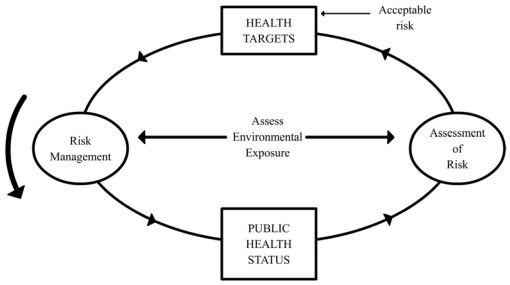

17

Regulation of microbiological quality in the water cycle

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Regulation focused on the control of microbiological hazards is important in reducing the incidence of infectious disease. Controls are required throughout the water and waste cycle and many stages are inter-related. The regulator should, therefore, take a 'whole of system' view of microbiological risks and ensure that essential and cost-effective interventions are promoted. This chapter provides an overview of the regulatory issues related to the proposed harmonised framework.

17.1 INTRODUCTION

Regulation is driven by two important objectives:

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(1) The protection of the public interest against sub-standard services that raise the risks of health impairment; and
(2) The provision of a transparent system of management where roles, responsibility and liability are clearly defined.

Historically, the development of standards and regulations related to microbiological quality in the water and waste cycle focused on drinking water supplies. In Europe and North America in the nineteenth century this was primarily driven by the need to address epidemics of infectious disease. During the early development of standards, the importance of faecal contamination of water was recognised and the roles of filtration and, later, disinfection were emphasised as critical to the control of drinking water quality. A strong emphasis was placed on sanitary integrity of water sources and supplies and on the use of sanitary inspection in monitoring water supplies. This was associated with the development of the concept of (faecal) indicator bacteria combined with simple methods to test for their presence as a means for assessing the potential presence of pathogens (Chapter 13 and Helmer *et al*. 1999).

Within the water sector, WHO has continued to advocate this approach with respect to control of drinking-water quality (WHO 1993), recreational water quality (Bartram and Rees 2000) and the quality of wastewater reused in agriculture and aquaculture (Mara and Cairncross 1989). Inspection, protection and treatment measures are given a high priority. Indicators to determine the acceptability of water quality include faecal indicator bacteria, turbidity, pH and free residual chlorine for drinking waters and intestinal helminth counts and trematode eggs for wastewater reuse. In the latter case, revised numerical values were recently proposed, taking into account epidemiological evidence for health risks (Blumental *et al*. 1999).

By contrast, national standards have tended to place the greatest importance on indicator bacteria rather than the many other indicators of system integrity and water quality noted above. In some countries, turbidity limits have recently been targeted as a treatment standard in response to risks of *Cryptosporidium* breakthrough. Risk assessment is being used in a number of countries to determine drinking water treatment requirements based on the risk of infection from reference pathogens (Regli *et al*. 1991, 1993).

Despite recent moves to expand the scope of regulations, in most jurisdictions, regulatory enforcement (i.e. action resulting from infringement) remains primarily based on the performance of the supply as determined by indicator bacteria. This almost exclusive reliance on indicator bacteria makes application of risk-based cost-benefit approaches difficult and inhibits the refinement of the definition of tolerable health risks. It also fails to address the breadth of interventions required to reduce disease burdens. It may

unintentionally result, for example, in an over-emphasis on water quality control in piped drinking water supply where investment in improving access and reliability of the water supply or improved excreta disposal might yield greater overall health benefits. The sole use of numerical limit values for indicator bacteria also mitigates against the process of incremental improvements and innovation in water supply that are frequently required (Briscoe 1996; Kalbermatten and Middleton 1999; see Chapter 16).

There is little doubt that water supplies which consistently meet standards set for indicator bacteria represent reduced risks to public health. The detection and control of indicator bacteria has proven effective in reducing the frequency of epidemics of bacterial pathogens. However, the value of these indicators to predict the presence of non-bacterial pathogens is limited (see Chapter 13) and there is increasing evidence of infections in populations consuming water that meets current indicator-based standards for drinking water quality (Payment *et al*. 1991; see Chapters 4 and 7).

