

Stepping Up

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PERFORMANCE OF
China's
URBAN WATER UTILITIES



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Greg J. Browder

with

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Foreword

Providing high quality urban services is fundamental to sustaining China's growth. As China transitions to a market economy, municipal utilities—including those providing water and wastewater services, are evolving into commercially viable companies under government oversight. Great challenges confront the reform process for China's water utilities, including rapid urbanization and emerging inequality coupled with severe water scarcity and degradation. Cities and their water utilities must provide services within a complex mosaic of policies and regulations provided by national and provincial governments. In China, as throughout the world, water is also a sensitive political issue. Governments are keen to provide good water service, but also attuned to the need to ensure that tariffs are socially acceptable. This report presents a strategic framework and set of recommendations for addressing these challenges and accelerating improvements in China's urban water utilities.

Since 1990, China has had remarkable success in increasing the stock of water infrastructure, expanding water supply coverage, and increasing the percentage of wastewater that is treated. The World Bank is proud to have contributed to these accomplishments by providing around \$5 billion in financing (disbursed or committed) to support thirty-four urban water projects throughout China. In addition to financing, the Bank aims to provide value by improving planning, promoting financial sustainability, supporting institutional reforms, and undertaking analytical studies.

Drawing upon the World Bank's experience in China, as well as the Bank's global knowledge, this report paints an attainable vision for the urban water sector in the year 2020. This vision entails the provision of safe and reliable drinking water for all, comprehensive stormwater drainage, and the collection and treatment of all municipal wastewater—provided by efficient and financially sustainable water utilities. The strategic framework and set of recommendations presented in this report

provide a starting point for achieving the 2020 sector vision. The development of specific policies and programs within this strategic framework will naturally need further research and testing, but the direction is clear and requires coordinated action from national, provincial, and municipal governments, as well as water utilities.

The World Bank stands ready to deepen our partnership with China through continued financing of urban water projects, as well as conducting additional research, sharing international experience, and engaging in policy dialogue at all levels of government. We trust that this report will serve as the foundation for a new generation of World Bank support for China's urban water sector.

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The study benefited greatly from extensive consultations with Chinese stakeholders. Five consultations were held in China, including (a) an initial consultation in Beijing to define the scope of the study (October 2005); (b) mid-term consultations to provide feedback on the preliminary recommendations (March 2006, in Beijing, Tianjin, and Ningbo); and (c) final consultation in Beijing (September 2006). The final version of this report was discussed with the Ministry of Construction in May 2007.

Key national government agencies that participated in the consultations include the Ministry of Construction, the State Environmental Protection Agency, Ministry of Water Resources, Ministry of Finance, and the National Development and Reform Commission. The China National Water and Wastewater Association also participated in the consultations. In addition, representatives from water utilities, consulting firms, and municipal governments provided feedback during the consultations. The study team is grateful to the Tianjin and Ningbo municipal governments for organizing and paying for the consultations in their cities.

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List of Acronyms

ADB	Asian Development Bank	NDRC	National Development Reform Commission
AMP	Asset Management Planning	NTU	Nephelometric Turbidity Units
BOD	Biochemical Oxygen Demand	OECD	Organisation for Economic Co-Operation and Development
BOT	Build Own Transfer	O&M	Operations and Maintenance
CDB	China Development Bank	P	Phosphorous
COD	Chemical Oxygen Demand	PB	Price Bureau
CSO	Combined Sewer Overflows	PHB	Public Health Bureau
CWWA	China Water Works Association	PPP	Purchasing Power Parity
DBO	Design Build Operate	PRC	People's Republic of China
DDD	District Drainage Department	PSP	Private Sector Participation
DRC	Development Reform Commission	RMB	China Yuan Renminbi
EPB	Environment Protection Bureau	SEPA	State Environmental Protection Agency
GDP	Gross Domestic Product	SOE	State Owned Enterprise
GDPST	Gross Domestic Product Secondary and Tertiary	SS	Suspended Solids
IRP	Integrated Resource Planning	TOT	Transfer Own Transfer
JBIC	Japan Bank for International Cooperation	UDIC	Urban Development Investment Company
JV	Joint Venture	UNEP	United Nations Environment Programme
MFB	Municipal Finance Bureau	VAT	Value Added Tax
MDD	Municipal Drainage Department	WHO	World Health Organisation
MOC	Ministry of Construction	WRB	Water Resources Bureau
MOF	Ministry of Finance	WS	Water Supply
MOPH	Ministry of Public Health	WW	Wastewater
MOU	Memorandum of Understanding	WWTP	Wastewater Treatment Plant
MWR	Ministry of Water Resources		
MWWC	Municipal Wastewater Company		
N	Nitrogen		



Executive Summary

China has made remarkable progress in expanding its urban water supply and wastewater infrastructure since 1990. Driven by about RMB 438 billion (\$54 billion) in spending, water supply and wastewater coverage in China's 661 designated cities has increased dramatically. The share of the urban population served by municipal water supply utilities increased from 50 percent in 1990 to 88 percent by 2005. Over the same period, wastewater treatment capacity has tripled. As of 2006, municipal plants had the capacity to treat 52 percent of the wastewater generated in urban areas. Industrial water use has decreased, and the growth in domestic water use has slowed due to increases in water tariffs and conservation measures. Municipal pollution discharges into the environment, although still high, have decreased. Addressing future challenges, however, will require not only more investment, but new approaches to:

- Enhance governance and regulation at the national, provincial, and municipal levels
- Boost utility operational and financial performance
- Increase user fees
- Ensure adequate fiscal support
- Explicitly recognize the constraints facing lower capacity cities and towns

This study reviews China's accomplishments in providing urban water services, identifies the major challenges, and recommends directions for the future. It aims to provide an assessment of where the sector stands today and to create a strategic framework for policy discussions, project design, and reform efforts. The scope of the study is limited to urban water supply and wastewater (including stormwater) management. It only touches upon the important associated issues of water resources and water quality management. The World Bank is assisting China in other endeavors to address these issues.

China's government has embarked on sector reforms to achieve the nation's environmental and public health objectives. The State Council, National Development and Reform Commission (NDRC), Ministry of Construction (MOC), State Environmental Protection Agency (SEPA), and other national government agencies have issued a variety of directives on water pricing, utility regulation, wastewater treatment, private sector participation, and other reform priorities. A vision of the sector is emerging where water supply and wastewater services are provided by utility companies operating under an effective regulatory system. These companies are generating revenues through

user fees set at cost recovery levels, accessing capital markets for finance, and performing at high levels. The vision entails the provision of safe and reliable drinking water to all residents, economically efficient stormwater drainage, and the collection and treatment of all municipal wastewater. This vision is attainable for all cities by 2020, although large and prosperous cities may achieve these goals faster than China's thousands of smaller and less affluent cities and large towns.

Sector Challenges

In its quest to achieve this sector vision, China will confront the following challenges:

Responding to rapid urbanization. China is experiencing the greatest wave of urbanization in history. The official urban population is expected to increase from about 550 million in 2005 to about 900 million in 2020. Providing urban water services to new residents and dealing with new spatial patterns of urban development, particularly in booming metropolitan areas, will be a demanding task.

Dealing with urban diversity. China includes a wide spectrum of cities and towns, from large and rich super cities such as Beijing and Shanghai to thousands of smaller and poorer cities and towns. China's policies, standards, and approaches for urban water services will need to be tailored to meet the economic and environmental reality of different types of cities. To deal with this issue, this study has classified Chinese cities into two groups:

- *High-capacity cities.* This includes all cities with a per-capita GDP greater than RMB 24,000 (\$3,000) regardless of population, or any city with a population greater than 500,000 and per capita GDP of RMB 12,000 (\$1,500.)

As of 2005, there were approximately 150 such cities with a total population of 200 million—about one-third of the urban population.

- *Low-capacity cities.* This includes all other cities and towns in China, including around 500 designated cities, and the 1,635 county capital towns, with a total population of around 400 million.

The concept of “high” and “low” capacity cities, and the criteria used to classify them, has been constructed to facilitate policy discussion. The intention is to underscore that some cities—that is, “high-capacity” cities—can aspire now to standards of urban water services enjoyed by high-income countries, such as those belonging to the Organisation of Economic Co-operation and Development (OECD). In contrast, “low-capacity” cities face constraints typical of lower-middle income countries around the world, and it will take time and government support to transition to higher service standards.

Meeting investment demands. The growth in urban population, combined with aspirations to improve the quality of water services, will require an accelerated capital works program. As shown in Table 1, the estimated investment needs for 2006–10 alone are expected to be approximately

TABLE 1. Approximate Sector Investments

Sector Investment	Total Investment 1991–2005		Estimated Investment 2006–10	
	US\$ billion	RMB billion	US\$ billion	RMB billion
Water Supply	25	200	20	160
Wastewater	29	230	34	270
Total	54	430	54	430

equal to investments over the last 15 years. Financing these investments, and ensuring investment efficiency, is a major challenge.

Confronting water scarcity and degradation. China is characterized by water scarcity in the northern regions of the country and by severely degraded water quality throughout the country. Per-capita water availability in the 3-H basins of north China (Hai, Huai, and Huang) is around 500 m³/year, which is well below the 1,000 m³/yr standard for water stress. In 2003, over 40 percent of China's river stretches were classified as severely polluted. China's coastal waters suffer from widespread eutrophication, including large-scale, toxic red tide of algae. In spite of extensive efforts to improve water quality and ensure reliable water supplies, seasonal shortages and polluted water resources will continue to pose problems.

Water Utility Performance

The financial and operational performance of water utilities (both water supply and

wastewater) provides a focal point for evaluating urban water services. Figure 1 illustrates at a conceptual level where China's utilities stand now, and where they could be by 2020. The key findings related to utility performance are summarized below.

Wide spectrum of utility performance. Many Chinese utilities operate at levels similar to most middle-income countries, but below the average for advanced industrial countries (e.g. OECD countries). However, there is a very wide distribution of performance: some utilities perform well, while many others operate well below their potential. Although there is some correlation between city size and utility performance, and city wealth and utility performance, the relationship is not particularly strong. Table 2 provides an example based on percentage of water service area with low water pressure. This observation highlights the potential for quickly improving performance if the practices of the well-performing utilities are adopted by other cities.

Financial performance. In 2004, 60 percent of water supply utilities in China

FIGURE 1. Illustrative Evolution of China's Water Utilities

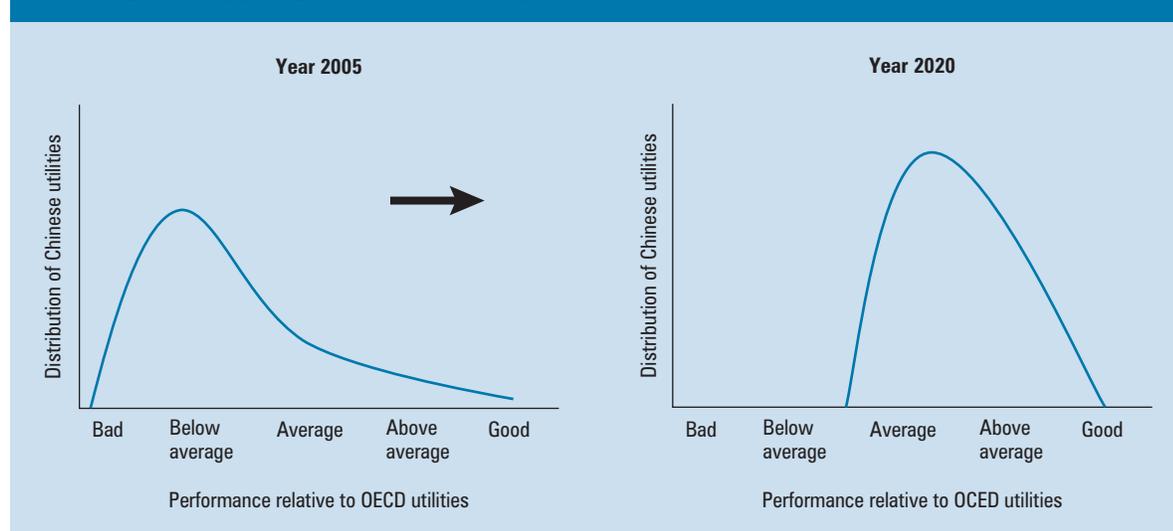


TABLE 2. Percentage of Utility Service Area with Low Water Pressure

City Type	Large and Rich Cities (%)	Medium Cities (%)	Small and Poor Cities (%)
Average	12	10	16
Best 25% of Utilities	0	0	0
Worst 25% of Utilities	45	33	46

reported negative net incomes, indicating that most of the companies were experiencing financial stress. Although there is no comprehensive data for the wastewater sector, the financial state of wastewater entities is certainly more precarious than that of water supply utilities. The national weighted average water supply tariff has increased more than 50 percent since 1998, and now stands at around 1.5 RMB/m³ (\$0.20). Starting in the late 1990s, most cities began charging wastewater tariffs, and the 2005 national average is 0.75 RMB (\$0.10). These rates, particularly for wastewater, are still insufficient to cover the full operating, maintenance, and capital costs. In addition, the collection of wastewater fees is a problem in many cities, particularly from industries. Most utilities still rely on municipal government equity contributions to finance a significant part of their investments.

Operational performance. China's water supply utilities generally provide 24-hour service, but the quality of the service is variable. As shown in Table 2, one-quarter of the water utilities are unable to provide adequate water pressure to more than 40 percent of their service area. Around 60 percent of China's 661 cities face seasonal water shortages, and over 100 cities have severe water constraints. On average, around 20 percent of the water produced at the water treatment plant is lost through leaky distribution pipes. Although a 20 percent

leakage rate appears good by international standards, this is largely because of China's compact, high-density distribution networks. When the leakage rate is calculated in terms of water loss per kilometer of pipeline, Chinese utilities have exceptionally high rates of water loss. Many cities have significant excess water treatment capacity, reflecting poor water supply planning practices. On a national scale, there is at least 50 percent excess treatment capacity.

China is rapidly constructing wastewater treatment plants; as of 2005, 364 out of 661 cities had plants, with a national capacity to treat around 45 percent of all wastewater. The average plant hydraulic utilization rate, however, was only 65 percent. The relatively low utilization rates stem from a variety of problems, including inadequate wastewater collection, poor planning, and a shortage of operating funds. Wastewater influent concentration is also often significantly lower than the design value, further contributing to the underutilization. Expansion and renovation of wastewater collection networks has lagged behind treatment plant construction. Inadequate collection systems in many cities result in excessive stormwater inflow and groundwater infiltration into the drainage pipes, stormwater drainage problems, and overflows of untreated wastewater into receiving water bodies.

Information gaps. Analysis of China's water utilities is complicated by the lack of

information on utility performance. The China Water Works Association and occasional surveys by the Ministry of Construction provide some information, but utility performance assessments are still inadequate and incomplete. The problem is particularly acute for wastewater, where many wastewater utilities are either government departments or operate on a quasi-department basis with significant municipal government budget support. This study relies on a myriad of different—and often incomplete—sources of information. Although the general picture that emerges is clear, the resolution of some specific features may be blurry.

Benefits of Improving Water Utility Performance

As shown in Figure 1, with the right government policies and programs, Chinese water utilities could perform at a level equal to or higher than utilities in OECD countries. The distribution of utility performance could also be much smaller. Water utilities should improve as China's economy grows and becomes more sophisticated and more closely resembles OECD countries. Moreover, China's water utilities must dramatically improve if China is to meet future challenges. The benefits of achieving the 2020 vision are considerable and include:

Environmental improvements. Restoring China's heavily polluted waters will take decades and will require continuous efforts to control municipal, industrial, and agricultural pollution. Pollutant loads from industrial and domestic sources have decreased from around 22 million tons of COD in 1995 to 13 million tons in 2004. By 2020, total industrial and domestic pollution loads could be reduced to 3 million tons of COD or lower. Based on other countries' experience,

receiving water quality will improve after controlling municipal and industrial pollution, but sustaining a healthy ecosystem is a more complex endeavor that involves managing urban and agricultural runoff, as well as toxic chemicals.

Protection of public health. Water pollution endangers public health through a variety of mechanisms, including (a) polluting drinking water sources; (b) contaminating seafood, particularly in the extensive coastal aquaculture zones as well as capture fisheries; and (c) transmitting diseases through contact in rivers, lakes, and coastal waters. Quantifying the linkage between water pollution and public health is complex and beyond the scope of this study, but the health impacts of water pollution are clearly a major issue in China. The unreliable and low-quality water service in many cities increases the risk of exposure to pathogens and toxic chemicals, and is a significant public health risk. Unreliable water supplies can also impact public health by hindering basic washing and sanitation. Improving drinking water quality will certainly reduce the rates of illness and morbidity, although more research is needed to quantify the impacts.

Economic benefits. Providing urban water services is an important part of the national economy. In 2005, annual capital investments in the sector accounted for about 0.4 percent of GDP, and operating costs for at least another 0.6 percent of GDP. If utilities can improve the efficiency of their capital investments by one-quarter—a target this study finds very plausible—economic savings to the country would be on the order of RMB 100 billion (\$12.5 billion). Most importantly, economic activity, particularly for industries and commerce, depends vitally on an adequate water supply. Environmental

improvements and protection of public health also generate direct and indirect economic benefits.

Enhance equity. Inequality is a serious and growing problem in China along three dimensions: (1) between rural and urban residents; (2) among cities, particularly between those in coastal provinces and other parts of China; and (3) among residents within cities. Adopting specific policy measures for urban water services that take into account and help compensate for these differences will help to alleviate some of the social tensions associated with inequality.

Achieving a Sustainable Balance

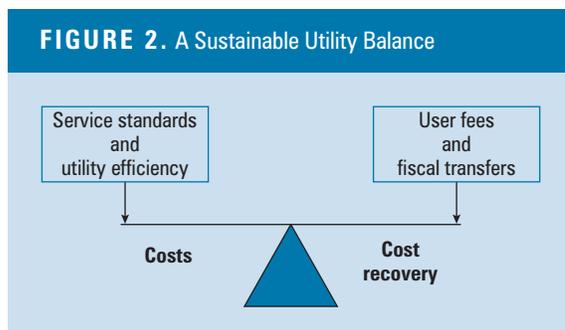
A water utility's performance depends on a number of factors that must be bundled together in a balanced manner to ensure sustainability and efficiency. The key components of the bundle are conceptually presented in Figure 2. The next few paragraphs discuss the components in general, followed by a summary of the situation in China.

Service standards. A water utility's service level depends partly on the applicable national standards, such as drinking water or municipal wastewater effluent. Municipal governments also have a large influence on service targets by specifying requirements

such as separate stormwater and wastewater collection systems; the level of water supply reliability; and water supply and wastewater coverage targets. The higher the service standards—all other things being equal—the higher the utility's costs. In most countries, there is a strong correlation between the level of economic development and the service levels that can be sustained. For example, Korea did not start its national wastewater management program until the mid-1980s when it had reached a GDP per capita of \$7,500.

