DIRECTIONS IN DEVELOPMENT

An Integrated Approach to Wastewater Treatment

Deciding Where, When, and How Much to Invest

MANUEL MARIÑO AND JOHN BOLAND

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The World Bank
Washington, D.C.

Manufactured in the United States of America
First printing May 1999

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Cover photograph by Curt Carnemark/The World Bank.

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ISBN 0-8213-4467-6

Library of Congress Cataloging-in-Publication Data

Mariño, Manuel.
An integrated approach to wastewater treatment: deciding where, when, and how much to invest / Manuel Mariño, John Boland.
p. cm. — (Directions in development)
ISBN 0-8213-4467-6
1. Sewage—Purification—Finance—Government policy—Case studies. 2. Sewage disposal plants—Finance—Government policy—Case studies. I. Boland, John. II. Title. III. Series: Directions in development (Washington, D.C.)
HD4475.M37 1999
353.9'324—dc21 99-12533
CIP

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Foreword

In spite of the large sums invested in wastewater management systems in recent years (up to 1 percent of gross domestic product (GDP) in European countries), untreated discharges from municipal, industrial, and agricultural activities continue to contaminate waterways and coastal areas on all continents.

Controlling water pollution is expensive. Even higher-income countries have a hard time mobilizing resources to expand the coverage of sound wastewater disposal, and to operate and maintain the new facilities. In developing countries, there is an even greater premium on ensuring that every dollar works harder. This is best done in a decentralized environment, with responsibility at the lowest appropriate level, stakeholder involvement, private participation in service delivery, and the use of market and regulatory signals. The challenge is how to reconcile this decentralization with a coherent framework for managing water resources across sectors, at the river basin level.

This paper looks at the experience of four higher-income countries (France, Germany, Spain, and the United States) in managing wastewater at the river basin level. Each of them has gone through three stages: uncoordinated local management first, then a decentralized approach with a lead planning and facilitation agency to help set priorities at the river basin level, and more recently a move toward uniform disposal standards. The paper concludes that the first stage has led to inefficiencies, as well as gaps in coverage, and the third-stage "blanket" approach gives poor value-for-money—a second-stage approach would be more effective for capital-scarce economies. Recent experiences in developing and transition countries are assessed against this framework.

The paper then maps a process by which a "stage two" approach could be implemented in a river basin: the role and design of a lead water resource agency, the planning and goals-setting process, and how stakeholders are involved. This is not meant to serve as a blueprint—the process would need tailoring to each country—but rather a useful checklist of issues to be addressed and possible ways to handle them. While the paper focuses on institutional arrangements, it also flags areas that call for complementary work: for instance, how the river agency might use markets (water trading) and price incentives (environmental taxes and grants) to convey agreed priorities to water users. Practitioners in government, donor agencies, and the private sector will find this paper a useful contribution to an urgent debate.

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Acknowledgments

The authors would like to acknowledge the advice and contributions of the following individuals, all at the World Bank, who provided peer review and assistance for this volume: John Briscoe, senior water adviser; Mike Garn, economist; Vincent Gouarne, sector manager; and Antonio Estache, principal regulatory economist, the World Bank Institute (formerly the Economic Development Institute).

Acronyms and Abbreviations

BOD	Biological oxygen demand
CEE	Central and Eastern European countries
CH	*Confederación Hidrográfica* (Spain)
CNA	*Comisión Nacional del Agua* (Mexico)
EU	European Union
ICPRB	Interstate Commission for the Potomac River Basin
NGO	Nongovernmental organization
RV	*Ruhrverband* (Germany)
SAR	Staff Appraisal Report
SS	Suspended solids
WHO	World Health Organization
WS&S	Water Supply and Sanitation

Overview

Where, when, and how much to invest in wastewater treatment? These are policy decisions that present many challenges and generally are not properly addressed worldwide. The most common situations are, unfortunately, those in which no treatment is provided at all. Even more conspicuous are the many recently built wastewater treatment plants that are not properly operated and maintained, or, in some cases, are not operated at all, only a few years (or even months) after construction ends.

Often, inappropriate treatment levels or treatment technologies have been selected, leading to excess costs or disappointing results. Such investments frequently are poorly targeted, providing abatement for low-priority effluents, or responding with a piecemeal approach to river basin pollution. Pollution problems are normally attributed to insufficient financial capacity, lack of institutional competence, or inappropriate technology. Insufficient scientific knowledge of receiving water conditions and uses is also a common contributor to inappropriate treatment levels and wastewater management practices.

It is normally accepted that, in order to address these deficiencies, improved investment performance requires a systematic approach to the evaluation or analysis of wastewater management actions, carried out within the framework of integrated resource management.

The purpose of this paper is to provide a general approach to deciding the "where, when, and how much" in developing and implementing wastewater management interventions. Its scope is determined by two main considerations: (a) the need to incorporate the general principles that determine water resources management policies into the design and selection of wastewater management and pollution control interventions; and (b) the need to address water quality problems at the appropriate geographical scale, normally—but not necessarily always—at the river basin level.

Conceptually, wastewater management is similar to water allocation and resource mobilization. Wastewater management should then normally be based on a river basin approach and on three elements:

- A decision on what must be achieved—what the society demands or wants in terms of water quality and the related uses or benefits to consider water as an economic good
- What the society can afford, what it is willing to pay for, and what is feasible for it to undertake and operate, which are in the end related to the costs that society as a whole has to bear to make solutions sustainable
- The institutional and regulatory framework to implement the process and provide the coordination mechanisms necessary for involving interested stakeholders in the two decisions mentioned before, so that an accepted and adequate combination of technical solutions, incentives, and control mechanisms can be agreed on and applied.

This paper is aimed to develop procedures to translate these concepts into priorities and policies for wastewater management.

Experience shows that the first step in the evolution of wastewater management policy in most countries is one of decentralized action (Level 1 in this paper). National standards are absent, weak, or ineffectual. Local governments may respond to citizen pressure, water quality problems, or the availability of grants and loans. Individual projects are costly, uncoordinated, and often ineffective. Overall results are highly varied and generally unsatisfactory. Level 1 management was common throughout Western Europe until early in this century; it persisted in the United States until the early 1960s. It remains common throughout the developing world.

Some countries have moved beyond decentralized action into a policy of coordinated regional action (Level 2), most often manifested as river basin–oriented planning and implementation. Regional problems are matched with regional solutions, with appropriate attention to institutional capabilities, stakeholder consultation, consideration of alternative strategies, and flexibility with respect to policy instruments. Level 2 efforts have generally led to comprehensive, adaptable, cost-effective solutions. Level 2 approaches began in Western Europe as early as 1913 in the German *Ruhrverband* and, at a national level, in the 1920s in Spain's *Confederaciones Hidrográficas*. The United States experimented briefly with this method prior to 1972. River basin management institutions continue in France, Germany, and Spain. Recent experimentation with Level 2 approaches has been initiated in Brazil, Colombia, Mexico, and Poland.

More recently, the United States and the European Union countries have opted for national standards–driven action (Level 3), where most wastewater management actions are undertaken—not in response to local conditions, but in accordance with a set of strong national standards and subsidies. This policy corrects the unevenness and occasional poor performance that may result from a Level 2 policy, but it does so at the expense of localized overcontrol, occasional undercontrol, rigidity, reduced innovation, and generally higher costs.

Level 3 policies have led to dramatic increases in the cost of wastewater management, producing projects that approach the limits of or exceed affordability, even for wealthy industrial nations. Furthermore, where Level 3 policies coexist with Level 2 institutions, as in Western Europe, the national standards preempt the basin-oriented planning approaches, reducing existing agencies to little more than revenue collection offices. The rate of environmental improvement may be temporarily accelerated, but cost-effectiveness drops and total costs grow very rapidly. Level 2 policies are distinguished by joint determination of goals and financing mechanisms, and by iterative refinement of these results. Level 3 policies, on the other hand, begin with fixed standards that may or may not reflect explicit goals. Financing mechanisms are developed later in a sequential, rather than a concurrent process.

In the absence of a fully quantitative evaluation method for developing an adequate wastewater management policy and solution this paper proposes a partially qualitative conceptual framework, based on what has been described as Level 2 institutional approach; this approach incorporates such quantitative measures as are available. This framework consists of the following steps:

- The geographical scale at which wastewater management should be implemented is selected
- A lead agency and the mechanisms for stakeholder participation are designed and the agency empowered
- Objectives are identified
- Objectives are translated to specific goals
- Alternative strategies—and their implementation instruments—are formulated so that they are capable of meeting goals
- The preferred strategy and instruments are selected and implemented; feedback is solicited; the strategy is re-examined based on the results of the feedback.

The selection of the area or geographical scale in a river that is adequate for an integrated and differentiated management of wastewaters (the "basin") is one of the most important steps of the policy development process. It should be selected, in each case, on the identification and evaluation of (a) the economic relationships that can be established among the different uses of water in the particular country or river basin; (b) the scale of the water quality problems; and (c) the stakeholders and their relation to the economic uses of the resources that are affected by pollution, and their relation to the causes of that pollution. The basin scope should allow for the consideration and integration of all these factors in the management process.

Depending on these factors, the geographical scale for management could include a whole river basin (as is normally the case in Europe), part of it (as is proposed in Colombia), or the river basin of a major tributary (such as the Ruhr River in Germany or the Tietê River in Brazil), including the coastal areas or not, or a combination of these.

Ideally, wastewater management strategies are carried out or at least overseen by an organizationally competent lead agency endowed with the authority and responsibility needed to perform the necessary functions, and the incentives to do so efficiently over an area that is related to the geographic scale of the water quality problems (the river basin). Unfortunately, such agencies are rarely found (the case of the *Ruhrverband* in Germany or the *Confederaciones Hidrográficas* in Spain are two examples). More often, wastewater functions are performed by a wide number of agencies and ministries. Effective wastewater management requires that one of these agencies be designated as the lead agency (the Interstate Commission on the Potomac River Basin in the United States is worth mentioning as a good example), with the capacity to coordinate the activities of others. In particular, the lead agency must be capable of communicating with all stakeholders and of resolving disputes among them.

The real authority and capability for implementing a wastewater management plan lies, not with any particular agency, but with the stakeholders collectively. They are the ones with the authority and capability to adopt and finance cooperative solutions and regulate their implementation. In many cases, it may be preferable if the lead agency is not itself a major stakeholder, serving a technical function only. This reduces the perception of the lead agency as having an independent agenda, thus improving its ability to promote consensus among the parties.

The lead agency should thus be responsible for two critical roles: (a) the development and implementation of the policies and objectives set forth by the stakeholders; (b) but also be in charge of identifying and assessing the policy options, the distribution of responsibilities and functions, and the evaluation of results and costs of these options, in order to present them to the stakeholders for selection. The French *Agences Financières de Bassin* and their corresponding basin committees represent an effective approach for the development of these functions.

Once the geographical area has been selected and the lead agency empowered, decisions on where, when, and how much to invest in wastewater management should be based on a clear identification of the objectives that are to be attained. These can normally be grouped under the three following items: *collection*—wastewater is safely removed from possible human contact; *protection of beneficial uses*—wastewater management protects valuable human uses of resources; and *protection of ecosystems*—wastewater is transported, treated, and disposed of in a way that protects valuable ecosystems.

The critical step becomes then the translation of objectives into action by setting specific goals for each part of the basin. The goals, which specify in detail what is to be accomplished, determine the wastewater management strategy to be employed. Goals should be chosen after full consultation with all stakeholders, and stakeholders should be informed of the relative costs of meeting alternative sets of goals. This can take the form of simple straightforward load reduction goals, as is proposed in Colombia's point source water pollution policy, or more elaborate approaches, such as the ones being developed under Catalonia's sanitation plan in Spain.

It is essential that the selected goals have the support of the affected community; otherwise, the feasibility of the resulting management strategy will be in doubt. All stakeholders must understand that the overall planning process is iterative: although goals are agreed on at the outset, these decisions may be revisited as information on cost and effectiveness of different strategies is obtained.

Once a feasible, practical system configuration which achieves the selected goals at least-cost has been identified, the main challenge is to transmit to all stakeholders a river basin perspective, to share these goals by collectively becoming beneficiaries of the policy for wastewater management, as well as responsible actors for its implementation, irrespective of where in the basin the pollution originates, or what it impacts. The German *Ruhrverband*, the Spanish *Confederaciones Hidrográficas*, and the French *Agences Financières de Bassin* all have particular mechanisms and instruments to transmit this idea to the basins' stakeholders.

Implementation strategies and instruments should then be formulated and applied in an open, iterative process, through which alternatives are devised, assessed, and compared to each other. Obviously, the chosen strategy and the instruments it incorporates should be the ones that meet the specified goals at minimum overall life cycle cost. However, deviations from this result may be allowed to permit exploration of important tradeoffs. The preferred strategy should therefore be selected on the basis of a comprehensive assessment that addresses environmental, social, economic, and financial effects within the particular political, legal, and institutional constraints. The implementation instruments should be designed to make the strategy sustainable and to introduce incentives that are adequate for the stated objectives.