Interpretation of the results of indicator bacteria analyses may not be straightforward. Typically, indicator bacteria are discrete in water and generally have a non-random distribution in water (Lightfoot *et al*. 1994). They are more likely to be found in clumps following treatment, rather than uniformly spread throughout the water (Gale *et al*. 1997). The volume of water actually analysed by taking occasional 100 ml samples from a large water supply is often less than one millionth of 1% of that produced. Therefore, the absence of indicator bacteria in these small samples may not reflect their true density in water (Gale 1996). Current approaches with a heavy reliance on the use of indicator bacteria are simplistic and are not based on a holistic understanding of the actual health risk derived from exposure. However, because penalties are linked to exceedance of the numerical value for the indicator, the achievement of the standard for the indicator inevitably assumes greater importance than the production of water that is of a quality suitable to protect public health. Thus the tool of monitoring and regulation has become, in many circumstances, the objective of treatment. Further difficulties can arise when the role or applicability of indicators is confused – often the very important difference between total coliforms and faecal coliforms is not clear to non-microbiologists. This leads to the application of excessive disinfection (and the production of disinfection by-products) to reduce total coliform levels even where there is no evidence of faecal contamination.

To address these concerns, revised health protection approaches need to be explored (such as the development of the proposed harmonised framework), and a more process-driven approach considered. Potential implications for future regulation include changes to the indicators of performance with reduced

reliance on microbiological parameters and greater reliance on process and system management. These should, in turn, be derived from evidence-based assessment of efficacy to develop a closer link to health outcomes. The use of risk assessment, process control and system management offer advantages for regulatory bodies, enabling them to establish systems that will promote realistic standards that can be modified with changing conditions.

17.2 DEFINING HAZARDS AND ACCEPTABLE LEVELS OF RISK

The proposed harmonised framework translates into a series of activities that regulatory bodies would undertake. These include:

- Identification of hazards and their significance in the local context – types of pathogen, health consequences (diseases and severity), prevalence studies, and possible identification of vulnerable and sentinel groups.
- Identification of health impacts – costs to individuals, costs to society.
- Public consultation – define acceptable risk, tolerable disease burden, willingness to pay for improvement.
- Characterisation of waters with respect to the hazards of concern.

The first two activities are based on sound scientific and health evidence to determine likely prevalence of diseases and the overall impact on the health of the population at large and on sensitive sub-groups. The differentiation of sensitive sub-populations may be important, for instance pregnant women in South Africa are at much greater risk from hepatitis E virus than males or younger children (Grabow 1997). The costs to the individual and society may be less easy to calculate and should take into account non-monetary costs and benefits from improved water and waste services.

Information from international reference sources such as Guidelines documents (see Chapter 2) provide much of the required information and can form the basis for public consultation. Consultation will only produce useful outputs if it is based on a thorough understanding (by all stakeholders) of the major issues and a balanced dialogue can be maintained (see Chapter 14). This is particularly important, as establishing an acceptable risk or tolerable disease burden is effectively asking people to define the level of ill-health they are willing to tolerate (see Chapter 10). In order to do this, the implications of

different levels of protection and/or treatment of water on costs to the consumer must be clear and understood by the general population.

In addition to targeted public consultation within this process, there are broader considerations. These include consideration of the proportion of costs that should be absorbed by the service provider without direct consequence on tariff. A further consideration is the incorporation of the estimates of costs accrued to society as a whole rather than to individuals or communities. This includes, for instance, the financial costs of medical treatment in epidemics. Furthermore, there are a broad range of engineering options for developing water and wastewater treatment and use strategies. For example, point-of-use treatment and/or provision of small volumes of specially treated drinking water to high vulnerability groups (e.g. those that are immune-suppressed) can reduce the treatment requirements for the bulk water supply and be a more cost-effective approach in some systems.