Utility operational efficiency. The more efficient a utility, the lower the overall costs for a given service level. Efficiency is needed across all business areas, including capital planning decisions, staffing levels, quality of operations and maintenance, and commercial practices such as billing and collection. Until the 1980s, most water utilities in OECD countries were government monopolies that had little incentive to improve efficiency. Since then, however, the cost of providing water services has increased significantly due to requirements for environmental improvements, high-quality water supplies, and constraints on water resources. Many utilities have come under pressure to continuously reduce costs and provide better service. The response in many countries has been to make utilities more autonomous and commercial (corporatization), or to bring in private firms to provide some or all of the service.

User fees. Water users, and wastewater dischargers, are required to make at least partial payments for the services provided by a utility. Revenues from users depend not only on the tariff levels, but also on the ability to bill and collect what is due. The tariff structure is also important in providing the right economic signals and ensuring equity,



while at the same time generating sufficient revenue for the utility. This study estimates that, in OECD countries, at least half of the water utilities receive sufficient user revenues to cover all operation and maintenance costs and partial capital costs.

Fiscal transfers. Many water utilities throughout the world, and most wastewater utilities, rely to some measure on government transfers. These transfers can take various forms, such as grants or concessionary finance by national governments, municipal government equity contributions, operating budget, etc. In the United States, for example, the federal government has provided over \$75 billion (RMB 600 billion) in grant funds since 1972 to support wastewater treatment plant construction.

China's Water Utilities Have Not Yet Reached a Sustainable Balance

The fundamental finding of this study is that most of China's water utilities are confronting a combination of factors that have not allowed them to achieve a sustainable balance. Service standards, particularly national standards, are set at levels equal to or above OECD countries and may be beyond the capacity of many of China's cities to attain. Many utilities, particularly for wastewater, operate at low levels of efficiency under the supervision of municipal governments with a lack of accountability, transparency, and customer orientation. These factors drive up the cost of providing the service.

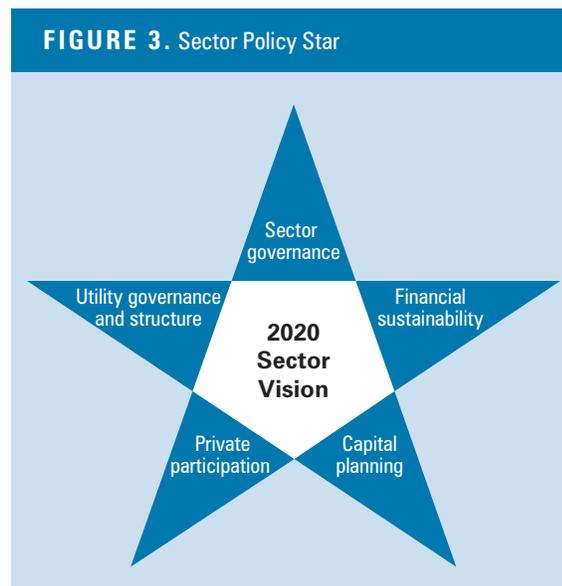
Many utilities are unable to cover their costs. This renders them incapable of achieving service targets, and constrains them from investing in the human resources or infrastructure necessary to meet those targets in the future. User fees, while gradually increasing, are still below the cost-recovery level, particularly for wastewater. Govern-

ment transfers, whether through capital or operating contributions, are typically not enough to cover the shortfall in user fees. Utilities cope by deferring asset renewal and expansion, not servicing their debts, or cutting back in maintenance and operations.

To solve these problems, confront future challenges, and achieve China's vision for the sector, the following sections layout a strategic framework centered on five inter-related themes presented as presented in Figure 3.

Adopting Goal-based Sector Governance

In the past, under China's planned economy, performance was measured in terms of achievement of physical targets, such as kilometers of pipeline or treatment plant capacity. The focus for the future should be on utility performance to achieve China's goals, including improving the environment, protecting public health, and providing good quality service to all at reasonable cost. This study recommends the following approaches



to move toward goal-based governance for the sector:

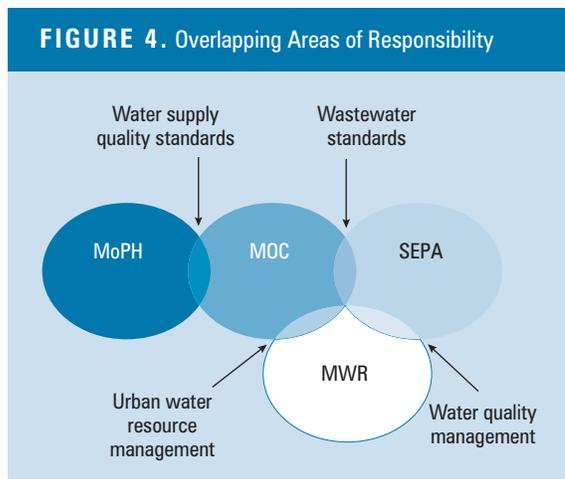
Improve National Policy Coordination

There are four main sector agencies at the national level that guide the urban water sector: the Ministry of Construction (MOC), State Environmental Protection Agency (SEPA), Ministry of Water Resources (MWR), and Ministry of Public Health (MOPH). The National Development and Reform Commission (NDRC) and Ministry of Finance (MOF) provide overall development policy and financial supervision to the sector. While the State Council issues key national policy statements (such as the historic 2000 Circular on “Strengthening Urban Water Supply, Water Saving, and Water Pollution Prevention and Control”), the various specialized sector agencies each issue a multitude of opinions, notices, circulars, etc. These are not always consistent, provide ambiguous guidance to cities, and may even be contested by other sector agencies. Figure 4 illustrates conceptually the overlapping areas of responsibility.

Prominent examples of areas of policy incoherence include the disconnect between SEPA guidance on the application of wastewater discharge standards and MOC con-

cerns on whether high levels of wastewater treatment are technically and financially viable for many cities. Many cities have established “Water Affair Authorities” that report to MWR and are mandated to provide integrated water management and supervise urban water utilities, yet MOC still issues most of the policy guidance related to urban water utilities. MOPH, in conjunction with China’s National Standardization Administration, issued new drinking water standards in 2007 that will require water supply utilities to take actions to upgrade their systems. In 2005, MOC also issued “sector recommended” water supply standards. Moreover, each sector agency produces a variety of sector reports, but often from a limited perspective. MOC may report on infrastructure construction progress, for example, while SEPA focuses primarily on pollution control. A national-level “status report” of where the sector stands in terms of providing adequate urban (and rural) water supplies would be great help for policy makers.

Differences of opinion and perspective among different sector agencies—and other stakeholder groups—are natural and necessary for good governance in the water sector. There must also be forums for open debate, mechanisms for policy research, and procedures for coordination and reconciliation of competing views. *This study recommends that the State Council establish a National Water and Sanitation Committee under a Deputy Prime Minister, with one ministry serving as the Secretariat.* The committee would not be a new agency, but rather be composed of representatives from the relevant national agencies, as well as other stakeholder groups. The committee could meet on a monthly or quarterly basis, with specialized ad hoc working groups. It could coordinate national policy formulation, inte-



grate decision-making among the different sector agencies, and monitor sector performance and development. In order to be focused and effective, the committee's mandate should be limited to water supply and sanitation, in both urban and rural areas.

Strengthen Provincial Government Oversight

Although urban water services are the responsibility of the municipal government, it is important to have an effective oversight and monitoring mechanism to ensure that cities and their utilities meet their obligations. China is too large for the national government to oversee thousands of utilities, and provincial governments are best placed to provide utility oversight and regulation. Provincial agencies already have many key mandates for utility oversight, including (a) utility supervision (construction departments); (b) approval of municipal tariffs (price department or DRC); (c) channeling national concessionary finance (DRC); (d) overseeing environmental compliance (EPB); (e) overseeing drinking water compliance (public health department); and (f) approval of large construction projects (DRC). The efforts of provincial agencies, however, are often hampered by lack of funds and real authority over municipal governments, as well as lack of coordination among provincial agencies.

This study recommends that provincial governments increase the budget and capacity of their provincial agencies and more vigorously exercise their oversight role for urban water services. Similar to the national government, provincial governments also need to improve policy coordination among the different sector agencies. This study also recommends that provincial governments establish “Provincial Water and Sanitation

Committees” or create new “Provincial Water Offices” that would consolidate urban water regulatory and oversight functions into one office.

Set Appropriate Water and Wastewater Standards

China should aim to have standards that are:

- *Affordable* to ensure the service is financially sustainable
- *Enforceable* to allow regulators to compel compliance
- *Efficient* to enable policy objectives to be met in a least-cost manner

The way China applies standards now does not fully meet these criteria, particularly for low-capacity cities. For example, SEPA's Circular No. 110 issued in 2005 requires all municipal wastewater treatment plants that discharge into key water resource protection areas and enclosed water bodies to meet Class 1A standards. This standard requires expensive tertiary treatment for the reduction of two nutrients, nitrogen and phosphorous. The standard also mandates extremely low levels for biological oxygen demand and suspended solids (10 mg/l). Although such high standards may be warranted on environmental grounds given China's highly degraded waters, it does not meet the requirements of affordability and efficiency. The standard effectively requires many cities to go from no wastewater treatment to technologically advanced and expensive plants. This will help reduce water pollution, but may not be economically efficient. Much of China's water pollution comes from runoff of fertilizer applied to agricultural land, large-scale livestock operations, and urban stormwater runoff. Pollution control measures for these sources are

just beginning in China, and putting more resources into these activities would yield greater marginal returns than tightening municipal treatment standards.

This study recommends that China use transitional wastewater standards for low-capacity cities and manage water quality from a watershed perspective. Cities and towns that cannot afford Class I or Class II standards could start by ensuring full collection of wastewater and low-cost, simple wastewater treatment. As their level of economic development improves, these cities could upgrade their treatment facilities and transition into compliance with national standards. Provincial governments could be in charge of determining which cities and towns should be subject to transitional standards. Provincial governments, and their specialized agencies, should also be responsible for developing economically efficient water quality improvement plans and ensuring that adequate administrative and financial mechanisms exist to implement high-priority pollution control activities.

China's updated drinking water standards, promulgated in 2007 (GB5749-2006), have features that this study recommends for wastewater management. The standard contains 42 items that are classified as "regular parameters" and apply to the whole country. The remaining 64 "non-regular parameters" will only apply to cities that meet certain criteria. The non-regular parameters include less common microbiological and toxicological compounds, particularly pesticides and synthetic organic compounds. As of 2007, the criteria for cities that must meet all requirements have not been specified, but presumably these will be larger and more affluent cities. By 2012 all cities must meet the standards for both regular (42) and non-regular (64) parameters. The standard is flexible in

that it distinguishes between higher and lower capacity cities, and provides discretion to the provincial government regarding how to apply the standard (42 regular or 106 regular and non-regular parameters). The standard also requires all cities to provide reasonable minimum water quality by complying with all regular parameters, which addresses the core issues. Finally, the standard uses a transitional approach, which allows cities to gradually upgrade their facilities by 2012.

The new drinking water standard has elements of flexibility, transition, and discretion that are a great step forward from previous approaches. However, *this study recommends a more realistic time frame for compliance with the new standard.* High-capacity cities could be required to meet the full standard (106 items) by 2012 at a minimum. Meanwhile, provincial governments should ensure that all cities comply with the regular parameters (42) as soon as possible. The timing for lower capacity cities to meet the full standard should be realistic and could be left to the discretion of provincial governments. *This study also recommends that provincial agencies undertake comprehensive and systematic evaluations of the safety of municipal drinking water systems and grade their performance.* The information should be made public, and municipalities should be encouraged to improve their water safety grade.

Improving Municipal Utility Governance and Structure

Municipal governments and their utilities operate within the framework provided by national and provincial policies. Different

models of structuring the urban water sector have emerged throughout China, some of which function better than others. In general, however, there is still huge potential for improving the efficiency of urban water utilities by modifying utility governance and structure. We have three recommendations:

Streamline and Coordinate Municipal Utility Governance

Municipal governments will need to improve their capacity to govern and regulate public utilities, while at the same time empowering the utilities to play the leading planning, financing, and operating role in the sector. In many cities, multiple city agencies make fundamental decisions and provide advice to the mayor and his vice mayors—on infrastructure targets, financing, tariffs, and budget transfers—without having a holistic view of the sector. Creating more integrated, accountable, and transparent city governance structures for the sector would help utilities achieve a more sustainable balance. It would also provide them with the institutional space to become modern organizations responsible for their own destiny, but under the leadership of the government. In some countries, cities have created “Water Boards” to help overcome coordination problems. These boards are typically appointed by the municipal government and empowered to make decisions (or recommendations) on key utility proposals, such as tariffs, budget transfers, capital programs, etc. *This study recommends that high-capacity cities experiment with streamlined utility governance structures, such as a Water Board or a multi-sector Public Utilities Commission. Lower capacity cities should make a concerted effort to coordinate the different government agencies overseeing water utilities.*

Empower Municipal Utilities and Hold Them Accountable

Although most water utilities are becoming more autonomous and commercialized, many still tend to function as implementing agents of government bureaus and respond to political directives. Moreover, water utilities, like many other state-owned-enterprises, have a culture of complacency and do not strive for excellence. *This study recommends that municipal governments empower utilities to take more responsibility for key corporate functions such as strategic master planning, capital improvement plans, developing financing strategies, formulating cost-recovery strategies, human resource development, monitoring and regulatory compliance, etc.* Some water utilities in China, particularly in larger and richer cities, are already close to becoming international standard water companies; the majority, however, are still underperforming. A culture of continuous utility improvement should be encouraged by national, provincial, and city governments. This can be realized through a commitment to transparency, customer orientation, monitoring and evaluating performance against other utilities and improvements over time, and the judicious use of the private sector. Professional organizations and research institutes have an important role to play in fostering a new culture of excellence.

Manage Wastewater as a Network Utility Business

Many cities in China have the view that drainage is a public good that should be financed and managed by a government department, whereas wastewater treatment is a commercial activity and should be paid for by user charges and managed by a company. This view is contrary to international practice. Approximately two-thirds of invest-

ment costs and about half of the operating costs of a typical wastewater system are related to the complex pipe networks and pumping stations scattered throughout the city. Collecting and conveying wastewater to the treatment plant is a prerequisite for successful wastewater management. Moreover, wastewater utilities have no control over industrial pollution discharges into the municipal system. The industrial dischargers can adversely affect the drainage network as well as interfere with the treatment process, potentially resulting in noncompliance with wastewater discharge standards and contaminated sludge (i.e. residual solids) from wastewater treatment plants.

The typical institutional arrangement for wastewater in China is fragmented. Fragmentation of the service usually takes two forms: (1) separation of drainage collection and treatment; and (2) in large cities, drainage collection is split between district and municipal drainage bureaus. This fragmentation often leaves the city without an entity with overall responsibility for the planning, financing, and operating of the wastewater system, including front-line responsibility for industrial dischargers. Moreover, these institutional arrangements hide the true overall cost of wastewater service, which can be significantly more expensive than water supply. Obscuring the costs inhibits cost recovery. In OECD countries, integrated wastewater utilities, often combined with the water company and considered part of the same service, are the norm. Integrated wastewater utilities should be the target in China as well.

This study recommends that municipal governments explore options for integrating wastewater service and recovering collection system costs from users. Some options for integrating the service include:

- One utility company owns and manages all drainage network and treatment plant assets.
- The treatment company enters into a lease contract for the drainage network.
- The treatment company enters into management contracts with the government drainage bureaus.
- A “Wastewater Group” is formed that puts all organizations under a single management team.

Pursue Opportunities for Aggregating Urban Water Services

Water utilities are typically organized along administrative boundaries. Aggregating services across administrative jurisdictions or functions can potentially generate benefits from economies of scale, more professional management, and improved access to finance. Many Chinese cities and towns, however, are trying to independently address their urban water problems, rather than cooperating with their neighbors. Potential approaches for aggregating service include: i) creating water and wastewater utilities with regional infrastructure in metropolitan areas; ii) creating multi-city water concessions where one utility serves a number of small cities or towns with separate infrastructure; and iii) combining water and wastewater utilities in the same city. *The Study recommends that provincial and municipal governments explore options for extending urban water infrastructure to suburban towns, as well creating regional water utilities which service multiple towns and cities.*

Moving Up the Financial Sustainability Ladder

Financial sustainability can be conceptualized as a ladder. As utilities take over more

financing responsibility and rely more on user fees rather than government transfers, they move up the ladder. Moving toward cost-recovery tariffs and greater reliance on capital markets for investment generates strong incentives for utility efficiency. It also enhances accountability to users who must pay for the service and to lenders who require repayment. Cost-recovery tariffs also allow the utility to operate in a more commercial manner and reduce its dependence on government transfers. The pace and extent to which utilities can move up the ladder depend in part on the city's level of economic development.

Ensure Utility Cost Recovery from User Fees

This means that a utility can generate sufficient revenues from user fees to cover its operating and maintenance costs and debt service. Revenue from user fees should also be adequate to fund a percentage of the utility's capital needs, preferably enough to at least systematically renew its existing asset base. A utility's debt service costs can be reduced by government equity contributions, grants, and concessionary finance. *This study recommends that all cities have user fees that cover the utility's costs and adopt financing strategies along the following lines:*

- *High-capacity cities.* Water supply and integrated wastewater utilities (i.e. drainage and treatment utilities) should finance all capital investments through capital markets, private investment, and internally generated cash with full cost recovery tariffs. The one exception is that municipal governments may wish to continue financing drainage investments to control the
- growth in tariffs. Under this scenario, the combined (water supply and wastewater) weighted average tariff would need to more than double by 2010 from the 2005 national average of around 2.5 RMB/m³ (\$0.30) to over 6 RMB/m³ (\$0.75).
- *Low-capacity cities.* Water supply utilities, and especially integrated wastewater utilities, will continue to need equity contributions, grants, and concessionary finance to keep tariffs at socially acceptable levels. Moreover, low-capacity cities should be subject to less stringent transitional water and wastewater quality standards to reduce costs. Under this scenario the combined (water supply and wastewater) weighted average tariff would need to at least double by 2010—from a 2005 national average of around 2.0 RMB/m³ to around 4.0 RMB/m³.

Raising tariffs is one method of increasing revenues. Of equal importance is improving fee collection and utilizing efficient rate structures. Although Chinese cities are rapidly installing water meters at the household level, smaller cities are lagging in this respect. Collection of wastewater fees is a common problem. In China, wastewater tariffs are included on the water bill and collected by the water supply company. In some cases, the water company does not diligently collect the wastewater tariffs nor pass the funds on to the wastewater utility. Collecting wastewater tariffs from large industries with their own water source is also difficult. Municipal governments should work to ensure these shortcomings are resolved and the wastewater company receives its entitled revenue.

