Integrated Wastewater Management

Appropriate wastewater management within an overall water resources management program is essential for responsible use of the environment and affordable provision of services. Such management programs are best developed at a river basin or subcatchment level. An approach is outlined for developing a wastewater strategy and an implementation plan for a river basin.

Integrated Management

The World Bank promotes a systematic approach to water resources management, incorporating water resources planning and management issues into policy discussions at the national level. Water quality protection and appropriate wastewater management are two essential elements in an integrated scheme.

The overall goal of water quality management is to protect the resource. Formal management normally becomes necessary when there are increasing and competing demands on the resource and when uncontrolled access or certain uses are likely to cause (or have already caused) unacceptable deterioration in water quality. The development of a realistic and practical management plan requires discussion, consultation, and negotiation, involving not just government and municipal agencies but also industrialists, local communities, NGOs, and representatives of nonpoint sources such as agriculture and transport. In many cases, the plan should be regarded as a process rather than a single document or agreement.

There are, unfortunately, numerous examples worldwide of poor wastewater planning and management—of poorly targeted government investments that addressed low-priority problems or tackled problems piecemeal and ineffectively. As a consequence, predicted benefits were not achieved, funds were diverted from other possible investments, and more cost-effective measures may have been neglected because of perceived administrative or political problems.

Failure of investment projects to achieve the design goals is often blamed on lack of institutional capacity or on financial weaknesses. A frequent cause, however, may be an insistence on inappropriate technologies and a failure to take into account the socioeconomic circumstances in which the plant must operate.

Basic Principles

In order to protect the quality of a water body, it is necessary to address the problems on at least the same scale as the water body itself, whether a lake, a river, or a coastal ecosystem. A focus on individual discharges without an understanding of the broader context is likely to lead to inefficient and often costly interventions. Comprehensive water resources management, of which wastewater management is one component, should be based on several broad principles:

- Water can be considered an economic good. (This is a basic principle of the World Bank's water resources policy; see World Bank 1993.)
- Water management must recognize the social aspects of water uses and therefore must involve the stakeholders at all levels.
- Maintenance of ecosystems is a legitimate goal of water management.
- The institutional framework and legal framework must be as broad as the physical water system.

Wastewater Management Approaches

A wide variety of wastewater management approaches are practiced throughout the world but they can be classified into three broad categories:

Decentralized local action
Coordinated regional action
Uniform national standards systems.

The first is essentially the project-by-project approach, driven by individual initiatives. While it may solve local problems, it is often inefficient and is not capable of dealing with widespread problems or large systems. It is typically the first stage of development in wastewater control but cannot be considered a desirable long-term approach.

The second approach appears to be the most attractive, in principle, because it can lead to comprehensive, cost-effective programs. However, although a regional or river basin approach is used in a number of European countries, it is by no means the norm in the industrial world.

The uniform national standards approach is the system currently used in the United States and was essentially the model underlying the EU approach. (Recent legislation, however, is moving toward an approach that allows more basin-level flexibility.) The national standards approach has the advantages of simplicity and uniformity of application.

In broad terms, the existing models that should be considered by developing countries are the uniform standards approach and the river basin approach.

Uniform Standards Approach

The standards-based approach is currently used in both the United States and the EU countries, but there are concerns in both areas about high costs, and questions have been raised concerning the efficiency of the overall system in meeting water quality goals.

The uniform standards system used in the United States since 1972 has achieved significant improvements in levels of wastewater treatment but at a cost higher than for alternative approaches. (It is noteworthy that, for a decade, federal subsidies provided much of the capital investment in municipal wastewater treatment.) Earlier legislation had established a system under which states set water quality standards for different bodies of water and then set limits on discharges at loads consistent with the quality standards. This approach was found to be unworkable, primarily because of the difficulties of apportioning total allowable loads among dischargers and of determining responsibility for breaches of water quality standards. The EU has adopted uniform wastewater treatment requirements without regard to local conditions, except for imposition of stricter requirements in “sensitive areas.” As the costs of implementing this policy—never seriously considered during preparation of the legislation—become clearer, opposition to the high charges and state subsidies required to finance the required works is increasing. The practical consequence of the high costs is delay in compliance with the requirements.

River Basin Approaches

The EU approach is, in fact, a departure from the river basin approach that was widely used in national systems in Western Europe. Germany, France, Spain, and the United Kingdom all have river basin authorities of one kind or another. All have systems of fees and charges that provide financing, to a greater or lesser degree, for wastewater investments. Those systems are now changing to come into compliance with EU requirements. Nevertheless, they still have some flexibility within their own areas of authority.