The monitoring and enforcement capacity in the lead agency is an institutional constraint that should always be considered and addressed in the early stages of the strategy formulation process. This capability and the means to cover its costs must be developed to monitor the performance of the selected strategy, both to determine that it is capable of meeting the specified goals and to detect instances of violations or inadequate performance. Information developed in the course of monitoring is also essential to support the necessary periodic re-examination of goals, and the development of incremental improvements in the implemented strategy that should reflect its dynamism.

1
Introduction

Worldwide experience in wastewater management has numerous examples of complete or partial failure. The most common management actions are, unfortunately, no action at all—by one estimate, as much as two-thirds of the wastewater generated in the world receives no treatment at all. Even more conspicuous are the many newly built wastewater treatment plants that are not properly operated and maintained, or, in some cases, that are not being operated at all.[1] Often, inappropriate treatment levels or treatment technologies have been selected, leading to excess costs or disappointing results, or both. Often such investments are poorly targeted, providing abatement for low-priority effluents, while more hazardous discharges go untreated. Many of these investments, responding to a piecemeal approach to river basin pollution problems, may also result in costly and ineffective solutions.

The consequences of these failures are that projected environmental and social benefits have not been realized; and water resources availability, already scarce, is further depleted by pollution, even after large sums are committed and spent. This has had an added strong negative impact on the already weak financial situation of water agencies, and has squandered public and political goodwill without producing expected results. As a result, these failures have jeopardized and delayed the timely adoption of appropriate and needed remedies.

Failures in water pollution–control investments are often attributed to lack of financial capacity in the operating agencies, or to a general lack of institutional competence. These diagnoses, although valid on first approximation, may overlook one or both of two common problems: (a) the responsibility of the designer or politician who did not take into account the specific socioeconomic and environmental conditions in which the facilities or solutions must operate and the particular characteristics and impacts of the pollution problems that "had to be solved"; or (b) the tendency of local authorities to request the "best" and "most modern" available technologies. In these circumstances, there is a distinct preference for equipment-intensive solutions, usually involving imported hardware, as opposed to low (soft) technology alternatives that might have been more appropriate. This bias is clearly exacerbated by foreign financing.

Insufficient scientific knowledge of receiving water conditions and uses is also a common contributor to inappropriate treatment levels and wastewater management practices. Where unnecessarily high levels of treatment are attempted, operating costs often exceed available funds. Also exceeded are the technical capacity and training of the personnel who will manage the treatment plants and the whole wastewater system. Consequently, the facilities are not operated and maintained correctly, and tend to fall out of use shortly after completion. The result is idle infrastructure that can itself become an environmental and public health hazard, creating conditions worse than those that prompted the investment in the first place. This problem is widespread in many countries, and particularly affects medium and small cities because (a) they tend to have weaker financial and technical capacity; and (b) in these medium and small cities the pollution problems created by inadequate wastewater management solutions constitute a smaller embarrassment to the central government than would be the case in a capital or major city.[2]

Although functioning wastewater collection and disposal systems are taken for granted in most cities in industrial countries, the reality is that, because of failures in wastewater management, the absence of such systems, particularly in many developing world cities, is common. The absence of these systems is normally associated with adverse public health effects (human exposure to wastes), inconvenience, excess cost (alternative disposal methods), and frequent affronts to sight and smell. As a result, inadequate wastewater management systems affect human

Figure 1. Wastewater and Water Resources Management: Similarities among the Main Elements of Proper Policies

Water	Wastewater
• The acceptance of water resources as an economic good	• Stakeholder's decision on what is necessary (cost/benefit and economic valuation)
• The involvement of stakeholders	• Willingness and capacity to pay
• Institutional perspective, river basin and legal framework	• Institutional capacity with stakeholders intervention for comprehensive river basin approach

settlements and ecosystems in important and complex ways. The discharge of untreated or partially treated wastes to lakes, streams, or coastal waters deprives aquatic species of light and oxygen, overfertilizes algae, introduces toxic substances, and creates further risk of human exposure to pathogens. This situation demands an improvement in the investment performance and a more systematic approach to the evaluation or analysis of wastewater management plans and actions.

Purpose and Scope

Against this background, this paper has three objectives:

- Emphasize the need for systematic evaluation of wastewater management actions and investments as part of any water resources management initiative
- Define the conceptual framework that should guide the analysis process
- Identify and explore techniques appropriate to this analysis.

The ultimate purpose of the paper is to provide a general approach to deciding the "where, when, and how much" in developing and implementing wastewater management interventions. Its scope is determined by two main considerations: (a) the need to incorporate the general principles that determine water resources management policies into the design and selection of wastewater management and pollution control interventions (see figure 1); and (b) the need to address water quality problems at the appropriate geographical scale, normally—but not necessarily always—at the river basin level.

The Principles for Water Resources Management

The integration of wastewater management and pollution control interventions and policies within the broader water resources management policy is essential for achieving the efficient use of the scarce resource available. It should ideally result in the most effective identification of the infrastructure, control, incentives, interventions, and allocation policies. It should also address social objectives within the framework of the particular social, economic, political, technical, and environmental constraints.

In this context, water quality protection, water demand management, and water allocation policies are all considered essential parts of any program for better water use and resource optimization. The fields of water quality protection and wastewater management (including the combination of treatment, reuse, and reduction alternatives) encompass the major efforts and account for nearly all capital spending. This paper focuses on wastewater management, while considering it within the overall framework of comprehensive water resources management.

This integration requires that the policy framework for wastewater management incorporate the three principles on which water resources management policy is based.[3] These are as follows:

- The acceptance of water resources as an economic good. This implies the need to consider the economic impact of the water-use impairment by pollution as a key element of the conceptual framework for wastewater management.
- The recognition of the social impact of water uses and management. This recognition leads to the desired involvement of all stakeholders at all levels and areas of the pollution control and wastewater management process, particularly in the setting of objectives, and in the decision, distribution, or acceptance of the financial effort to achieve them.
- An institutional perspective that requires the comprehensive treatment of water resources and wastewater management interventions. This treatment is normally, but not always, at the river basin or catchment level. The perspective also requires a legal framework that defines the rules and incentives to optimize the use and protection of all resources, financial and physical.

Conceptually, then, wastewater management is similar to water allocation and resources mobilization. Optimal wastewater management should thus be based on a river basin approach and on three elements: (a) a decision on what must be achieved—what the society demands or wants in terms of water quality and the related uses or benefits to consider water as an economic good; (b) what the society can afford, what it is willing to pay for, and what is feasible for it to undertake and operate, which is in the end related to the costs that society as a whole has to bear to make solutions sustainable; and (c) the institutional and regulatory framework to implement the process and provide the coordination mechanisms necessary for involving interested stakeholders in the two decisions mentioned above, so that an accepted and adequate combination of technical solutions, incentives, and control mechanisms can be agreed-on and applied.

In this paper we present our ideas on how the conceptual framework for wastewater management should address the institutional developments required to involve users and stakeholders in the process, the setting of objectives and goals that recognize the economical value of water resources, and the formulation of the strategy for achieving them in the most efficient and sustainable way.

It is also aimed at developing procedures to translate these concepts into priorities and policies for wastewater management. For the development of the conceptual framework presented here, we have taken into consideration the characteristics, conditions, and constraints normally found in developing countries.

However, the conclusions are also applicable to many industrial countries that are faced with the need to improve and expand their wastewater management infrastructure to respond to the demand for better environmental conditions, but who are at the same time faced with diminishing budgetary resources and who must look for ways to improve the efficiency of their investments.

The Geographical Scale of Water Pollution Problems

Water quality problems typically occur at the scale of rivers, lakes, or coastal ecosystems; therefore, the solutions to these problems must be found at a comparable geographic scale. This essentially means that (a) wastewater management policies should address all sources of pollution likely to stress a given ecosystem or water use, now or in the foreseeable future, no matter where in the river basin or catchment area that may occur; and (b) wastewater management interventions should take into account all available options for source control, reuse, and treatment and be designed and decided from a river basin perspective, avoiding as much as possible the case-by-case approach, with piecemeal solutions.

The basin-oriented approach proposed in this paper balances the attention to municipal, industrial, and other pollution sources, large and small, in a search for the most cost-effective actions.[4] This can be contrasted to the more common project-oriented approach, which tends to focus on the largest single source, such as the municipal wastewater generated in the capital city. Implementing this single project is seldom adequate and often costly, since it ignores the relationship and integration of wastewater management measures in the broader comprehensive water resources management policy of the particular river basin or country. This river basin approach to the geographical scale of wastewater management interventions is also consistent with the World Bank policy on water resources management.

Wastewater management and pollution controls are among the elements of water resources management that will require larger investments and policy developments in the next decade. Industrial countries such as France, Germany, Spain, the United Kingdom, and the United States are implementing large investment plans to protect scarce resources from pollution and improve environmental and health conditions. These investments are usually at large costs that result in substantial increases in the price of water. In Germany, for instance, water prices rising to the order of 20 DM (around US$14) per m^3 are being mentioned by the water companies to cover investments, mainly in wastewater management and pollution control, of about 300 billion DM (190 billion

US$) during the next decade. The situation in developing countries is even worse, since for comparable pollution problems and ever greater water scarcity conditions, the available financial means are much smaller. Therefore, wastewater management will compete for these financial resources at the expense of the environment and the quality of water resources unless better and more efficient policies are developed and adopted, and effective evaluation procedures are used to set priorities.

Notes

1. Peter Rogers, "Integrated Urban Water Resources Management, *Natural Resources Forum*, February 1993, pp. 34.
2. As an example, it was estimated at the end of 1980s that more than 90 percent of the wastewater plants in Mexico were operated incorrectly or not at all.
3. See "Water Resources Management. A World Bank Policy Paper" (1993), which describes a general framework for improving the management of water resources and the principles that define the World Bank's policy on this subject.
4. By the term "basin" we refer to the area or geographical scale in a river where economic relations can be established among its different water uses and their impacts, so as to justify its integrated and differentiated management. This can include a whole river basin or part of it, the river basin of a major tributary, the coastal area adjacent to the discharge point, or a combination of these.

2
Wastewater Management Practices

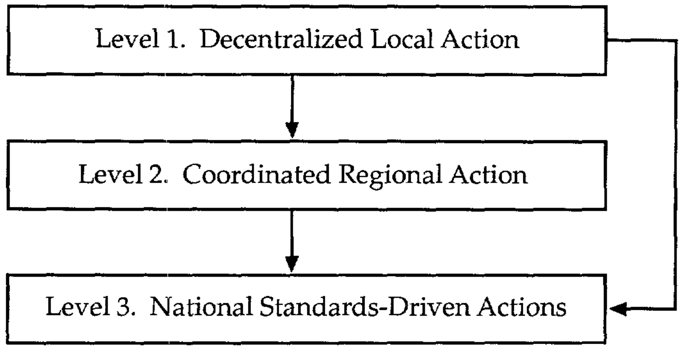
Wastewater management practices throughout the world are at least as diverse as the countries themselves. Some countries, especially those with a long history of coping with environmental problems, have been developing wastewater management policies for years. These policies are often the result of experimentation with alternative approaches. Most developing countries, on the other hand, have only recently been faced with water pollution problems and have begun to address some aspects of wastewater management. They tend to borrow policies and approaches from industrial countries. The democratizing countries of Central and Eastern Europe and the former Soviet Union present a particular situation, since they possess considerable indigenous capability but must struggle with the twin legacies of inadequate infrastructure and financial stringency.

In reviewing the experiences and practices of various countries, it is possible to group wastewater management policies according to the type of intervention used for implementation (see figure 2). Three possible levels of intervention can be described as follows:

LEVEL 1. DECENTRALIZED LOCAL ACTION. Most wastewater management efforts are the result of individual action by firms or cities, normally with the financial backing of central governments that provide substantial subsidies. National standards are absent, weak, or ineffective. Local governments may respond to citizen pressure, water quality problems, and the availability of grants or loans with a piecemeal approach. Individual projects tend to be costly, and overall results are highly variable and often unsatisfactory.

LEVEL 2. COORDINATED REGIONAL ACTION. Regional solutions are developed in response to regional problems. Goals and financing mechanisms are decided jointly and iteratively. This approach can lead to cost-effective programs, provided there is sufficient attention to institutional capabilities, consultation with stakeholders, consideration of alternative strategies, and flexibility with respect to policy instruments.

Figure 2. Wastewater Management Practices and Education



LEVEL 3. NATIONAL STANDARDS–DRIVEN ACTION. Most wastewater management actions are undertaken pursuant to a set of uniform national or international standards. Depending on the level of the standards and the arrangements for monitoring and enforcement, the result may range between the two extremes: environmental damage from undercontrol and excess costs resulting from overcontrol. Standards are set first, then financing mechanisms are devised. This approach is characterized by rigidity and lack of opportunity for local initiative. Centrally provided construction subsidies also tend to promote inefficient capital intensive solutions, while trying to support the achievement of the uniform standards.