Externalities, such as regional agreements or protocols that must be adhered to, must also be addressed and in some cases will be the principal consideration. Such externalities should also encompass potentials for lost earnings either from the presence of unacceptable microbiological hazards in key exports (e.g. shellfish, raw fruit and vegetables) or through lost income from reduced tourism due to poor international perceptions of safety. The latter point is increasingly important for some lower-income countries for which tourism is a rapidly growing sector, but where demands from the tourist population for health protection are high.

In all these stages the regulator would normally take the lead to ensure that the standards and norms established match current capacities and demands. In order to achieve this, a degree of consensus is required between the different stakeholders, and inter-agency collaboration is essential. In most cases, the standard-setting body would, by preference, be multi-sectoral in order to achieve this and would in particular ensure that health and social welfare concerns are adequately addressed in addition to technical and economic considerations.

As a first step, the available water resources should be characterised according to their use and quality requirements. For example, it is common for source waters that are destined to become drinking water to be protected through set-back distances, protection zones and discharge permit levels. The value of characterisation is that it may reduce the frequency with which detailed hazard assessment needs to be carried out and simpler techniques can be used to evaluate hazards in an approach based on sanitary survey/inspection. This characterisation will need periodic updating, but can form the basis of establishing the requirements of individual water and wastewater plants and the degree to which watercourses will require protection based on their use. It will

also inform decision-making regarding allocation of different resources to different purposes.

17.3 RISK MANAGEMENT

From a regulator's viewpoint there are three broad approaches to risk management. While they are not entirely mutually exclusive, each has a very different focus, as summarised below.

- Specifying water quality requirements. This is the traditional approach outlined above in which indicators are used as the primary regulatory requirement. The problem of the target of monitoring becoming the treatment objective was introduced earlier. Where this type of approach is used, some division of monitoring between the supply agency responsible for 'quality control' and an independent agency responsible for 'surveillance' is typically encountered. Where a significant volume of testing is undertaken by the regulatory agency this may constitute a transfer of costs from the operator to the regulator.
- Direct regulation of processes. Specification of, for example, treatment processes to be applied to waters of differing qualities is commonly encountered in water quality legislation – both for drinking water supply and for wastewater treatment. This approach places additional burdens on the regulatory agency, which becomes responsible for the validity of the requirements made (i.e. the supplier is not responsible for public health but rather to put in place the treatment requirements specified by the regulations). For the purposes of surveillance, compliance is relatively easily assessed since the existence and operation of processes may be readily verified. Complementary measures such as the maintenance of records available for audit by the regulator may contribute to this.
- Requirement to demonstrate safe practice. In some instances, and more frequently in sectors other than water, the approach taken has been to require that the operator undertakes a risk assessment and puts in place adequate measures to protect public health. The assessment may require approval by a third party (which may have responsibility for public health) and would commonly specify elements such as definition of critical control points and validation and verification requirements (see

below). Such an approach places a burden on the operator to adequately assess and document safety. Where small operators dominate this may not be achievable unless a support system can be developed (through provision of model codes and operating practices for different types of facility, for example). For the regulator, such an approach provides a simple framework within which to apply an auditable approach that may be more effective and reduce costs in many circumstances.

It is the third of these approaches that was recommended at the Stockholm meeting as providing the basis for the harmonised framework. There were many reasons for this, with one of the most important being the adaptability of the approach, enabling different local circumstances to be taken into account. In addition, the third approach is adaptable enough to include appropriate elements of the first two. For example, there needs to be some form of process specification. This can be locally derived and can be site-specific or involve adoption of generic approaches. The *prima facie* verification programme may include indicator measurements.