Such flexibility to set appropriate local standards within some national framework provides the possibility of setting priorities and realistic targets consistent with available resources. However, the implementation of a river basin approach requires a level of institutional sophistication that may take time to develop. Therefore, practical systems are often a mixture of basin management and standards.

In practice, a *combined approach* may be best, using both control of pollution at source through emissions limits and environmental quality standards for individual pollutants.

Options for Developing Countries

Many developing countries have established uniform national discharge standards, but these are often ignored. Whatever may be the chosen long-term system for a country, in most cases lack of financial and institutional resources will impose a cost-minimizing, priority-setting approach in the short to medium term, and this must be carried out on a water body basis.

Practical Framework

In many developing countries, inadequate wastewater control and rapidly growing populations have led to deterioration of natural water systems, public health impacts, and increased economic costs, as well as broader losses of environmental benefits. The development of a solution requires numerous decisions on the area to be served, the technology to be used, the location and standard of discharge, and the allocation of the cost burden. Solutions must be sought on the same scale as the problems, typically on the scale of a river basin or a lake catchment.

Although it would be desirable to have a fully objective method for comparing and ranking alternative upgrading programs, there are difficulties in valuing the environmental impacts of wastewater discharges. More important, perhaps, the distribution of costs and benefits will vary with different programs, and a process approach is required to reach a consensus among the parties involved.

The framework suggested here is a practical approach that quantifies the issues wherever possible but allows for identification of alternatives, followed by discussion and selection of a preferred option. Because no approach will be perfect, there must be mechanisms for monitoring, review, and adjustment over time.

The key steps are to:

- Establish a lead organization and involve stakeholders
- Identify broad goals
- Define specific, measurable objectives
- Formulate and assess possible strategies
- Select the preferred strategy, and then implement and monitor it.

Lead Organization

For progress to be made, there must be general acceptance of the importance of the problem, and there must be an organization or agency that takes the lead in the process. Ideally, this would be an existing river basin agency, but in practice, the problems may have arisen because there is no such body.

The lead organization must have access to all the relevant ministries and agencies and must have enough influence to ensure the involvement of key private sector stakeholders. It must also be sufficiently persuasive to promote discussion and consensus among the many parties involved. It does not have to have all the powers and functions necessary for implementation, and in fact it may be better for it to be given only technical and coordination functions, as this will reduce concern that it is driving a particular agenda. However, it must have sufficient support at all government levels and with other stakeholders so that all the relevant bodies cooperate in the planning process and are held to the agreements reached.

Goals

Broad agreement must be reached on the overall goals of a water resources strategy or of a wastewater management program. These goals can include social concerns (improving public health conditions or extending services to groups that are presently outside the system); economic issues such as reducing costs of water supply, protecting fisheries, or encouraging development; and environmental goals such as protecting or restoring certain ecosystems.

All these goals are important, and they will conflict to some extent. None can be given absolute priority over the others. The aim of planning is to find the strategy that allows significant progress toward achievement of all the goals.

Measurable Objectives

The agreed goals must be translated into specific, measurable objectives so that different strategies can be developed and assessed. This is an iterative process that may also include staging the objectives to reach a realistic program.

Depending on the scope of the planning process, the objectives could include coverage of municipal services, specific levels of service for water and sanitation customers, protection and provision of treated water, and the like. For the purposes of this discussion, however, the focus is on water quality objectives.

Water Quality Objectives

Management of water quality should focus on the ambient state of the water. Typically, the first step is to develop water quality objectives (WQOs) that define target values for key ambient quality parameters. These numerical WQOs can then be used to evaluate existing conditions; as a basis for the establishment of load limits for inputs to the water body (if this approach is adopted); and as a yardstick against which to measure changes over time.

The concept underlying WQOs is that of the beneficial uses of the water body (be it a river, lake, coastal zone, or whatever.) These uses represent the ways in which the community would like to make use of the water body. They include ecological uses such as preservation of species in the wild and fish breeding, as well as more direct uses such as drinking water. The clearest example of such uses is the goal set down in U.S. legislation of making surface waters “fishable and swimmable.” In practice, most systems adopt four to six main uses for which clear numerical parameters can be agreed on.

A typical set of uses (in more or less descending order of water quality) would be:

- Source of potable water
- Maintenance of fishery ecosystems
- Agricultural uses (irrigation and livestock)
- Amenity and conservation.

These uses are sometimes also presented as a classification, with Class I (potable water, in this example) typically having the highest standards and with the lowest category representing those waters that fail to meet even the lowest of the desired uses. For each of these classes, a set of basic numerical parameters can be defined, often focusing on key factors such as dissolved oxygen levels and nutrients (see the Annex).

