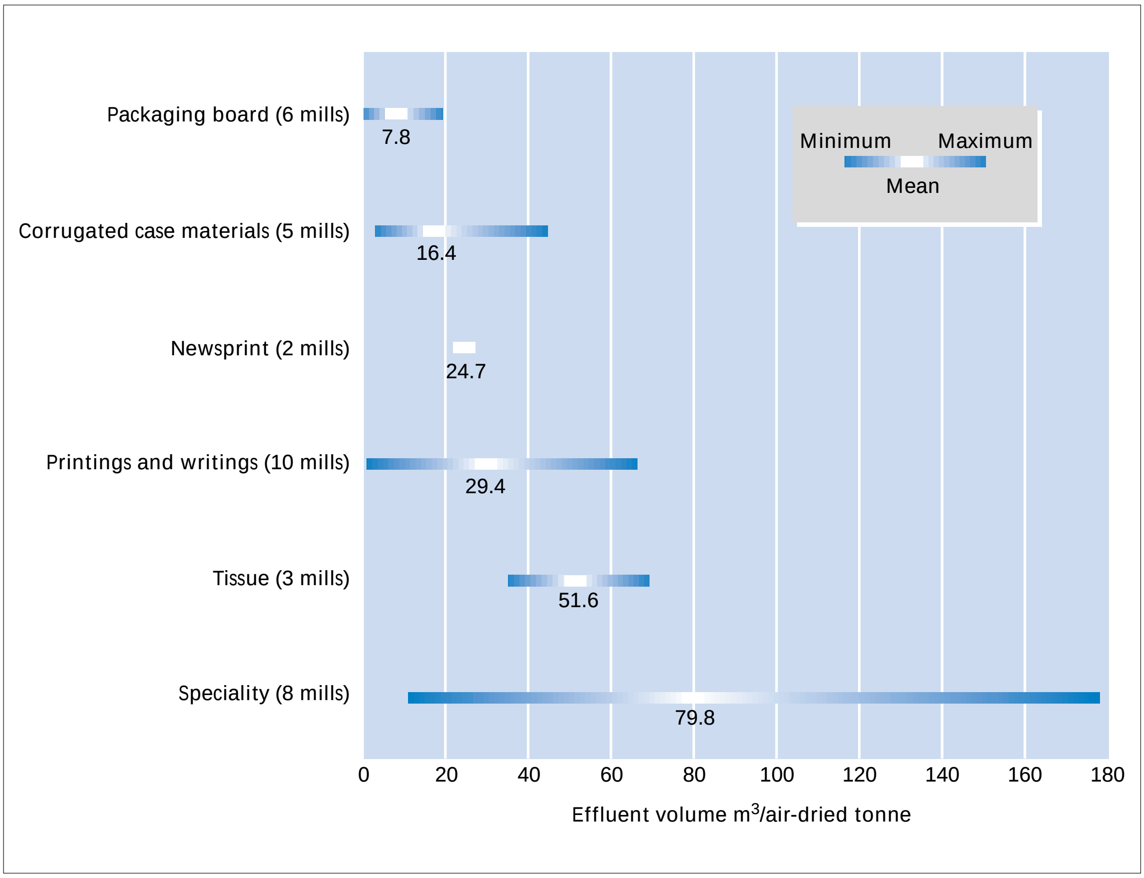


Fig 5 Specific effluent discharge range per sector

3.3 SUMMARY

Overall, the findings of The Federation and telephone surveys demonstrate that within most industry sectors there is significant scope for improving the efficiency with which water is used in the manufacturing process. Even in those sectors that use relatively small volumes of water, there is a clear variation between the best and worst performing mills. Section 5 outlines possible methods for controlling water consumption and assesses their take-up across the industry.

Significant variations in water consumption are observed within all the industry sectors. To some extent the factors outlined above can account for these variations, particularly where a mill produces a wide range of grades and uses both recycled and virgin fibre as feedstock.

Comparison is particularly difficult in speciality mills, where a wide range of product and process constraints has a considerable bearing on the standards of performance that may be achieved. While some of the factors described above may limit efficiency, mills should question whether such constraints represent a real or only a perceived barrier to improvement.

- Is your company as efficient in its use of water as previously believed?
- Comparing your company's performance with that of its competitors, is there scope for further improvement in the efficiency of water use?

4 WATER SUPPLIES, EFFLUENT DISCHARGES AND COSTS

Water is essential for the manufacture of paper and board. However, its use and discharge impose cost burdens on the industry. This Section explores the various components of these costs to UK producers.

4.1 WATER SUPPLY AND ITS ASSOCIATED COSTS

Paper and board mills obtain their water from three main sources:

- the mains supply;
- ground water sources, abstracted via boreholes;
- surface water sources such as rivers, lakes, canals and reservoirs.

For the 34 mills for which complete data are available, 76% of the water is abstracted from surface water sources (Fig 6).

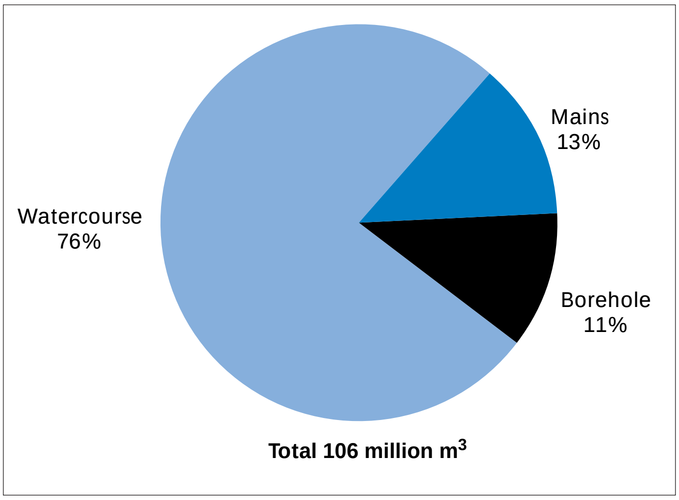


Fig 6 Source of water supply

The costs associated with water supply consist of either the charges made by water companies for a mains supply or the costs of abstraction licences for surface water or ground water abstraction. Additional costs may be incurred for pumping and for treating incoming raw water on site.

Fig 7 provides a breakdown of the basic supply costs for 21 mills supplying appropriate data. These costs do not include any associated pumping or pre-treatment costs, although these may, in some cases, be significant. Mills that pay nothing for their water supply are excluded.

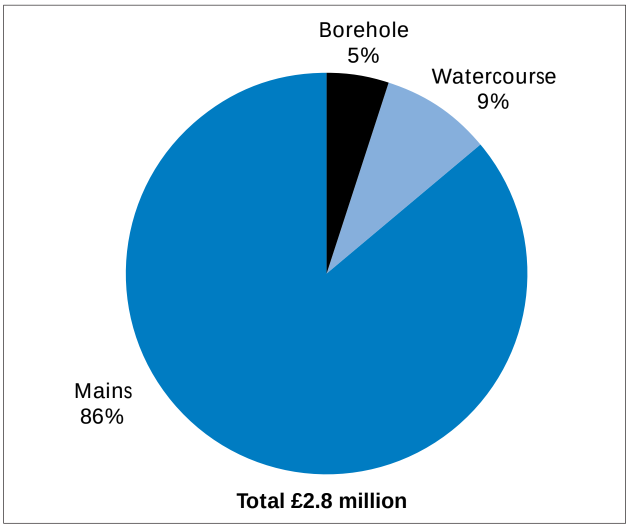


Fig 7 The costs of water supply

section 4

Fig 8 shows the variations in costs for the three sources of water supply. It is clear from this that water company charges to customers vary widely, and some mills may be able to benefit from more favourable large-user tariffs.

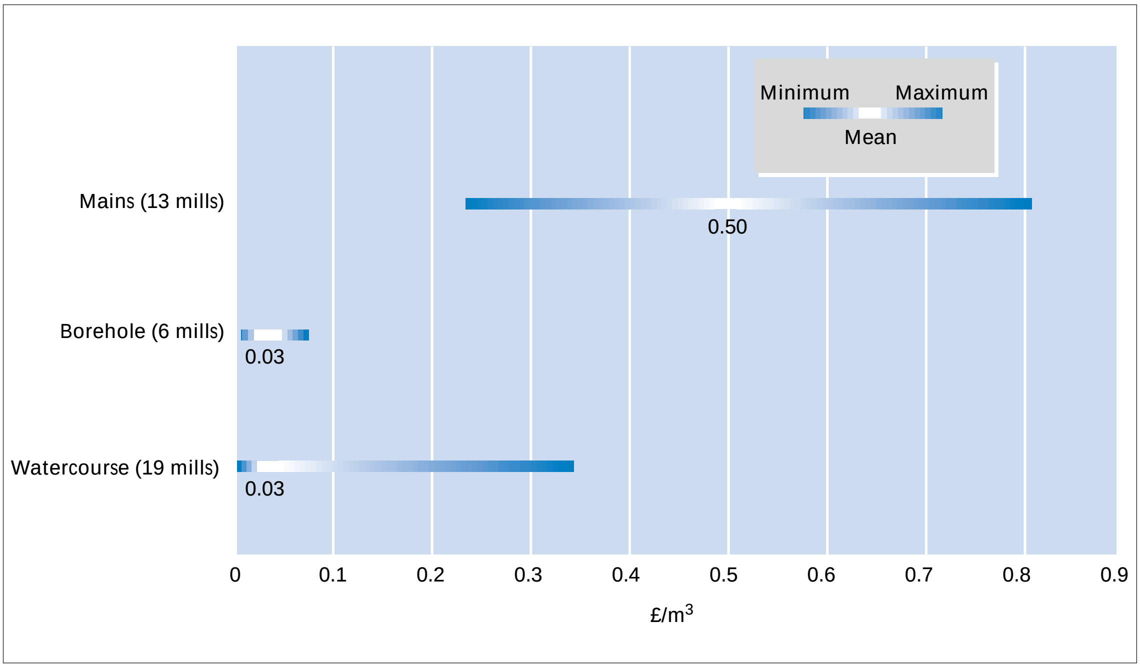


Fig 8 Variations in water supply costs

When scrutinising water-supply costs, perhaps the most important parameter for mills to consider is the cost per tonne of paper produced. Fig 9 illustrates the variation in these specific water costs for each industry sector. Mills that pay nothing for their water supply are excluded.