When applying this type of approach the basic requirement is that an operator prepares a hazard analysis and risk management plan that would include, as a minimum, the following components:

- Baseline characterisation of the source water quality and its variability.
- A verified description of the system and processes.
- The description of water quality objectives appropriate for the specified water use.
- Hazard analysis including an assessment of the type and magnitude of risks.
- The identification of points at which hazards need to be controlled (control points – jargon terms include critical control points, points of attention, sanitary operating practices or preventative measures and choice depends on local preference).
- Monitoring of treatment efficiency indicators to pick up potentially problematic failures of the process at the control points.
- The setting of critical limit targets for monitored activities.
- A corrective action plan in case of failure to comply with the critical limit targets (which would normally distinguish between minor events and events of potentially major public health significance).

- Validating (proving) that the facility is *prima facie* capable of meeting the appropriate water quality targets or other regulatory requirements.
- Verification activities to provide *prima facie* evidence that water is meeting the requirements and that public health targets are being achieved (including record keeping).

This process is outlined in more detail in Chapter 12. However, some of these components are reviewed from a regulatory perspective below.

17.3.1 Critical control point identification

One of the key elements within risk assessment and management is the identification of points within the water or wastewater chain that will either:

- reduce pathogen presence;
- remove/inactivate pathogens, or
- prevent exposure to pathogens.

These are often termed the critical control points as they represent the parts of the cycle where definable action can be taken that will result in (often quantifiable) change in risk and which will provide protection against unacceptable microbiological quality. A range of terms have been used by different regulators for these critical control points depending on the level of criticality (i.e. 'control points' or 'points of attention'), or nature of the process (i.e. 'preventative measures' or 'sanitary standard operating procedures'). For simplicity, here we will use the term critical control points.

In order that critical control points have relevance for the regulatory regime (and especially enforcement), they should be in areas where specific action is required. For instance, while control of agricultural pollution in a catchment is a 'conceptual' critical control point, it is little practical value in terms of the regulator to measure compliance. This would need to be translated into a specific action. An example might be a seasonal restriction on the application of manure, or a restriction on feedlots within a distance specified on the basis of the potential for pathogen migration. A similar process would be seen in regard to treatment processes where the degree of specification would typically be expected to cover defined operational performance criteria (length of filter run, backwash efficiency or effluent retention time, for instance). Regulators have options to employ direct regulation of specific critical control point limits or indirect regulation by requiring that an operator demonstrate that their total

system has adequate capacity to reach a defined water quality target, without specifying the processes through which this should be achieved.

As different microbiological hazards have different characteristics in terms of pathogenicity, occurrence and survival, different pathogens may require different critical control points. Some types of pathogens may represent particular hazards or challenges and it is sensible to define the critical control points with regard to such 'reference' pathogens. Clearly, different reference pathogens will be required within the various parts of the water cycle and the most appropriate micro-organism selected for each stage of risk mitigation (based on resistance, pathogenicity and nature/magnitude of exposure). Within this, due consideration should be given to average conditions, seasonal variations and extreme events. The latter may, for instance, take into account treatability of drinking water under extreme contamination due to floods or may be used to define effluent quality when flows in receiving water are very low.

17.3.2 Process adequacy (validation)

A key component underlying the process of critical control point identification and application is that there should be evidence of efficacy in terms of risk mitigation or reduction. In this way, the critical control point is related back to the hazard assessment.

During planning and commissioning it is essential that any facility be demonstrated to be capable of meeting the water quality targets or other regulatory targets assigned. During the design phase this may imply theoretical estimations or, in some cases, pilot plant work. For smaller facilities 'standard designs' may be adopted in some circumstances. There would be a requirement that plans are approved and performance certified during commissioning by a 'competent authority'. These are relatively straightforward regulatory requirements to implement and costs largely accrue to the operator where the costs of the competent authority are of experts paid from operator funds rather than provided by the regulator itself. This does, however, raise the issue of shifting liability and also the need for guidelines or regulations on how to certify competence. The objective of this validation exercise is to provide objective evidence that the water quality for the designated use is unlikely to deviate beyond a stated target.