Designing appropriate tariff structures is an important element in helping utilities

increase revenues, protect the poor, and send the correct economic signals. The pace at which tariffs can be increased is inhibited by the potential impact on the lower income segment of the population. There is considerable international experience with designing low-income support programs that could be applied in Chinese cities to allow an acceleration of tariff increases while protecting the poor. Tariff structures, which are predominantly volumetric-based, could also be adjusted to send better economic signals, improve the reliability of utility revenues, and potentially increase overall utility revenues. These measures include increasing block tariffs, fixed and variable tariff components, and load-based wastewater tariffs.

Make More Use of Debt Financing

China's strong economy has created a high level of liquidity in the domestic banking system, and Chinese banks are encouraged to lend to creditworthy municipal utility companies. This has created a golden opportunity for water utilities to tap into domestic credit markets to finance investments. Utility companies in many economically advanced countries take on high levels of debt, often over 50 percent of total assets, because they operate in a low-risk environment. Chinese utilities, in contrast, typically have much lower debt-to-asset ratios, and rely more heavily on municipal governments for finance. Because aggregate information on water utility capital financing is lacking in China, this study produced its own general estimate of financing sources in Table 3.

Because municipal governments in China can not borrow directly and there are many competing uses for governments funds, financing capital works through utility debt is generally more attractive than government contributions. Moreover, to the extent that

TABLE 3. Indicative Ranges of Urban Water Sector Financing Sources: 1991–2005

Financing Source	Water Supply (%)	Waste-water (%)
Municipal Government	20–30	40–50
Domestic Banks	20–30	10–20
State Bond Program	10–20	20–30
Private Sector	10–20	10–20
China Development Bank	10	5
International Financial Institutions (WB, ADB, JBIC)	5	10

utility debt service is paid by user fees, debt financing is more economically efficient as the users pay directly for the service, whereas municipal government funds come through general taxation.

Many Chinese banks, however, are hesitant to lend directly to utility companies because of concerns about repayment capacity. *This study therefore recommends that Chinese cities should transform their financially stressed utilities into creditworthy enterprises that can fund an appropriate share of their capital program through commercial debt.* As China's financial markets evolve and become market-oriented and sophisticated, improving the credit status of municipal utilities will become even more important. The national government can also facilitate better access to debt financing by allowing longer maturity bank loans and providing greater latitude to water utilities to issue enterprise bonds.

Create Incentive-Based Concessionary Finance Programs

China's national government provides significant levels of finance to the urban water sector. The two main instruments are the China

Development Bank (CDB), which offers long-term loans, and the NDRC-administered state bond program, which offers long-term, low interest loans and grants. These two sources account for around 25 percent of all sector financing. These financing mechanisms, however, could be further refined through structured programs similar to other countries that promote policy objectives by adopting clear priorities, eligibility criteria, appraisal standards, legal covenants, project monitoring, reporting, and program evaluation. Creating incentive-based grants and loans can be a strong driver for reform. Concessionary finance is also an important tool for ensuring equity, particularly for smaller cities and towns with more limited financing alternatives. Currently, most of the CDB and state bond funds go to larger prefecture level cities.

This study recommends that the national government restructure existing concessionary finance programs (or develop new ones) for the urban water sector. There are many different options that need to be studied and pursued, but the following principles should guide the reforms:

- National government funding for the urban water sector should be significantly increased.
- More funding should be channeled to low-capacity cities and towns.
- Provincial governments should take the lead in designing and administering concessionary finance program(s).
- The program(s) should be structured to provide the right incentives, with carefully designed eligibility criteria, appraisal procedures, and monitoring and evaluation activities.
- A range of financing instruments should be considered, including loans,

grants, revolving loan programs, credit enhancements, output-based aid, etc.

Use the Private Sector to Help Improve Municipal Utilities

Cities throughout China have turned to the private sector to finance, construct and operate water supply and wastewater treatment plants. There are over 50 water supply projects, and well over 100 wastewater projects in China with private sector participation. (the exact number is not known). Some municipal water supply companies are also forming joint ventures with private companies. This flurry of private participation brings new stakeholders, capital, and expertise into the sector, but it also needs to be managed properly to ensure sustainable arrangements.

This study has two general recommendations on private participation. First, municipal governments and their utilities should engage with the private companies as part of an overall reform process to ensure a sustainable utility balance. Most importantly, if user fees and fiscal transfers are inadequate, then regardless of whether ownership and/or operation is public or private, the service will not be sustainable. BOT arrangements need to be handled with special care to ensure that overall sector funding is adequate to meet the obligations of the BOT contract *and* the requirements of the water supply and drainage networks.

Second, the general approach in China is that private companies must “pay to play,” meaning they must invest their own funds if they are to participate in the sector. There are, however, many non-investment models that could beneficially be employed in China, including management, affermage, lease, and design-build-operate arrangements. These non-

investment private arrangements are particularly attractive for cities that (a) do not have financing constraints, but want to improve the performance of their utility; or (b) cities where the investment risks are large, particularly in low-capacity cities.

Improve Utility Capital Planning to Lower Costs

The urban water business is capital intensive, so good decisions on infrastructure investment can lower costs and improve service. Many cities and utilities in China have deficiencies in planning, often rooted in inappropriate policies, institutions, and incentives. Another contributing factor is that utilities are still building up their expertise and learning from international and domestic experiences. This study identifies two important areas for capital planning.

Water supply planning. Water supply planning needs to become more sophisticated and participatory to meet complex challenges. New and innovative options are being pursued to address water shortages, such as developing new water sources, long-distance water transfers, reallocation from agricultural to municipal use, water reuse, demand management through tariffs, reducing water leakage, encouraging water conservation, etc. While these actions have a potential role to play in meeting urban water needs, most cities still do not employ sophisticated water planning methodologies that explicitly consider multiple objectives, uncertainty, and risk in order to determine the optimal resource mix for meeting their urban water demand. In particular, economic, financial, and environmental objectives are often not fully factored into water supply planning exercises, which tend

to be driven by physical planning approaches or are policy-driven.

Investments in water supply and drainage networks. Investments in water supply and drainage networks need to be better planned. Upgrading and expanding water supply and wastewater pipes and pumping stations will constitute around 70 percent of future investments. The proper planning of these investments holds huge potential for savings. Developing asset management programs (AMP)—which collect information on existing assets (particularly buried pipes), use sophisticated methodologies for analyzing the data, and link investments to overall service goals—are becoming standard practice for utilities around the world. This approach should be used in China too. Utilities should also carefully consider the costs and benefits of two different types of drainage systems: (1) combined systems, which convey both wastewater and stormwater; and (2) separate drainage systems. Separate drainage systems, which are increasingly popular in China, can cost up to double combined systems, and the environmental benefits may not in some cases be justified. Low-capacity cities should avoid separate collection systems.

A Strategic Action Plan

Table 4 provides a summary of the key strategic recommendations. Designing policies and programs to implement these strategies requires sustained attention and commitment by all levels of government, utilities, professional organizations, advocacy groups, businesses, and citizens. To this end, the World Bank stands ready to assist China with financing, project and program design, studies, and policy dialogue.

TABLE 4. Strategic Action Plan		
Strategic Recommendation	Responsible Parties	Time
Adopting Goal-Based Sector Governance		
Improve National Policy Coordination: • National Water and Sanitation Committee	State Council and National Agencies	2008–10
Strengthen Provincial Oversight: • Increase Agency Funding and Capacity • Provincial Water Committee or Office	Provincial Government and Agencies	2008–12
Set Appropriate Water and Wastewater Standards • Low Capacity Cities Use Transitional Standards	National and Provincial Agencies	2008–12
Improving Municipal Governance and Sector Structure		
Streamline Municipal Utility Governance: • Water Boards or Multi-Sector Commissions	Municipal Governments and Agencies	2008–12
Empower Municipal Utilities • Utilities Take Over Core Corporate Functions • Increase Accountability and Transparency		
Manage Wastewater as a Network Utility Business • Integrated Drainage and Treatment Management • Charge Users for Drainage Service		
Exploit Opportunities for Aggregation of Services • Metropolitan Utilities with Regional Infrastructure • Utilities Serving Multiple Cities		
Moving Up the Financial Sustainability Ladder		
Ensure Utility Cost Recovery from User Fees • Tariffs Cover O&M, Debt, and Asset Renewal • Governments Partially Finance Drainage Works • Concessionary Finance for Low-Capacity Cities	Municipal Governments and Utilities	2008–10
Make More Use of Debt Financing • Enhance Utility Credit Status through Cost Recovery		
Improve Concessionary Finance Programs • Increase National Government Funding • Develop Incentive-Based Programs • Target Low-Capacity Cities	State Council, NDRC, and National Agencies	2008–10

(Continued)

TABLE 4. Strategic Action Plan (Continued)		
Strategic Recommendation	Responsible Parties	Time
Private Participation to Improve Municipal Utilities		
Private Participation to Improve Municipal Utilities <ul style="list-style-type: none"> • Private Participation As Part of Sector Reform • Utilize More Non-Investment Arrangements 	Municipal Governments and their Water Utilities	2008–on
Improve Capital Planning to Reduce Costs		
Improve Capital Planning <ul style="list-style-type: none"> • Improve Water Supply Planning • Develop Asset Management Planning (AMP) • Strategic Selection of Drainage System 	Water Utilities	2008–on



Introduction

Objectives and Scope

How can China sustain and improve urban water services as it makes the transition to a market economy, undergoes rapid urbanization, and confronts extreme water resource degradation? This study provides a panoramic view of the sector, identifies key challenges and strategic approaches for the future, and aims to assist Chinese policy makers in formulating a reform agenda for the next decade. It also seeks to establish a framework for World Bank policy discussions with China's government, thereby enhancing the effectiveness of Bank support.

China is experiencing the greatest wave of urbanization in history. The urban population has increased from 300 million in 1990 to around 550 million in 2005, and is expected to grow to as much as 900 million by 2020.¹ In addition to limited water supplies across much of the country, China also has some of the most polluted rivers in the world and its coastal waters are on the brink of ecological collapse. Urbanization and its intersection with water resources and water quality—one of China's great development challenges—is the subject of this report.

A decade ago, the World Bank's *China Urban Environmental Service Management* report provided an overview of the challenges. This 1995 report highlighted the poor state of water supply infrastructure and the

almost complete absence of municipal wastewater treatment. Water prices were unsustainably low and public utilities inefficient. Since then, the situation has improved significantly. Large investments have been made in upgrading water supply and wastewater infrastructure, and water and wastewater tariffs have increased. Domestic and international private companies are now actively involved in the sector. There are still, however, many large and complex financial, institutional, and technical challenges ahead.

Given China's size and diversity, the study identifies strategic directions to pursue rather than specific solutions. It provides illustrative examples from Chinese and international experiences. Clearly, Chinese municipalities, provinces, and the national government will need to develop their own tailor-made solutions.

The scope of the study is limited to urban water services. As used here, urban areas mean China's 661 designated cities, all of which have populations greater than 200,000 people. This analysis can also be extended to large towns and towns surrounding large cities. Urban water services mean the provision of water supply, stormwater drainage, and wastewater management. Since stormwater and wastewater are closely linked through combined drainage

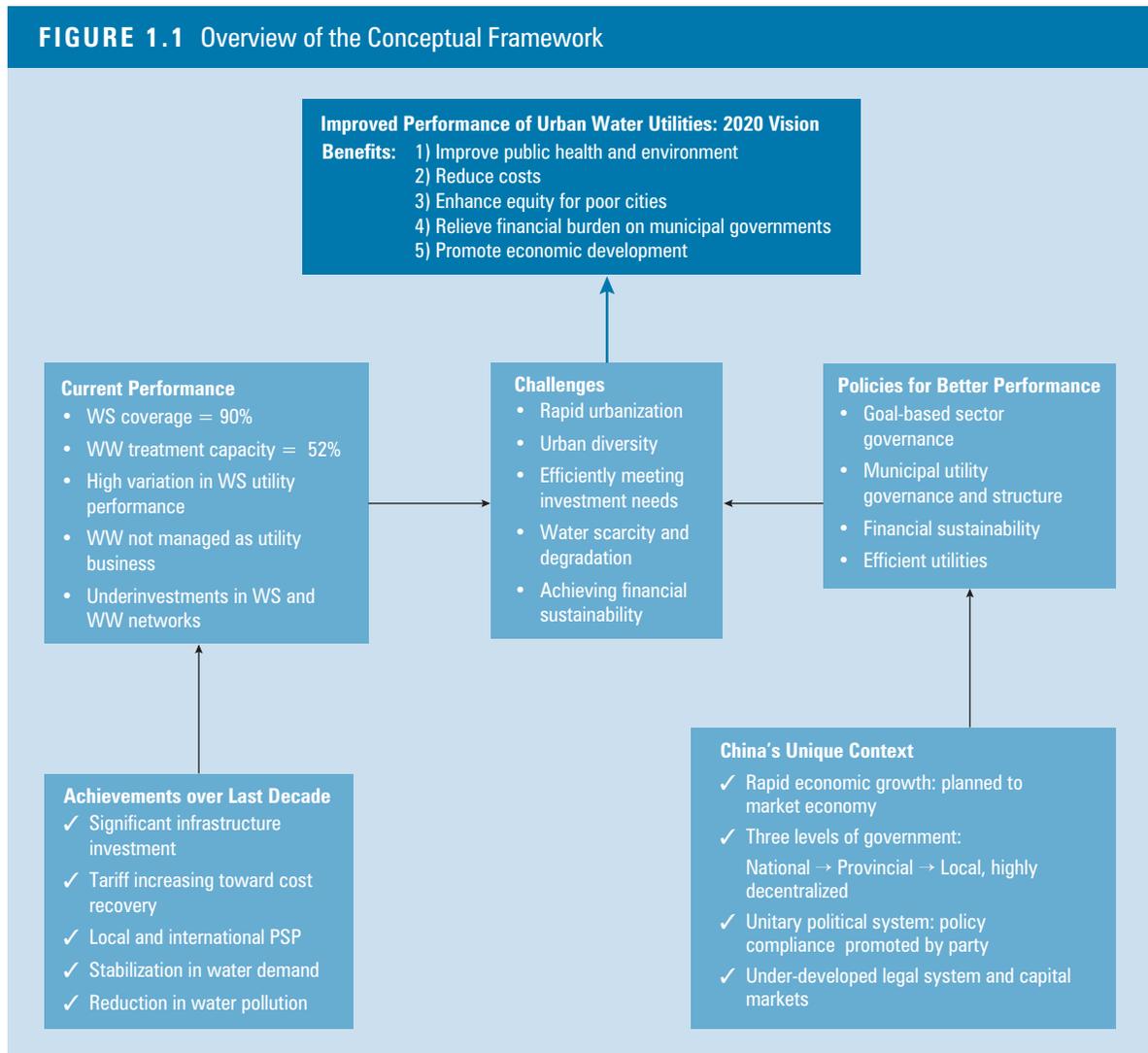
systems in most Chinese cities, the term “wastewater” refers to both services unless otherwise noted. The study focuses primarily on the issues of utility performance, not water resources and the environment. The World Bank is working with China in other endeavors to help address critical water resource and environmental issues.

Conceptual Framework

Figure 1.1 provides an overview of the conceptual framework.

The key elements in the conceptual framework are the following:

Current Performance. We first examine the current performance of urban utilities. Chinese urban utilities currently perform, on average, in a manner consistent with other middle-income countries such as Brazil or Russia. Water supply coverage is generally good, although the quality and reliability of the service is highly variable among cities. Most cities have well-developed sanitary drainage systems. The overall wastewater



treatment rate, while still low, is rapidly expanding. However, most urban wastewater management systems are not operated as utility businesses. Many such systems perform poorly, both financially and operationally. The combination of tariffs and government subsidies is generally adequate to sustain operations, but there is systemic underinvestment in water distribution and wastewater collection networks.

Achievements. The achievements in China's urban water sector over the last decade have been remarkable. China's urban water industry—in parallel with the country's overall rapid development—has been transformed through investments equal to around 0.4 percent of annual GDP.² Water services are no longer perceived as being primarily a public good to be provided by the government, but rather as a quasi-private good provided in a commercial manner with users bearing most of the costs. Domestic and international companies are keenly interested in China's urban water market and private investment is flowing into the sector. Finally, China has made significant progress in stabilizing overall water demand as industry has become more efficient, and consumers are reacting to higher prices and water conservation efforts. Significant strides have been made in controlling overall municipal and industrial pollution. Receiving water quality, while still bad, does not appear to have deteriorated over the last ten years.

Challenges. In spite of China's achievements, the challenges are daunting:

- **Urbanization.** The country's urban population is expected to increase from around 550 million in 2005 to at least 900 million in 2020, fueling the demand for more infrastructure investments.
- **Urban Diversity.** China is a large and diverse country, with a wide spectrum of wealth among its cities. Cities such as Shanghai strive to become economically dynamic global centers of excellence, while smaller and poorer cities, mainly in the west and northeast of the country, confront economic stagnation, unemployment, and deteriorating infrastructure. Crafting realistic sector policies to meet the wide variety of urban situations in China is a complex but necessary endeavor.
- **Water Scarcity and Degradation.** Much of China is arid, and water pollution is a problem throughout China. Securing reliable high-quality water supplies, and improving water quality in rivers, lakes, and coastal waters, will require a sustained national effort.
- **Investment Needs.** Overall investment needs are large and growing, due to increases in urban populations and national aspirations to address water pollution and scarcity issues by adopting higher service standards.
- **Utility Financial Sustainability.** The large investment needs, combined with higher operating costs, will put pressure on cities and their utilities to become more efficient and financially sustainable.

China's Specific Context. Meeting future challenges will require policy approaches that fit the country's political and economic context. Four broad factors dominate China's development and influence the overall evolution of the urban water sector. First, China is transitioning from a planned economy to a

market economy. This transition has fueled an unprecedented spurt in economic growth, with annual GDP growth averaging close to 10 percent per year over the last decade.³ The transition has also left a legacy of government institutions and policies that originated during the planned economy era struggling to define their role in a more market-based economy. Second, China has a unified political system headed by the Communist Party that has evolved in a specific historical context. Government policy is made and implemented through a combination of legal mechanisms and party influence. Third, China has a complex multi-tiered government administrative system that is highly decentralized. Local governments play a dominant role in infrastructure service provision and financing, while national and provincial governments focus primarily on policy and regulatory matters. Finally, given the size and sophistication of China's economy, it has a relatively underdeveloped legal system and capital market structure, though they appear to be evolving quickly.