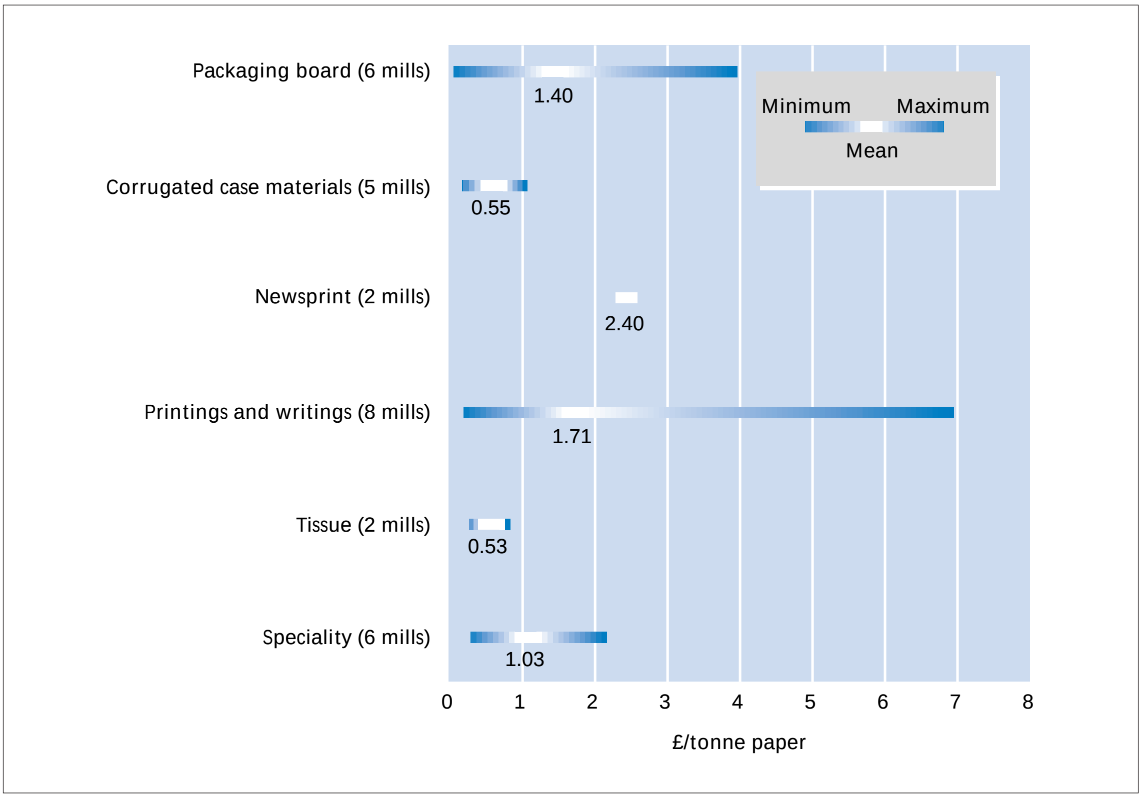


Fig 9 Variations in the costs of water supply per tonne of paper produced

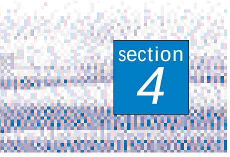


Fig 9 shows that there are wide variations in the water component of unit production costs in three major industry sectors: newsprint, packaging board, and printings and writings. For the lower grade, lower value products in particular, this variation may be significant in terms of overall production costs.

The water cost per tonne of paper produced is dependent on two principal factors:

- the water supply cost;
- the efficiency with which water is used in the production process.

Mills may have limited scope for reducing the cost of their water supply in terms of £/m^3. For those mills seeking to improve their specific water costs, the most practicable option may be to improve the efficiency with which water is used. Section 5 explores in more detail the options available to mills for controlling their SWC.

- Is your company at a commercial disadvantage because of high water-supply costs?
- Can your company's profitability be enhanced by improving the efficiency of water use?

4.2 EFFLUENT DISCHARGES AND COSTS

Typically, water is used in mills for:

- the papermaking process;
- boiler water make-up;
- cooling water.

Although, in many cases, some degree of recycling takes place within and between the various applications (Section 3), the water is eventually discharged from a number of points to the mill's effluent treatment system or to sewer, ultimately passing to a watercourse (including estuaries), with some being lost to atmosphere as steam. Fig 10 provides a breakdown by volume of mill effluent discharge for each application and receiving stream.

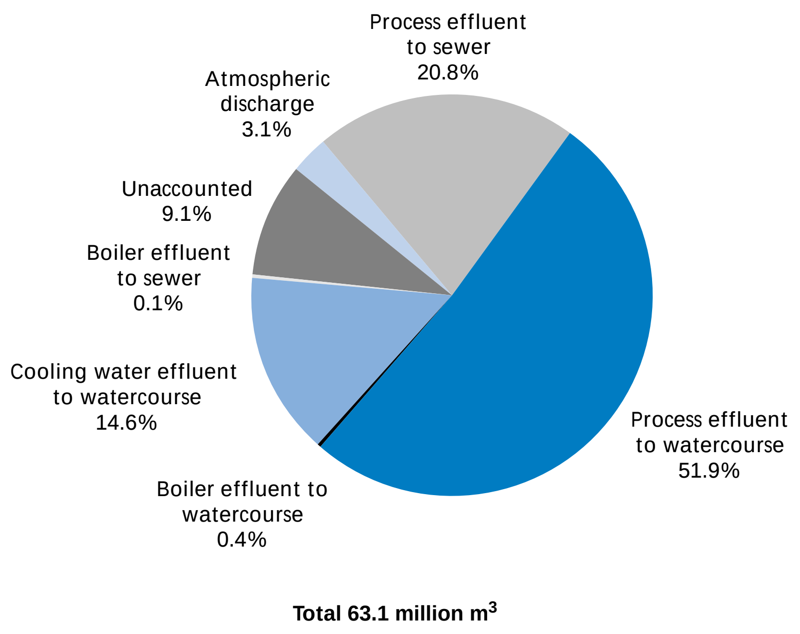


Fig 10 Breakdown of aqueous discharges

Effluent discharge costs money, either indirectly through the cost of installing and operating an effluent treatment plant (ETP), or directly through the charges for discharging to sewer.

In most cases where mills discharge to watercourses, some form of on-site effluent treatment is required to ensure that final effluent quality is within the limits set by the discharge consent. The construction and operation of an ETP means the cost of effluent treatment is borne by the mill, and it has proved difficult, given the scope of the surveys used for this Guide, to assess these internal costs accurately. Nevertheless, the costs of installing and operating ETPs are controllable and may be addressed through water minimisation measures.

Where mills discharge directly to sewer, the water company receiving the effluent makes a charge. This trade effluent charge is determined using the Mogden Formula. The Formula takes into account the volume and strength of the effluent, linking the charge imposed to the subsequent cost of treatment. Appendix 1 describes the Mogden Formula in more detail and illustrates how it is applied.

A number of mills that ultimately discharge to sewer also operate an ETP. This allows them to reduce the biochemical oxygen demand (BOD), chemical oxygen demand (COD) and suspended solids loadings prior to discharge, thereby reducing the total trade effluent charge incurred.

Table 3 summarises the effluent treatment methods used by all mills covered by The Federation and telephone surveys, whether they discharge to surface waters or to sewer.

The total direct cost of effluent discharge for the 34 mills providing accurate data and paying for effluent discharge is about £4.3 million/year (Fig 11). This consists almost entirely of trade effluent charges and does not include any of the capital or operating costs associated with on-site ETP.

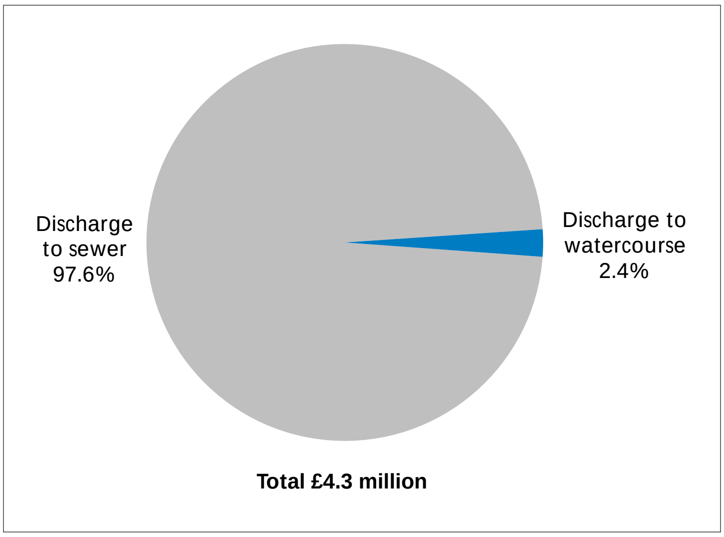


Fig 11 Breakdown of effluent disposal costs

Trade effluent costs at the mill level can vary significantly across the industry. They are determined by the characteristics of each mill effluent in terms of the volume, COD load and suspended solids load discharged, and by the degree of treatment provided by the water company/authority receiving the effluent. Some regional variation also occurs because of the different pricing regimes of water companies/authorities (Appendix 1).

Effluent COD and suspended solids loads are determined by the level of good housekeeping at the mill and its effectiveness in preventing material loss to drain, and by the nature of the pulp being processed. Final effluent strengths will also vary with the degree of on-site treatment prior to discharge to sewer. Fig 12 illustrates the variations in effluent charges observed during the survey.

		None	Primary treatment			Secondary treatment[1]			Tertiary treatment[2]	Discharge	
Industry sector	Number of mills		Gravity of settlement	DAF clarification	Fibre removal	Anaerobic	Aerated lagoon	Activated sludge	Membrane	Sewer	Watercourse
Packaging board	2		✓							✓	
	1		✓	✓				✓			✓
	1				✓	✓		✓			✓
	1										✓
	1	✓								✓	
Corrugated case materials	2		✓			✓		✓			✓
	1		✓					✓			✓
	2			✓						✓	
	1			✓							✓
Newsprint	1				✓			✓	✓		✓
	1										✓
Printings and writings	1		✓			✓	✓	✓			✓
	2		✓					✓			✓
	4		✓							✓	✓
	1				✓					✓	
	1									✓	
	2	✓								✓	
	1	✓									✓
Tissue	1		✓		✓	✓	✓				✓
	1		✓					✓		✓	
Speciality	1		✓					✓			✓
	1		✓							✓	
	3		✓								✓
	1			✓							✓
	1									✓	
	1	✓								✓	
Fine papers	1			✓							✓
Packaging paper/wrappings	1		✓					✓			✓

[1] Other secondary treatment options include trickling filter and high rate filter technologies.