Examples of each of these approaches can be found by examining practices in various countries. Some countries have employed a particular type of policy for many years, or have used a different method in the past, while others can be observed in transition from one level of intervention to another.

Eventual transition through all three intervention levels is by no means a foregone conclusion, nor is it even to be expected. Later sections of this paper will argue that cost-effectiveness and sustainability are best achieved through a coordinated regional approach—Level 2. Yet most industrial countries have moved to a Level 3 approach, and many developing countries are moving in the same direction. To understand these trends in context, it is necessary to review the practices of a number of representative countries.[1]

Industrial Countries

Following is a review of wastewater management policies in the United States and several countries within the European Union.

United States of America

Prior to the 1950s U.S. wastewater policy was determined by state and local governments (Level 1, above), with some large cities and firms installing reasonably effective treatment works, but most ignoring the problem. In the 1960s federal legislation promoted the initiation of river basin–planning activities, intending to lead to coordinated regional solutions (Level 2). In one prominent case in 1961, the Delaware River Basin Commission dramatically improved the quality of the river through a comprehensive, cost-effective policy.[2] Among other accomplishments, the percentage of the 282 municipal discharges provided with primary or secondary treatment was increased from less than 50 percent to 100 percent in ten years. Concern over lack of action in other parts of the country, however, led to federal preemption of state authority and abandonment of the regional approach after a relatively short time.

Current wastewater policy in the U.S. is governed by the federal Clean Water Act, first enacted in 1972 and revised at least four times since then. The Clean Water Act is a large and complex piece of legislation, characterized by strong national standards implemented through command and control measures. As such, it is an example of a Level 3 approach. It employs both technology-based effluent standards and ambient water quality standards. The standards are applied to discharges through a system of renewable permits. Approximately 384,000 such permits are currently in force. There are no special charges or taxes associated with discharge. Even though the standards imply a cost-benefit analysis, costs and benefits of specific actions are not a consideration in setting standards or developing policy.

Enforcement is based on self-monitoring by discharges as well as an independent monitoring activity carried out (in most cases) by state agencies. Some categories of industrial discharges are required to pretreat waste before discharge into a public collection system. Nonpoint sources are subject to varying degrees of regulation, depending on the nature of the source. Limited reuse of treated effluent occurs in a few areas, including Arizona, California, and Florida.

Wastewater collection, treatment, and disposal systems are owned and operated by local or regional governments or, in the case of industrial systems, by private firms. Privately owned or operated urban systems are rare. Discharges into the public collection systems normally face user charges levied on the basis of water use. In most cases, revenue from these charges is more than sufficient to cover operating and maintenance expenses. In prior years, large federal grants (up to 75 percent of construction cost) were available for new treatment plants. Many states provided additional grants for the same purpose. The federal Construction Grant Program ended in 1985, although some state grant programs continue. During its life, the Construction Grant Program was frequently criticized for providing incentives to build oversized and capital-intensive treatment facilities, resulting in problems with operation and maintenance.

Current policy requires that all urban discharges have at least biological secondary treatment. This requirement has been challenged in the case of ocean discharges, where biological oxygen demand (BOD) reduction provides little or no benefit to receiving waters. San Diego, California, has been ordered to replace a high-dose chemically enhanced primary plant with a biological secondary facility at a cost in excess of $2.5 billion. Available studies predict that this upgrade will produce no perceptible improvement in receiving water quality. In an unprecedented move, a federal judge recently refused to enforce the Clean Water Act in this instance. Further legal action is expected. Meanwhile, it is increasingly evident that full compliance with national technology-based standards will prove to be financially unfeasible in many locations, and that a more flexible approach will be required.

Criticisms of the U.S. policy commonly mention rigidity, excess costs arising from uniform national standards, lack of effective incentives for source control and pollution prevention, discouragement of technological innovation, poor control of nonpoint sources, and limited control of toxic substances. Some current political opposition to the policy focuses on the large costs imposed on local governments by federal action ("unfunded mandates"). To address theses issues, since 1995 the U.S. Congress has considered revisions to the Clean Water Act, such as H.R. 961, passed that year. Among the suggestions that were heard are various forms of a return to a watershed-based approach with increased local participation and control (Level 2). Other proposals involved general weakening of the federal standards, with increased flexibility in compliance.

European Union

Wastewater management policy in the European Union (EU) is generally regarded as the reference model for many developing or transition countries, particularly in Central and Eastern Europe. Present policy is the result of enormous social and economic development during the past decades. Two related factors have defined this policy: (a) ambitious goals for water and sanitation infrastructure coverage and; (b) widespread public pressure for improved environmental quality that is translated into the setting of restrictive quality and effluent standards by the European Commission in Brussels.

EU wastewater management policy is based primarily on homogeneous effluent standards and, to a lesser extent, on solving site-specific receiving water quality problems. The EU legislation forces a uniform level of load reduction. This approach builds on the secondary treatment approach institutionalized by the U.S. Clean Water Act for municipal wastewater and high biodegradable organic content discharges (Directive 91/271/CEE) and on industry-specific load and concentration effluent standards for toxic and hazardous substances (Directive 88/464/CEE and those that complement it). For sensitive areas subject to eutrophication the EU standards introduce additional requirements to remove nutrients (on the other hand, for less sensitive areas the policy accepts a reduction in treatment requirements). The 91/271 Directive also introduces a progressive compliance requirement with the standards, depending on the size of the discharges and the sensitivity of their location. Because the effluent standards are rather stringent and budget is assumed to be normally available through user fees or subsidies from the EU regional development funds, this policy presumes that water quality will improve over time, at least where point sources are the dominant cause of pollution. The EU policy, like the United States policy, is an example of a Level 3 approach to wastewater management.

This policy is far from cost-effective. In fact, as in the United States, cost-effectiveness has not been one of the factors considered in the setting of the standards. The costs of meeting the standards were not discussed or made public to those who would bear them—the residents and other taxpayers. One economist-politician who participated as European parliamentarian in the setting of these standards said that if the costs had been made explicit, the standards would probably not have been passed.

Although environmental and other interest groups, as well as contractors, equipment suppliers, consultants, and private operators, are pleased with the outcome of this policy and the abundance of funds that have resulted from its application, the formerly solid public support is starting to show some fissures. Consumers—and politicians—are beginning to complain about the extremely high costs of water and wastewater service, weakening the assumption that the users will happily pay the required user fees. Local authorities, faced with the increased costs and the complication of additional operation and maintenance requirements—which are now passed down to them—are increasingly talking about "phasing" compliance with the standards, since it becomes clearer that the huge resources needed to achieve the policy objectives cannot be raised from public budgets or from increases in the water bills passed on to consumers.

Additionally, the EU policy represents a 180-degree turn from most European experience and practice in the area of water resources and wastewater management. Indeed, it does not build on experiences such as those provided by the *Ruhrverband* in Germany, the *Confederaciones Hidrográficas* in Spain, or the *Agences Financières de Bassin* in France. In those situations quality objectives and the related investment plans are financed through a combination of user fees and subsidies, which are decided on with various degrees of stakeholder involvement at the river basin level. On the contrary, the EU now follows the "set uniform standards and then raise the money to pay for them" approach used in the United States, which corresponds to the intervention Level 3 of wastewater management policy mentioned above, precisely when the United States is rediscovering the original European ideas.

The main elements of the original approach embodied in the French, German, and Spanish river basin institutions could well form the core of a new agenda for wastewater management, which seems to be adopted by the new framework directive. Their development histories are described below.

GERMANY. In 1913 a special decree created the *Ruhrverband* (RV) as a self-governing public entity with the objective of improving the quality of water in the Ruhr river basin. All users of water in the river basin are compulsory members of the RV (directly or, for small users, through their closest municipal government), and contribute to its finances according to the "units of damage" (*Belastungseinheiten*) that are assigned by the RV, in direct accordance with the "polluter pays" principle. The model was later adopted elsewhere in the state of North Rhine–Westphalia. A total of 12 similar water associations were eventually formed.

Since its creation, the RV has used its own resources and government subsidies to construct and operate wastewater management infrastructure in the river basin. It decides on priorities and levels of treatment for the different wastewater treatment plants. This system allows the users to influence the wastewater management policy and investments of the RV through the "Assembly of Associates," and has involved them through their contributions to the RV budget. The RV system demonstrates a Level 2 approach to wastewater management.

In the past 15 years the situation has changed considerably due to increased concern for environmental quality. This has led to the introduction of uniform standards as promulgated by the EC. Also, since the adoption of high standards, abundant resources have been made available to build wastewater treatment plants as long as it is argued that the environment is improved. This clearly pleases environmental advocacy groups and, less publicly, other special interest groups such as consultants, equipment suppliers, and construction companies that will benefit from the sector's new wealth. However, it has had a major impact on the cost of water (water charges on the order of US$14 per cubic meter are being discussed to cover expected costs). This, in turn, is creating concern among consumers and those involved with national economic policy.[3]

A water pollution charge (*Abwasserabgabe*) has existed in the territory of the former Federal Republic of Germany since 1981. The charge applies to a wide range of pollutants, and is closely linked to a system of discharge standards and discharge permits. The level of the charge has been raised a number of times, after advance warning, to dischargers. Explicitly designed to have an incentive effect, the German water pollution charge is widely regarded as effective in reducing discharges.

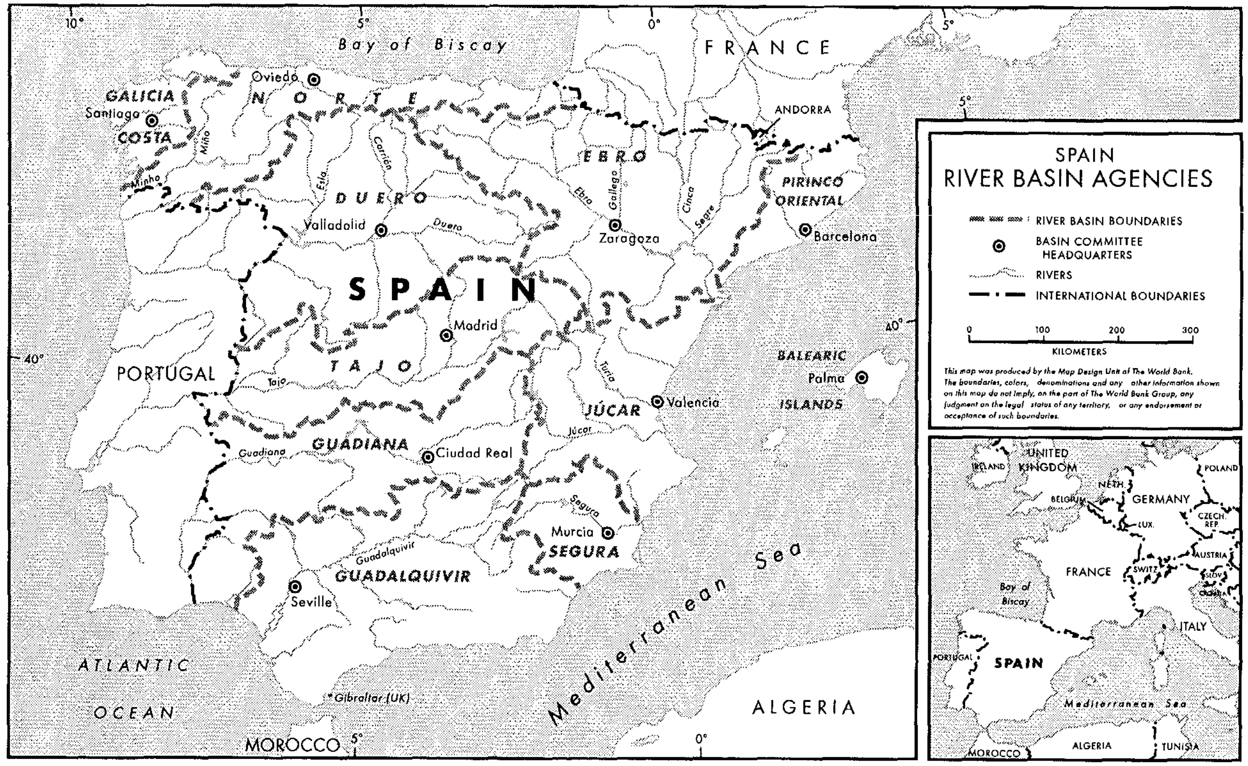
SPAIN. Spain has managed its water resources at the river basin level since the 1879 Water Law and particularly since the creation, in 1926, of the *Confederaciones Hidrográficas*. These are decentralized self-governing institutions for each major river basin (10 in peninsular Spain), with strong participation of stakeholders in the management and in the decisionmaking process (see figure 3). They were established for the planning, construction, and operation of hydraulic infrastructure, as well as for the supervision of water uses. The use of economic instruments for the management of water uses is even older, with the introduction of water user fees in 1902 for purposes of infrastructure cost recovery.