2020 Sector Vision. A vision of what the sector could look like in 2020, if appropriate policies and programs are pursued, is presented in this study and includes:

- Large and rich cities provide high-quality water and wastewater services, and establish stormwater quality management programs. Utilities operate at international standards and rely on capital markets and user fees, but wastewater utilities still receive some municipal government capital contributions.
- Smaller and poorer cities provide reliable water supply and treat all waste-

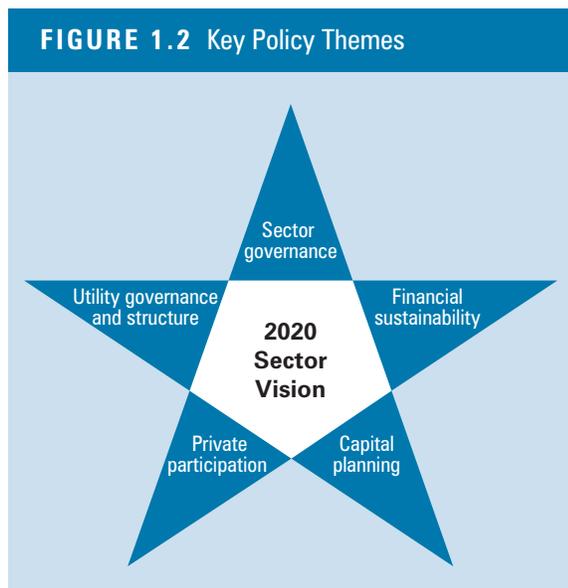
water to an intermediate level. Utilities are financially sustainable and rely on user fees for their revenues, but also receive municipal equity contributions and national concessionary finance to maintain acceptable tariff levels.

The benefits of adopting the strategic recommendations and achieving the sector vision are significant and warrant attention from national, provincial, and municipal governments. Improved utility performance, in terms of increasing the amount of wastewater collected and treated, and improved water supply quality and reliability would result in environmental and public health benefits. Improved efficiency would lower costs for a given level of service and help relieve the financial strain on cities and their citizens. The study recommends specific policies for addressing the disparities among cities in China, such as concessionary finance programs and appropriate service standards. Finally, improving investment and operational efficiency in a sector that accounts for around 1.0 percent of China's annual GDP will help promote overall economic development.⁴

Key Policy Themes and Strategic Directions

The key elements of the urban water sector, as presented in Figure 1.2, are interrelated and must be in balance for urban water utilities to perform efficiently. Definitions of key terms are presented in the glossary.

Goal-Based Sector Governance. In the past, under China's planned economy, performance was measured in terms of achievement of physical targets, such as kilometers of pipeline or wastewater treatment plant



capacity. The focus of the future should be on efficient urban water utility performance as a means to achieving the nation's goals, including improving the environment, protecting public health, and providing good quality service to all at reasonable prices. New targets—such as improvements in ambient water quality, safe drinking water and reliable service, and cost-efficient service delivery—should take the place of physical targets. This requires developing consistent policies, setting appropriate wastewater discharge and water supply quality standards, and ensuring effective regulatory systems at the national and provincial levels. Because standards in China may be unattainable for many cities and regulatory systems are weak, municipal governments and their utilities do not have strong incentives to provide high quality and efficient services.

Municipal Utility Governance and Structure. Provision of urban water services is the responsibility of local governments in China. The policies and practices of the

municipal government set many of the parameters in which the utility operates, including tariff and subsidy policy, appointing utility management, determining the extent of utility transparency and accountability, and defining the scale, scope, and authority of urban water utilities. Many urban water utilities are not able to perform efficiently because municipal governments do not provide a suitable framework of policies, practices, and organizations.

Financial Sustainability. Two financial parameters dominate in the urban water industry: cost recovery levels and access to financing. A significant problem confronting many urban water utilities is the lack of balance between standards, such as drinking water supply and wastewater treatment standards, and the utility's ability to recover its costs. High standards result in expensive investments that utilities are not able to finance or sustain due to low levels of cost recovery. Although there is scope for increasing user fees, there are limits to the rate of increase that would be socially acceptable. The study suggests that a utility's costs—and thus required cost recovery levels—can be managed through a combination of appropriate standards, improved utility efficiency, municipal government equity contributions, and more effective national concessionary programs. Even with lower utility costs for a given level of service, there is a clear need to increase revenues in most Chinese cities, particularly for wastewater services. Provided there are adequate cost recovery levels, Chinese utilities also should be able to take greater advantage of China's large and liquid capital markets.

Private Participation. The potential for water utilities to perform well is deter-

mined largely by three factors: (a) sector governance; (b) municipal utility governance and structure; and (c) level of financial sustainability. These factors provide the incentives that ultimately determine water utility performance. Rather than address these fundamental issues, many municipal governments—encouraged by national policy—turn to the private sector to help provide better service. The study suggests that municipalities should first understand the root causes of municipal utility underperformance and then select, design, and implement the appropriate private sector arrangement as part of an overall reform program.

Capital Planning. More than any other utility business, capital investment decisions

have a profound effect on overall water and wastewater costs. There is considerable potential for lowering costs through improved capital planning, particularly for water supply planning, water distribution and wastewater collection network renovation, selection of combined versus separate drainage collection systems, and industrial wastewater treatment plant sludge management.

For each of the five general policy themes, the study develops strategic directions (see Figure 1.3) for consideration by national, provincial, and municipal governments, as well as utility managers. These recommendations need to be further developed and refined before their actual application, but they provide a set of interconnected policy enhancements to help improve the performance of urban water utilities.

FIGURE 1.3 Strategic Directions for Key Policy Themes

Policy Themes	Strategic Directions
Goal Based Sector Governance	<ul style="list-style-type: none"> • Improve National Policy Coordination • Shift from Physical Targets to Policy Goals • Set Appropriate Water Supply and Wastewater Standards • Enhance Provincial Government Oversight
Municipal Utility Governance and Structure	<ul style="list-style-type: none"> • Streamline Municipal Utility Governance • Foster Efficient Utilities • Manage Wastewater as a Network Utility Business • Exploit Opportunities for Service Aggregation
Financial Sustainability	<ul style="list-style-type: none"> • Achieve Utility Cost Recovery • Make More Use of Debt Financing • Improve National Concessionary Finance Programs
Private Participation	<ul style="list-style-type: none"> • Ensure Private Arrangement Fits Into Sector Reform Plan • BOT Treatment Plants Fit Into Utility Network Business • Make More Use of Non-Investment Arrangements
Capital Planning	<ul style="list-style-type: none"> • Utilize Integrated Water Planning Methodologies • Develop Asset Management Planning (AMP) • Strategically Plan and Manage Drainage Systems • Manage Sludge as Environmental and Financial Priority

Urban Water Market Segments

To facilitate policy analysis and international comparisons, we developed definitions of different urban water market segments in China. China's national policies in the urban water sector tend to be general in nature. They are often directed at the highest capacity cities, which then serve as models for other cities. China's statistics generally organize data by city population size and geographical region, which is a useful first step, but do not explicitly consider the level of economic development.

Three Categories Used for Empirical Analysis. Chinese cities vary widely in terms of population, wealth, and climatic conditions. We examined the variables that influence a city's capability to provide good water and wastewater service. We assumed that the percentage of installed wastewater treatment capacity (i.e., capacity of treatment plant (m³/day) as a percentage of municipal wastewater) in 2005 is a good proxy for the city's technical and financial capacity. The percentage of wastewater treatment was used as a dependent variable, and correlated with the following independent variables: population, GDP per capita, and climate. The statistical analysis revealed good correlation between the level of economic development (GDP per capita) and the percentage of wastewater treatment, and also between population and wastewater treatment percentage. The weak correlation between city size and per-capita GDP indicates that there are many relatively affluent smaller cities. Hence, both city size and level of economic development need to be taken into account when considering capacity to deliver water services. The correlation between climate and wastewater treatment

percentage is relatively weak; cities in the water-rich south of China are as likely as cities in the water-poor north to have wastewater treatment. Based on this analysis, we developed the following typology to help structure the discussion about different water market segments.

- *Category I: Large and Developed Cities:* (a) population greater than 2 million; and (b) GDP per capita greater than \$3,000.
- *Category II: Medium Cities:* All cities that are not Category I or Category III cities—these generally (although not exclusively) fall between the income and size boundaries of Category I and III cities.
- *Category III: Small and Developing Cities:* (a) population less than 0.5 million; and (b) GDP per capita less than \$1,500.

These categories are different than those used by the Ministry of Construction (MOC). The MOC only considers a city's population, and not its level of economic development. In 2005, China had 661 officially designated cities. In addition, there were 1,636 county-level towns—with 96 million urban residents—that serve as the seat of county governments.⁵ The Ministry of Construction (MOC) has collected summary data on water supply and wastewater services for these “county towns;” most of them share similar characteristics with Category III cities. All are under 500,000 in population and generally have GDP per capita less than \$1,500. Unless otherwise noted, data on Category III cities does not include the county towns (disaggregated information was not available). For policy-related issues, however, county towns and Category III cities can be considered as a group.

TABLE 1.1 Urban Water Market Segments

Market Segments	Number of Cities	Total Population (million)	Per Capita GDP (RMB)	Average Wastewater Treatment Coverage (%)	Average Water Supply Coverage (%)
Category I: Large and Developed Cities	21	90	35,900	61	93
Category II: Medium Cities	331	201	19,100	38	91
Category III: Small and Developing Cities	310	58	7,300	21	86
County Towns	1,636	96	NA	11	82

Source: MOC, China Urban Construction Statistics Yearbook (2005).

Table 1.1 presents the China urban water market segments used in the study, and summarizes population and urban water service coverage for each segment.

High- and Low-Capacity Cities. The classification of cities into three categories is useful for empirical analysis, but unwieldy for general policy discussions. Moreover, there are some Category II and III cities with per-capita GDP above \$3,000 that bear more resemblance to Category I cities. Likewise, there are some Category I and II cities with per capita GDPs below \$1,500. Rather than create multiple city categories, we used the following classification when discussing policy recommendations:

- **High-Capacity Cities.** This includes all cities with a per-capita GDP greater than \$3,000 regardless of population, as well as cities with a population greater than 500,000 and per capita GDP of at least \$1,500. As of 2005, there were approximately 150 such cities with a

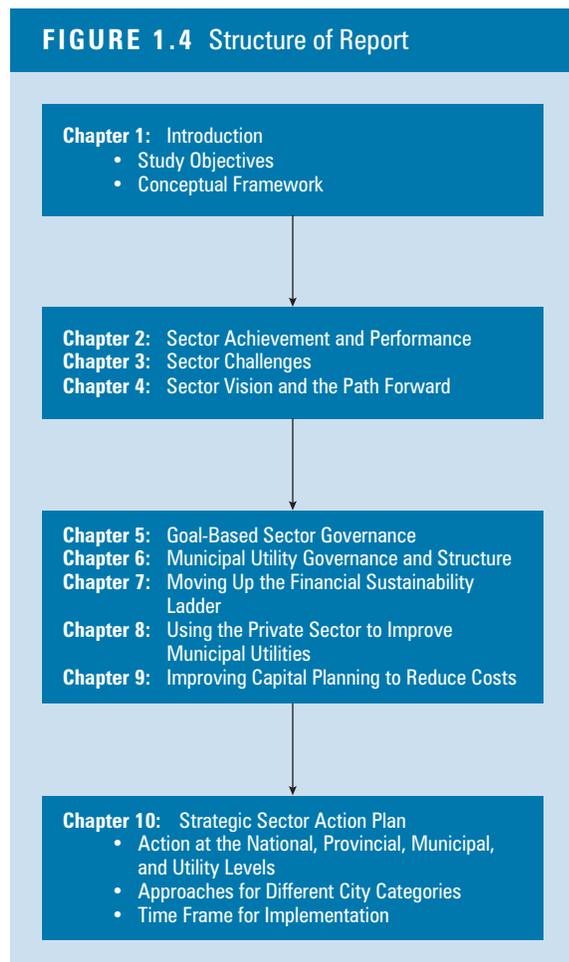
total population of 200 million—about one-third of the urban population.

- **Low-Capacity Cities.** This incorporates all other cities and towns in China—including around 500 designated cities and the 1,636 county capital towns—with a total population of around 400 million.

The concept of “high-” and “low-” capacity cities, and the criteria used to classify them, is intended to facilitate the policy discussion. The intention is to underscore that some cities—“high-capacity” cities—can aspire to OECD standards of urban water services. In contrast, “low-capacity” cities face many of the constraints typical of lower-middle income countries around the world. The study explores the policies and approaches for these two different types of city.

Report Organization

The study organization is illustrated in Figure 1.4. Chapter 2 provides an analysis of

FIGURE 1.4 Structure of Report

the achievements and current performance of China's urban water utilities. Chapter 3 discusses the challenges ahead, while Chapter 4 describes a vision of what the sector could look like in 2020 and the benefits of achieving the vision.

Chapters 5–9 are the key policy chapters and are organized around the four key policy themes. Each chapter generates a set of strategic directions that China should pursue for enhancing the performance of its urban water utilities. Chapters 5–8 deal primarily with policy-related issues. Chapter 9 discusses some technical issues related to capital planning. Chapter 10 summarizes the recommended strategic directions.

Data Sources

Information on sector financial and operational performance in China is difficult to obtain or nonexistent. The decentralized nature of municipal infrastructure service, and the nontransparent sector management combined with relatively weak regulatory systems, has resulted in a shortage of reliable data. We relied on a myriad of different—and often incomplete—sources of data. Although the general picture that emerges is clear, the resolution of some of the specific features is not. Key sources of information include: (a) annual statistical yearbooks and reports by the MOC and State Environmental Protection Agency (SEPA); (b) China Water Works Association yearbooks; (c) the 2005 North China Water Study jointly sponsored by the World Bank and the MoC; and (d) studies produced by the Asian Development Bank on China's urban water sector.

The research benefited from extensive consultations with Chinese stakeholders, which partly compensated for the patchy data. Five consultations were held in China, including: (a) an initial consultation to define the scope of the study in Beijing (October 2005); (b) mid-term workshops to provide feedback on the preliminary recommendations in Beijing, Tianjin, and Ningbo (March 2006); and (c) final consultation in Beijing (September 2006). During the consultations, the Chinese stakeholders were allowed to quantitatively and qualitatively evaluate the relevance of the strategic issues and the appropriateness of the approaches.

The study also utilizes the World Bank's extensive project experience over the past two decades. As shown in Annex 1, the World Bank has played an active role in the sector and accumulated extensive experience in a variety of settings. In total, the Bank has financed over

25 projects with urban water components in China since 1987. We also used general (i.e. non-China) World Bank reports on water supply and sanitation to identify key concepts and useful international experience.

Notes

1. The estimated urban population of 550 million includes 340 million people living in 661 designated cities, about 110 million living in 1,464 county towns, and another 100 million in 18,428 towns. The figure does not include floating population in urban areas. The floating population means non-registered urban residents; estimates typically range from 50–100 million people. The 2020 estimate is based on an annual growth rate of 1.25 percent and a target of around 55 percent urbanization rate.
2. Sector investment figures were derived from the *China Urban Construction Statistics Yearbook (2005)* and GDP figures from the *World Development Indicators (2006)*.
3. *World Bank Development Indicators (2006)*, online version.
4. Based on note 2 above, the sector investments accounted for around 0.4 percent of GDP in 2004. Revenues from water and wastewater tariffs are estimated to account for around 0.5 percent. For estimating sector revenues, an average water supply tariff of RMB1.4 and wastewater tariff of RMB 0.5 were used. The water supply amounts are taken from the *China Urban Construction Statistics Yearbook (2005)*, and the wastewater water amounts were estimated at 45 percent of water supply. Information on government transfers for operating expenses (as opposed to tariffs) is not available, but should account for at least 20% of revenue from tariffs (0.1 percent of GDP), thus the total minimum percent of GDP is 0.4 percent (investments) + 0.5 percent (tariff revenue) + 0.1 percent (government transfer) = 1.0 percent.
5. MOC, *County Towns Statistical Brief (2004)*.



Sector Achievement and Performance

Chinese cities have made remarkable progress in building infrastructure and expanding water supply and wastewater services. But many of China's water and wastewater utilities can significantly improve their performance with respect to operational efficiency, financial sustainability, and cost-effective investments.

As shown in Box 2.1, on average, the performance of Chinese utilities is comparable to other middle-income countries such as Brazil or Russia, but still far below OECD countries such as the United Kingdom. Moreover, there is a wide variation in performance among utilities, both between and within the urban water market segments—indicating that the potential exists for rapidly increasing performance within the existing institutional and policy context. As China's economy grows and becomes more sophisticated, China should also ensure that its utilities' performance improves over time.

Briefly, China's urban water situation has the following characteristics:

- Urban water supply coverage has increased from 50 percent in 1990 to 90 percent by 2005, and overall municipal water use has remained stable. Many Chinese cities still suffer from seasonal water shortages.
- Chinese cities have well-established water utility companies, but many utilities have excess treatment capacity, need to renovate their distribution networks, and are struggling financially.
- Urban wastewater treatment capacity has increased to 52 percent by 2005, but overall municipal pollutant loadings have only decreased slightly since 2000 due to rapid urbanization.
- In 2005, 60 percent of China's cities had wastewater utility companies. Most companies are relatively new. They are responsible for wastewater treatment, while government bureaus provide drainage services. In many cities, treatment plants are underutilized, drainage networks need to be expanded and renovated, and wastewater services are underfunded.
- Lack of information and transparency on sector and utility performance complicates the identification of problems and reduces accountability, particularly for wastewater.

Sector Achievements

As described below, the sector has been characterized by large increases in urban water infrastructure, increased water supply

BOX 2.1 International Performance Comparisons

The table below shows how China's urban water utilities compare with other middle-income countries such as Brazil and Russia, as well as the United Kingdom. Chinese cities have some characteristics that impact utility performance. First, China has much more compact systems with an average of 1,100 people per kilometer of distribution network, which is almost triple the rate of Russia and Brazil. This helps explain why non-revenue water percentage is low, even though leakage per kilometer is high. Second, the percentage of domestic customers in China is much lower than in the other countries, indicating that Chinese utilities have a large industrial customer base. Similar to utilities in Brazil and Russia, many Chinese water supply utilities cover their operating costs, but only barely.

Comparisons between China and other countries (2004)				
Key Indicators	China	Brazil	Russia	UK
Water coverage in urban areas (%)	86	81	99	100
Wastewater coverage in urban areas (%)	43	38	90	100
Population per km of distribution network	1100	357	400	>200
Water metering (% of connected population metered)	90	88	<30	<50
Domestic water tariff (\$/m3)	\$0.15–\$0.30	\$0.65–\$0.80	\$0.35–0.45	\$2.20–2.70
Water production (liters per capita/day)	303	274	450	300
Domestic water consumption supplied by municipal utilities (%)	46	71	68	80
Total average non-revenue water (%)	18	46	40	15
Total average non-revenue water (m3/km network a day)	54	42.3	20	5
Operating cost coverage ratio	1.0	1.0	1.0	1.2
Payment collection rate (%)	85	94	90	99.5

Sources: Prepared by Alexander Danilenko (2006), World Bank. Chinese data based on Chinese Water Works Association Yearbook (2005); UK data on OFWAT annual performance report (2005); Brazil data on SNIS (2006); Russian data on Goskomstat (2006); and World Bank estimates.

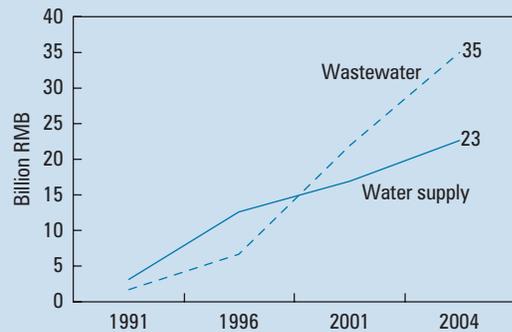
coverage, stabilized urban water use, increased wastewater treatment capacity, and stabilized pollutant loads.