[2] Other tertiary treatment options include enhanced settlement chemicals and sand filtration technologies.

Table 3 Forms of effluent treatment and discharge routes

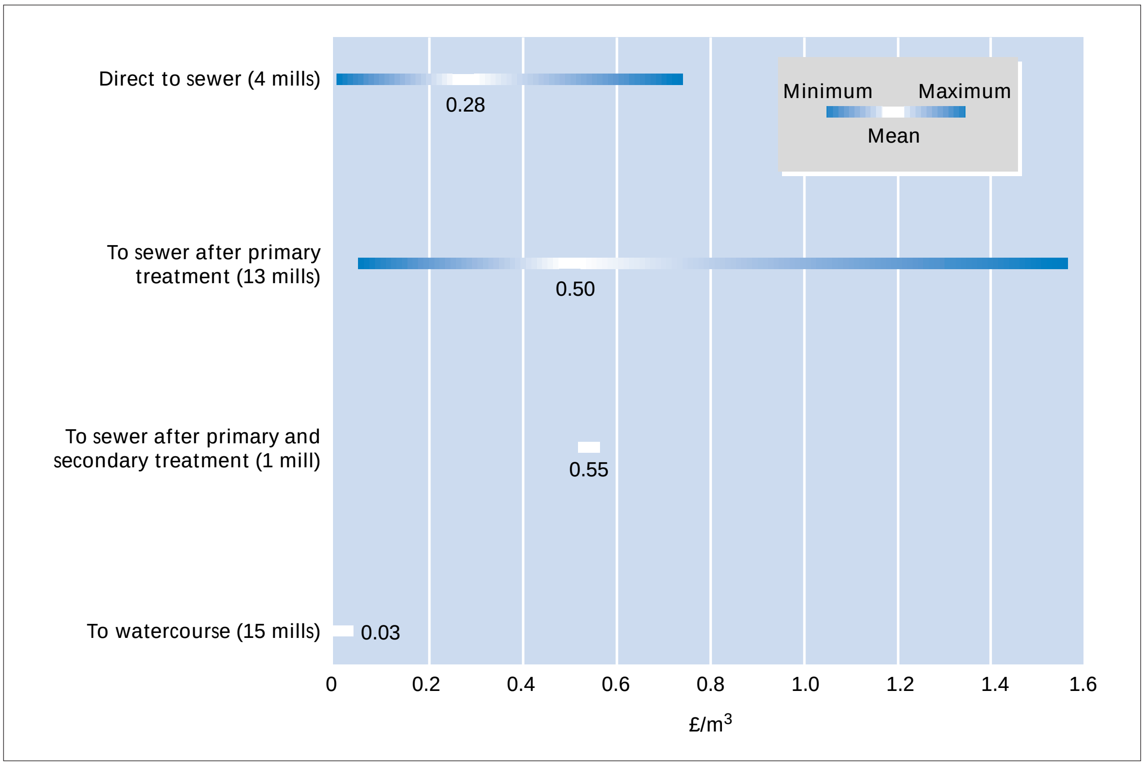


Fig 12 Variations in effluent disposal charges

Figs 13 and 14 provide an indication of the cost of effluent discharge per tonne of paper produced for each industry sub-sector. Since actual discharge costs vary significantly depending upon whether or not the final effluent has been treated, data for mills discharging to sewer are presented separately from data for mills discharging to a watercourse.

Those mills with ETP may find it useful to compare their treatment costs with typical trade effluent charges per tonne of paper produced.

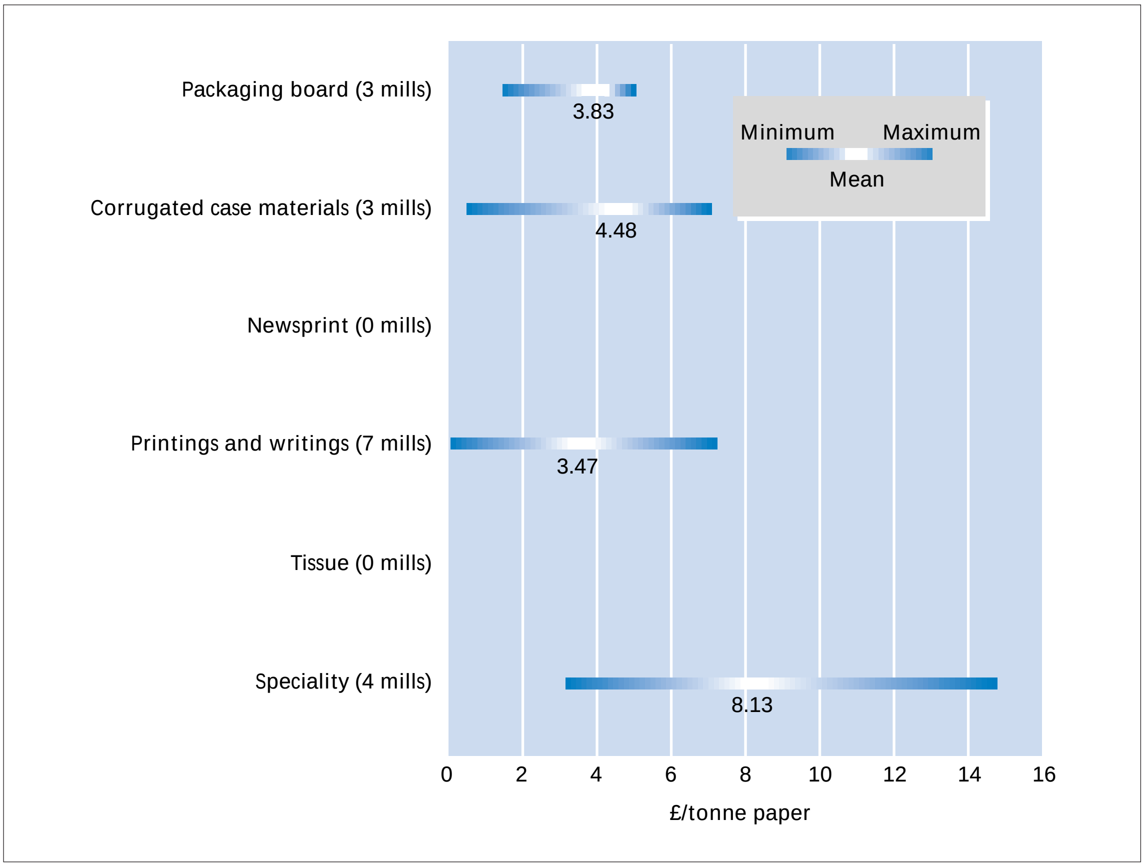


Fig 13 Effluent cost per tonne of paper for discharging to sewer

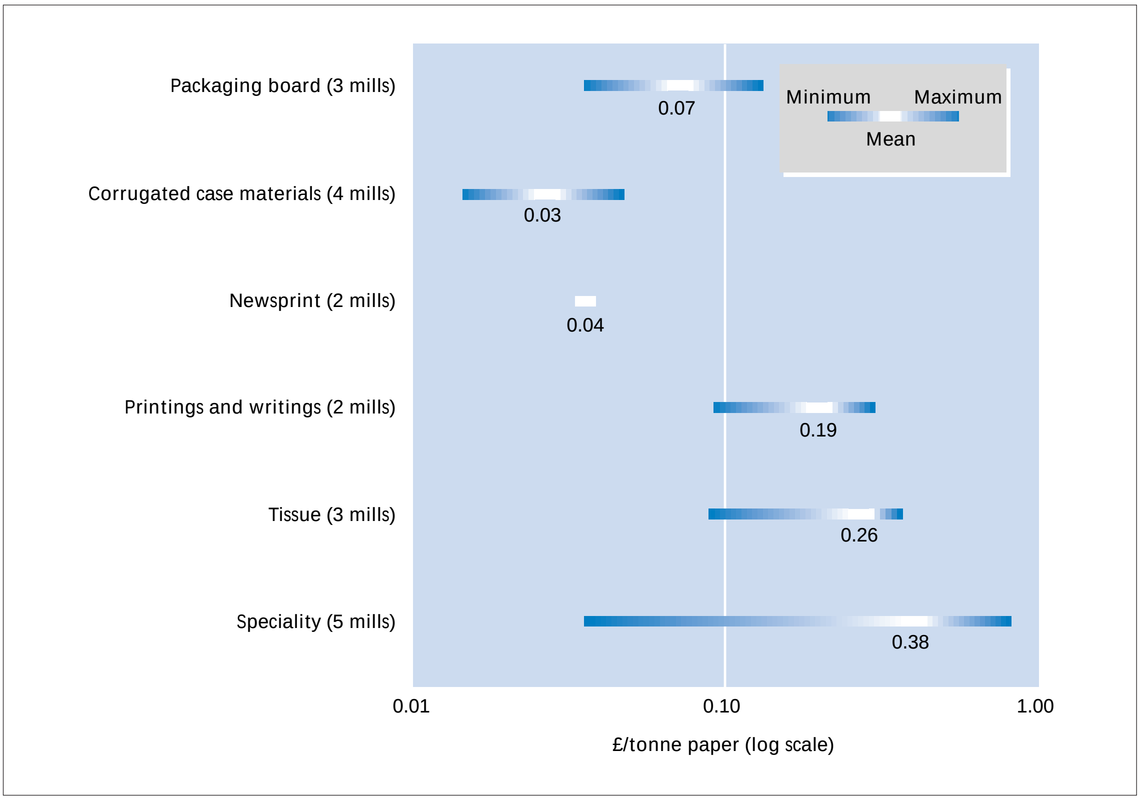


Fig 14 Effluent cost per tonne of paper for discharging to watercourse

Mills can effectively reduce effluent discharge costs, whether these are incurred externally through trade effluent charges, or internally through the construction and operation of an on-site ETP. Table 4 summarises the potential impact of control measures on discharge costs.