Initially, the *Confederaciones Hidrográficas* were responsible only for water quality monitoring as part of their overall water resources management function. They have also played a role in financial support to local governments, channeling federal grants and subsidies to investments initiated at the municipal level which were later operated by municipal water companies or services. Responsibility for municipal services, including water supply and sanitation, rested completely at the local government level, in accordance with the Spanish legal system that grants full local autonomy in this area (this framework has also been adopted in many Latin American countries).

Many Spanish cities and towns were provided with wastewater treatment plants through this system, but with little financial sustainability—at the end of the 1970s, only 17 percent of the constructed wastewater treatment plants were in operation. In addition, little (if any) consideration was given to intrabasin water quality priorities or to coordination in the planning of these investments. These omissions were inconsistent with other water resource management actions, always undertaken with a river basin—or even interbasin—approach, and undertaken through the direct and active participation of all relevant stakeholders within the framework provided by the *Confederaciones Hidrográficas*.

This situation improved with the decentralization of the country into 17 autonomous communities after the constitution of 1978 and the adoption of the new Water Law in 1985. This Law introduced discharge fees (*Cánones de Vertido*) to be set, collected, managed, and applied by the existing *Confederaciones Hidrográficas*, "in the improvement of the hydraulic environment of their particular river basins." Regional water

Figure 3. Spain River Basin Agencies



quality management programs were also initiated, such as the Integral Water Plan for Madrid, the Catalonian Sanitation Plan, or the Greater Bilbao Integral Sanitation Plan for those areas where pollution problems were more acute and required a regional approach.

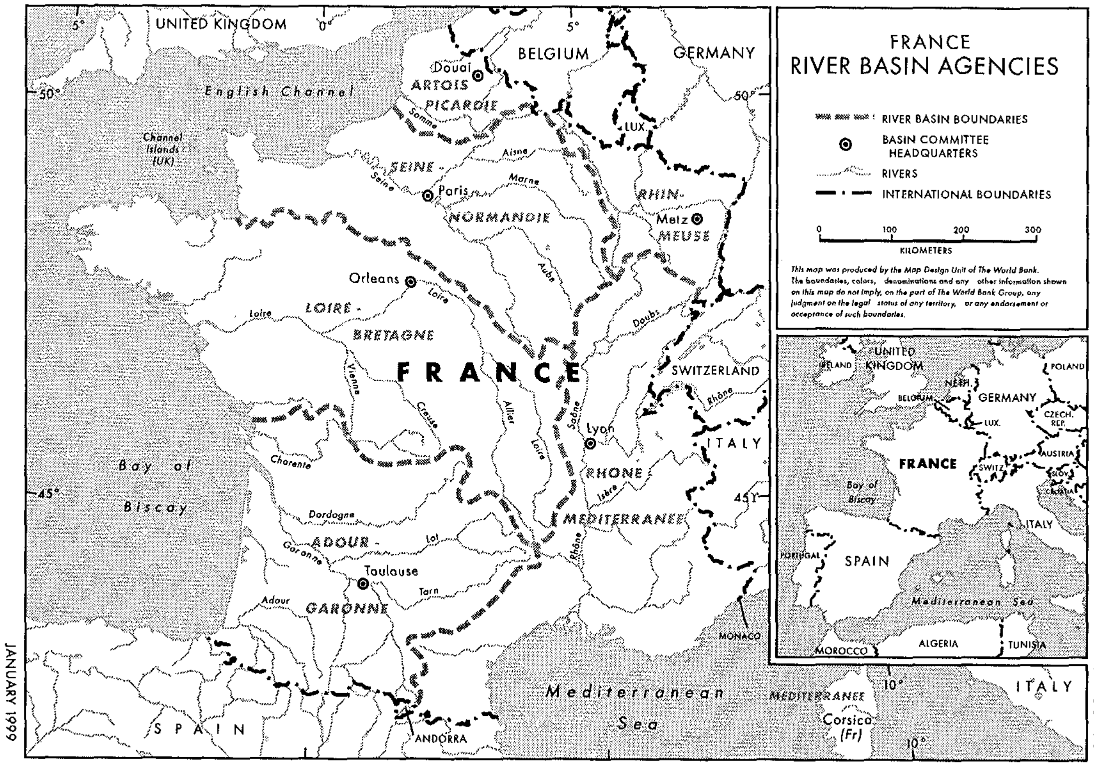
Under this new situation a two-step wastewater management policy was adopted using the participatory approach provided by the *Confederaciones Hidrográficas*: (a) water quality objectives were selected on a regional or river basin level; and (b) wastewater management investment plans were prepared with the guarantee of financial sustainability provided by user fees, supplemented in some cases by construction subsidies from the central or regional governments. In the case of Catalonia—and soon after in Galicia and Valencia—the regional plan covers not only the construction of the infrastructure, but also its operation and maintenance. This latter function is performed on a regional basis by a Sanitation Council (*Junta de Sanejament* in Catalonia), a regional self-governing body.

Through this process consumers, users, and other relevant stakeholders are all informed and involved in the selection of the quality objectives and in the evaluation of the cost implications. They can realize the impact of the selected solutions on their water bills and financial obligations and can influence the final decision on the level, type, and priority of the investments, which are regionally optimized. This provides, therefore, a well-developed example of Level 2 wastewater management.

The issuance in 1991 of the EC Directive on Municipal Wastewater Treatment, setting uniform treatment requirements, has altered this system. Although no estimates are available on the financial impact of the application of this Directive, it clearly modifies the selection of priorities and the allocation of resources, which had reached a high degree of efficiency through the regional approach described above.

FRANCE. Until the 1960s wastewater treatment investments in France were undertaken by municipalities, with the financial support of the central government. This arrangement could barely cope with emerging problems of water quality. Water management was based on a body of texts and central government regulations that evolved, through the years, into a legal labyrinth with numerous actors that very often rendered state action inefficient. To manage and finance the wastewater treatment effort needed, France adopted in 1964 a new Water Law that created seven river basin agencies (*Agences Financières de Bassin*) modeled after the German North Rhine–Westphalia and Spanish systems (see figure 4). In each of the river basins all aspects of water policy and planning are referred to a basin committee which represents all stakeholders—national, regional, and local governments; industrial and agricultural interests; and citizens—supported by a technical and financial basin agency that performs the executive function.

Figure 4. France River Basin Agencies



The agencies are government-owned corporations. They prepare and propose for approval by the committees a five-year plan that is based on the adopted water policies. The plan determines how resources will be invested (which sections of rivers and treatment levels should receive priority support) to maximize the environmental benefits, and which levels of environmental quality can be obtained for different levels of financial resources. On the basis of this information the basin committees determine the combination of costs and environmental quality objectives for their particular river basin and how the services should be financed.

The river basin agencies collect revenues—mainly through water abstraction charges levied as part of individual water bills and through fees for direct discharges—and pass them back to municipalities and industries as subsidies and soft loans; these loans are used to supplement local resources for investments in the agreed-on water and wastewater treatment facilities. This system has been able to channel substantial funds to the management of water resources, increasing the efficiency of their use and the correspondence between local initiatives and the overall priority demands in the particular river basins. This approach has been used in several other countries, including Spain and the Netherlands, and has recently been adopted in Colombia.[4]

The river basin agencies do not manage investments or infrastructure—that is done by the firms or municipalities—nor do they set or enforce regulations. They concentrate on providing technical and financial support for consistent water management and the optimization of investments.

The agencies are perhaps best known for their system of pollution charges applying to direct discharges, first levied in 1964. The charges apply to treated or untreated waste, and are based on mass loading of three classes of pollutant (oxygen demand, suspended solids, and toxins).

Treatment plant construction depends mainly upon the amount of revenue that the charges produce (US$1.8 billion in 1996, which covered 40 percent of the investments. The other 60 percent was covered by national government grant subsidies, local users' tariffs, and municipal contributions in some towns). This has constrained the effectiveness of the charge, as well as the size of the investment program. Its effectiveness has also been constrained by its inability to charge and influence nonpoint agricultural sources, which represent an important factor in the rivers' water quality.

In any case, the pollution charges and the resources generated by them have contributed to an important reduction in the industrial discharges (27 percent from 1982 to 1992) and to an increment of the municipal wastewater treatment from less than 50 percent in 1982 to over 70 percent in 1992.[5] Current pollution charges are generally still considered to be too low to have a significant effect on municipal discharges, even though they have grown fast in real terms from the mid-1980s, representing a big component of recent water tariff hikes.

Examples from Some Transition and Developing Countries

Following are some examples from Central and Eastern Europe, Mexico, Brazil, and Colombia.

Central and Eastern Europe

Wastewater management decisions and planning in Central and Eastern European (CEE) countries responded to a centrally organized and planned economy until very recently. Although large investments were made in the area of water pollution control with the use of centrally provided subsidies, under this management approach less than one third of the wastewater produced in urban areas is treated. Treatment levels in rural areas and small towns (in the 5,000 to 25,000 population range) are even lower, and the availability of sludge treatment facilities is very limited. As a result of this situation, important water quality deficiencies are common in most of these countries.

Many wastewater treatment plants suffer from poor designs that respond to local demands or to the desire to meet, at the local level, centrally designed, homogeneous, and usually unrealistic and untenable effluent standards (only the Czech Republic and Bulgaria depend upon centrally issued receiving water standards for the control of wastewater discharges). These plants usually contain low-quality, outdated equipment that has a high energy demand. The result is serious operation and maintenance problems, including hydraulic overloads that often exceed 100 percent. Activated sludge is the preferred process for secondary treatment in all CEE countries—it is employed in about 50 percent of the constructed treatment plants.

The recent political changes in the CEE countries have resulted in an accelerated and sometimes disorganized decentralization in the area of wastewater management. As a result, the planning and construction of a wastewater treatment plant in most of these countries now involves several central government ministries, the regional governments, and the local government. Operation and maintenance responsibilities are generally being transferred to local authorities. Centralized strategic and financial planning by the state has been almost completely abandoned, and state subsidies are generally absent—sometimes replaced by newly established environmental and water funds supported by polluter fees (in Poland, for example). Coinciding with these political changes, the construction of a large number of wastewater treatment plants was initiated in recent years (there are more than 1,000 partially constructed plants in the CEE countries). However, most of these plants still suffer from faulty designs and, particularly, significant over-sizing—sometimes by as much as 100 percent—as a result of past practices in forecasting treatment needs and an uncoordinated local perspective in the planning process.

Some initiatives have attempted to fill the vacuum created by the end of the central government planning and management role. As an example, in Poland, river basin agencies on the French model (designed with the help of the French government) have been proposed to manage water resources in seven regional areas. Pollution fees that contribute to an environmental fund have been instituted and partially enforced. New environmental legislation is also being enacted in most CEE countries that would lead to new water quality and effluent standards and river classification schemes. The tendency in these countries is to avoid water quality standards and adopt the effluent standards in use in the EU, an approach that will preempt the still-unrealized Polish system for regional management. However, budgetary realities, generally overlooked or not considered at all at this point, will restrict the capacity of all these countries to afford the investments required to comply with EC standards, particularly over the near term.

Mexico

Water pollution control has been a key objective of Mexican water resources planning since the early 1970s. Currently, Mexico presents one of the most instructive examples of the evolution and experience in water resources and wastewater management in developing countries.

Water resources management in Mexico is the responsibility of the federal National Water Commission (CNA). However, efforts in the area of wastewater management have normally been the result of pollution control initiatives that started at the municipal level, particularly after the 1983 amendment to the Constitution that assigned to the municipalities the responsibility for the provision of water supply and sanitation services. Lack of resources and other priorities have resulted in limited investments in this area and only a small fraction of municipal and industrial discharges is currently treated before discharge (20 percent in the case of municipal discharges and 10–15 percent in the case of industrial discharges). Unaffordable operation and maintenance costs have also plagued many of these treatment plants, many of which stopped operation shortly after completion (less than 10 percent of the existing wastewater treatment plants in Mexico are now estimated to be operating satisfactorily).

To address this problem and the growing demand for water quality, a Basin Council was established in the Lerma-Chapala river basin in 1989 by CNA to test an integrated water pollution approach, based on the concept of river basin management. The results to date suggest that it has obtained improved financial sustainability, increased state and local involvement in the planning and implementation of pollution control programs, and improved compliance with industrial effluent standards. Further modernization to the sector has been achieved with the new Water Law, which introduces pollution charges and mandates the creation of river basin councils to manage resources in an integrated way at the river basin level. CNA is currently extending the Lerma-Chapala approach to other river basins and is developing a simplified procedure for adapting effluent standards and pollution charges to the specific pollution levels of each river basin. In this way, Mexico is moving into Level 2 in the evolution of wastewater management policies.