Large Increases in Urban Water Infrastructure

Investments in water supply and wastewater infrastructure have increased dramatically since 1990 (see Figure 2.1). The total sector

investment over the period 1990–2005 is estimated to be around RMB 438 billion (\$54 billion), split about evenly between water supply and wastewater.¹ Investment in China's urban water infrastructure has averaged around 0.4 percent of GDP over this period. In 2004, annual revenues from water and wastewater fees consisted of about 0.5 percent of GDP.² During the 1990s, spending

FIGURE 2.1 Annual Investment in Urban Water and Wastewater Infrastructure



Source: MOC, China Urban Construction Statistics Yearbook (2005).

on water supply outpaced wastewater, but since 2000 investments in wastewater have increased dramatically.

The rapid increase in urban water infrastructure reflects the general municipal infrastructure trend. Since 1995, China's GDP has almost tripled while overall annual municipal infrastructure spending, including roads, has increased six-fold.³ Water supply and wastewater account for only 10 percent of total municipal infrastructure spending.⁴ There are a number of driving forces accounting for the explosion of municipal infrastructure construction:

- A rapid increase in urban population and economic development
- A backlog of deferred infrastructure investments before China's economy experienced its current high growth stage
- The government's expansionary fiscal policy as a method of stimulating domestic demand and reducing dependency on export-led growth

- A recognition by China's municipal leaders that infrastructure provides a necessary foundation for economic development

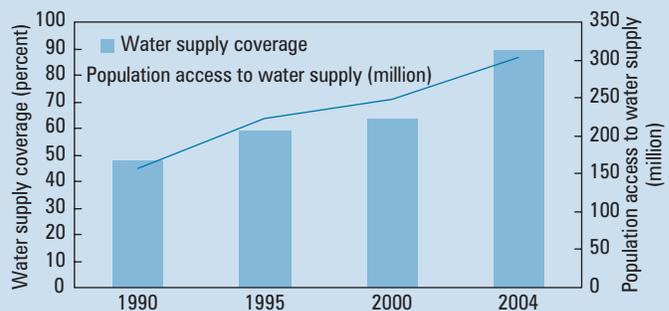
Increase in Water Supply Coverage

As shown in Figure 2.2, piped water supply by municipal water utilities has increased over the past 15 years in terms of both the number of urban population served and water supply coverage rate. China's urban water supply coverage has increased from less than 50 percent in 1990 to about 90 percent in 2004. Category I and II cities have coverage rates over 90 percent, while Category III cities have 86 percent coverage on average.⁵ The coverage for county towns is estimated at 82 percent, although this may be highly variable.

Stabilized Urban Water Use

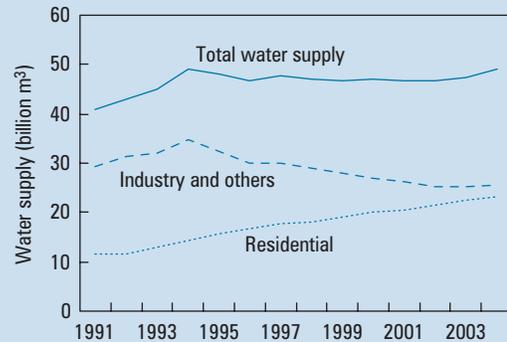
Figure 2.3 shows the total amount of water used in urban areas from 1991 to 2004. Industrial water use has decreased significantly, while domestic water use has increased in line with population growth, resulting in an overall stable water demand in spite of rapid economic growth. Controlling urban water demand has been achieved

FIGURE 2.2 Urban Water Supply Coverage



Source: MOC, China Urban Construction Statistics Yearbook (2005).

FIGURE 2.3 Urban Water Supply



Source: MOC, China Urban Construction Statistics Yearbook (2005).

through a combination of increases in water tariffs, water conservation measures, and industrial restructuring over the last 15 years. Industrial water demand has decreased by about 30 percent since 1995. The decrease in demand has been caused by several factors, including the following:

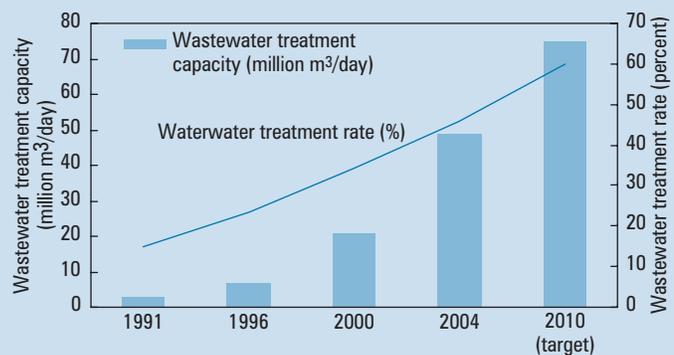
- Industrial restructuring caused many unprofitable and inefficient state-owned enterprises to be replaced by more modern and efficient export-oriented enterprises.
- The government emphasized industrial water recycling and cleaner production for all industries.⁶
- Increased municipal water tariffs triggered a price elasticity effect, driving down overall industrial demand.
- Many water-consuming industries were relocated outside of the core city area and may no longer be served by municipal water utilities.

Domestic water use has approximately doubled over the last 15 years. At present, it is approximately equal to industrial water use at the aggregate national level (see Figure 2.3). The urban population has increased by 1.8 times over the same time period, indicating that per capita domestic water use has only slightly increased, in spite of higher household incomes. When income rises, particularly when starting from a low level such as in China, the income elasticity effect usually results in higher water use. In Chinese cities, however, water prices have also been rising, thus eliciting a price elasticity effect and dampening demand. Meanwhile, municipal governments have actively promoted water conservation. In sum, the overall trend for urban water use appears to be gradually increasing, in line with the urbanization level. The demand-dampening factors—such as increasing prices, including the associated cost of wastewater, along with conservation efforts—should continue to hold in the future.

Increase in Wastewater Treatment Capacity

As shown in Figure 2.4, the ratio of municipal wastewater treatment plant (WWTP) ca-

FIGURE 2.4 Municipal Wastewater Treatment Capacity



Source: MOC, China Urban Construction Statistics Yearbook (2005).

capacity to overall wastewater volume in urban areas has increased from 15 percent in 1990 to about 52 percent in 2005. However, the installed capacity is not always fully utilized so that the percentage of pollution collected and treated may be significantly lower.

Figure 2.4 shows that the total installed capacity of municipal wastewater treatment plants has doubled over the last decade, reaching approximately 52 percent of treatment capacity for total municipal wastewater (that is, from both domestic and industrial sources). By the end of 2004, 364 out of the total 661 cities in China had built 708 WWT plants with a total treatment capacity of 49 million m³ per day. In 2000, China's State Council set a target of 60 percent urban wastewater treatment by 2010. The 11th Five Year plan (2006–2010) has proposed a more ambitious goal of 65 percent by 2010.⁷

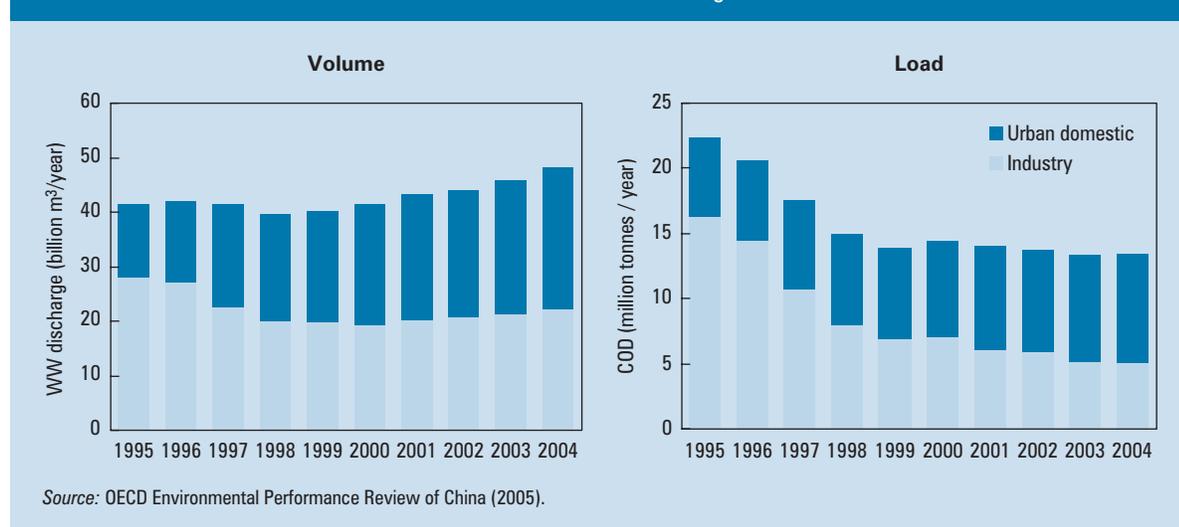
Category I cities have made the most progress, with an average treatment capacity of 61 percent in 2004. Some Category I cities—such as Beijing, Shanghai, and Tianjin—have nearly completed their waste-

water treatment plant construction. The treatment capacity rates in Category II and III cities are 38 percent and 21 percent respectively, while the treatment capacity rate in county towns is only 11 percent.

Stabilized Pollutant Loads

Figure 2.5 shows total pollutant loads from industrial and urban domestic sources. Industrial pollution loads have decreased significantly since 1995 due to industrial restructuring, a focus on clean production, and construction of industrial wastewater treatment facilities backed by strong environmental enforcement. Urban domestic pollution loads appear to have slightly increased since 1995. Although Chinese cities are rapidly increasing wastewater treatment coverage, the urban population is also expanding rapidly. The urban population increased from 352 million in 1995 to 564 million in 2005. Taking into account increases in both population and treatment coverage, the number of urban residents without wastewater treatment stayed approximately the same from 1995 to 2005.

FIGURE 2.5 Trends in Industrial and Urban Wastewater Discharge Flows and Loads



Water Supply Utility Performance

This section describes some of the key performance issues confronting water supply utilities, including:

- Water supply reliability and quality
- Overcapacity in treatment facilities and high leakage rates in distribution systems
- Financial sustainability

Most cities have well-established municipally owned water supply companies, many of which belong to the China Water Works Association (CWWA). The association produces annual yearbooks that compile self-reported information on a number of key performance indicators. In addition, the World Bank and the Ministry of Construction jointly managed a pilot benchmarking study in 2004 that investigated the performance of twelve water supply utilities located in representative cities. The MOC also undertakes a periodic survey of water utility performance, some of which is publicly available. To the extent possible, the data are analyzed across the three different urban water market segments.

Water Supply Service

Table 2.1 indicates that many water utilities suffer from widespread problems with low

water pressure. On average, Category III cities perform the worst, with 16 percent of the service area suffering from low pressure problems. What is most striking about Table 2.1 is that the lowest performing quarter of utilities have on average low water pressure in around 40 percent of their service area—regardless of city category. Water is generally supplied 24 hours a day in Category 1 cities. However, the reliability of service is often much lower in Category II and III. The benchmarking study indicated that water supply service was continuous in all cities except two, both of which were Category III cities. One of the cities provided water supply service 18 hours per day, and the other city provided only 12 hours per day due to a combination of a shortage of water resources and lack of funds.⁸

China suffers from scarcity and uneven distribution of water resources. Many cities are forced to suffer seasonal droughts or invest in expensive long-distance water sources to secure a reliable and high-quality water source. In 2004, MOC reported that seasonal water shortages affected more than 400 of China's 669 cities; about 110 cities were facing serious shortages requiring drastic water-use restrictions.⁹ Water pollution in China's surface water is severe, particularly in the northern part of the country. Due to a lack of alternatives, however, many Chinese water utilities are forced to abstract water from polluted rivers and lakes, resulting in higher operation costs and lower water quality. Many cities, particularly in the north of China, also rely on unsustainable extraction of groundwater as an important raw water supply source.

The quality of water provided by Chinese municipal water utilities is difficult to ascertain due to the weak regulatory and public reporting systems. The CWWA *Yearbook* re-

TABLE 2.1 Utility Service Area with Low Water Pressure

	Category I Cities (%)	Category II Cities (%)	Category III Cities (%)
Average	12	10	16
Best 25% of Utilities	0	0	0
Worst 25% of Utilities	45	33	46

Source: China Water Works Association Yearbook (2005).

ports close to 100 percent compliance with drinking water quality standards, including total coliforms, chlorine residual, and turbidity. The benchmarking study reported that five of the twelve plants in the surveyed cities produced turbidity levels above 1.0 NTU, which creates concerns for human consumption. Poor water quality is generally due to outdated water treatment technology and high levels of pollution in the raw water. Water quality monitoring is generally poor and the data is consequently unreliable.¹⁰

Investment Efficiency, Treatment Plants, and Distribution Systems

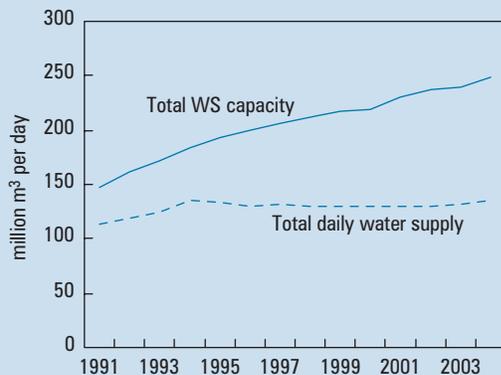
There is significant overcapacity of water supply treatment facilities in many cities (see Figure 2.6). At the national level, the ratio of installed treatment capacity over water consumption at peak time reached about 1.5 in 2004, which means that water treatment capacity is 50 percent more than needed at peak consumption. The primary reason for this overinvestment is that municipal water utilities did not take into account

the overall reduction in demand that occurred during the 1990s due to the dampening factors discussed above. While many cities have overinvested in water supply treatment facilities, there is significant underinvestment in water distribution networks, with consequent service delivery and sustainability problems.

Chinese cities have high population densities, with most residents living in multi-story apartment blocks. This results in compact distribution systems, with an extraordinarily large number of customers per kilometer. Table 2.2 shows that the average non-revenue water rate is around 20 percent for most cities. Chinese cities report high billing and collection rates, so most of the non-revenue water comes from physical leakages. At first glance, the percent of non-revenue water appears to be exceptionally good by international standards. There is considerable variation within city categories, however, and the lowest performing quarter of utilities in Category II and III cities average around 35–40 percent leakage.

If the actual volume of losses per km of distribution pipeline is accounted, Chinese utilities do not perform well, with an average of around 50–75 m³/km per day, twice the leakage rate in Brazil and Russia and more than 10 times the rate in the U.K. The lowest

FIGURE 2.6 Water Supply and Production Capacity (Municipal and Self-Supply)



Source: MOC, China Urban Construction Statistics Yearbook (2005).

TABLE 2.2 Non-Revenue Water For Chinese Utilities
Percent of water produced and lost (m³/km-day)

	Category I Cities	Category II Cities	Category III Cities
Average	17 (68)	22 (75)	24 (53)
Best 25% of Utilities	11 (32)	10 (18)	9 (11)
Worst 25% of Utilities	23 (120)	36 (178)	39 (121)

Source: China Water Works Association Yearbook (2005).

performing utilities average around 150 m³/km-day. The generally poor distribution performance is further confirmed by the high pipe breaks per year. For instance, the average breakage rate in the pilot benchmarking cities was around 2 breaks/km/year (4 cities with 4 breaks/km-year), compared to 0.2, 0.5, and 3.5 breakage rates in the U.K., Russia, and Ukraine respectively.¹¹

There are a number of reasons why the performance of distribution networks is so poor in many cities. Many pipelines are old and need rehabilitation, plus many newer pipelines built prior to 1990 were constructed with poor quality materials and substandard construction methods. There has been limited funding to support the maintenance and rehabilitation of these pipelines, and until very recently private firms were not allowed to invest in distribution networks. Finally, the asset management systems of most water utilities are rudimentary and many utilities do not have the expertise to cost-effectively prioritize distribution system renovations.

Water Utility Financial Performance

Table 2.3 shows that the financial situation of most water utilities is not good, and even

appears to be deteriorating. According to the CWWA data, over 60 percent of 531 water utilities in 1997 experienced positive net income. In 2004, however, the number of water utilities with positive net income had declined to 40 percent. Table 2.2 also shows that the range between cities within the same category is actually higher than between the different city categories. This indicates that the financial status of a water utility company is only loosely correlated with city size and wealth, and that even small and poor cities can have financially sustainable water utilities if they are well-governed and managed. Some common reasons for the high percentage of unprofitable water supply utilities include:

- Water tariffs, though increasing rapidly, are generally still below cost-recovery levels
- Large investments programs have resulted in high debt service costs
- Water demand has experienced slower than expected growth
- Some utilities may have an accounting loss but have a reasonable cash flow to maintain operations

The financial status of a water utility is fundamentally affected by its billing and collection performance. The *CWWA Yearbook* reports high rates of collection, but it is not clear what percentage of customers are actually metered and billed. The benchmarking study attempted to determine the level of metering in the 12 surveyed cities, but encountered difficulties in data reliability and definitions. Metering coverage is defined as the percentage of “connections” with meters. Although six cities report 100 percent metering, the benchmarking study noted that the average population per metered connection is 25, indicating that either (a) one meter

TABLE 2.3 Net Income to Revenue Ratio in 1997 and 2004

Profits/Sales	1997	2004 (661 cities)		
	(531 cities) Average	Category I	Category II	Category III
>10%	10	0	7	4
10% to 0%	48	38	41	32
0% to -10%	16	33	18	26
>-10%	23	29	33	38
Total	100	100	100	100

Source: China Water Works Association Yearbook (2005).

often serves more than one household, and/or (b) some households are not metered. Overall, Chinese utilities have made impressive efforts to meter their customers and the metering level undoubtedly increased significantly over the last decade, albeit starting from a very low level.

Self-Supply Water Users

Although located within the service areas of municipal water utilities, many large industries and their residential compounds have an independent water supply. Self-supplied municipal and industrial water use is estimated at around 12 percent of total urban use.¹² This percentage can be much larger in northern cities with groundwater supplies. Self-supplied users are generally required to pay a nominal water resource fee, but can generally produce their water at much lower cost than the municipal utility. Industrial self-supply within the service area of a municipal water utility can cause problems, including (a) water supply company revenues are reduced and the per-unit cost of municipal water supply increases; (b) industries often overexploit groundwater due to its low price; and (c) it is difficult to collect wastewater fees from self-

supplied users because they cannot be charged through the normal route of the municipal water supply bill.