Measure	Impact on effluent charges	Impact on on-site treatment costs
Reduce effluent volumes (hydraulic load) by minimising water use.	Reduces volume component in Mogden Formula.	Reduces capital cost by reducing design capacity of plant. May reduce pumping, aeration and other operating costs. May improve treatment plant performance.
Reduce raw effluent strength loadings by reducing raw material loss to effluent or removing materials from effluent.	Reduces COD and suspended solids components in Mogden Formula.	Reduces operating costs - aeration, chemical additions (flocculants, hypochlorite, polyelectrolytes), sludge disposal.

Table 4 Impact of control measures on discharge costs

- Are your company's discharge costs typical?
- Is your company paying the correct amount for effluent discharge?
- What are the operating costs of on-site effluent treatment plant?
- Can your company achieve operating cost savings in on-site effluent treatment plant by introducing water efficiency measures elsewhere within its process?
- Can the capital cost of planned investment in effluent treatment plant be reduced or even eliminated by greater efficiency in water use?

4.3 OTHER COSTS

Water supply and effluent disposal represent the two most readily identifiable cost elements of water use. However, it is almost certain that opportunities for reducing costs through water minimisation will also exist within the whole range of processes carried out by paper and board mills.

The complexity of water use in mills is such that it was not possible to address every aspect of water use during the preparation of this Guide. However, areas where further savings may be realised include a reduced requirement for incoming process water treatment and lower pumping costs.

The major driving force for water minimisation is the improved retention of raw materials in the paper web; this can be achieved by selecting the correct minimisation measures. The savings in raw materials and the increase in productivity give rise to further cost savings.

Before introducing water minimisation measures it is essential to consider the impact of these measures across the entire scope of mill operations. This will ensure that all opportunities for cost savings are identified and a robust case for investment is prepared.

- Is management sufficiently aware of **all** the costs relating to mill water use?

5 CONTROLLING WATER CONSUMPTION

Whatever their specific water consumption, few paper and board mills are likely to be making the best possible use of their water supply. This Section outlines some of the measures available to mills for controlling water use. It indicates the extent to which these measures have been adopted by the telephone survey respondents and assesses the observed impact of certain key measures on mill performance and profitability.

5.1 WATER MANAGEMENT TECHNIQUES

Sound water management is the key to success in improving the efficiency of water use in mills, and a water management plan can include several key measures. The first of these is to gain a comprehensive understanding of the mill water system. More sophisticated management tools such as monitoring and targeting (M&T) can also be employed at any stage in the management process. Applied correctly, M&T has proved a powerful management tool in controlling energy consumption and the experience of some UK mills has demonstrated that the technique can be used successfully to minimise water use. It is also important to manage the production process itself to achieve fundamental reductions in water consumption.

5.1.1 Some key water management measures

Gaining a detailed knowledge of mill water systems

A knowledge of mill water systems is fundamental to sound water management. It ensures that meters are appropriately located for monitoring and control, and it provides a sound basis for the water and fibre mass balances that are needed to ascertain exactly how much of each is being lost and from where. This knowledge should also extend to drainage systems to facilitate the monitoring and control of effluent discharge and to determine the impact on treatment needs.

Establishing a mass balance of water flows

Producing a mass balance will identify the main areas for improvement and for the introduction of monitoring and targeting. If automatic measurement and sampling systems exist and are reliable, the task is simplified. However, the survey revealed that the provision of reliable sub-metering was not common.

Introducing monitoring and targeting systems

If it is not possible to measure consumption, it is not possible to manage it. Meters should be installed and calculation methods established for measuring consumption in key areas where consumption is high. Excessive metering is costly in terms of both equipment and the staff time needed to obtain readings and analyse data. An effective monitoring and targeting system will ensure the early recognition of excessive consumption and allow it to be acted on immediately.

Improving production scheduling

Improvements in production scheduling, longer production runs and fewer product/colour changes can mean fewer plant washdowns and reductions in water use and effluent discharges.

Improving plant washdown procedures

Plant washdown procedures can be improved in three ways:

- by ensuring minimum fibre retention in the system at washdown;

- by using specially designed spray balls for chest washing;
- by using low-volume, high-pressure spray equipment.

Accurately costing plant washdown in terms of water use, effluent treatment and disposal, fibre loss, cleaning chemical consumption, machine downtime and energy use is likely to stimulate an improvement in the efficiency of current procedures.

Managing white water overflows

Operators in modern paper mills have a large number of different parameters to supervise. Because they feel that their primary duty is to produce paper to the desired quality at an optimum production speed, controlling fresh water intakes and white water overflow discharges is often of secondary importance.

Operators should:

- be fully conversant with the operation of and demands on the white water system;
- aim to reduce white water overflows by avoiding the unnecessary addition of fresh water;
- ensure no water is added to the white water system during periods of no throughput;
- ensure automatic systems for managing white water levels are frequently maintained so they operate correctly.

5.1.2 Adoption of water management measures

The telephone survey sought to establish the extent to which mills have adopted various water management measures. Respondents were asked whether or not they had:

- a satisfactory knowledge of the mill water system;
- metering in place to gain an accurate breakdown of water usage;
- effective monitoring and targeting methods in place;
- improved production scheduling either to prevent white water overflow or to reduce the need for plant washdown;
- an accurate idea of the cost of plant washdown procedures.

Fig 15 illustrates the level of take-up of these measures.

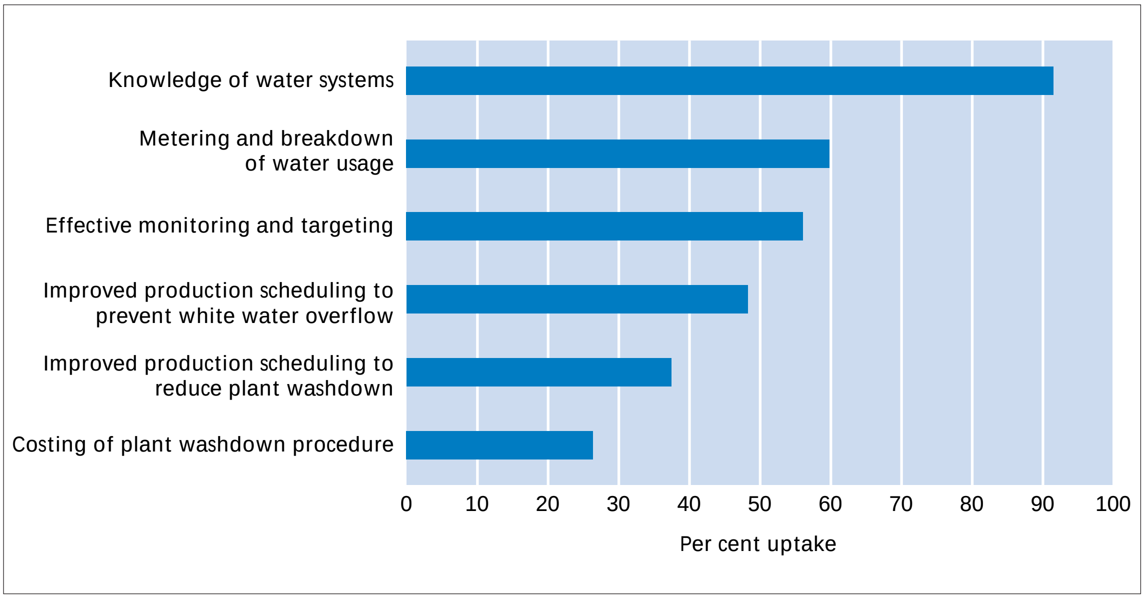


Fig 15 Level of take-up of water management measures

While most mills believed they had a good knowledge of their water systems, less than 60% had an accurate breakdown of water usage and fewer still used M&T techniques. M&T can be a powerful management tool, and 61% of the 19 mills that had installed such a system had a specific water consumption (SWC_s) that was lower than the median for their industry sector.

Less than 50% of mills had improved their production scheduling to prevent white water overflow, and fewer still had implemented similar measures to reduce the number of plant washdowns. However, these measures are likely to be less relevant to mills in sectors such as packaging board, corrugated case materials and tissue manufacture, where the emphasis is on long runs of a single grade and colour.

5.2 GOOD HOUSEKEEPING MEASURES

Introducing simple good housekeeping measures is often one of the best ways of beginning to control water use. In many cases such measures require little or no capital investment and have an immediate and obvious impact. Early successes provide an incentive for introducing more comprehensive and capital-intensive measures.

In practice, the environmental benefits of some good housekeeping measures may be limited, and there is not always a direct link with improved effluent treatability or better materials retention. Nevertheless, significant cost savings can be identified, particular where mills are using a mains water supply.

> Perhaps one of the greatest benefits of good housekeeping measures is that they provide a starting point for the development of a water minimisation culture within the mill.

section 5

5.2.1 Some common good housekeeping measures

Preventing temporary and accidental discharges

Temporary and accidental discharges are those that are not directly connected to the process or that occur intermittently. Examples include overflows from water tanks, pulp tanks or other equipment with poor level controls; spent washwater from equipment cleaning; and flushing water from floor washing. The volumes associated with these discharges are almost never quantified and can vary significantly. Furthermore, with the gradual closure of water systems, discharges of this type will comprise a growing proportion of the total discharge volume. Avoiding such discharges depends on operator awareness and motivation.

Repairing leaks

Paper mills have extensive pipe networks. These are subject to thermal movement and corrosion, and this can result in leakage. Equipment seals also commonly leak as a result of wear. Mills should repair leaks on a regular basis rather than delaying repairs until a factory shutdown or until the installation of new/modified processes and equipment.

Controlling flow rates

Certain types of equipment, for example the many shower, screen and saveall sprays, require a continuous supply of water. These items, plus equipment seals and cooling water supply systems, should be fitted with devices that allow flow rates to be controlled and equipment to be isolated for servicing or repair. Water pressure fluctuations should be taken into consideration when selecting these devices.

Minimising hose reel use

Excessive hose reel use can result in a high and varied water consumption. By fitting triggers that automatically switch off when the hose is abandoned by the operator, and by using high pressure, low-volume systems, it is possible to reduce significantly both water consumption and effluent discharge volumes.