One of the consequences of treating the different components of the water and wastewater cycle separately has been to distort the control of risks derived from infectious diseases towards the production of drinking water, despite obvious comparative advantages in many cases of controlling risks closer to the source of contamination. The multiple barrier principle has long been applied to

drinking water supply and the same principle can easily be applied at the broader water and waste cycle level.

For the regulator, the most important aspect at this stage is to define the appropriate intervention within the cycle. This approach tries to answer the following questions:

- Where is human exposure to the hazard within the water and waste cycle most likely to occur or be most significant?
- What is an acceptable risk within each stage of the water and waste cycle based on the hazard and nature of exposure for each pathogen?
- At which point in the cycle will action be most cost-effective?
- What will be the impact on downstream stages of the cycle of the application of an acceptable risk level at an upstream stage?

The next stage is to assess the efficacy of the critical control points in meeting the acceptable risk level. This requires an initial 'research' stage that assesses how effective different processes are in producing water or wastewater of acceptable quality and the operational boundaries that describe performance. The treatment of wastewater and drinking water typically utilises multiple stages of treatment (and in the case of drinking water, source protection measures), thus such boundaries should define not only the combined effect of the multiple stages, but the performance of each individual process.

In many cases, such research has already been undertaken through studies of inactivation rates of particular pathogens in unit processes and through treatment trains. In most cases, therefore, the 'research' component may be limited to literature-based assessments of efficacy. Experimental research may only be required where the level of acceptable risk is significantly lower than attainable by typical treatment performance reported by previous research, where ambient conditions are significantly different from those challenges reported from experimental treatment efficacy research, or where either a new hazard is defined or new process evaluated.

The critical control points within the treatment process can then be defined for the plant as a whole and for unit processes. These critical control points are effectively the key operational parameters that control the overall capability of the process to reduce the hazard to the acceptable risk level.

17.3.3 Monitoring to match the critical control points

For each critical control point, there should be some means of monitoring its effectiveness to ensure that performance targets are within critical limits. This

monitoring system needs to provide a reliable assessment of whether the critical control point is being applied effectively and the residual risk is acceptable. Unless there is a simple means of monitoring, repeated and routine hazard assessment would be required, which would become unduly expensive and ultimately difficult to sustain.

Monitoring systems need to be:

- Specific - related to a particular critical control point and not to a broad set of inter-related factors.
- Measurable – it should be possible to translate the critical control point status into some form of quantifiable assessment, even if data collection is based on semi-quantitative or qualitative approaches.
- Accurate – providing an accurate reflection of the critical control point status and sensitive to changes that are of relevance to changes in exposure; they should also have fairly small and precise confidence and prediction intervals, to increase the value of the data they produce.
- Reliable – to give similar results each time it is measured; again this should be within precisely defined confidence and prediction intervals to allow the degree of uncertainty to be described within routine monitoring.
- Transparent – the process of selection of the monitoring variable, the method and frequency of measurement and the interpretation of the results should be transparent and accepted by all stakeholders.

For all components of the system, the choice of monitored variables should be evaluated and validated alongside the critical control point efficacy validation and testing in order that they can be calibrated against an acceptable risk of exposure. The subject of the monitoring should be relatively simple to measure and permit information to be collected frequently and cheaply. Any system of monitoring that becomes too complicated or expensive is unlikely to be effective.

17.3.4 Corrective actions

Where monitoring demonstrates that critical control points are likely to fail, based on the exceedance of a critical limit, corrective actions need to be taken. Regulators can ensure that the appropriate organisations have incident management plans to regain control. These can be generic plans that describe incident management protocols, lines of communications and strategies that can be applied to any incident. These generic plans describe the process by which an

incident team will regain control of the situation. For reasonably foreseeable system failures it is better to develop and test specific plans to enable a rapid and effective response. Careful analysis of responses to system failures can be used to help organisations prepare better for subsequent system failures.

17.3.5 Verification and auditing

It should be stressed that it would be expected that some additional *prima facie* verification that water quality targets were being met would be required. Most likely, this would retain the use of indicator bacteria and public health verifications. However, the use and interpretation of such information would be incorporated into a multi-factorial assessment of risks to health. Additional verification activities would assess the adherence of operational systems and personnel to appropriate practice.