Wastewater Utility Performance

China has embarked on a national program to treat urban wastewater and the rapid increase in treatment capacity is impressive. This section describes some of the key performance issues confronting urban wastewater management, including:

- Wastewater treatment plant performance
- Inadequate drainage collection networks
- Underfunding of wastewater services

Wastewater companies have only been established in most Chinese cities since 2000. Their scope of service is generally limited to wastewater conveyance and treatment. Drainage collection, whether through combined or separate stormwater and sanitary drains, is usually provided by the municipal (or district) drainage bureau. Box 2.2 pro-

BOX 2.2 Wastewater Technical Terms

- **Drains/Sewers.** There are four types of drains: (a) stormwater drains, which carry stormwater only; (b) sanitary drains, which carry wastewater only; (c) combined drains, which carry stormwater and wastewater; and (d) interceptors, which connect with combined drains and convey the wastewater to the treatment plant during dry periods.
- **Pumping Stations and Overflows.** Drains may require pumping stations in the networks to make them hydraulically stable. Overflows are incorporated into a combined drain to spill excess water from an overloaded pipeline (during and following heavy rain) into a convenient watercourse.
- **Drainage Networks.** A drainage network is divided into a hierarchical system of drains commonly called tertiary drains (at the building level), which connect to secondary drains (typically along smaller roads) and then to primary drains (typically along larger roads). The classification is usually somewhat arbitrary.
- **Wastewater Treatment Plants.** The treatment plants treat wastewater conveyed through an interceptor or a sanitary drain. During rain events, the interceptor typically contains a mixture of stormwater and wastewater.

vides a definition of wastewater technical terms. The fragmentation of wastewater services, and its relative immaturity, has resulted in an almost complete lack of utility financial and operational information to evaluate the sector. Until 2005, the China National Wastewater Association served as the professional association for the sector, but it did not produce annual yearbooks of key information similar to the China Water Works Association Yearbook. In 2006, the two organizations joined to form the China National Water and Wastewater Association. The joint World Bank-MOC benchmarking study in 2004 and a similar World Bank study in 2001 looked at a number of wastewater utilities, but due to the lack of information and transparency, the data collected was often unreliable and of low quality.

Wastewater Treatment Plant Performance

Box 2.3 shows the MOC's assessment of wastewater treatment plant performance. The benchmarking study indicated that the treatment plants operate, on average, at 60 percent of their hydraulic design capacity. Since most treatment plants are in the early stages of their operational life, the average

hydraulic utilization rate appears reasonable, but there is a large variation among the plants. Around one-third of the plants operated at a hydraulic capacity utilization rate of less than 50 percent and another third were near 100 percent utilization. One-third of the plants had influent biochemical oxygen demand (BOD) and suspended solids (SS) concentrations well below design standards, indicating significant underutilization of load capacity. The treatment plant records showed that they operated mostly in compliance with discharge standards. In 2004, the China National Auditing Office issued a report stating that 60 out of 78 audited wastewater treatment plants were underutilized due to the lack of operating funds or delays in construction of auxiliary facilities.¹³

Drainage Collection Networks

There is very limited information on collection system performance in China. MOC records indicate that the total length of collection system pipelines has increased significantly, from a national total of 139,000 kilometers in 1995 to 358,000 kilometers in 2005.¹⁴ The MOC figures do not make a distinction between separate or combined (san-

BOX 2.3 MOC's Analysis of Wastewater Treatment Operational Performance

By the end of 2004, the national urban wastewater treatment plant operation rate averaged 65 percent, five percentage points higher than in 2001, but some completed plants have not fully displayed their benefits. By the end of June 2005, out of 364 cities with plants, 38 cities' plant operation rate was lower than 30 percent, including 17 cities with plants that were not yet commissioned. Of this total, seventeen were prefecture level cities, two were large cities with a population over 500,000, and six were in cities within key river basins. An analysis showed that the reasons for the failure of the completed plants to function properly were primarily the following: (a) in some cities, management systems were still not in place; (b) wastewater fees were too low to ensure operation; (c) collection networks were incomplete; (d) treatment plants were oversized, and (e) wastewater treatment plants were complex and difficult to operate.

Source: MOC, Circular on Treatment of Urban Wastewater (2005).

itary and stormwater) drainage pipelines. Many cities are clearly struggling with the development and operation of their collection networks. Box 2.4 provides information on Tianjin's drainage collection system and demonstrates some of the challenges. Since Tianjin is a Category I city, the problems faced by Category II and III cities may be even more severe.

Wastewater Financial Performance

The wastewater sector in a typical city is often fragmented among different service providers, including public departments providing local drainage services and more commercially oriented companies providing

wastewater conveyance and treatment services. Most wastewater companies are still in their infancy, but undoubtedly face many future financial challenges. The China Drainage Association, unlike the China Water Works Association, does not collect financial information from its members, and thus there is no national database on the financial status of wastewater companies—which would in any case only be a partial perspective, as drainage services would not be included in most cases. According to the above MOC analysis and the analysis presented in Chapter 7 (Financial Sustainability), wastewater tariffs are very low, and the wastewater sector is struggling with financial sustainability issues.

BOX 2.4 Overview of Tianjin Drainage System in 2005

A comprehensive assessment of the drainage collection system was conducted in Tianjin as part of a World Bank-financed project. The assessment revealed that although Tianjin is moving relatively quickly in constructing the necessary wastewater treatment plants, there is a need to improve the drainage collection system, as the following data show:

Extent of Drainage System: The total length of drainage pipelines is 4,753 km, of which:

- Stormwater: 1,982 kms;
- Sanitary: 1,928 km; and
- Combined: 1,042 kms.

Drainage Coverage: Fifty-nine percent of the city area is covered by stormwater drainage and 69 percent by sanitary drainage.

Asset Condition: Twenty-five percent of pipelines have exceeded their service life. There are 186 pump stations, of which 94 (50 percent) have equipment that exceeded service life.

Flooding: There are 36 key floodprone street intersections. Among them, 9 have adequate stormwater drainage, 12 have been partially improved, and 15 suffer frequent flooding. All 33 large underpasses in Tianjin are subject to flooding.

Wastewater Collection: The separation of stormwater and wastewater drains is incomplete at the lateral level, resulting in stormwater going into wastewater drains and wastewater going into stormwater drains. The low construction standards lead to frequent breaks and blockages.

Wastewater Treatment: The installed wastewater treatment capacity is 930,000 m³/day, a 59 percent coverage. The goal by 2010 is to collect and treat at least 90 percent of the wastewater.

Source: Tianjin Drainage Study, Tianjin International Engineering Consulting Corporation (2005).

The Challenge of Industrial Wastewater.

Industries account for about half of the 50 billion m³/year of urban water use,¹⁵ and China aggressively pursues industrial pollution control. By 2001, over 61,220 industrial wastewater treatment plants had been constructed; official data indicate an 86 percent compliance rate with the 2001 standards.¹⁶ Since most of the plants had been constructed before municipal wastewater management systems were in place, the relevant effluent standard is to discharge directly into the receiving water body. For industries without their own treatment plants, they should naturally discharge into the municipal collection system. Industries with their own wastewater treatment systems need to decide whether to discharge into the municipal system (with lower BOD and SS discharge standards) or continue to treat for discharge directly into the environment. Any industry that discharges to the municipal system must meet pretreatment requirements in order to minimize impacts on the municipal wastewater collection and treatment systems. Most cities have not yet developed integrated strategies to deal with the following issues: (a) ensuring adequate pretreatment prior to discharge into the municipal system; (b) determining which industries should convert from self-treatment to discharge into the municipal system; and (c) treating complex wastewater with a high percentage of industrial waste.

Chapter Summary

This chapter has identified a number of issues regarding the achievement and performance of China's urban water utilities, including:

- Starting from a low base in 1990, Chinese cities and their utilities have

rapidly expanded water supply and wastewater treatment coverage through large-scale infrastructure construction programs.

- There is a wide variation in utility performance, both between and within different city categories. Some cities are able to provide high-quality service, while other cities struggle. This indicates that underperformance stems partly from poor sector governance and regulation, which allows some cities and their utilities to provide substandard service.
- There is a lack of data and transparency to evaluate utility performance, particularly for wastewater. The situation undermines efforts to identify problems and ensure accountability, thereby restricting the scope for improving utility performance. Box 2.5 shows how Brazil has addressed the issue of utility performance information, which could serve as an inspiration for a similar program in China.

Notes

1. *China Urban Construction Statistics Yearbook* (2005)
2. See Chapter 1, Footnote 4.
3. *China Urban Construction Statistics Yearbook* (2005)
4. *ibid*
5. See Technical Notes, Chapter 1.
6. For example, the national "Cleaner Production Promotion Law" was passed in 2002.
7. The "11th Five-Year Plan on Urban Wastewater Treatment and Reuse Infrastructure Construction" set a national target of 65% wastewater treatment rate, including: 80% for provincial capitals; 60% for prefecture level cities; 50% for county-level cities; and 30% for county capital towns. Source: CIECC (2006).
8. World Bank (2005). North China Water Quality Study Report Component A: "Water Utility Case

BOX 2.5 Brazil National Sanitation Information System (SNIS)

Brazil's National Information System for Water Supply and Sanitation (SNIS) was created in the mid-1990s under the Water Sector Modernization Project (PMSS), a federal program financed by the World Bank. SNIS is a federal database maintained by the Ministry of Cities. It aims to promote (a) planning and implementation of public policies; (b) guidance in the allocation of financial resources; (c) assessment of utility performance; (d) management improvement through increased efficiency and effectiveness; (e) guidance on regulatory activities; (f) benchmarking and yardstick comparison; and (g) dissemination of sector data to the public domain.

The SNIS database covers information on 279 regional and municipal utilities, consisting of water supply data for 4,186 municipalities (95 percent of the population) and sewerage data for 968 municipalities (71 percent of the population). SNIS reports have been compiled and published annually covering the period 1995 to 2005. Utilities provide data on their water supply and sanitation services, including operational, managerial, financial and service quality information through a tailored software package. SNIS products include databases; software for data collection; diagnoses of service provision coverage and performance; an annual performance national sector overview; a glossary of technical terms and indicators; and an internet site with over 4,000 visitors per month. The database is used by a wide variety of institutions, including governments, utilities, regulatory entities, research and financial institutions, and international development agencies.

SNIS provides a tool to monitor and supervise utility performance. For utilities, the database provides performance benchmarking and comparison with other utilities. It allows state and municipal governments to press utilities to enhance their performance. In addition, SNIS contributes to enhancing transparency by inviting the general public, media, politicians, NGOs, and others to participate in discussions on the sector generally and on service provision more specifically. Finally, the federal government has recently started to use SNIS in order to help prioritize sector financing demands.

Lessons learned from SNIS include the following: a) establishing a national information database takes time and perseverance; b) it requires leadership and coordination even though it is undertaken collectively; c) incentives and obligations to improve responsiveness and accuracy of data are important, although voluntary mechanisms have worked relatively well (a degree of "peer pressure" to be included in the database now exists among service providers and local governments); d) the system has become the yardstick of the Brazilian water industry; e) SNIS allows Brazil to take its benchmarking to a regional and international level; and f) once such a system is established, it becomes self-perpetuating.

Source: Presentation by ANA (Miranda and Marinho) at World Bank Water Week (2003)

- Study," pg. 21. The two cities were Yuncheng in Shanxi Province and Bozhou in Anhui Province.
9. See Xinhua News Agency September 28, 2003, "Water from Shanxi to Ease Shortage in Bei-jing" at: <http://www.china.org.cn/english/2003/Sep/76227.htm>. The article reports that: "Beijing is one of the many cities on the Chinese mainland with water shortage problems. About 420 of 600 cities on the Chinese mainland suffer water shortages, according the Ministry of Water Resources. A total of 110 cities are in acute shortage, resulting in 200 billion yuan (US\$24 billion) to 300 billion yuan (US\$36 billion) in lost industrial output each year, figures provided by the ministry show."
 10. World Bank (2005). North China Water Quality Study Report Component A: "Water Utility Case Study."
 11. Alexander Danilenko (2006) "Background Paper on North China Water Quality Study."
 12. *China Urban Construction Statistics Yearbook (2005)*
 13. General Office of China National Audit Office (2004)
 14. *China Urban Construction Statistics Yearbook (2005)*
 15. See Figure 2.3
 16. OECD (2005), Environmental Performance Review of China.

3

Sector Challenges

China not only needs to improve the performance of its urban water utilities, but it must also prepare for the pressing challenges of the future, including:

- *Responding to rapid urbanization.* China is experiencing the greatest wave of urbanization in history; the official urban population is expected to increase from about 550 million in 2005 to about 900 million in 2020.¹ Providing urban water services to new residents and dealing with new spatial patterns of urban development will be a demanding task.
 - *Dealing with urban diversity.* China has a wide spectrum of cities and towns, from large and rich super cities such as Beijing and Shanghai to hundreds of smaller and poor cities. China's policies, standards, and approaches for urban water services will need to be tailored to meet the economic and environmental reality of different types of cities.
 - *Confronting water scarcity and degradation.* Water is scarce in the north of China and water quality throughout the country is severely degraded. In spite of extensive efforts to improve
- water quality and ensure reliable water supplies, seasonal shortages and polluted water supplies will continue to pose problems.
 - *Meeting investment demands.* The growth in urban population, combined with aspirations to improve the quality of water services, will require an accelerated capital works program. The estimated investment needs for 2006–10 alone are expected to be around RMB 400 billion (\$50 billion)—approximately equal to investments over the last 15 years. Financing these investments, and ensuring investment efficiency, is a major challenge for the sector.
 - *Improving utility financial sustainability.* Some water supply utilities, and most wastewater utilities, rely heavily on municipal government funding. Utilities that rely more on user fees generally increase transparency and accountability, become better able to access capital markets, and operate at a higher level of efficiency.

This chapter examines these challenges and their implications for the urban water sector.

Responding to Rapid Urbanization

China's rapid urbanization has been accompanied by economic growth and transformation. Much of this urbanization is centered on large metropolitan areas, with rapid development of towns and peri-urban areas. These trends have the following implications:

- Water services will need to be provided to a large influx of urban residents.

- Economic growth will help cities both to expand service and upgrade standards.
- New patterns of spatial growth will provide opportunities to aggregate service provision and lower costs, provided local governments can cooperate.

To understand these issues, Box 3.1 describes China's different government levels and how "cities" and "towns" are administered.

BOX 3.1 China's Administrative System and Definition of Cities and Towns

In China, the governance structure is a hierarchical and decentralized system in which functional responsibilities are delegated through a four-tiered system: (1) central level; (2) provincial level; (3) prefecture level; and (4) county level.

The county level is the basic building block of the decentralized administrative and fiscal system. A prefecture-level entity is composed of a number of county-level entities; similarly, a provincial-level entity is composed of a number of prefecture entities. There are 32 provincial-level entities in China, including 23 formal provinces, 5 autonomous regions where ethnic minorities dominate, and 4 "municipalities:" Beijing, Shanghai, Tianjin, and Chongqing. This does not include Hong Kong, Macau, and Taiwan. There are no prefectures in a municipality. In actual practice, the administrative relationships are more complex, but the four-tiered explanation provides the basic framework.

The term "city" has a dual—and often confusing—meaning in China. In the Chinese system, a "city" can refer to an administrative jurisdiction, which can cover both rural and urban areas. For example, a prefecture-level city in the administrative sense is composed primarily of rural areas with a number of urban centers. On the other hand, a "city" can also refer to a specific urban area. This study uses the latter definition of city and only considers urban areas.

As of December 31, 2004, China has 661 "designated" cities (i.e. major urban areas): 4 municipalities, 283 cities that are the capitals of prefecture-level entities, and 374 cities that are the capitals of county-level entities. Administration of the cities is carried out by city governments (sometimes referred to as municipal governments). The city is further divided into urban districts, which provide more local administration and public service functions. Reflecting the dual definition of cities in China, the mayor of a city that is the capital of a prefecture entity has two functions: (1) direct responsibility for the city government; and (2) oversight responsibility for the county-level entity within the prefecture. In 2005, approximately 340 million people lived in designated cities.

In total, there are around 2,010 county-level entities in China. As noted in the preceding paragraph, 374 of these county-level entities have large urban areas that are designated as "cities." The remaining 1,636 county-level entities each have an urban area, which is the seat of government; in this study, they are called "county-towns." In 2005, approximately 96 million people lived in county-towns, resulting in an average population of around 60,000.

Towns are another type of urban area in China. In total, there are 18,256 towns in China—including the 1,636 towns referred to as "county-towns." Towns are administratively and fiscally subservient to county-level governments. In 2005, approximately 100 million people lived in towns (excluding county towns), resulting in an average population of around 6,000.

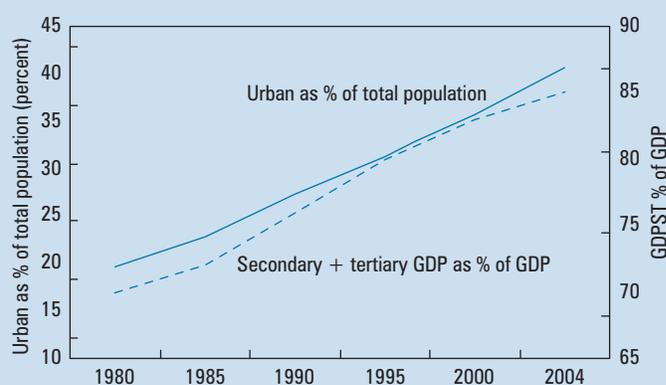
Source: Adapted from Wikipedia (http://en.wikipedia.org/wiki/Political_divisions_of_China)

Rapid Urbanization Accompanied by Economic Growth and Transformation

Around 1980, China started a transformation from a planned economy to a market economy. The country's real GDP then grew an average 9.6 percent a year in the period from 1979 to 2005.² The evolutionary trend from a rural agricultural society to an industrialized and urban country is reflected in Figure 3.1. The increase in China's urbanization level is roughly consistent with the change in the country's macroeconomic structure, where the secondary and tertiary sectors now account for 85 percent of China's GDP, compared with about 65 percent in the early 1980s. The urbanization rate has more than doubled over the last 25 years, and reached 43 percent in 2005. In 2005, the total official urban population was around 550 million, including 340 million in 661 cities, 96 million in county-towns, and around 100 million in towns. This does not take into consideration an additional "floating" population of 80 to 120 million people. This rapid increase in the urban population has strained urban water and wastewater infrastructure, and created a large demand for upgrading and expansion of services.