Improving boiler water management

Excessive filter backwashing and softener regeneration, the poor maintenance of steam traps and poor levels of condensate return give rise to unnecessary water use and should be avoided.

5.2.2 Adoption of good housekeeping measures

Telephone survey respondents were asked whether or not action had been taken by their mill to:

- improve the control of water flow rates to process showers etc;
- improve plant washdown procedures;
- repair leaks on a regular basis;
- improve boiler water management by better steam trapping and condensate recovery;
- fit triggers to all hoses.

Fig 16 illustrates the level of take-up of these measures.

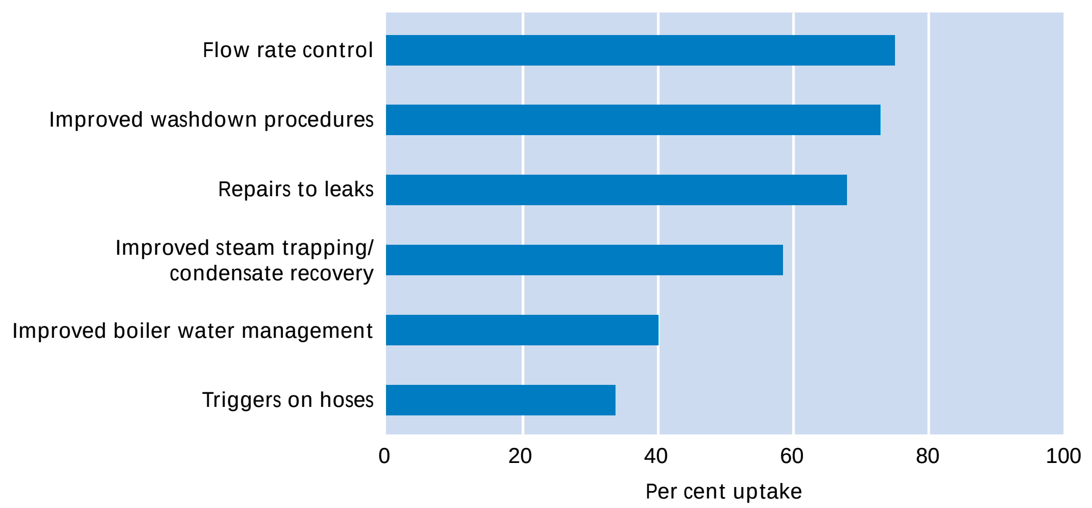


Fig 16 Level of take-up of good housekeeping measures

The relatively high level of adoption of good housekeeping measures by mills participating in the survey reflects both the perceived benefits and the minimal levels of capital, time and management outlay required for their implementation.

5.3 PLANT AND PROCESS MODIFICATIONS

Sections 5.1 and 5.2 outline key measures for minimising water consumption using existing plant and processes. These will allow mills to identify and evaluate opportunities for reducing consumption by plant and process modifications and could include the following.

5.3.1 Improving white water systems

Several methods can be used to improve the efficiency of water use in white water systems.

Correct design and sizing

Designing a white water system with an appropriate storage capacity and proper controls will help to reduce or prevent overflow. The correct sizing of storage capacity is particularly important because there are large variations in demand from and input into white water systems.

Installing separate white water systems for each paper machine

In many mills, two or more paper machines operate with common white water and broke systems. This makes the white water balance difficult to supervise. Separating the systems enables the optimum balance for each machine to be achieved.

Storing pulp at a higher consistency

Both broke and fresh pulp are stored at a relatively low consistency (usually 3 - 10%). The content of the pulp storage towers is therefore almost entirely white water. Storing pulp at a higher consistency could reduce overflows from existing white water systems.

Effective maintenance and operation of fibre recovery systems

Excess white water usually passes through a fibre recovery unit before being discharged as effluent. These fibre recovery units often perform poorly because of the fluctuating loads applied to them. White water systems should therefore be designed so that the loads on such units are constant. Automatic systems for managing white water levels should also be regularly maintained to ensure correct operation.

The take-up of measures to reduce white water overflow across the industry are illustrated in Fig 17.

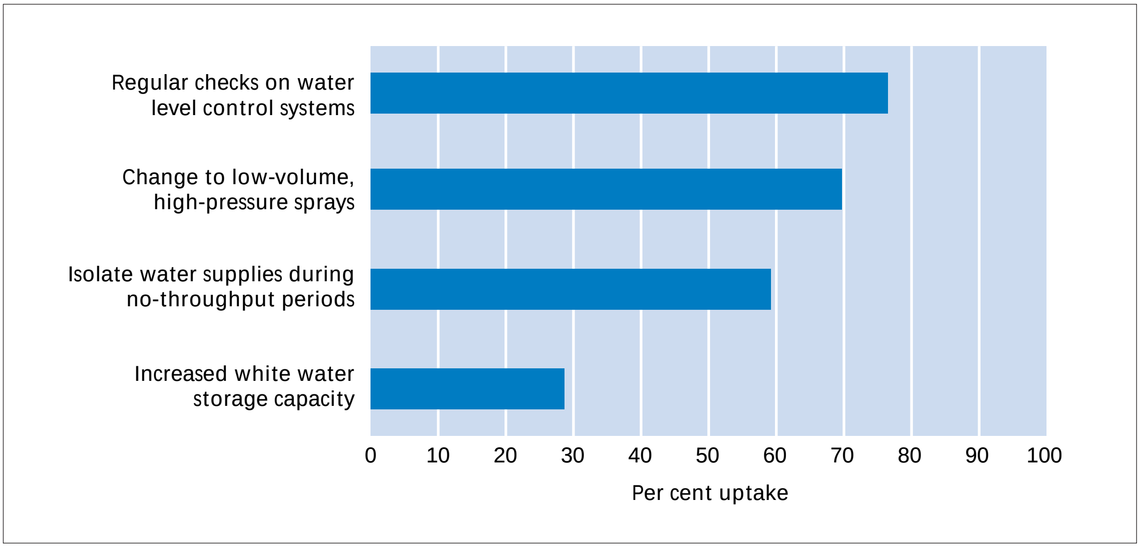


Fig 17 Level of take-up of measures to reduce white water overflow

5.3.2 White water recycling

The amount of white water excess depends upon the degree of recycling or closure in the paper machine. The higher the degree of closure, the smaller the amount of white water excess. The following are opportunities for recycling white water.

The dilution of fibre raw materials

Regardless of its initial consistency, the pulp must be diluted to a consistency of 3 - 5% before it is pumped to the stock preparation end of the paper machine. In most cases, the most suitable water for this purpose is unclarified white water. If several different white waters are available, the one with the highest fibre content should be used.

The dilution of fillers

Fillers are usually diluted using fresh water. However, it is often possible to replace the fresh water with clarified white water.

Fresh water is generally used for diluting chemicals before they enter the paper machine. Using clarified white water may reduce the effectiveness of the chemical, and this means that a larger dosage may be required. Coating colours and surface sizing processes are also very sensitive to contaminants such as fibre material which may cause quality problems and production losses. Neither white water nor clarified white water can therefore be used for these processes

Shower water systems

The shower water system is usually the largest consumer of fresh water in the paper machine system, accounting for 20 - 30 m^3/tonne of paper. To reduce the consumption of fresh water, most of the shower water used should be clarified white water.

Shower water is used in four main areas of the paper machine, and Table 5 indicates those locations where white water or clarified white water can be used.

Appendix 2 details typical white water quality and water quality criteria for showers.

A general rule when choosing between white water and fresh water is that fresh water must be used when the pressure is above 1 000 - 2 000 kPa. In some critical locations it may be necessary to use fresh water, regardless of the pressure level.

When fresh water is used as shower water it must be heated to 50 - 60°C to ensure efficient washing and a low water consumption. The fresh water used for this purpose should be cooling water that passes through the drier section, heat recovery and condensate system condensers before entering the warm water tank.

section 5

Machine section	Typical consumption m^3/tonne	Locations where white water or clarified white water may be used	Locations where fresh water is needed
Wire section	10 - 20	Breast roll Wire-turning roll and wire return rolls Knock-off shower Trim knock-off shower Wire-cleaning shower	Wire-cleaning shower (high pressure) Couch suction box Trimming Headbox
Press section	5 - 15	Cleaning of rolls	Conditioning of felts Lubricating showers for felt suction box Lubricating showers for press roll suction box.
Fibre-recovery system	0 - 5	All positions	
Broke system	0 - 5	All positions	

Table 5 Opportunities for re-using white water in shower systems

Vacuum systems

Liquid ring vacuum pumps consume sealing water at a rate of about one litre/minute per installed kW. To maintain the vacuum level, the temperature of this seal water must be below 30°C. White water temperatures are above 30°C and so recycled 100% white water cannot be used. Recirculating vacuum seal water via cooling towers or heat exchangers with heat recovery[1] can significantly reduce fresh water consumption.

The take-up level for white water recycling measures is illustrated for each industry sector in Fig 18.