17.4 APPLICATION OF THE FRAMEWORK TO COMMUNITY DRINKING-WATER SUPPLY SYSTEMS

A large proportion of the world's population relies on services that are not utility-managed, but are managed by the users or community that they serve. This group represents special problems for regulation (Howard 2000). As regulation is based on a principle of protecting the public interest, it is effective when there is a clear organisational separation between the supplier of the water and the consumers. Where the consumers also operate the supply, the enforcement of standards becomes difficult unless the impact on health can be seen to be affecting people outside the immediate community, for instance in tourist locations or where water is used for food processing. Direct regulation, therefore, is often restricted to the design and construction phases rather than subsequent operation and maintenance.

However, while direct regulation may be problematic, there is a great need for surveillance as a supporting function that promotes improved public health and the ongoing (often incremental) improvement in services. This role is therefore often geared towards training and support to communities in an attempt to improve the quality of services. The application of the framework in these situations is discussed below.

Community-managed drinking water supplies range in size from single point sources, such as a borehole with handpump, to relatively sophisticated piped distribution systems that utilise multi-stage filtration and/or disinfection. Some of these serve single households, while others are designed for relatively large

communities of several tens of thousands of people. While the majority of these supplies are found in developing countries, they also represent a significant proportion of supplies in the countries of Central and Eastern Europe and the newly independent states as well as in Western Europe and North America.

Community-managed supplies are not restricted to rural areas and small towns, but are common in many urban areas worldwide (Howard *et al*. 1999). Their use may be found in very large cities. For instance, in Dhaka, tubewells with handpumps are a highly significant source of drinking water given very low rates of access to piped water (Ahmed and Hossain 1997).

The microbiological quality of the water supplied to small and community-managed water supplies is a major concern worldwide. In developing countries, many supplies routinely show contamination whether in urban areas (Gelinas et al. 1996; Howard et al. 1999; Rahman et al. 1997) or in rural areas (Bartram 1998). In industrialised countries, similar problems are noted. For instance, an assessment of the quality of small supplies in the UK found that almost 50% of supplies failed to meet prevailing microbiological criteria and had increased problems (Fewtrell et al. 1998). Similar problems are noted in the US and in Germany.

Some of these problems relate to lack of technical capacity and expertise within the communities for undertaking water quality analysis. Few communities that manage their own supply have access to the equipment and skills to undertake routine water quality monitoring. As a result, monitoring necessarily becomes increasingly infrequent and must be done by an outside agency. In many cases, the methods adopted for such monitoring result in lengthy delays in reporting of results to users and managers of the supply. This inevitably compromises the usefulness of such data in implementing remedial actions, and the results may have limited value in more complex systems as water quality at the time of sampling may not reflect subsequent (often rapid) changes in quality.

Furthermore, where results are relayed to the community, there are often difficulties in their interpretation in relation to potential health risks and in the appropriate remedial actions that should be taken. This lack of understanding is frequently translated into a lack of action of behalf of the community, leading to frustration among staff from local environmental health and water supply sectors.

An important component in ensuring that communities take appropriate action is to ensure that there is effective management to direct operation and maintenance activities and to respond rapidly to failures in the water supply. In many countries, a water source committee would undertake the management of a community water supply. These committees are usually made up of between 6 and 12 members of the community, and are responsible for overall management

of the source. As women tend to be the managers of water, such committees are often formed to ensure that women are adequately represented.

The role of the water source committee includes setting and collecting revenue from users and agreeing community contributions in kind to undertake routine maintenance and cleaning. It also liaises closely with the caretaker (who may also be a member of the committee) in agreeing the timing and resources required for maintenance and repair work.