Urban residents have become significantly richer over time. With their increased ability to pay, they have demanded better water services. The average urban income per capita rose from 1,500 RMB (\$187) in 1990 to RMB 10,493 (\$1,300) in 2006. In contrast, rural per capita income in 2006 was only RMB 3,255 (\$406). Moreover, unlike urban residents, most rural residents do not receive subsidized health care or education, and only a small percentage participate in pension systems.³ Given the disparities in wealth between rural and urban households, there is a strong incentive for rural residents to migrate to the cities. In the past,

FIGURE 3.1 China's Economic Transformation and Urbanization

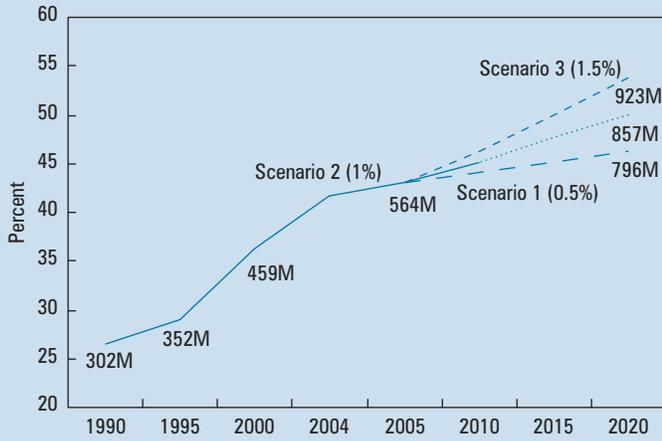


Source: Chreod, "Metropolitan Regions: New Challenges for an Urbanizing China" (2005).

this natural economic attraction has been dampened by government efforts to control rural-urban migration by denying unauthorized rural migrants legal status, thus complicating access to basic services in the city such as housing, schools, and health care. The system of control is slowly being relaxed, which is resulting in widening disparities of urban income as poor rural migrants come to urban areas.

Fueled by the country's rapid industrialization, the migration of farmers from rural to urban areas, and sustained economic high growth, current urbanization is expected to continue over the next few decades. Assuming an urbanization rate of 1.5 percent, which is not particularly high when compared with the historical experience of other countries at similar stages of economic development, this could result in over 900 million urban residents by 2020 (see Figure 3.2). Under any scenario, the absolute increase in urban residents in the next 15 years will be immense and will create huge demands for urban infrastructure, including water, wastewater, and stormwater

FIGURE 3.2 Urbanization Trends and Projections



Source: China Statistical Yearbook (2005).

facilities. Rapid economic development also provides municipal governments with available financing sources to tackle these huge investment challenges for the water sector.

Urbanization Taking Place in Metropolitan Areas

China has over 50 metropolitan regions in total, which are anchored by cities with over 1 million non-farming residents and encompass adjacent counties and districts. These metropolitan regions are the economic development powerhouses of the country. Although the metropolitan regions hold only 29 percent of the country's total population (370 million), they contribute to 53 percent of China's GDP and 62 percent of all non-farming GDP from manufacturing, construction, and services. GDP per capita within 50 kilometers of the metropolitan centers is 160 percent higher than the national average. This rate falls dramatically at a distance of 50 to 100 kilometers from the metropolitan core and

drops again beyond 100 kilometers. Beyond 100 kilometers, it remains relatively stable no matter how far out from the centers.⁴

China's metropolitan regions can be broken into four tiers by the relative size of the non-farming population. The first tier of three metropolitan regions in China includes Shanghai (17 million non-farming population), Beijing (14.5 million), and Guangzhou (13.7 million). The second tier consists of 11 metropolitan regions with urban populations ranging from 5 million to 10 million. The third tier, with populations ranging from 2 to 5 million, consists of 20 regions. The remaining 19 regions belong to the fourth tier. While first- and second-tier metropolitan regions are located along the coast, many of China's medium and small metropolitan regions are located inland.

The spatial urban expansion pattern in China differs considerably from that in North America and many European countries. Rural populations and immigrants, unfettered by mobility restrictions, poured into the cities in these countries. Urban development then grew outwards into the suburbs as residents sought cheaper and better housing and companies attempted to lower business costs and avoid congestion.

In China, urban households and state-owned enterprises (SOEs) faced strict constraints on labor and capital mobility and had much more limited relocation choices. Urban households were tied to the city through the household registration system (*hukou*). The vertically integrated state-owned-enterprises (SOEs) maintained localized supply chains in order to promote local economic development. Moreover, heavy subsidies as well as the allocation of free or cheap urban land to SOEs gave them little incentive to relocate to lower-cost suburban

areas. Nevertheless, with rapid economic development, pressures started to build in many regions, partially due to industrial relocation from the central cores to new suburban industrial parks, and partially due to government efforts to promote relocation to improve housing conditions and reduce inner city residential density. As a result, many metropolitan regions in China have recently experienced a complex mix of both centrifugal and centripetal growth patterns. Their spatial pattern is a combination of high density in central areas, which can create problems such as traffic congestion and air pollution if not properly managed, and dispersed suburban areas, which increase the cost of infrastructure provision.

The characteristics of China's metropolitan development have important implications for the urban water sector. Much of the water infrastructure in the core urban areas, particularly water and drainage pipelines, needs to be renovated. Given the heavy traffic congestion, this will be a complex task. The suburban areas are expanding outward quickly and require new infrastructure, which will be expensive given the relatively low population densities. Finally, China's administrative and fiscal system is decentralized, and the suburban districts and counties surrounding the core urban areas tend to independently develop their water infrastructure without taking advantage of the benefits that might accrue from aggregation of water services at the regional level.

Towns Expanding Rapidly in the Countryside and Peri-Urban Areas

Towns have grown rapidly in China, with the total number increasing from fewer than 3,000 in 1980 to over 18,000 in 2005.⁵ Towns play two important roles in China's urbanization process. First, in some instances they

are integral parts of the booming metropolitan areas. As a whole, towns now hold 52 percent of China's metropolitan population, and are playing an increasingly important economic and social role. In many metropolitan areas, land-intensive and pollution-generating industries are being relocated from inner urban areas to towns due to lower land cost and labor availability. Unlike cities, which control migration, towns in metropolitan areas generally welcome rural migrants as a source of cheap labor. Second, the central government has new development policies to encourage rural residents to move to towns located in the countryside in order to improve their quality of life with better services. China's 10th Five-Year Plan (2001–05) called for the rapid development of small towns as the main focus of the urbanization strategy.

The fast development of towns throughout China has two major consequences for the urban water sector. First, towns located on the fringe areas of metropolitan regions are economically and environmentally linked to the core urban areas. Their urban water services will need to be at a level consistent with the core urban area. In many instances, this is most economically achieved through the provision of regional infrastructure. Second, towns located in rural areas will need to develop low-cost and sustainable approaches to their urban water services, particularly for wastewater management.

Dealing with Urban Diversity

Not only are China's cities rapidly growing, but inequality is increasing both between cities and within cities. These trends have the following implications:

- China's policies, standards, and approaches for urban water services will need to be tailored to meet the economic and environmental reality of different types of cities.
- As users pay more for urban water services, more attention will need to be paid to protecting the urban poor through special programs.

Growing Inequality

The Gini coefficient is a parameter used by economists to measure income inequality: the higher the Gini value, the more unequal the income distribution. The overall Gini coefficient in China has increased from below 0.3 in the early 1980s to 0.45 in 2005.⁶ For comparison, the Gini coefficient of Japan, which is one of the egalitarian countries, is 0.25 while Brazil, which is considered one of the world's more unequal countries, has a coefficient of 0.59. A major driver of income inequality is the urban-rural income gap. The ratio of urban to rural per capita income in 2005 stood at around 3.0.⁷ There are, however, increasingly important urban income disparities along two dimensions:

Coastal vs. Inland Disparity. The process of reform and opening was spearheaded on the coast with preferential treatment granted to engage in trade, host foreign investment, and generally develop a market economy. Inland regions and the northeast were hindered in their transition not only by delayed policy relaxation but by a legacy of bigger and more entrenched state enterprises that remained shielded from market discipline to protect vested interests. The coast also has a natural geographic advantage in conferring ready transportation links to the outside world and ready economic links to Hong Kong and Taiwan.

Within-City Disparity. In the past, income gaps in China were mainly between city and countryside residents. Since 2000, however, the income gap among urban residents has risen quickly; the urban Gini coefficient in 2005 was estimated at 0.4.⁸ Given China's rapid industrialization and urbanization, at least a short-term increase in the Gini coefficient could be expected. Moreover, the high levels of economic growth indicate that urban residents in general are becoming wealthier, although the income gap may be widening.

Urban Water Market Segments

The disparities between different types of cities were discussed in Chapter 1 in the context of "urban water market segments." The summary table from Chapter 1 is presented below in Table 3.1.

Table 3.1 shows that generally, the smaller and less affluent the city, the lower the levels of wastewater treatment and water supply coverage. Moreover, Chapter 2 indicated that, on average, Category III city water utilities performed poorly along most key variables, including water supply reliability, water quality, and financial performance.

Implications of Urban Diversity for the Urban Water Sector

The wide range of urban situations in China calls for adjusting national policies, standards, and concessionary finance programs to meet the economic realities of the smaller and poorer cities. China's current national policies, such as drinking water quality and wastewater discharge standards, are often directed at the highest capacity cities and only loosely enforced. Similarly, most of the national concessionary finance funds go to the larger prefecture-level cities. Low-cost, easy-

TABLE 3.1 Urban Water Market Segments

Market Segments	Number of Cities	Total Population (million)	Per Capita GDP (RMB)	Average Wastewater Treatment Coverage (%)	Average Water Supply Coverage (%)
Category I Cities: Population > 2 million GDP-capita > \$3,000	21	90	35,900	61	93
Category II Cities —In Between Category I and Category III Cities—	331	201	19,100	38	91
Category III Cities Population < 0.5 million GDP-capita < \$1,500	310	58	7,300	21	86
County Towns	1,636	96	NA	11	82

Sources: MOC, China Urban Statistics Yearbook (2005); and MOC, County Towns Brief (2004).

to-operate water supply and wastewater systems in smaller and poorer cities—where reasonable standards are enforced—are more realistic than universally high standards requiring expensive technology in many of China’s cities.

The widening income disparities within many Chinese cities also complicate tariff increases. Urban households in China must now pay for services once provided by the state, or state-owned enterprises, such as housing, health care, education, and public utilities. Lower- and middle-income households are struggling to meet these new expenses. Growing income disparities are feeding discontent—making increases in water tariffs politically complicated. Finding ways to increase utility revenues, while still protecting the poor and avoiding discontent among middle-income families, is a dilemma facing most Chinese cities.

Confronting Water Scarcity and Degradation

The combination of high population density, rapid economic growth, and accelerating urbanization has created a water resource crisis in China. Although this study does not focus on water resources, this broader topic has important impacts on urban water services:

- Water resource constraints and water quality degradation will require cities and their utilities to adopt more sophisticated and non-traditional approaches to ensuring reliable and cost effective ways of meeting the growing urban water demand.
- The extreme degradation of water quality in China’s rivers, lakes, and coastal areas is caused by a combination of

sources, including municipal, industrial, urban and agricultural runoff, as well as livestock operations. China's environmental regulators will need to strike a cost-effective balance between municipal and industrial pollution control, and managing agricultural and nonpoint sources of pollution.

Water Scarcity

China suffers from an uneven temporal and spatial distribution of water resources (see Box 3.2). Many cities are forced to suffer seasonal droughts or invest in expensive long-distance water sources to secure a reliable and high-quality water source. Chinese cities are also experimenting with nontraditional water sources such as wastewater reclamation, desalinization, brackish water use, etc. Demand management tools—including water conservation and water pricing—are also being increasingly used. Although all these approaches, as well as

others, are potentially viable, cities and their utilities will need to improve their overall water supply planning approaches to ensure the optimal combination of alternatives to reduce overall costs and ensure good service.

Water Quality Degradation

In spite of improved municipal and industrial water pollution control (see Figure 2.5), China's surface water quality does not appear to have improved over the last decade. Figure 3.3 shows that the percentage of surface water rated higher than Category V (i.e. the most heavily polluted water bodies) has hovered around 35 percent.

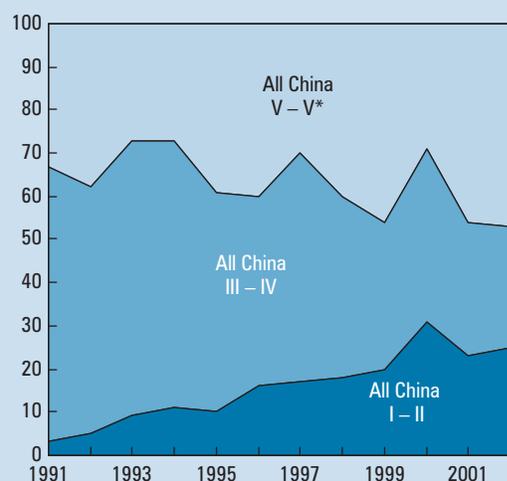
Moreover, water quality in China's coastal areas and key lakes appears to be declining, due in part to higher levels of nutrient loading, resulting in algae blooms and eutrophication. Water quality is affected by a number of other activities other than municipal pollution, such as discharges from over 18,000 towns, polluted agricultural runoff, live-

BOX 3.2 China's Water Resources

Water resources are scarce in China. Per capita freshwater availability in China was only 2,210 m³ in 2004, about one-quarter of the world's average. The per-capita water availability in the highly populated 3-H basins in the north of China (Huai, Huang, and Hai) is only 500 m³/person—below the internationally accepted threshold of 1,000 m³/person for severe water stress. Groundwater overdraft is a major problem in many places in China; many cities and the surrounding agricultural communities are relying on unsustainable groundwater resources.

Although municipal and industrial water demands have priority over agricultural water use, many cities still experience frequent water shortages. According to the *China Economic and Social Development Report* (2004), more than 400 cities in China face water shortages; in 110 cities, these shortages are severe.

Water resource distribution in China is extremely unbalanced among regions and seasons. Water shortage problems are most acute in dry seasons in the northern and western regions. South China has about 80 percent of the total water resources, while the North has only 20 percent. In comparison, the North has about 47 percent of the total population and produces 45 percent of the GDP. In addition, 60–80 percent of annual precipitation occurs in the four summer months, which contributes to flooding in the summer in the South, while the North has an extremely dry winter. China has an extensive and almost fully developed reservoir system operated by local, provincial, or national water resource agencies to help maintain water availability, but the fundamental constraint is the lack of sufficient runoff water in the North. Water resource agencies have responded to this situation by developing long-distance water transfer schemes, the most prominent of which is the South-North water diversion project. Drought emergency measures are also frequently applied in Chinese cities to deal with short-term water shortages.

FIGURE 3.3 Average Water Quality in Chinese Rivers from 1991–2002

Source: World Bank, Water Quality Management Policy (2006).

stock waste, and industries discharging wastewater outside of municipal boundaries. China's water pollution problems are serious and will remain so in the future.

Meeting Infrastructure Investment Needs

China will need to significantly expand its stock of infrastructure to respond to rapid urbanization, rehabilitate existing assets, and

implement national programs for wastewater treatment and drinking water safety. This will generate pressure to:

- Finance new investments, particularly through debt and equity markets rather than the municipal government budget
- Ensure that service standards are cost-effective and affordable
- Make good capital planning decisions that minimize costs while meeting service standards and regulations

Huge Future Sector Investment Requirements

Table 3.2 summarizes total investments over the period 1991–2005, and estimated investment over the period 2006–2010. From 1991 to 2005, around RMB 430 billion (\$54 billion) was spent in urban water infrastructure.

This study estimates that around the same amount, RMB 430 billion (\$54 billion) will be spent during the 11th Five-Year-Plan period (2006–2010), indicating that the rapid acceleration of infrastructure spending that began in the early 1990s will continue into the future.

Wastewater Investments. Investment in wastewater started slowly, but surpassed

TABLE 3.2 Approximate Urban Water Sector Investments

Sector Investment	Total Investment 1991–2005		Estimated Investment 2006–2010	
	US\$ Billion	RMB Billion	US\$ Billion	RMB Billion
Water Supply	25	200	20	160
Wastewater	29	230	34	270
Total	54	430	54	430

Source: MOC, Urban Construction Yearbook (2005); projections based on World Bank estimates.

water supply by 2000, and the growth rate is accelerating. The 11th Five-Year Wastewater Sector Plan (2006–2010) prepared under the auspices of the MOC estimates the total investment requirements necessary to meet the 11th Five-Year-Plan target of 70 percent urban wastewater treatment is around RMB 300 billion (\$38 billion). Given financing and implementation constraints, this study estimates the actual amount will be lower. Figure 3.4 shows the estimated breakdown in costs for different types of wastewater investments. In comparison with past capital works programs, more emphasis is being put on drainage networks (63 percent of costs) and sludge management facilities (14 percent). Wastewater treatment plants only account for around 16 percent of total costs.

Water Supply Investments. The 11th Five-Year Plan, for the first time, did not analyze the water supply sector. The national government now considers water supply to be a commercial activity and theoretically should

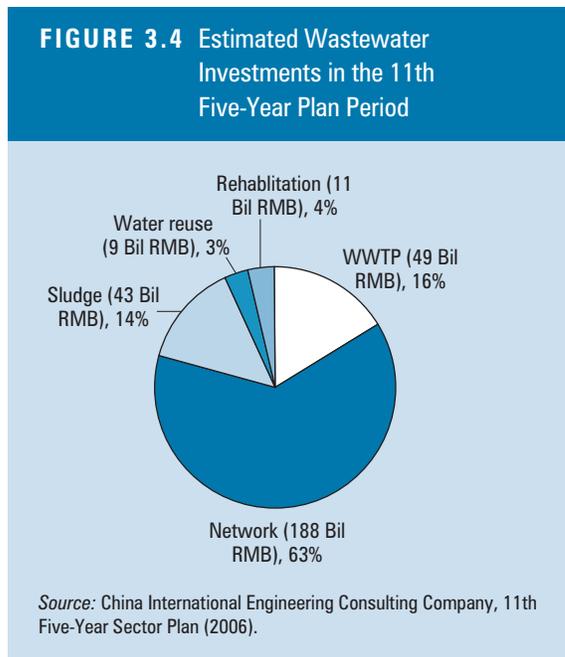
not be supported by the government. Many water supply companies, however, are still provided with significant capital subsidies in the form of equity contributions to overcome financing constraints and keep tariffs lows. We estimate that water supply investments will continue to increase gradually over the next five years, driven primarily by the growing urban population, the need to rehabilitate distribution networks, and the need to upgrade treatment plants in large cities to accommodate higher drinking water quality standards.

Improving Utility Financial Sustainability

Improving utility financial sustainability will help utilities finance future investments and improve performance. The concept used in this study is presented in Box 3.3, and uses the imagery of “climbing up the ladder” of financial sustainability. Improving financial sustainability for an urban water utility depends on many factors that are often beyond the control of the utility, including (a) tariff setting; (b) subsidies; (c) environmental and service standards; and (d) financing options. A financially strong utility generally is a result of good sector and utility governance, coupled with sound utility management.