[1] Energy Efficiency Best Practice Programme Good Practice Case Study 127, July 1992

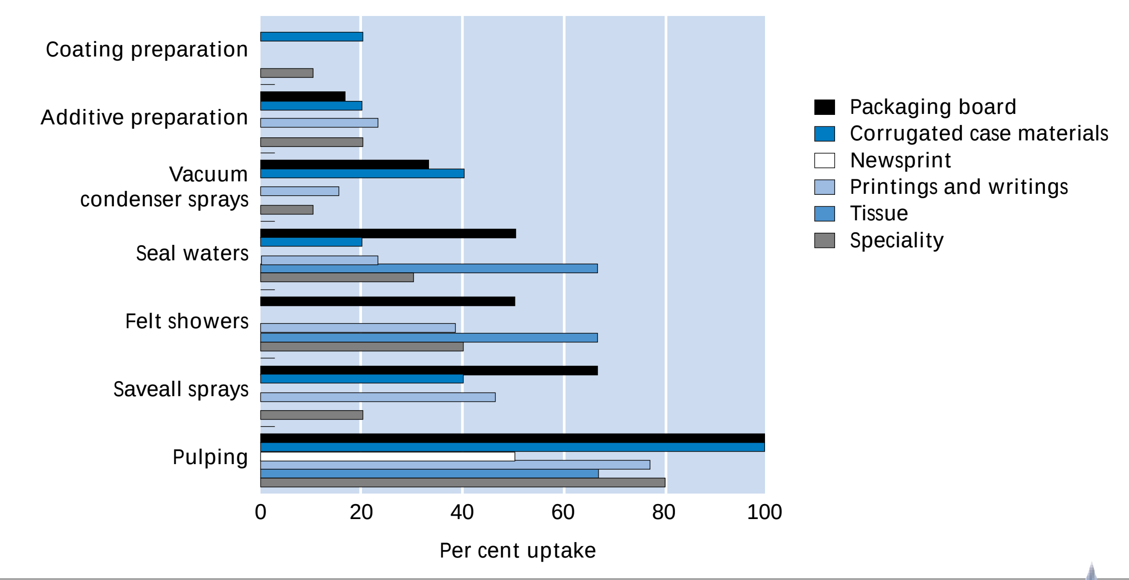


Fig 18 Level of take-up of white water recycling measures

KEY TECHNOLOGIES FOR IMPROVING WATER QUALITY

Generation of clarified water from white water

Clarifying white water will increase the scope for its re-use in various process applications. Suitable clarification techniques include filtration, dissolved air flotation (DAF), hydrodynamic separation and sedimentation. Use of an on-line turbidity meter in the clarified water helps to ensure consistent water quality.

Generation of fresh water from white water

For certain grades of paper such as corrugated medium and linerboard, it is possible to operate with zero liquid effluent once water use has been minimised.

For other grades of paper, techniques for generating fresh water from white water require further development.

The take-up of techniques for improving water quality is illustrated for each industry sector in Fig 19.

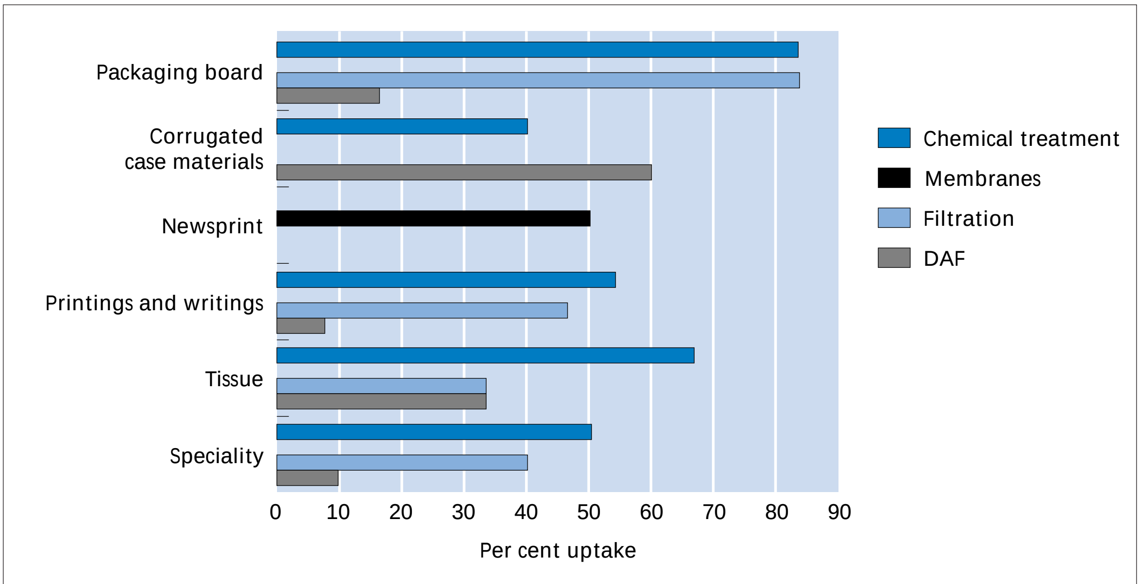


Fig 19 Level of take-up of white water quality improvement measures

5.3.3 Eliminating, minimising or re-using fresh water

The following are some of the opportunities for eliminating, minimising or re-using fresh water.

Reducing the sealing water required for pumps and agitators

Sealing water is needed to prevent the fibre suspension entering the seal between the shaft and the housing. The consumption of sealing water for pumps and agitators can be reduced in two ways:

- by controlling the water flow to each pump/agitator;
- by using dynamic or mechanical seals that need no sealing water.

The water quality requirements for sealing water are set out in Appendix 2.

Optimising shower water use

Shower effectiveness can be combined with minimum fresh water use by careful consideration of the following:

- number of shower positions required;
- position of shower nozzle;
- distance between nozzle and felt/wire;
- type of nozzle - flat or needle jet;
- nozzle diameter;
- water pressure (up to 6 000 kPa);
- water temperature;
- oscillating speed of shower pipe;
- jet angle against the felt/wire;
- intermittent operation of high-pressure needle showers.

> Optimising these conditions allows fresh water consumption for showers to be reduced from 1 000 - 2 000 litres/minute to 50 - 100 litres/minute per metre of wire width. The lifetimes of the felt and wire may also be extended.

Industry take-up of certain measures designed to eliminate, minimise or re-use fresh water is illustrated in Fig 20.

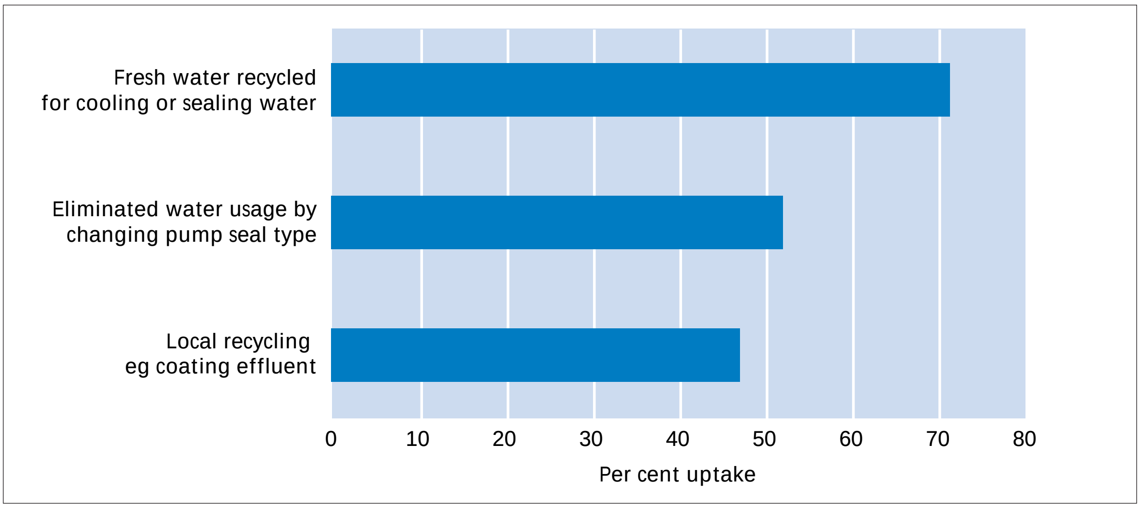


Fig 20 Level of take-up of measures to eliminate, minimise or re-use fresh water

5.3.4 Industry take-up of consumption control measures

In summary, the survey has established the extent to which measures have been implemented in four areas:

- preventing the overflow of white water (Fig 17);
- re-using white water (Fig 18);
- improving white water quality (Fig 19);
- eliminating/minimising fresh water use (Fig 20).

The results show there is a decline in the percentage take-up of these measures as one progresses from preventing white water overflow, through elimination/re-use, to improving white water quality. The last of these options is likely to incur the greatest capital costs and disruption to the process during implementation. The other options are easier to implement.

The white water re-use applications considered to have the greatest impact on water usage performance are:

- wet-end showers;
- saveall sprays;
- vacuum system sprays;
- pulping;
- sealing waters.

Fig 21 shows the number of mills that have re-used white water for one or more of the above applications and the effect this had on their water consumption.

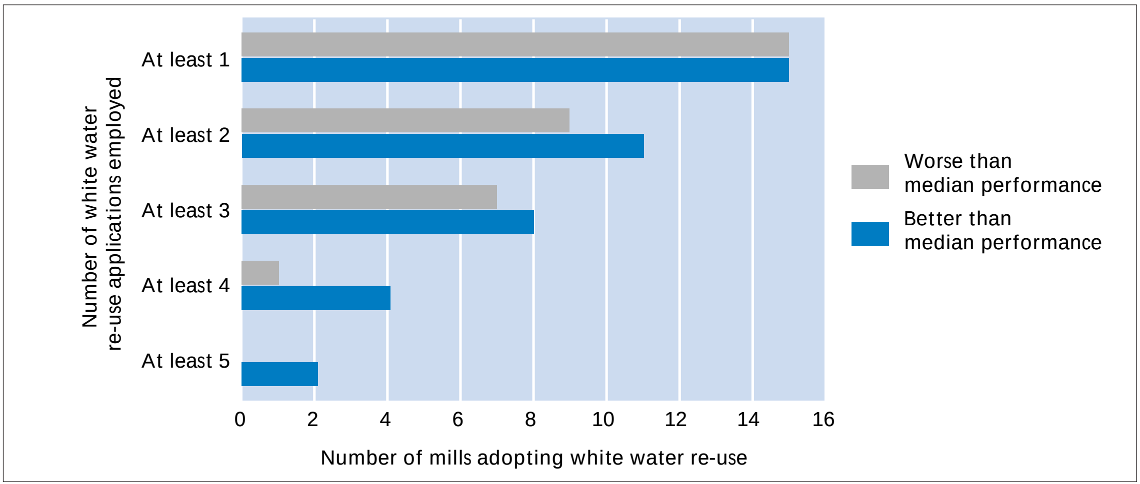


Fig 21 Effects of white water re-use on mill water consumption

Most mills re-use white water in at least one mill application; as the number of re-use applications increases, the greater is the impact on specific water consumption rates. Most mills re-using water in two or more applications enjoy specific water consumption levels that are below the median value for their sector. Of the five mills re-using water for four or more applications, all but one have a specific water consumption lower than the median.

- Is your mill doing as much as its competitors to improve performance?
- What measures could be implemented right now?
- What measures are readily achievable and are a priority for future action?
- What support and information is needed to assist this process?