Brazil

Brazil federal system has produced different approaches in its different states, but the most developed among them is the one used in São Paulo. The largest city in Brazil, São Paulo, is also one of the largest urban agglomerations in the world, with a population of over 17 million. Most of this area is drained by the Alto Tietê River, a tributary of the Tietê/Paraná river system. Before the 1950s, the Alto Tietê was still used for recreation within the metropolitan area. With population growth and increasing industrialization, pollution levels in the river reached critical levels. Efforts to intercept and treat industrial and municipal wastewater began in 1976. Today, despite the expenditure of more than US$1.5 billion on treatment works, the mean flow of the river is 58 percent untreated sewage as it leaves the center of the metropolitan area. The river remains devoid of life, a sanitary hazard, and an affront to the senses.

In the late 1980s another major effort was begun to deal with the pollution of the Alto Tietê. A river basin plan was developed with the goal of reaching target water quality conditions by the year 2005. Intermediate goals were also set for 1995, including a reduction of the untreated sewage fraction of the river from 58 percent to 5 percent. The intermediate plan includes five new treatment plants, additional sewerage, and increased industrial treatment, at an estimated capital cost of US$2.6 billion.

The river basin planning is being carried out jointly by a number of state and regional agencies. In 1992, these agencies began to investigate the application of economic instruments to the São Paulo region. A system was envisioned of user charges for discharges into the public sewerage system, pollution charges for directed discharges into the river and its tributaries, and abstraction charges for users of water from the river. It was expected that these charges would promote more rational use of the river and provide a revenue stream to support the required investments. Specific charge proposals are currently under development.

Colombia

In 1993 the Colombian Ministry of the Environment designed a national wastewater decontamination program based on and implemented through a nationwide system of pollution charges and regional environmental funds.

Under this program rivers and lakes are divided into local river basin management areas by the Regional Environmental Authorities, based on social, economic, and environmental criteria. Representatives of the community negotiate a five-year total pollution load reduction target for each river basin management area, based on locally perceived costs and benefits of pollution reduction.

A pollution charge is levied on municipal, industrial, and farm effluents.[6] The charge starts from minimum values of US$30 per ton of BOD and US$13 per ton of suspended solids (SS), increasing gradually until the target is met, with the aim of equalizing the marginal costs of treatment across the different polluters in the management area.

The charges feed regional decontamination funds, managed by the regional environmental agencies, that finance wastewater management investments (70 percent), allocated on the basis of their cost and BOD reduction effectiveness, and the management of the program (30 percent). The funds cover, among other things, project feasibility studies, soft loans for industry and agriculture, and grants and loans for municipal wastewater treatment plants.

Overview

These brief discussions of experiences throughout the world illustrate several interesting points. First of all, the industrial economies all show a common evolutionary history. Each of these countries began with the uneven, uncoordinated practices associated with local initiative, described earlier as a Level 1 wastewater management policy. In all cases, this approach was recognized as ineffective many years ago.

The next step was a coordinated river basin–oriented approach, which utilizes a regional, participative model for planning and management. This transition to Level 2 began as early as the beginning of the twentieth century in Germany and Spain, and as recently as the 1960s in France and the United States. The next transition, to policies driven by a set of uniform national standards (Level 3), began in 1972 in the United States, and more recently in Europe with the adoption of the EU Directives on municipal wastewater treatment. Accordingly, the United States' brief experiment with basin planning effectively disappeared without a trace, while Western Europe's well-known basin agencies (for example, in France, Germany, and Spain) continue to function, although under strong constraints on their management autonomy. However, as the United States experience makes clear, Level 3 policies can be expected to preempt and eventually render superfluous any vestiges of Level 2 institutions and policies.[7]

Central and Eastern Europe, on the other hand, utilized a form of Level 3 management under the former political system, although it was an unsuccessful experience. Despite signs of interest in Level 2 regional policies, most CEE countries appear to be returning to a national standards–driven approach, based on the recent model of the EU. Little thought seems to have been given to the very high costs now being dealt with in the EU.

Developing countries throughout the world are most often characterized by a highly uneven application of Level 1 wastewater management policies. As these countries begin to devote more attention and resources to wastewater problems, they seem uncertain as to which model to pursue. Brazil, Colombia, and Mexico offer interesting examples of attempts to apply a regional Level 2 approach, achieving water quality improvements in a flexible, cost-effective way.

It is instructive to compare these new ideas and approaches from developing countries to the first signs in the United States of a desire to return to a regional, basin-oriented approach, or the most recent trend in the EU toward the coordination of measures within river basin districts, the economic analysis of water uses, and the incorporation of environmental costs that the Framework Directive under preparation seems ready to introduce.

Although some industrial countries have gone through a common evolutionary history that involved the three levels, these should not be seen as parts or steps of a necessary or desirable transition. Furthermore, these experiences show that a Level 2 type of approach is feasible and tends to result in the most sustainable and cost-effective solutions—and are therefore the favored ones in this paper—even though each one of them has both positive and negative aspects:

1. The Level 1 approach allows a good response to local short-scale interests (particularly of localities situated in the upper reaches of the river basin), but does not respond to broader goals and does not account for other effects outside the local area of interest. It is normally easy to apply since it is based on self enforcement.
2. The Level 2 approach provides the basis for quantitative methods of evaluation of priorities, stakeholders participation and a river basin approach—all elements of what are considered a correct wastewater management policy. Its applicability and results depend to a great

extent on the implementation and financing instruments adopted and suffer from the difficulties of properly measuring the costs of pollution and the related benefits of controlling it.

3. The Level 3 approach is effective in achieving load reduction targets, although it depends heavily on the availability of adequate enforcement capacity and abundant financial resources, normally in the form of subsidies. Because of this dependence, and Level 3's difficulty taking into account local conditions or the inter-relations within the river basin, this approach tends to lead to overexpenditure and to the allocation of resources and interventions based on factors other than their effectiveness on the overall water quality in the basin.

Notes

1. This chapter draws extensively from "Mexico Second Water Supply and Sanitation Project SAR," World Bank, 1994; "Municipal Wastewater Treatment in Central and Eastern Europe," World Bank, 1993; J. Briscoe, "Implementing the New Water Resources Policy Consensus: Lessons from Good and Bad Practices," presented at the IWRA Conference, Cairo, Egypt, 1994; J. Briscoe, "The German Water and Sewerage Sector: How Well It Works and What It Means for Developing Countries," World Bank, 1995; H. Sunman, "The Application of Charging Schemes for the Management of Water Pollution," *Natural Resources Forum*, 1993, pp. 133–41; I. Serageldin, *Water Supply, Sanitation, and Environmental Sustainability: The Financing Challenge*, World Bank, 1994; U.S. National Research Council, *Managing Wastewater in Coastal Urban Areas*, National Academy Press, 1993; SABESP, *Depollution of the Tietê River*, São Paulo, Brazil, 1991.

2. See www.state.nj.us/drbc for more data and information.

3. Findings of the water sector World Bank study tour to Germany, 1995.

4. The Netherlands adopted a Surface Water Charge in 1970. It is similar to the French pollution charge in that it is conceived primarily as a revenue measure, rather than as an economic incentive. Municipalities levy charges on behalf of the State Water Authority. Proceeds from the charges subsidize the construction of wastewater treatment plants by industry and municipalities. Despite the emphasis on revenue-raising, the Dutch charge seems to comprise an effective incentive for pollution abatement. The charge is widely believed to be a major factor in a two-thirds decline in industrial pollution during the 1970s.

5. P. Chapuy, 1996, "Evaluation de l'efficience des systèmes de redevance de pollution de l'eau: étude du cas de la France." Direction de l'Environnement. OECD.

6. On April 1997, 12 regional authorities had completed their implementation plans, 3 had introduced the pollution charge, and the 10 most important authorities are expected to be charging by the end of 1998. Thomas Black, 1997, personal communication.

7. It is interesting to note that, similarly to what happened in the United States, although the Directive reduced the autonomy of the river basin agencies to select their wastewater management policies and objectives, it brought a wealth of funds for pollution control that further exacerbated the lack of a cost-effective approach in their interventions.

3
Conceptual Framework for Wastewater Management

The development of an effective wastewater management policy requires numerous decisions on the area to be sewered, the options for controlling pollution at the source or for reusing wastewaters, the technology to be employed in their treatment, and the discharge location or locations. Many different system configurations and policy approaches are possible, each with a unique set of beneficial and adverse effects. Each configuration results in a set of services, while impacting environmental resources in particular ways. Each policy approach provides different advantages while requiring particular conditions to be effective.

From the analysis of the experience to date made in the previous chapter, it can be derived that the most efficient approach should be based on an institutional framework equivalent to what has been called Level 2. It would also be desirable to have a fully objective method for comparing and ranking alternative wastewater system configurations under this institutional framework.

As has been said before, this would require, among other things, a capability for resource valuation that could identify the consequences and opportunity costs associated with various patterns of resource use. This information could be combined with monetary costs and other data to provide a ranking of alternative configurations. It would also permit quantitative evaluation of individual projects.

Unfortunately, this capability does not normally exist. Some work has been done, particularly in the area of human uses of water resources, which permits the quantification and monetization of certain environmental values. However, most environmental impacts of wastewater disposal, especially those involving ecosystem impacts, are beyond the reach of economic valuation at the present time.

In such a situation, several approaches are possible. One is to abandon any attempt at formal evaluation, designing and implementing management systems on the basis of fixed criteria and some notion of standard practice. National or international water quality standards (such as those used in the Level 3 approach) often form the basis of such a system design, even where near-term achievement of those standards is unlikely. Insistence on a particular technology, regardless of suitability or local conditions, may also result from this view of the problem. This standards-driven approach is probably the most common in practice, among other things, because it is simple to apply given sufficient resources. However, costs tend to be excessive by comparison to potential benefits, and can lead to malfunctioning systems and damage.

Another choice would be to limit evaluation to those factors that can be measured in monetary units. This second method, clearly deficient but sometimes advocated, has a particularly unsatisfactory result in the case of wastewater projects. Since the benefits of wastewater management are usually not monetized, while most costs are fully reflected as cash flows, any comparison of monetary benefits to monetary costs will fail to justify many wastewater management projects and systems. This distorted view of project merit should not be the sole criterion for evaluating and ranking wastewater projects or systems.[1]

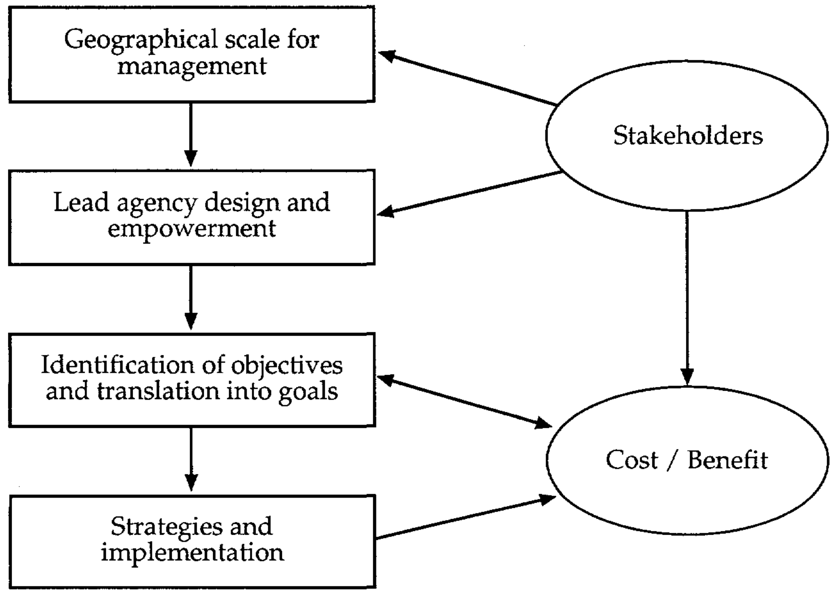
The relative scarcity of monetized benefits leads to other problems. Public willingness to pay for wastewater operations may be less when the expected benefits are mostly qualitative or nonmonetized. This, in turn, threatens the viability of some existing and proposed systems. Further problems arise when attempts are made to include the nonmonetized benefits in conventional cost-benefit assessments. Undervaluing benefits will cause feasible projects to be rejected, while overvaluation may lead to acceptance of ill-advised proposals.

In the absence of a fully quantitative evaluation method for developing an adequate wastewater management policy, this paper proposes a partially qualitative conceptual framework, based on what has been described as the Level 2 institutional approach, incorporating such quantitative measures as are available through the involvement of the basin stakeholders in the decisionmaking process (see figure 5).

A possible process to develop this approach—and to formulate and implement optimal strategies for wastewater management—is discussed further in this chapter. It consists of the following steps:

- The geographical scale at which wastewater management should be implemented is selected
- A lead agency and the mechanisms for stakeholder participation are designed and the agency empowered
- Objectives are identified
- Objectives are translated to specific goals
- Alternative strategies—and their implementation instruments—are formulated so that they are capable of meeting goals

Figure 5. Conceptual Framework



- The preferred strategy and instruments are selected and implemented; feedback is solicited; the strategy is re-examined based on the results of the feedback.