Given an agreed classification, an initial step is usually to map the basin into classes or uses based on estimates of current water quality. From this baseline, the broad goals can be translated into desired beneficial uses for all the waters of the basin. The key point of debate will be the realistic long-term achievement of high-level uses for areas that are now very polluted. (The return of salmon to the formerly very heavily polluted Thames River in London is often quoted as an example of what can be achieved with consistent effort over a long period.) Once a first set of quantified goals has been prepared, the critical step is to develop an improvement strategy that specifies the costs of and constraints on achieving the goals. This should be the beginning of an iterative process aimed at reaching agreement on short- to medium-term goals that can be achieved with the resources to be made available.

Strategy Formulation

A management strategy is a set of decisions, policies, regulations, infrastructure investments, and other activities that, if implemented, is expected to reach the selected goals. A wastewater management strategy would typically include controls on industrial and nonpoint sources (including standards, charges, and other instruments), development of reuse, redefinition of municipal sewer catchment boundaries, upgraded treatment, relocation of discharge points, changes in regulated water flows, and a range of other actions.

Strategy formulation should include the preparation of a number of dissimilar options that are all relatively cost-effective but that may depend on nonquantifiable factors such as the degree of industrial discharge realistically attainable within the time frame or given different distributions of the cost burden through taxes and charges. A key variable will be the rate of progress that can be achieved at different levels of resource availability. All reasonable configurations of technologies, regulations, and system components should be included, with realistic costs assigned to each configuration.

The stakeholders need to be involved both in the determination of the options to be analyzed in detail and in the selection of the preferred strategy. (Documents available from the World Bank Group offer advice on public involvement in environmental assessment and similar projects.) The development of the strategy should involve, where necessary, the examination of existing institutions, regulations, and fiscal constraints to determine the benefits and costs of possible changes in these constraints. Achievement of significant progress may require changes in some of the existing systems. The arguments for such changes must be made clearly and persuasively.

The outcome of the process should be the selection of a preferred strategy that is acceptable to all the key stakeholders and that sets out clearly the actions to be taken, the resources required, and the legal and administrative responsibilities for each action.

Implementation

The agreed strategy should include an implementation schedule covering not only the adoption of standards, regulations, and policies and the construction of new facilities but also the generation of long-term political and financial support for the operation and maintenance of the old and new systems.

Monitoring

The design of the strategy must include the capability to monitor its implementation. Monitoring should cover the progress of both the implementation of the agreed strategy and improvements in the overall condition of the environment as the strategy is put in place. A successful monitoring program requires time, money, and appropriate expertise. The location of the responsibility for monitoring has to be given careful consideration so as to achieve an independent review while taking advantage of existing operational expertise.

The strategy should include formal reviews of progress as implementation proceeds, to allow for adjustment in response to changing circumstances or improved information. A high-level advisory group can be a good mechanism for providing such reviews.

Resources

The preparation of a comprehensive river basin strategy can require significant time and resources. However, the first steps—acceptance of the need for a comprehensive approach, designation of a lead agency, and identification of broad goals—-require breadth of vision and political commitment more than financial resources.

The level of detail in the analytical work required to define the objectives and to evaluate the strategies will depend on the complexity of the river basin and of its problems. In some cases, a simple model using estimated loads from a few critical sources may be adequate. For large, complex water bodies the exercise can cost hundreds of thousands of dollars. (For further information see the chapters on Water Quality Models and Optimizing Wastewater Treatment.)

Normally, specialist modelers (consultants or academics) need to be involved. It is important, however, that the analytical work be used a tool for the development of the strategy rather than as an end in itself.

Annex. Some Examples of Classification Systems

Chile has a national system of classification of waters that covers surface water, groundwater, and coastal waters. Surface waters are generally divided into three categories:

- 1C. Noncontact recreation; propagation and maintenance of aquatic life; fishing; agriculture and any other uses not given a higher classification
- 1B. Contact recreation and all uses under 1C
- 1A. Source of water for drinking, cooking, food processing and all uses under 1B.

There are two exceptional categories:

- 1EB. Uses beyond 1A—water for which an exceptionally high quality is desired
- 1EM. Uses below 1C, describing waters that fail to reach the basic classification.

Poland generally uses three classes for surface water:

- III. Industrial water supply and irrigation
- II. Water for animals, recreation, and water sports
- I. Potable water and support of salmonoid fishes.

China has a similar classification but with five classes.

In each case, a number of key parameters such as biochemical oxygen demand (BOD), dissolved oxygen, and nutrients are used to define the classes. The values used are broadly similar but can vary. Care must be taken in making comparisons, particularly in relation to the conditions under which the parameters are measured. For example, in Poland, the parameters are set in relation to mean-low flows, rather than average flows.

Reference

World Bank. 1993. *Water Resources Management*. World Bank Policy Paper. Washington, D.C.