6 REMAINING OBSTACLES TO IMPROVEMENT

Sections 3 and 5 of this Guide show that there is still a gap between what is actually being done and what could be done to make more efficient use of process water. Significant variations in specific water consumption rates have been identified in each of the industry's major sectors, suggesting that many mills could improve their water use efficiency. Similarly, while a number of mills have introduced management measures and process modifications to minimise water consumption, others have not yet implemented any significant level of control.

The survey findings indicate that significant barriers exist which hinder the adoption of water minimisation technologies and techniques. The industry's perception of these barriers is illustrated in Fig 22.

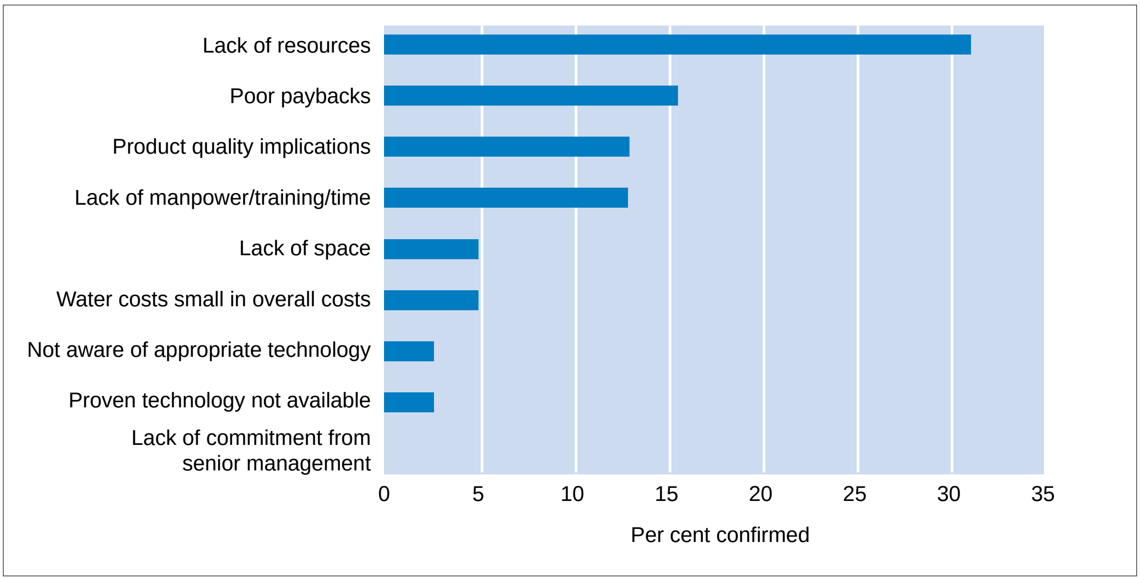


Fig 22 Perceived barriers to improvement

Economic factors are important determinants of the pace of change, and it is recognised that water minimisation measures must compete with other calls for scarce investment funds. More than 30% of survey respondents believed that opportunities for reducing costs by minimising water use were being lost because of a lack of financial resources. Fifteen per cent considered that the paybacks associated with water minimisation measures were insufficiently great to secure the requisite funding.

Payback periods reflect the relationship between capital and installation costs on the one hand and cost benefits on the other. While the cost of water minimisation technology is unlikely to fall dramatically in the short term, a better appreciation of the potential cost savings may make the case for investment more attractive. Companies introducing the management measures described in Section 5 - monitoring and targeting in particular - will acquire a better understanding of their current levels of water use and loss. They should also take into account the full cost implications of water use in any investment appraisal, including the operating costs of on-site effluent treatment plant.

Several mills have expressed concern about the impact of water minimisation, and particularly water closure, on product quality. While product quality must be the prime concern for all mills, selection of the appropriate water minimisation technology and a better understanding of what constitutes best practice may help to allay some fears in this area.

Human resources are essential to the implementation of any water minimisation measure, whether it is management-based or equipment-based. Almost 15% of mills identified the lack of these resources as a significant barrier to improving water use efficiency. To overcome this barrier it is important to secure the commitment of senior management to any water control programme. This should ensure sufficient resources are made available to achieve effective change.

- What barriers are preventing your company from reducing its water consumption?
- What approaches could your company adopt to overcome these barriers?
- Is the case for investment being presented as effectively as possible, taking into account all potential cost savings?
- Could more be done to ensure that any potential effects on product quality are fully understood and overcome?

section 6

7 WATER MINIMISATION ACTION PLAN

The use of water in paper and board manufacture is a highly complex aspect of the process, and the survey undertaken to provide information for this Guide has highlighted the enormous variation in the performance of different mills and the practices employed. Most mills could probably benefit from further improving the efficiency of their water use. This would generate significant costs savings as well as reducing both levels of resource dependency and the environmental impacts associated with effluent treatment and disposal.

The following Action Plan for water management will help your mill achieve these benefits in an effective and straightforward manner. Fig 23 provides a framework that you can adapt to meet your mill's requirements or to match existing structures. The key elements of the Plan are described below.

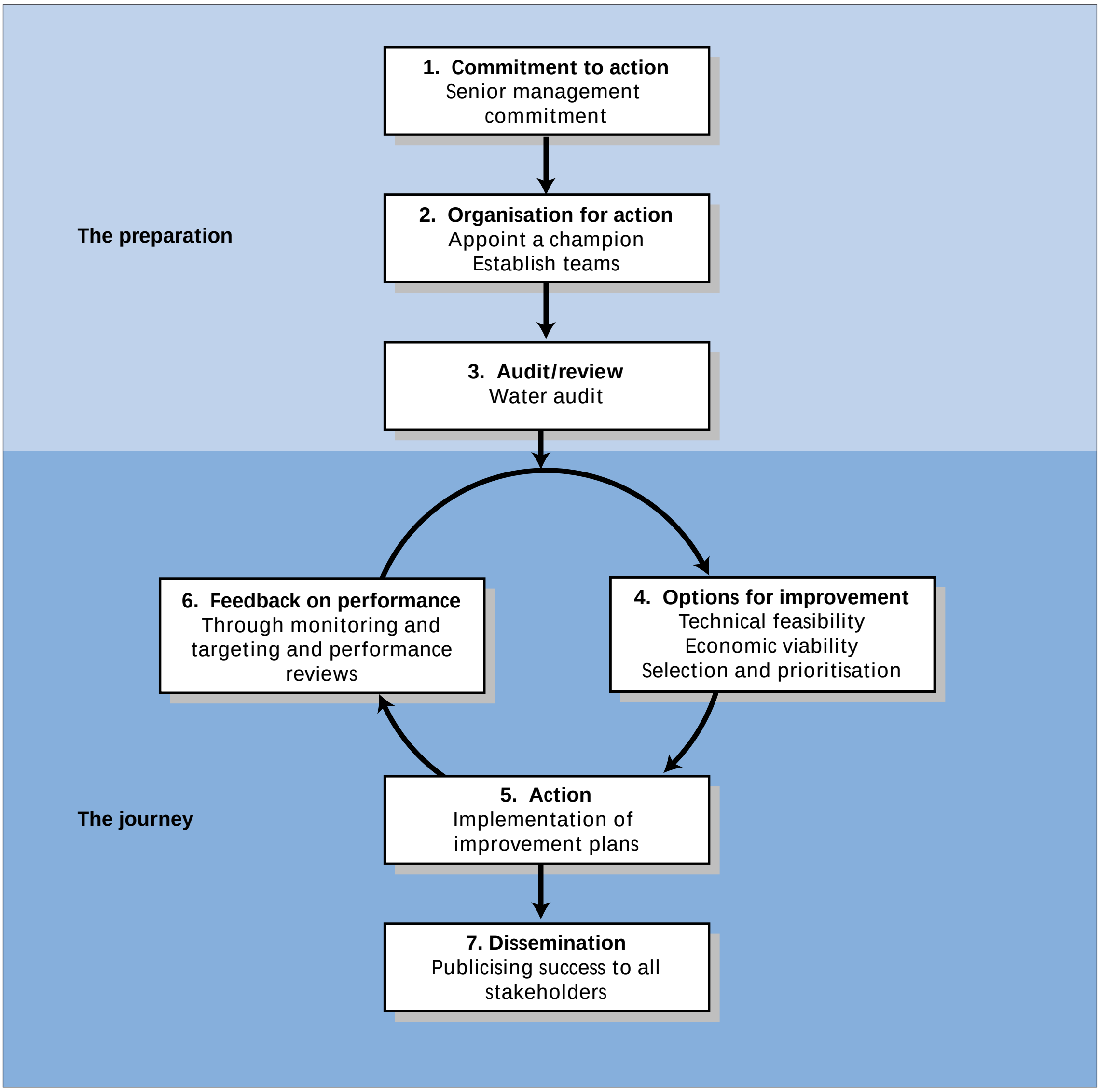


Fig 23 Framework for a water minimisation Action Plan

Ensure commitment to action

Your first step is to make the case for further action. Use this Guide to help you review your mill's water performance and the procedures employed. Assess mill circumstances and determine the need for, and likely benefits arising from, an improvement programme focusing on water use. Use this information to gain the commitment of senior management to such a programme and thereby secure an appropriate allocation of manpower and resources.

Organise for action

Establish an organisational structure that will allow you to proceed with the improvement plan and allocate responsibilities accordingly. Where appropriate, appoint a champion for the programme and form the necessary teams to secure its implementation[1]. Involvement across the mill may be essential, particularly when undertaking an audit or review. Identify and address any additional training needs. Remember that no-one understands the mill better than those who work in it, and no-one will, therefore, be better placed to ensure the success of measures implemented under the plan.

Review and audit water use

Use the teams or individuals responsible to undertake a comprehensive water audit of the site, establishing where and how water is used and where it ends up. Identify all points at which water is lost and, most importantly, identify the costs associated with each element of the process or flow. The scope of the review should cover:

- water abstraction;
- incoming water treatment;
- effluent treatment;
- effluent disposal;
- water clarification;
- pumping and distribution;
- energy and materials (fibre) losses as a result of leaks and effluent discharge.

The end result should be a comprehensive mass balance for the process with an accurate characterisation of costs.