Geographical Scale

As was mentioned before, water quality problems typically occur at the scale of rivers, lakes, or coastal ecosystems. The solutions to these problems should be found at the same or larger geographic scale, and must address all sources of pollution likely to affect a given ecosystem or resource, no matter where in the river basin they may occur. This basin-oriented approach should lead to the search for the most cost-effective wastewater system configurations. Implementation of a basin-oriented approach should also build upon the relationship and integration of wastewater management policies in the broader comprehensive water resources management policy of the country or the particular river basin. The result should be a feasible, cost-effective policy.

The selection of the area or geographical scale in a river that is adequate for an integrated and differentiated management of wastewater is one of the most important steps of the policy development process. It should be selected, in each particular case, after the identification and evaluation of (a) the economic relations that can be established among the different water uses in the particular country or river basin; (b) the scale of the water quality problems; and (c) the stakeholders and their relation to the economic uses of the resource that are affected by pollution and their relation to the causes of that pollution. The area should allow for the consideration and integration of all these factors into the management process.

In Western Europe's experiences the management areas normally comprise the whole river basin because of the size of most main river basins and the extensive and well-established relationships among water uses, pollution, and stakeholders in these rivers.[2]

The experience of the Delaware river basin in the United States also seems to point to whole river basins as the geographical scale that is appropriate for wastewater management. However, although the idea of extrapolating the use of the whole river basin as the management area has its advantages, the specific circumstances and conditions of European rivers are not easily found elsewhere. The scale of the pollution problem, the relations among the different water uses the area supports, and the involved stakeholders should be the determining factors for selecting the management area in each particular case. Depending on these factors, the geographical scale for management could include a whole river basin, part of it, the river basin of a major tributary, the coastal area adjacent to the discharge point, or a combination of these.[3]

The process for selecting the geographical scale for management should begin, therefore, with the identification of affected and geographically relevant stakeholders. These include any local, regional, and also national government agencies that would be affected by the wastewater management plan, including but not limited to those agencies with wastewater management or water quality responsibilities. Other important stakeholders include associations of irrigation, industrial, commercial, or residential users; large industrial firms; tourism-oriented businesses; NGOs with interests in wastewater, environmental, or related issues, and so on.

Through the involvement of all stakeholders, the selection of the management scale should allow for a comprehensive perspective in the selection of wastewater management interventions, avoiding as much as possible the case-by-case approach, with piecemeal solutions. It should also balance the attention to municipal, industrial, and other pollution sources, large and small, in a search for the most cost-effective actions and allow for the consideration of all available options and combination of pollution control and reduction at the source, reuse of wastewaters, and treatment technologies. It should, finally, permit the integration of wastewater management measures into the broader comprehensive water resources management policy of the particular river basin or country.

Lead Agency

Ideally, the tasks described here would be performed by an organizationally competent lead agency that is endowed by the stakeholders with the authority and responsibility to perform the necessary functions, and the incentives to do so efficiently.[4] Unfortunately, such agencies are rarely found. More often, responsibility and operational competence are divided among several agencies and ministries. One may be responsible for collection, another for treatment, another for water quality protection, and so on. Typically, no single agency has a reason to consider the effectiveness or efficiency of the system as a whole.

Consistent with the principles enunciated before, in order to be effective the design of the lead agency must start by recognizing that the real authority and capability for implementing a wastewater management plan lies, not with any particular agency, but with the stakeholders collectively. The identification, empowerment, and development of the mechanisms that guarantee the adequate involvement of all relevant stakeholders is thus a critical factor in achieving and implementing a satisfactory wastewater (and water resources) policy. The potential for subversion of the process in order to achieve a specific outcome favored by some subset of stakeholders is quite real.

For this and other reasons it is preferable that the lead agency itself not be a major stakeholder, and that it instead serve a technical function only, providing the information and analysis in order for the stakeholders to reach decisions. (The solutions adopted in France, Germany, and Spain, as well as the Interstate Commission on the Potomac River Basin in the United States, described in the attached box 1, are all good examples of this.)[5] This reduces the perception of the lead agency as having an independent agenda, thus improving its ability to promote consensus among the parties. It also reduces the risk of a deliberately incomplete identification of stakeholders.

In other to proceed, the lead agency must be identified and given responsibility for the development and implementation of the wastewater management strategy. Ideally, the lead agency would be formed around an existing resource agency, with responsibility for water resources or environmental management over an area that is related to the geographic scale of the water quality problems (for instance, the river basin). This would facilitate the integrated planning of wastewater facilities, and would permit lessons learned in the wastewater planning effort to be applied to other resources.

It is desirable that the lead agency have capabilities in the areas of management, planning, and regulation, although this does not mean that it should necessarily perform all these functions. If the lead agency does not itself perform all related functions, it must be able to solicit and

Box 1. A Lead Agency: The Interstate Commission on the Potomac River Basin in the United States

In the 1980s the Washington, D.C., metropolitan area faced a water supply crisis. The 3 million residents of the area, as well as U.S. government offices, were supplied by 29 independent water supply agencies. Water was obtained from a number of local sources, but 70 percent came from the unregulated flow of the Potomac River, a barely adequate and highly risky supply. Available supply barely covered demands in 1980, with no reserve for future growth or for dry years. During the previous 30 years successive studies had warned of the need to construct dams on the Potomac River or its tributaries. The water agencies waited for the U.S. Army Corps of Engineers to find a solution, but the Corps was unable to do so. Proposal after proposal was defeated for a combination of economic and environmental reasons. Another Corps study, authorized in 1974, presented its interim proposals in 1979. Four plans were presented. They differed from previous proposals in that they all included substantial water conservation as a plan element, and a costly interbasin diversion from the Potomac River, with uncertain environmental consequences. Controversy erupted, and it seemed that yet another Corps proposal was destined to fail.

At this point something unique happened. The three largest water agencies in the region, joined by many of the smaller ones, formed two task forces; the Corps of Engineers formed a third task force. The three task forces set out to find a workable solution to the problem. Much of the technical work was delegated to the Interstate Commission for the Potomac River Basin (ICPRB), a tiny agency previously occupied with river

mobilize the active participation of the organizations and ministries that do perform them. This participation must be sufficient to give the lead agency access to relevant information and experience, and to promote consensus among the affected agencies.

The lead agency could collect fees and provide funding or matching grants for wastewater treatment, but should not engage in the design, procurement, or construction of the treatment plants. This should be the function of municipal Water Supply and Sanitation (WS&S) utilities or regional sanitation companies.

As part of the strategy, the lead agency should help define the responsibilities and functions of each of the involved agencies, other participants and the stakeholders of the basin, providing appropriate procedures and instruments for providing incentives, as well as measuring and rewarding performance. To the extent that such a strategy redefines the responsibilities of the various agencies and ministries, it is especially important that the planning process have the full support of monitoring. ICPRB quickly assumed a leadership role, and was able to guide the task forces through an unprecedented exercise. Traditional planning concepts and design criteria were abandoned and replaced with notions of risk management, regional systemwide operation, and joint management of supply and demand. Jurisdictional boundaries were erased for planning purposes, and the river basin was analyzed as a single unit. It was discovered that, with a high level of regional cooperation, the water supply problems of the metropolitan area through the year 2030 could be solved with a combination of a small, local side-stream reservoir, demand management, drought management, and revised operation of two existing reservoirs located 200 miles upstream. The solution was embodied in eight legal contracts, signed by all the parties, which set forth the terms of cooperation, performance, and cost-sharing. The contracts were signed in 1982.

Twelve years later, the regional solution remains robust, it continues to provide abundant, reliable, and inexpensive water to the Washington region, and promises to do so until at least 2030. The river is managed by ICPRB in an integrated way, although each agency retains all of the authority and responsibility that it had before. Credit for this goes to all of the participants, but particularly to the ICPRB, which proved to be the catalyst and the facilitator of a bold and innovative solution. In the complex political environment of the Washington region, this role would not have been possible for one of the major players. It was possible for ICPRB exactly because it lacked power: it was regarded as a technical agency, an honest broker, and a threat to no one. As such it became, in effect, the lead agency for a regional water supply solution.

the central and regional governments. Regardless of how these responsibilities are allocated among ministries and agencies, it is essential that the lead agency be capable of dispute resolution.

It is important that a clear separation be set between the regulatory functions that the lead agency would perform as part of the implementation of the wastewater management policy, and the implementation of the actions incorporated in the adopted strategy. Similarly, the lead agency should not be involved with the economic regulation of the water and sanitation utilities and companies. This would ensure clarity of mandates and facilitate the protection of resources and consumers against monopoly abuse.

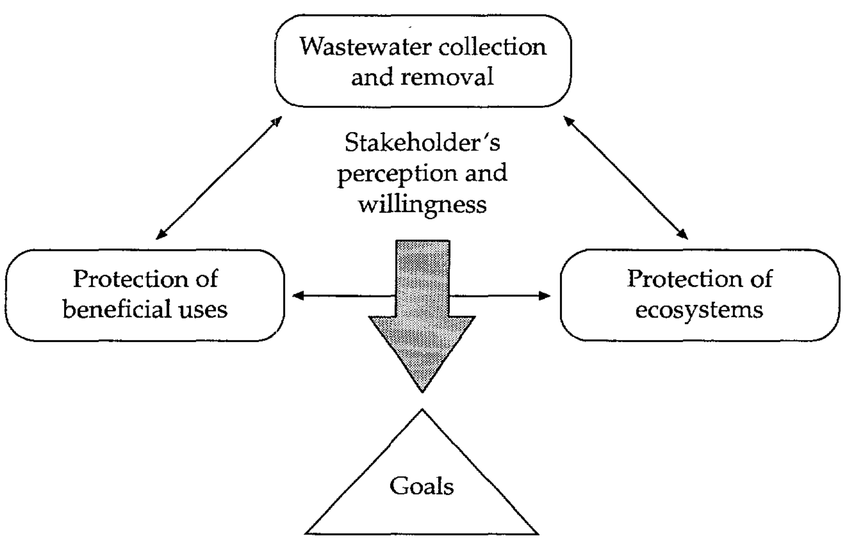
The lead agency should thus be responsible for two critical roles: (a) the development and implementation of the policies and objectives set forth by the stakeholders that, as have been pointed out, are the ones that ultimately determine the authority and capability to adopt and finance solutions; and (b) be in charge of identifying and assessing the policy options, the distribution of functions, and the evaluation of results and costs of these options, in order to present them to the stakeholders for selection. Examples of this type of roles are the cases of the French *Agences Financières de Bassin, the Ruhrverband* in Germany, and the Spanish *Confederaciones Hidrográficas*.

Objectives

In order to identify and measure the beneficial and adverse effects of wastewater systems there must be agreement concerning the objectives of wastewater management (see figure 6). Every wastewater system is constructed with some objectives in mind, either explicit or implicit. Explicit objectives may include very specific statements of purpose, such as avoiding beach closures, reducing harm to a particular fishery, eliminating noxious odors near a river, or solving a sewage-flooding problem in an urban area. Implicit objectives may include similar purposes, as well as a desire for greater convenience and efficiency in urban life.

It is best if the objectives can first be stated at a general level, so that they are broadly applicable to all systems under all conditions. Later, these general objectives can be translated into specific goals applicable to the local situation. In this way the specific goals are likely to be collectively more comprehensive, and possibilities for tradeoffs among individual goals become apparent.

Figure 6. Identification of Objectives and Translation into Goals



At the most general level, wastewater management policy is driven by one or several of the following three objectives:[6]

Collection and Removal of Wastewater: Wastewater should be removed from possible human contact or proximity in a way that promotes public health and avoids nuisance.

This objective drives decisions concerning the areas to be sewered and the design of the sewerage system (technology, density, construction practices, and so on). These decisions, in turn, reflect the feasibility and application of in situ treatment and disposal of wastes in part or all of the study area. Decisions are also influenced by sanitation practices in the catchment area, including the prevalence of piped water, housing conditions, characteristics of building plumbing systems, and access to flush toilets.

Protection of Beneficial Use: Wastewater should be managed to protect valuable human uses of the river basin in the catchment and disposal areas.

Wastewater management should seek to minimize disruption of or maximize benefits from human activities and protect those who engage in these activities from exposure to disease-carrying organisms. The most common case is where untreated or inadequately treated wastes are exposed to human contact, creating a nuisance and a risk of pathogen transmission that may interfere with water abstractions for potable supply, agriculture, swimming, boating, passive recreation, tourism, and other human activities. Wastewater management should also seek to reduce the impact on commercial, recreational, and subsistence fishing, which might be induced by damage to ecosystems. However, wastewater management should do more than avoid damages by giving adequate consideration to all available options of reuse of wastewater, which may bring incremental benefits along with the adequate disposal of effluents.