When water source committees run effectively, the management of the water supply and the quality of water provided is usually good. Failures in management by the committee often translate into poor management and poor water quality. For example, in Uganda, a common feature in the failure of many small supplies (including point sources and public taps) was the absence of an active water source committee, many of which had become non-functional over time. Where such committees were reactivated, improvements in overall water supply quality were seen. In this case, an important factor in the promotion of better quality of drinking water could be an active and effective water source committee. Factors that would support the role of the committee include receiving adequate training in monitoring, maintenance and management of the supply and having access to appropriate tools and spare parts to carry out maintenance activities. These could be likened to critical control points and monitoring could be focused on the frequency and scope of training, use of specific maintenance and management tools. Another activity that could be thought of as a critical control point would be ongoing support through surveillance programmes.

17.5 APPLICATION OF THE FRAMEWORK TO WASTES MANAGEMENT

In terms of the management of wastes, an equal potential is noted for improved management of microbiological risks as noted for drinking-water supply. Local use of wastes is common in many parts of the world where excreta has traditionally been used as a fertiliser and effluent for irrigation. The use of untreated wastes in agriculture and aquaculture may also be common.

There may be specific issues that relate to small-scale waste reuse applications where excreta is used from pit latrines. In these cases, critical control points are usually based on storage of excreta, with the length of residence time of the excreta within the pit being the critical limit used as a surrogate measure of likely inactivation of *Ascaris* eggs. However, as this critical control point is a direct responsibility of the user, the technical component must be supported by training and guidance from agriculture and

environmental health field staff. A similar situation is likely to be found where a household or community fish pond is supplied by human waste as a nutrient source. The technical basis for the critical control point may be easy to define (based on treatment of waste or retention within a container), but the educational component is likely to be the more critical focus in practice.

For all aspects of the control of microbiological quality in water and wastes, general environmental health protection will also be critical. This will have impacts on the quality of water used for drinking, the quality of wastes and wastewater reused and on water used for other purposes, including recreation and also domestic chores such as laundry and bathing. The promotion of sanitation, proper siting of excreta disposal facilities in relation to drinking water sources, fish ponds and natural water courses and good management of wastes and hygiene will all lead to reduced hazards. This will again require an interface between the technical and educational components of critical control points, with promotion of good practice at a community level being more important than external systems of verification.

The implications for water supply agencies and regulators in reducing risks to users of community-managed services is clear. In the assessment of whether these services are adequate, not only should the infrastructure critical control points be assessed but also the educational and management points. The absence of management structures such as committees should imply action is required by the sector regulator to ensure that agencies engaged in the delivery of services address this properly.

While the framework does not necessarily overcome the legal problems relating to the regulation of community-managed water and wastes systems, it does provide a mechanism by which reductions in health risks from water and wastes can be significantly enhanced. It also provides much greater potential for communities to be active players in managing risks and monitoring the changing levels of risk that they are exposed to and this, in the long term, should translate into improved sustainability.

17.6 IMPLICATIONS FOR INTERNATIONAL GUIDELINES AND NATIONAL REGULATIONS

The development of the harmonised framework has regulatory implications as it will require the regulator, in conjunction with water suppliers and other stakeholders, to establish standards that are acceptable and systems of verification that are reliable. The development of the framework will allow more realistic and effective control of health risks from infectious diseases. This more

intelligent regulatory approach will require regulators and operational organisations to think more about the most effective and efficient way to protect public health. This may involve increasing the level of resources (including personnel) that are dedicated to water cycle management. The expectation is that this systematic and evidence-based approach to regulation will lead to better-targeted and, possibly, less costly engineered works while at the same time enhancing public health overall.

This development should not inhibit innovation by applying rigid standards and prescriptions that will limit the potential for new treatment technologies or distribution materials to be developed. One purpose of the regulatory regime is to ensure that 'consumers' get access to a product that is of an acceptable quality in the most cost-effective manner. The need to innovate is particularly acute in developing countries where the derivation of more realistic, evidence-based and balanced standards would contribute greatly to the broader need to address the challenges of providing adequate services to the whole population.

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