Identify options for improvement

- Review the findings of the audit.
- Identify possible options for improvement and assess these in relation to process requirements.
- Establish any technical or process implications arising from the proposed improvements.
- Assess the economic feasibility of each option before selecting and prioritising options for implementation.
- Where an option requires a capital input, make sure that the measure is supported by a robust case for investment.

Throughout the option identification and selection process it is essential to maintain commitment to the plan both from senior management and across the site.

[1] See Good Practice Guide (GG27): *Saving Money Through Waste Minimisation: Teams and Champions.*

Implement the selected options

Ensure feedback through monitoring and targeting

Implement a monitoring and targeting programme to provide feedback on the success of measures implemented under the plan. Remember that monitoring and targeting is a means of driving improvement forward.

Disseminate successes achieved

Disseminate the successes achieved as widely as possible within the mill. This will help you to maintain the commitment of the workforce. Presenting the results at board meetings will help to ensure the continued commitment of senior management. Publicise and promote successes to stakeholders outside the company. This can generate widespread recognition of the company's achievements. Improving the mill's environmental credentials may generate even further cost benefits.

Work within existing environmental management systems

If your mill has an established environmental management system, the organisational structures and plans to allow you to meet the requirement for continued environmental improvement will already exist. In this case you should consider how to integrate a water minimisation plan into the existing structures. You may even establish a specified reduction in specific water consumption as one of your key objectives for environmental improvement.

Can the Environmental Technology Best Practice Programme provide any further help?

- Mills with specific environmental queries can contact the Environmental Helpline on 0800 585794.
- Mills employing fewer than 250 people can ask for a counselling visit to advise on any aspect of waste minimisation, including water use.

Appendix 1

THE MOGDEN FORMULA AND UK TRADE EFFLUENT CHARGES

Water company charges for trade effluent discharged to sewer are based on the Mogden Formula. This formula attempts to link charges to trade effluent customers to the costs that they impose, ie customers pay according to the volume and strength of the effluent they discharge.

The Mogden Formula is expressed as follows:

$$C = R + M + V + Bv + \frac{OtB}{Os} + \frac{StS}{Ss}$$

where:

C = Charges in pence/m^3

R = Reception and conveyance

M = Treatment and disposal where effluent goes to a sea outfall (M for marine)

V = Primary treatment (V for volumetric)

Bv = Additional volume charge if biological treatment is required

Ot = Chemical oxygen demand (COD) of effluent after one hour quiescent settlement at pH 7

B = Biochemical oxygen demand of settled sewage

Os = COD of crude sewage after one hour quiescent settlement

St = Total suspended solids (mg/litre) of trade effluent at pH 7

S = Treatment and disposal of primary sludge

Ss = Settleable solids (mg/litre) - suspended solids after one hour quiescent settlement

Values for B and S may be corrected for average regional strength (B' and S'):

B' = B/Os

S' = S/Ss

Charges for B' and S' are usually expressed in pence/m^3 relative to standard strength (concentration usually expressed in mg/litre). Standard strengths vary from company to company. To maintain comparability, the charges shown in the following tables (B' and S') are corrected for standard strength and shown as pence/kg.

appx A1

The extent to which the Mogden Formula is applied depends on the degree of treatment provided by the water company receiving the effluent:

Discharge directly to a watercourse - mill pays only the R component

Discharge via an effective sea outfall - mill pays only R + M

Discharge receiving primary treatment only - mill pays R + V + S

Discharge receiving full treatment - mill pays R + V + S + B

The charges paid by mills for each m^3 of effluent discharged will also vary because of variations in water company charges and in the strengths discharged.

Variations in water company/authority trade effluent charge factors for 1996/97 are shown in Table A1.

	Minimum charge (£)	R p/m³	V p/m³	Bv p/m³	M p/m³	B' p/kg	S' p/kg	Regional strengths Os mg/l	Ss mg/l
Anglian	108.00	9.38	14.68	2.84	7.27	34.70	19.63	447	403
Dwr Cymru	102.00	11.00	7.23	2.89	10.72	33.37	33.65	500	350
North West	99.00	10.00	8.00	1.10	7.40	22.34	25.73	367	237
Northumbrian	239.00	19.30	9.47	-	-	37.30	39.05	386	187
Severn Trent	107.00	15.48	14.60	-	-	24.90	19.00	351	343
Southern	110.00	19.73	14.41	2.32	2.54	42.01	26.39	452	512
South West	118.70	31.92	29.42	-	-	69.64	63.26	744	489
Thames	70.00	6.53	8.03	-	-	28.43	47.98	445	336
Wessex	160.00	12.75	12.60	0.50	-	30.50	41.92	802	313
Yorkshire	195.00	17.00	19.53	-	-	21.19	36.09	926	339
E of Scotland[1]	110.00	7.89	6.63	-	-	48.59	17.47	334	233
N of Scotland[2]	-	9.99	4.73	-	-	27.89	20.48	350	250
W of Scotland	130.00	4.68	4.83	-	-	23.25	18.00	240	155
N Ireland[3]	-	10.00	8.00	-	-	20.83	16.67	480	340

[1] Trade effluent data for the East of Scotland Water Authority were provided by Lothian Regional Council. Tayside Regional Council has a flat rate charge of 23 p/m³.

[2] Trade effluent data for the North of Scotland Water Authority were provided by Grampian Regional Council.

[3] Trade effluent data for Northern Ireland were provided by the Department of the Environment for Northern Ireland Water Services Division. There is currently no minimum charge in place in Northern Ireland, although this may be introduced in the future.

Table A1 Water company/authority trade effluent charge components 1996/97

Trade effluent charge calculation: a worked example

Anglian Water Mogden Formula values:

R = 9.38 pence/m^3

V = 14.68 pence/m^3

Bv = 2.84 pence/m^3

B' = 34.70 pence/kg

S' = 19.63 pence/kg

For 1 m^3 of low-strength effluent (Ot = 200 mg/l and St = 300 mg/l), the volumetric charge C can be calculated as follows:

$$C = R + V + Bv + B'\,Ot + S'\,St$$

$$= 9.38 + 14.68 + 2.84 + (34.7 \times 0.200) + (19.63 \times 0.300)$$

$$= 39.729 \text{ pence/m}^3$$

$$= £0.397/\text{m}^3$$

For a total discharge of 5 000 m^3, the charge would be 5 000 m^3 x £0.397

= £1 986

Table A2 shows the charge variations between water companies for 5 000 m^3 of low-strength effluent and the same volume of a high-strength effluent.

Water and sewerage companies/authorities	Low-strength effluent (£)	High-strength effluent (£)
Anglian	1 986	6 644
Dwr Cymru	1 894	6 910
North West	1 564	5 034
Northumbrian	2 397	8 054
Severn Trent	2 038	5 567
Southern	2 624	8 344
South West	4 712	14 935
Thames	1 732	6 681
Wessex	2 226	7 201
Yorkshire	2 580	6 280
East of Scotland	1 474	7 673
North of Scotland	1 322	5 246
West of Scotland	978	4 282
Northern Ireland	1 461	4 681

NB: All bills are shown rounded to the nearest £. Bills for full treatment of effluent are calculated according to the Mogden Formula where the effluent characteristics are:
Low strength: COD = 200 mg/litre and Ss = 300 mg/litre;
High strength: COD = 2 500 mg/litre and Ss = 1 000 mg/litre.

Table A2 Water company charges for 5 000 m^3 of low-strength and high-strength effluent

Appendix 2

WATER QUALITY REQUIREMENTS

This Appendix describes typical white water composition and water quality requirements for showers, boilers and sealing water.

Parameter	Range
pH	4.9 - 7.3
Conductivity (mS/cm)	3 - 11
COD (mg/litre)	4 500 - 22 000
BOD_5 (mg/litre)	2 000 - 8 000
Suspended matter (mg/litre)	4 500 - 23 000
Dissolved matter (mg/litre)	1 000 - 10 000
Sulphates (mg/litre)	240 - 2 350
Chlorides (mg/litre)	130 - 2 950
Sodium (mg/litre)	100 - 800
Calcium (mg/litre)	360 - 2 040
Magnesium (mg/litre)	30 - 110
Iron (mg/litre)	0.1 - 47
Alum (mg/litre)	0.5 - 53
Aerobic micro-organisms (10^6 coliforms/ml)	100 - 300
Anaerobic micro-organisms (10^6 coliforms/ml)	15 - 950

Table A3 Typical composition of white water[1]

Nozzle	Water type		Examples
(diameter mm)	Fresh	Process	
0.3 - 0.7	✓	-	Felt conditioning, knock-off showers
0.7 - 1.0	✓	TS <60 ppm	Dandy roll, trim squirt, couch roll
1.3 - 3.0	✓	TS <180 ppm	Felt cleaning, felt lubricant, headbox
3.0 - 5.0	-	TS <1 200 ppm	Wire return roll, breast roll
5.0 - 19	-	✓	Trim knock-off

Table A4 Water quality criteria for showers[1]

appx A2

[1] Blanco, A; Negro, C; Garcia, J and Tijiro, J. *Predicting the impact of closing the water system in paper mills.* Appita 96/436.

Parameter	Range
Boiler Water	
pH	8.5 - 9.6
Total organic carbon (mg/litre carbon)	<0.2
Hardness (mg/litre $CaCO_3$)	-
Dissolved oxygen (mg/litre O_2)	<0.007
Iron (mg/litre)	<0.01
Copper (mg/litre)	<0.01
Sealing Water	
pH	>5.5
Dissolved matter (mg/litre)	<500
Suspended matter (mg/litre)	<350
Hardness (mg/litre $CaCO_3$)	<200
Chlorides (mg/litre)	<50
Sulphates (mg/litre)	<100
Sulphides (mg/litre)	<50

Table A5 Quality requirements for boiler and sealing water[1]

[1] Blanco, A; Negro, C; Garcia, J and Tijiro, J. *Predicting the impact of closing the water system in paper mills*. Appita 96/436.

The Environmental Technology Best Practice Programme is a joint Department of Trade and Industry and Department of the Environment initiative. It is managed by AEA Technology plc through ETSU and the National Environmental Technology Centre.

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FOR FURTHER INFORMATION, PLEASE CONTACT THE ENVIRONMENTAL HELPLINE

0800 585794

e-mail address: etbppenvhelp@aeat.co.uk

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