Protection of Ecosystems: Wastewater should be transported, treated, and disposed of in a way that protects valuable ecosystems.

This objective aims to protect naturally occurring ecosystems, maintaining water and sediment quality conditions conducive to restoring and maintaining biota in appropriate numbers and diversity. Once wastewater is collected, there are many choices as to how it may be transported from the catchment area, the number and location of treatment sites, what treatment technology will be applied, where treated effluent is discharged, and the design of the outfall line and diffuser. Where reuse is practiced, this represents an alternate means of disposal, with environmental effects and risks of its own. Related decisions affect the handling, storage, treatment, and disposal of sludge. Environmental impacts are possible anywhere throughout this system, but are most likely to occur at the final disposal sites for effluent and sludge.

The wastewater management policy should seek to identify the strategy that provides the best combination of progress toward all aspects of these objectives. The main challenge is to transform these general objectives into specific goals, then find a feasible, practical system configuration that achieves the selected goals at least-cost. Another important challenge is to involve all stakeholders with a river basin perspective to share these objectives by collectively becoming beneficiaries of the policy for the management of the wastewater, as well as responsible actors for its implementation, irrespective of where in the basin the pollution originates or what it impacts.

Goal Setting

Objectives are translated into action by setting specific goals for wastewater management strategy. These goals should specify in detail what is to be achieved: for instance, restore and protect a particular fishery, meet World Health Organization (WHO) water quality guidelines for a particular bathing beach, and so on. It is progress toward these goals that generates the direct and indirect benefits of wastewater management. As these benefits should be identified and potentially measured, the process must start by identifying as precisely as possible what is to be achieved.

These goals should also be set in a participative process involving all significant stakeholders. It is essential that the selected goals have the support of the affected community: otherwise the feasibility of the resulting management strategy will be in doubt. Also, it should be understood that the overall planning process is iterative: although goals are agreed upon at the outset, these decisions may be revisited as information on cost and effectiveness of different strategies is obtained.

The importance of adopting a structured goal-setting process as is described here is that it forces the involvement of stakeholders in the setting of goals and, therefore, in the distribution and acceptance of the financial effort needed to achieve them. Also, the process makes explicit the expectations of society for the wastewater plan, and facilitates future assessment of the actual performance of the resulting system (box 2).

In practice, most water quality–related goals can be stated in terms of water and sediment quality criteria or standards. These should be spatially delimited: that is, a water quality criterion intended to protect shellfish should apply to areas containing shellfish beds; a criterion adopted to protect bathing beaches should apply to waters near such beaches, and so on. The advantage of such specificity is that the resulting set of criteria can be more thoroughly monitored and effectively enforced. Outfalls and diffusers can thus be located in waters with less restrictive criteria, and still protect more sensitive areas, while reducing the overall cost of the interventions.

Box 2. Goal-Setting Process

In the initial round of goal setting it is expected that the lead agency would develop and disseminate certain basic information on existing demographic and environmental conditions, then propose a list of specific wastewater management goals. This list would then be elaborated and extended as a result of comments and suggestions from stakeholders. Discussions between the lead agency and stakeholders may or may not lead to understandings as to priorities among goals. The discussion might take the form of proposals and comments exchanged between the lead agency and individual stakeholders, or it may utilize public meetings, committees, focus groups, or other devices.

Following the development of the initial list of goals, the lead agency proceeds with the development of a strategy designed to meet those goals. The implementation schedule and preliminary cost of that strategy, together with information on how the cost would be borne, are communicated to stakeholders. They are then asked to re-evaluate their choice of goals in light of the cost information. This is the first step in an iterative process designed to reach consensus on the benefits and costs of the wastewater management strategy. Further iterations may be needed to achieve reasonable agreement.

This process should be repeated periodically in the future, probably every four or five years, to respond to demographic changes, or as additional information of environmental conditions becomes available. It is essential to make all stakeholders understand that besides being an iterative process, it is also an evolving one, where objectives, goals, and strategies should necessarily change with time and be agreed on by those that ultimately have the authority to do so: the stakeholders themselves.

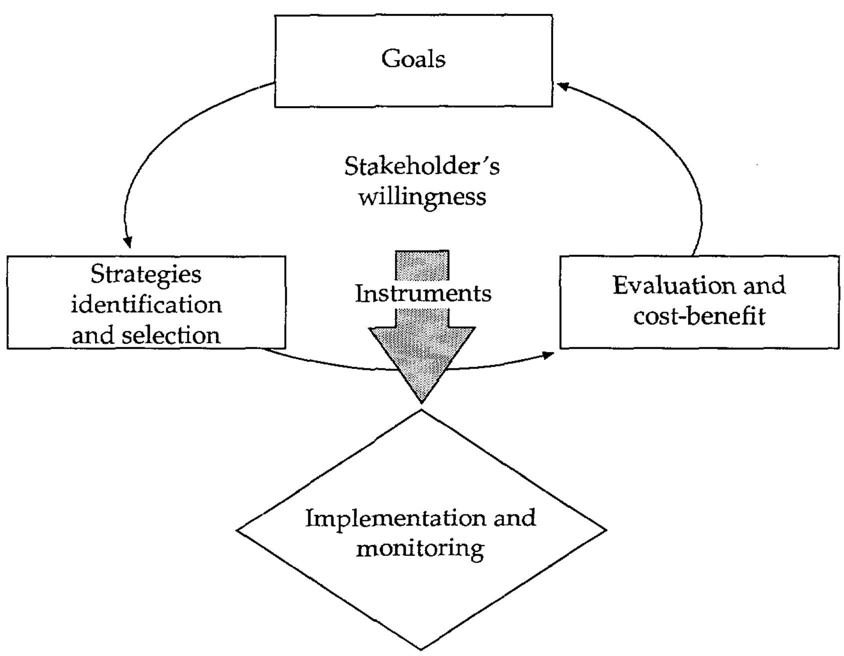
In many cases, ambient water quality standards may already exist in law or regulation (these are often based on recommended international guidelines, such as WHO guidelines). Where existing conditions differ substantially from the standards, the wastewater management plan should include interim steps on the way to achieve the ultimate goals, which might be represented by these standards, with a gradual approach based in simpler more sustainable interventions.[7] Once implemented, because the plan is subject to periodic re-evaluation and adjustment, the performance should improve over time.

The questions of whether the existing standards are the best ones, or whether more or less restrictive standards should apply, do not need to be addressed in the early stages of policy formulation. Moreover, they should be left open because for practical purposes they are irrelevant—they can normally not be achieved immediately. Once an effective wastewater management system is in place, with the decisionmaking mechanisms properly developed, decisions on standards can be made in the light of accumulated knowledge and experience.

Strategy Formulation and Assessment

A management strategy is a set of decisions, policies, regulations, infrastructure, and activities which, if implemented, is expected to meet selected goals (see figure 7). By meeting the goals, the management strategy should be able to achieve the three objectives of wastewater management. In principle, more than one alternative strategy may be devised to meet a given set of goals. One strategy may require high levels of treatment at municipal discharge points while ignoring industrial and nonpoint source discharges; another might place a heavier burden on nonmunicipal discharges while achieving the same water quality goals; another might rely mainly on water conservation, water demand management, and extensive reuse. Instead of requiring extensive end-of-pipe treatment, more attention may be given to pollution prevention and source reduction. Extensive reuse may replace discharge into natural waters.

Figure 7. Strategy Formulation, Selection, Implementation, and Evaluation



Implementation instruments embedded in a strategy may range from conventional regulatory mechanisms as command-and-control approaches to land use controls, education, economic instruments and incentives, and voluntary action. Strategies may also vary with respect to the sequencing of actions, the gradualness of the interventions or the time scale of compliance with goals.

The strategy's formulation consists of the development of one or more detailed sets of actions that promise to meet the specified goals at minimum overall life-cycle cost. In practice, it is best to develop several relatively cost-effective but otherwise dissimilar alternatives, because the final choice may turn on factors other than total cost. For example, a low-cost strategy may depend upon intensive enforcement of industrial pretreatment standards, enforcement that might be judged unfeasible over the long term, or politically unacceptable, or both. Another strategy may have a low overall cost, but if much of that cost is to be borne by private citizens (for instance, through high user charges intended to act as water conservation measures), then a more expensive plan with lower private costs may ultimately be selected. Key recommendations for the strategy's formulation are summarized in box 3.

Existing Constraints

An important issue in strategy formulation is whether to accept existing constraints as binding. In most cases, if strategies were to be developed within the framework of existing laws, regulations, fiscal constraints, and practice, very few alternatives could be proposed. In the absence of legislation authorizing economic incentives, these would be omitted and jurisdictional boundaries would preclude regionalization. Such barriers might readily be removed if the actual advantage of doing so could be understood. It is best, therefore, to formulate alternative strategies without consideration of most existing constraints. These issues can be considered again when the strategies are assessed and compared.

Where individual strategies exhibit conflicts with political, legal, institutional, or fiscal constraints, the assessment process should include investigation of ways to resolve those constraints. Where resolutions seem possible, the needed actions should be incorporated into the strategy.

Process for Formulation and Assessment of Strategies

A possible approach for formulating and assessing the strategies could consist of an iterative process with three main steps: (a) an assessment of the river basin; (b) the development of evaluation procedures for prioritizing investments; and (c) the identification and evaluation of investment priorities and applicable management instruments.

Box 3. Key Recommendation for Strategy Formulation

Do not anticipate the final decision. The best approach is to present one efficient plan that meets the goals at the lowest overall life-cycle cost, along with several alternative plans that illustrate possible tradeoffs, and that allow for cost comparisons. One alternative strategy might have lower private costs, at the expense of higher total costs; another might make greater use of in situ treatment; another might minimize the use of foreign exchange; and so on. In this way, if the final decision is to implement something other than the least-cost plan, it is clear what has been gained and what has been given up.

Openness and transparency. All parties should have confidence in the essential fairness of the procedures being used. Unless there is a sense of trust in the integrity of the planning process, no plan will be taken at face value by all the stakeholders, and effective discussion of alternatives will not be possible.

All reasonable configurations, technologies, and regulatory instruments, together with alternatives for the graduality of their application, should be considered. In managing industrial discharges, for example, some firms may be permitted to continue discharging to streams while other discharges are intercepted and treated centrally, or all firms may be included in the central system. The treatment works may be designed to accommodate expected industrial discharges, or the strength of those wastes may be reduced through pretreatment requirements, or through economic incentives. Similar choices exist for other classes of discharges. Systems may be more or less integrated spatially, and may make use of varying levels of technology. Although existing collection systems and treatment works may be incorporated in the final strategies where doing so contributes to lower total cost, the possibility of abandoning some existing infrastructure should be evaluated.

Stakeholders should be able to make cost comparisons among strategies. This would ideally require the computation of total overall life-cycle cost. This consists of the initial costs of all elements of the strategy plus the continuing costs of those elements over the lives of the related facilities or equipment. Using an appropriate discount rate, these various costs are converted to annualized cost and summed over all elements of the strategy. Similar data should ideally be prepared about the benefits to be achieved.

Determine the likely impact on all sectors of society and the economy. This includes not only such matters as the effectiveness of the strategy in meeting its goals and the overall cost of implementation, but also the cost impact on individuals and groups of individuals; the burden placed on various agencies and institutions; any divergence of the strategy from customary practices or cultural norms; the need for subsidies and user charges, and the nature and incidence of such charges; impacts on the political distribution of power and control; coordination needs; options to resolve disputes; and so on.

The lead agency should first assess the base river basin conditions, both presently and those expected as results of development trends and, particularly, of any decentralization process underway in the country. It should ideally analyze all the physical and institutional conditions that influence the water resources management approach to be used. A list of the main aspects to be analyzed is included in box 4.

Next the lead agency should develop, structure, and test the "evaluation procedure" to select and assess priorities in water quality protection and pollution control. It could possibly be synthesized in the form of an algorithm intended to be used by the lead agency for its dialogue with the stakeholders to develop consensus, dispute resolution, and selection of priorities.

The evaluation instrument should incorporate the capacity to analyze the constraints (available resources, stakeholders' participation, and social demands) that influence the selection and the wastewater

Box 4. Content of the River Basin Assessment

The assessment of the river basin should include the study and analysis of the following aspects:

(a) **The typology and characteristics of the river basin**, including the available water resources; their uses and demands; the river basin physical conditions; the environmental constraints; the wastes entering the system (agricultural, urban, and industrial); and the actions that affect its quality (such as abstractions and transfers among river basins or deforestation)

(b) **The impacts of wastewater discharges** on water quality and of water quality on the uses of water; the costs linked to the water pollution levels; and the impact of these pollution levels on the intended socioeconomic and development objectives and plan for the river basin and the country

(c) **The institutional framework** of the area, in particular: distribution of responsibilities in the selection and implementation of wastewater management options and priorities; technical and financial capacity of present water utilities, regulatory bodies and agencies involved in the management of water resources—especially in the monitoring and enforcement of water quality; territorial structure, and distribution of governance among institutions; and stakeholders and political relationship of power among them

(d) **The social demand and concern** for water pollution problems (present and potential) and the available financial and technical resources that determine its willingness and capacity to implement and afford solutions.

management alternatives. It should allow the decision, for a given level of resources availability, on what are the priority wastewater management actions. Under this step the tools and instruments needed for this evaluation, such as river quality modeling or economic impact modeling, should be prepared (box 5).

The third step should develop on the findings of the first to identify and define priority investments and management-implementation instruments.[8] The key questions that should be addressed as part of this step are summarized in box 6.

The results of the studies carried out under this step should be incorporated in the "proposals for a comprehensive river water quality protection plan" that should be presented for the stakeholders' consideration. They should include (a) the economic and financial mechanisms for

Box 5. Wastewater Management Modeling

Model Details. Strong modeling capacity is one of the lead agency's key needed tools for adequate wastewater management. In order to be useful for the selection of alternatives and options, models for wastewater management should be able to examine the tradeoffs between objectives—such as economic growth among competing sectors, or public health or environmental protection—in the allocation of water quantity and quality. The intent is to provide a tool through which the diverse stakeholders in the lead agency may gain an understanding of the impacts of alternative strategies of water management, and reach a consensus on the best use of the available resources and policies.

Model Components. The major components that should form the basis for the model are as follows:

a. Objective Functions. The objective functions should include, by sector, the costs of the actions and the benefits that accrue as a function of water use and quality, net of the costs. Typical benefits could be calculated using the product's value (such as crop, industrial product, or energy), demand curves, revenues from water charges or pollutant fees, or avoided costs. The objectives should be set up to allow for aggregation by region, stakeholder, and sector.

b. Constraints. The constraints in the model should ensure the values of the decision variables remain in the range of feasibility. They should at least include (i) system continuity (such as mass balance of flows and pollutants); (ii) budget and financial viability; (iii) environmental requirements (such as water quality standards, or assimilative capacity of river); (iv) engineering feasibility (such as capacity of conduits, treatment plant limitations); (v) use-related requirements (such as crop pollution control; (b) the needs for strengthening of monitoring and enforcement institutional capacity; (c) a tentative set of scenarios of priority wastewater management investments; and (d) economic balance of the program and options for cost-sharing among the basin stakeholders.

This plan should be based on the modeling and preparation of the scenarios, in terms of river water quality, that would result from the alternative options for wastewater management (considering the different combinations of reuse-treatment levels of all the discharges in the river basin as well as the application of "soft" instruments for pollution control). These can be expressed by significant parameters such as oxygen content, suspended solids concentration, benthic oxygen demand, eutrophication levels, or concentration of toxic substances (phenols, ammonia, heavy metals, and aromatic hydrocarbons primarily), selected on

requirements, flood protection, and industrial and household uses); (vi) legal, institutional, and political values; and (vii) public health, social, or cultural issues.

c. *Strategies and Sensitivity.* The capacity to run sensitivity analyses and allow the generation and exploration of alternative strategies should be an essential component of the model. The model should allow the manipulation of at least the following management options: demand and supply management, regulatory measures, wastewater treatment and reuse, pollution prevention, water and pollution charges, new institutional arrangements and environmental reclamation. The optimal solutions should at least be tested over a range of hydrologic situations to evaluate whether small changes in parameters affect the values of the decision variables. To optimize each alternative strategy, the model should also be based on methods of constrained optimization, and be multi-objective—by stakeholder, by sector, and by region (such as sub-basin).
d. *Development approach.* The approach to model development should ensure that stakeholders are involved throughout the model development. The input from the stakeholders should influence the nature of the objectives to be considered in the model, but emphasis should be placed on capturing the breadth of the issues involved in water resource management, which includes wastewater management. A conceptual model or problem statement should be jointly developed, outlining the management issues, constraints, measures of performance, and indicators for decisionmaking. The formulation should also allow for variable weighting of the objectives. The model should be developed iteratively, and should evolve through interaction with stakeholders. The model could evolve from a simpler, descriptive model in the first phase to one that forms the basis for decisionmaking in subsequent phases.

Box 6. Questions on Priority Investments and Managing-Implementation Options

What are the options for pollution control? Options include (i) alternative investments in wastewater management; (ii) alternatives for reuse or treatment; (iii) degree of treatment; (iv) available technologies; (v) alternatives for water conservation and demand management as a way to reduce wastewater; and (vi) expected impacts on water quality, water uses, and water institutions' financial and operating situation

What is the institutional framework needed to make them feasible, both in terms of the management of the water resources and of the functioning of the water utilities that would ultimately operate and maintain the infrastructure? The framework should include options such as the establishment of a regional sanitation company to undertake or manage the pollution control infrastructure, or an environmental fund to finance it.

What should be the instruments for implementing the strategy? The instruments should cover command and control mechanisms, market-based instruments (such as pollution or use fees, fiscal incentives, or product taxation), regulation, monitoring, enforcement capacity, and the alternative financing mechanisms, including the use of subsidies and seed fiscal money to support local and regional investments.

What are the coordination needs for resolution of disputes and to reach agreements among involved or interested stakeholders? It especially applies to the selection of priorities and to the options for sharing the financial effort that would ultimately lead to policy actions. Particular attention should also be given to the distribution of roles and functions and the coordination possibilities among the different government levels (municipal governments, regional governments, regional water authorities, and central government ministries) and later among the different sub-basins of the particular rivers to be addressed.

What resources might be available? Options include abstraction and polluter fees, resource transfers from national fiscal funds, budgetary contributions by local and regional governments, donor contributions, and contributions from the stakeholders and polluters themselves (industry, agriculture, or transport). These resources should be sufficient to make the lead agency financially viable and capable of performing the roles and functions assigned to it.

the basis of the uses that are affected by pollution, rather than on the pollution sources.

Ideally, the water quality scenarios could also be expanded to incorporate the impacts on the uses of the resource and on the costs to the users for the whole region. The expansion should be to the level that is necessary for their evaluation by the stakeholders, to allow them to ultimately decide on the water policy and action programs by providing them with the assessment of (a) the opportunity costs of water uses (for instance, economic costs incurred because of lack of water quality); (b) the costs of pollution control actions and investments; and (c) the institutional capacity and cost requirements to properly implement, monitor, and enforce the adopted wastewater management options.

Selection, Implementation, and Monitoring

After the alternative strategies have been thoroughly analyzed and assessed, one of them must be selected for implementation. The selection process, like the goal-setting process, should be based on broad participationof all types of stakeholders. It is particularly important to stress that those who will bear the cost of the plan, as well as those who must take various actions, must understand the reasons for selecting the final strategy.

Implementation involves not only the construction of facilities and the adoption of regulations and policies, but also the resolution of constraints and conflicts, and the development of long-term political and financial support for operation and maintenance of the needed infrastructure.

There must be a capability to monitor the performance of the selected strategy, both to determine that it is capable of meeting the goals and to detect instances of violations or inadequate performance. Where violations of standards or regulations are detected, an enforcement capability must exist, sufficient to promote future compliance. This requirement goes beyond the usual water quality monitoring found in developing countries, usually within the ministry of health. The monitoring system must be designed to collect information on the goals of the wastewater strategy, and on the performance on individual dischargers and system components and pass it over to the stakeholders periodically for maintained support and re-evaluation. A successful program requires time, financial capacity, expertise, and appropriate legal authority.

Whether the responsibility for monitoring should remain in the ministry of health, or wherever else it is currently housed; or whether it should be placed in the lead agency or with some other management agency are complex questions. Monitoring by a lead or management agency is likely to produce the most useful data. On the other hand, an independent or nonmanagement agency is in a better position to effect enforcement, should violations be detected. The solution may be a distribution of the monitoring function over several agencies, with a sharing of data. This latter solution may be difficult to achieve in many countries.

Beyond detecting violations, monitoring information is also used to verify the assumptions of the goal setting and strategy formulation processes. Information obtained in this way is fed back to the first steps in the planning process, permitting the relevant agencies and stakeholders to revisit the determination of goals. If goals are modified as a result of this review, it may be possible to propose incremental changes in the implemented strategy to reflect those modifications. In this way, the process is iterative, constantly reassessing its own performance and modifying policies accordingly.

Overview: Key Elements and Steps for Reform

The preceding analysis shows that the key elements for the successful development and implementation of a wastewater management policy are (a) the acceptance of water resources as an economic good, considering the economic impact of pollution impairment of its uses in the selection of priorities; (b) the recognition of the fact that the real authority and capability for implementing a wastewater management policy lies, not with any particular agency, but with the stakeholders collectively; and (c) the empowerment provided by the stakeholders to a lead agency to provide the data and information necessary for the different stakeholders to understand the economic implications of wastewater management decisions, with technical credibility to mediate in disputes resolution and lead to optimized solutions, all of it at the appropriate geographical scale, which is normally—but not necessarily always—the river basin.

These elements represent a departure from the most common situations that are normally characterized, either by responsibilities on decisions or financing located at the municipal governments or water companies, or by centralized planning and implementation, without stakeholders' participation. Clearly, the changes and redistribution of responsibilities required to adopt the proposed conceptual framework cannot be fully adopted in one step in most situations.

These elements also determine the minimum and first steps that are needed to implement an effective wastewater management policy in those cases in which the whole application of the conceptual framework described above might not be feasible. As a minimum we consider that it is necessary to (a) define the management's geographical scale (as defined above) and identify the stakeholders in it; and (b) involve them in the decisionmaking process through a lead agency. To this end the appropriate management framework must be set up to provide the stakeholders with the information necessary to perceive and assess the real economic value of water, the impact of pollution on it, and the effect and costs of alternative solutions and forms of implementing them.

The gradualness of the reform should lie in the selection and type of the lead agency (at the least it must be empowered and trusted by the stakeholders) and in the form, mechanisms, and degree of stakeholders' involvement in the management process and in the adoption of decisions.

Notwithstanding the difficulties involved, the evidence available—both positive and negative—shows that the adoption of policies based on these elements and the principles described in this paper, even with a gradual approach, are more effective, will lead to more sustainable solutions, and make better use of the scarce resources normally available for this type of investments.

Notes

1. An opposite reaction has recently been taking place in some of the most developed and wealthy nations, where the lack of appropriate valuation methods for environmental resources is leading to the adoption of solutions that seek "complete protection," regardless of the cost. These solutions tend to be unsustainable in the medium term, particularly when the approach is copied in developing countries.

2. One significant exception is provided by the *Ruhrverband*, which manages the river basin of the Ruhr, a tributary of the Rhine.

3. In the extreme, in the absence of these relations, it could have a local scale, although this should not be mistaken as a Level 1 approach.

4. The term "lead agency" was chosen as a compromise among different denominations for the institution or organization that should ideally be available for developing and implementing the wastewater management policy in a given river basin. As it is explained in the text, its key characteristics are that it must be formed by and represent the stakeholders collectively, be endowed by them for this task, and should serve as a conflict resolution tool among them.

5. National Research Council, *Water for the Future of the Nation's Capital Area, Committee to Review the Metropolitan Washington Area Water Supply Study*, National Academy Press, Washington, D.C., 1980; and Robert S. McGarry, "Potomac River Basin Cooperation: A Success Story," in National Research Council, *Cooperation in Urban Water Management*, National Academy Press, Washington, D.C., 1983, pp. 90–102.

6. All of these objectives are important: none can be given absolute priority over the others. While the collection objective can be viewed as separable in some circumstances (collection system design may not be affected by subsequent decisions regarding treatment and disposal), the same cannot be said for the remaining two objectives. Ecosystem protection and protection of beneficial uses clearly interact. Even though these objectives may often be consistent, there are important cases where they are not. For example, disposal sites that avoid sensitive or endangered biota may displace human activities, or vice versa; when financial resources are much scarcer than needs, treatment options might be

relegated in favor of improved collection and other actions for protection of beneficial uses or ecosystems.

7. One common challenge that has to be faced in the goal-setting process is the demand by politicians, environmental groups and part of the population for the almost immediate achievement of the most "advanced" and demanding standards, often taken from developed countries, disregarding gradual approaches. This demand is normally made without considering the costs and time normally required for achieving these standards, the need to balance priorities and available resources or the real costs of the impact produced by the pollution that is to be controlled.

8. The issues of design and assignment of the instruments for the implementation of the pollution control strategy has been treated by Antonio Estache (personal communication); R. Seroa, "Utilização de Criterios Económicos para a Valorização da Agua no Brasil," Instituto de Pesquisas Económicas 556, 1998; F. Mendes and R. Seroa, "Instrumentos Económicos para o Controle Ambiental do Ar e da Agua," Instituto de Pesquisas Económicas 479, 1997; and Sergio Margulis, among others.

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COVER DESIGN: THE MAGAZINE GROUP

ISBN 0-8213-4467-6