Status of China's Water Utilities

Chapter 2 provided a general overview of the financial status of urban water utilities; Chapter 7 will provide a more in-depth analysis. Most of China's water supply utility companies fall in the middle or lower end of the financial sustainability ladder. Although some richer cities have water supply companies that are marginally creditworthy,



BOX 3.3 Financial Sustainability Ladder

Financial sustainability reflects a utility's capacity to meet its financial needs. There are several different levels of financial sustainability. Figure 5.1 presents a "financial sustainability ladder" and defines the following rungs: (a) *unviable loss-making utilities*, which meet the minimum financial sustainability threshold through both capital and operational subsidies; (b) *pay-as-you-go recovery of cash needs*, in which only capital financing needs subsidies; (c) *cost recovery*, in which utilities are profitable in any given year, but profitability is not sustainable in the long term, for example from insufficient renewal of assets; (d) *sustainable cost recovery*, in which utilities sustain the impact of long-term costs, including asset renewal; (e) *marginally creditworthy*, which requires utilities to have reliable refinancing sources and secure access to loans; and (f) *creditworthy*, the top level, which requires utilities to become creditworthy and the country's banking system and capital markets to function well.



All the utilities in the ladder are viewed as potentially financially sustainable. But their levels of financial sustainability are quite different. In general, the higher the financial sustainability level, the better the utility's capacity to meet ongoing cash needs, to cushion unanticipated cost increases and sudden financial shocks, and to fulfill capital financing requirements for further business expansion. A utility can move upward in the sustainability levels by fundamentally reducing risks or unpredictability of funding sources at each stage.

Source: World Bank Water and Sanitation Working Note 7 (2005), "Financing Water Supply and Wastewater Investments: Estimating Revenue Requirements" by Aldo Baietti and Paolo Curiel.

most cities still subsidize their companies. Fund shortages often prevent utilities from undertaking necessary asset renewal activities. Wastewater companies are generally financially weaker than water supply companies. Many wastewater companies are not responsible for wastewater collection, which in many cases is operated by a municipal

drainage department that relies solely on government budget transfers.

Benefits of Moving Up the Ladder. Less reliance on government funding, and more on user fees and capital markets can generate strong forces for improving efficiency. A predictable and adequate source of revenues

from user fees is usually more secure than relying on government transfers. Reliance on user fees is also more likely to increase accountability as customers will demand better service. If tariffs are low and the utility receives its budget directly from the government, it is less likely to be responsive to the needs of water users. Accessing financing through capital markets, as opposed to government equity contributions, requires utilities to demonstrate a greater degree of financial discipline, transparency, and accountability. Finally, governments are less able to politically manipulate utilities for their short-term interests, such as keeping tariffs artificially low or using utility employment as a source of patronage.

Limits to Moving Up the Financial Ladder. Although this study promotes the objective of urban water utilities moving up the financial sustainability ladder, there are obvious constraints to the pace at which this can occur. The lack of social acceptance by users may limit the pace and extent of tariff increases, particularly if the utilities are seen as being unaccountable and inefficient. In China, capital markets are still not fully developed and politically directed lending can undermine capital market discipline. Finally, municipal leaders may reap significant benefits from their control of the utility and be reluctant to allow the utility to quickly move up the financial sustainability ladder.

Chapter Summary

The five key challenges facing China and its urban water utilities in their efforts to improve performance are:

- *Responding to rapid urbanization.* Providing urban water services to new residents and dealing with new spatial patterns of urban development will be a demanding task.
- *Dealing with urban diversity.* China's policies, standards, and approaches for urban water services will need to be tailored to meet the economic and environmental reality of different types of cities.
- *Confronting water scarcity and degradation.* In spite of extensive efforts to improve water quality and ensure reliable water supplies, seasonal shortages and polluted water supplies will continue to pose problems.
- *Meeting investment demands.* Financing these investments, and ensuring investment efficiency, is a major challenge for the sector.
- *Improving utility financial sustainability.* Relying more on user fees, and less on government transfers, will help utilities increase transparency and accountability, improve access to capital markets, and operate at a higher level of efficiency.

Notes

1. See Chapter 1, Endnote 1.
2. *World Development Indicators* (2006)
3. The 2006 figures are based on a 2006 article from the U.S. China Business Council website, "China's Economy" at <http://www.uschina.org/info/chops/2006/economy.html>. The 1990 data is from an article "How to Make China Even Richer" in the *Economist* (March 23, 2006).
4. Chreod (2005)
5. *China Statistical Yearbook* (2005)
6. Mai and Weimer (2005).
7. *ibid.*
8. Xinhua News Agency. "Urban Income Gap Widens to Alarming Level." February 7, 2006.

4

2020 Sector Vision and Path Forward

If China is successful in improving the performance of its urban water utilities and meeting future challenges, there will be significant environmental, public health, and economic benefits. This chapter presents a sector vision for the year 2020 whereby:

- High-capacity cities provide high-quality water and wastewater services, and establish stormwater quality management programs. Utilities operate at international standards and rely on capital markets and user fees, but wastewater utilities still receive some municipal government capital contributions.
- Low-capacity cities provide reliable water supply and treat all wastewater to an intermediate level. Utilities are financially sustainable and rely on user fees for their revenues, but also receive municipal equity contributions and national concessionary finance to maintain acceptable tariff levels.
- Protecting public health by providing safer water and improving raw water quality
- Economic benefits by operating more efficiently and reducing costs for a given service level
- Promoting economic development and equity

The benefits of realizing this 2020 vision are significant and include:

- Water quality improvements in China's heavily degraded rivers, lakes, and coastal areas

The level of economic development in a city will have a profound effect on the evolution of its water utilities. Thus, the sector vision will need to take into account the different types of cities in China. The role of the government is to design and implement policies and programs that enable cities to improve the performance of their urban water utilities as quickly as possible—and in particular support the smaller and poorer cities. By comparison, Box 4.1 provides an example of the evolutionary track of Korea's wastewater sector.

Sector Vision in 2020

If China's urban water sector continues to evolve, improving service, increasing investment, and meeting the challenges outlined earlier, by 2020 the sector might look as follows.

BOX 4.1 South Korea: Wastewater Treatment Coverage vs. Economic Development

From 1980–2000, South Korea experienced a period of rapid urbanization and economic growth that bears some similarity to China's current development path. The figure below shows that South Korea's urban wastewater treatment coverage increased over time and with economic development. The figure expresses GDP per capita in terms of constant year 2000 U.S. dollars (adjusted for purchasing power parity to help take into account currency fluctuations and distortions). Several points are noteworthy:

- South Korea embarked on a national wastewater management program in the mid-1980s when adjusted GDP per capita was around \$7,000. South Korea then took around 20 years to achieve wastewater treatment coverage of 80 percent. China embarked on its municipal wastewater program around 2000 when its adjusted GDP per capita was \$4,000, and it may also take around 20 years to reach its national objectives.
- Category I cities in China had almost reached Korean levels of adjusted GDP per capita and wastewater treatment by 2005. Category III cities, however, have much lower adjusted GDP per capita (\$3000), but are driven by national policy to start their wastewater management programs at a much lower level of economic development than Korea's cities or the Category I cities.

One of the challenges facing the Chinese government is how to expedite the transition of cities to higher service levels within their economic development constraints and priorities.



Source: World Development Indicators and South Korea Ministry of Environment Statistical Yearbook

All of China's 661 cities and over 2,000 large towns have urban water systems that protect public health, contribute to the improvement of water quality, and provide efficient stormwater drainage. Services are provided through municipal utility companies, many of which have established part-

nerships with the private sector. Some cities have combined their water and wastewater utilities into single organizations, and expanded service into the surrounding towns and counties. Municipal governments have streamlined their governance system to ensure that key decisions such as tariff levels,

budget transfers, investment approval, and financing strategy are taken in a coordinated manner. Special programs have been established to ensure that water is affordable for the urban poor. Information on utilities is publicly and easily available and citizens and government use the information to monitor their utilities. Table 4.1 provides a summary of how urban water utilities would be performing in 2020.

Vision for High-Capacity Cities

As discussed in Chapter 1, high-capacity cities include all Category I cities (population greater than 2 million and GDP per capita greater than \$3,000) and the affluent Category II medium-sized cities. These

cities have high-quality water supplies that meet international drinking water standards. They have comprehensive wastewater systems that collect and treat all of the wastewater at the secondary level or higher. Sanitary sewer overflows are minimized and stormwater pollution control programs are being established. The utilities finance all of their investments through capital markets, except for stormwater drainage, which is still paid for by the municipal government. The utilities have adequate revenues from users to meet their operational, debt service, and asset renewal costs. In some cases, municipal governments have established “Water Boards” that are responsible for tariff regulation; some of these boards even regulate other

TABLE 4.1 Chinese Urban Water Utilities in 2020

High-Capacity Cities			
	Service Levels	Financing Sources	Revenue Sources
<i>Water Supply</i>	<ul style="list-style-type: none"> • Full coverage, continuous supply, adequate pressure • Low level of non-revenue water • Compliance with all 2007 drinking water standard parameters 	<ul style="list-style-type: none"> • Capital markets • Internal Cash • Municipal equity for drainage 	<ul style="list-style-type: none"> • Water users with low income help
<i>Wastewater</i>	<ul style="list-style-type: none"> • Full separate/combined collection coverage • Wastewater treatment at Class 1B or 1A standards • Storm water quality management programs 		<ul style="list-style-type: none"> • Water users with low income help • Industries according to pollution loads.
Low-Capacity Cities			
<i>Water Supply</i>	<ul style="list-style-type: none"> • Full coverage, continuous supply, adequate pressure • Reduced level of non-revenue water • Compliance with all primary 2007 drinking water parameters 	<ul style="list-style-type: none"> • Capital markets • Internal cash • Municipal equity • National concessionary finance 	<ul style="list-style-type: none"> • Water users with low income help
<i>Wastewater</i>	<ul style="list-style-type: none"> • Full combined collection coverage • Low-cost wastewater treatment (Class 2 or 3) 		<ul style="list-style-type: none"> • Water users with low income help • Industries according to pollution loads.

municipal utilities such as gas, district heating, power distribution, etc.

Vision for Low-Capacity Cities

All Category III cities (population less than 500,000 and GDP per capita less than \$1,500), less affluent medium-sized Category II cities, and all large towns are considered “low-capacity” cities. These cities and large towns have made tremendous strides in improving water services. Water is provided with adequate pressure throughout the day. Although drinking from the tap will not result in illness, most residents still purchase bottled water or boil the water first. All of the wastewater is collected and treated, although many cities have low-cost treatment systems that do not fully meet the highest national standards. The water utility is generally self-financing—with occasional assistance from the municipal government, but the wastewater sector receives significant financial assistance from municipal government funding and national concessionary finance programs. Revenues from users are sufficient to cover all the costs of utilities, including asset renewal.

Effective Sector Governance

The leadership, oversight, and financial assistance of the national and provincial governments have been crucial for realizing these achievements. The national government has made the provinces responsible for ensuring municipal governments provide adequate water services. The national government has also significantly increased the level of concessionary finance, and channels the funds through the provinces. Provincial governments have responded by establishing solid oversight programs that assist and monitor municipal utilities, and ensured that funds from the national government are used efficiently to meet the nation's objectives.

Benefits of Achieving the Sector Vision

As outlined in the 2020 sector vision, improving the performance of China's utilities would generate the following benefits:

Environmental Improvements

It will take decades to restore China's heavily polluted waters, but there can be continued improvement over the next 15 years. According to Figure 2.5, the total COD load from domestic and industrial sources in 2004 was approximately 13 million tons. If the sector vision is achieved, this pollution can be reduced by at least 75 percent over the next decade, which will have a significant impact on water quality in China's aquifers, rivers, lakes, and coastal waters, and allow aquatic ecosystems to begin a process of renewal. Based on other countries' experience, receiving water quality will improve after controlling municipal and industrial pollution, but sustaining a healthy ecosystem is a more complex endeavor that involves managing urban and agricultural runoff, as well as toxic chemicals. Box 4.2 provides an example from the Chesapeake Bay in the United States. Correcting decades of pollution in China will take an equally long time, but controlling municipal and industrial pollution is a critical step in a long journey.

Improvements in Public Health

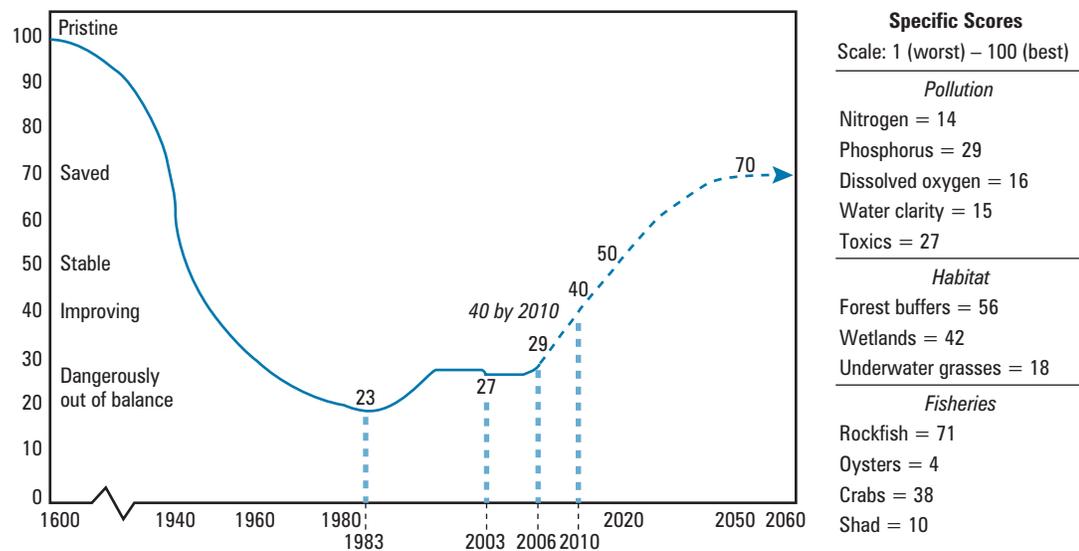
Water pollution endangers public health through a variety of mechanisms, including (a) polluting drinking water sources; (b) contaminating seafood, particularly in the extensive coastal aquaculture zones as well as capture fisheries; and (c) transmitting diseases through contact in rivers, lakes, and coastal waters. Quantifying the linkage

BOX 4.2 Ecosystem Restoration in the Chesapeake Bay, United States

The Chesapeake Bay is one of the ecological treasures of the United States but has been under severe stress over the last century due to pollution, overexploitation of fisheries, and shoreline development. The Chesapeake watershed contains 16 million people and covers parts of six states in the mid-Atlantic region. The first Chesapeake Bay Agreement was signed in 1983 and the Chesapeake Bay Program evolved as one of the nation's top ecosystem restoration priorities.

Since 1983, all cities in the watershed have constructed wastewater treatment plants, some of which remove the two major nutrients, nitrogen and phosphorous. In spite of spending billions of dollars to control municipal water pollution, the Bay's ecosystem is still close to collapse due to urban and agricultural runoff, lack of nutrient removal in some wastewater treatment plants, shoreline development, and atmospheric deposition of nutrients.

The Chesapeake Bay Foundation, a nongovernmental organization, produces annual "State of the Bay Reports" that grade overall ecosystem health based on a scale of 1 to 100. By this measure, the overall ecosystem status of the Chesapeake Bay has only improved marginally since the 1970s. The complexity, cost, time, and political commitment necessary to restore the Chesapeake Bay underscores that improving degraded water bodies (such as the Bohai Sea in China) can take many decades, and success is still uncertain.



Source: Chesapeake Bay Foundation (2006).

between water pollution and public health is complex and beyond the scope of this study, but is a major issue in China. The unreliable and low quality water service in many cities is a public health concern. Although Chinese custom is to drink boiled water, typically as tea, exposure to biologically unsafe water and toxic contaminants is a significant public health risk.

Unreliable water supplies can also impact public health by hindering basic washing and sanitation. Although China does not appear to have a serious water supply quality problem—except in cases of emergencies such as industrial pollution accidents—the impact of water services on public health is not well understood. Achieving the sector vision will undoubtedly improve public

health by reducing water pollution and improving the quality of water supplied by water utilities.

Cost Reductions for a Given Level of Service

The cost of providing urban water services is driven mainly by service standards and the efficiency of the utility. The sector vision calls for service standards to be calibrated to the economic and financial capacity of the cities. Once appropriate standards are set and implemented, then the economic cost of the service is very much dependent on the efficiency of the utility in making investment decisions and operating its facilities. There is huge scope for reducing costs of urban water services in China. Improving the efficiency of capital planning could conservatively reduce overall investment requirements by one-quarter, or RMB 100 billion (\$16 billion), over the period 2006–10.¹

Relieve Financial Burden on Municipal Governments

The sector vision calls for shifting more of the financing burden to the utility companies and away from municipal governments. It estimates that approximately 30 percent of all funding for water and wastewater infrastructure over the last decade has been provided by municipal governments.² If this trend were to hold in the future, municipal governments would have to fund around RMB 130 billion (\$16 billion) over the period 2007–10 alone. Municipal governments have limited financial resources, which are generally more efficiently spent on providing public goods that promote economic development and improve the quality of life, such as roads, parks, education, and public safety. Achieving the sector vision would move the financing burden away from the municipal government and

toward utilities that rely on user fees as a revenue base.

Promote Economic Development

All of the benefits identified above have direct and indirect economic benefits that would help promote overall economic development in China. Improvements in public health would reduce medical costs and improve worker productivity. Environmental improvements would directly improve some economic sectors such as aquaculture and fishery yields. Most fundamentally, improving investment efficiency would allow scarce capital to be employed in other, more productive uses.

Enhance Equity

Inequality is a serious and growing issue in China along three dimensions: (1) between rural and urban areas; (2) among cities, particularly between the coast and other areas; and (3) within cities. The key policies and programs embedded in the sector vision will help overcome these inequalities. Appropriate wastewater discharge and water quality standards will help reduce costs for smaller and poorer cities. National concessionary finance programs that target poorer cities and ensure efficient utilities will reduce costs. Although user fees will need to be increased, special programs will be formulated to protect the urban poor.

Strategic Directions and the Way Forward

Achieving the sector vision presented in this chapter will require enhanced policies and programs to improve utility performance. These enhancements are illustrated in Fig-

FIGURE 4.1 Strategic Directions for Key Policy Themes

Policy Themes	Strategic Directions
Chapter 5: Goal Based Sector Governance	<ul style="list-style-type: none"> • Improve National Policy Coordination • Shift from Physical Targets to Policy Goals • Set Appropriate Water Supply and Wastewater Standards • Enhance Provincial Government Oversight
Chapter 6: Municipal Utility Governance and Structure	<ul style="list-style-type: none"> • Streamline Municipal Utility Governance • Foster Efficient Utilities • Manage Wastewater as a Network Utility Business • Exploit Opportunities for Service Aggregation
Chapter 7: Financial Sustainability	<ul style="list-style-type: none"> • Achieve Utility Cost Recovery • Make More Use of Debt Financing • Improve National Concessionary Finance Programs
Chapter 8: Private Participation	<ul style="list-style-type: none"> • Ensure Private Arrangement Fits Into Sector Reform Plan • BOT Treatment Plants Fit Into Utility Network Business • Make More Use of Non-Investment Arrangements
Chapter 9: Capital Planning	<ul style="list-style-type: none"> • Utilize Integrated Water Planning Methodologies • Develop Asset Management Planning (AMP) • Strategically Plan and Manage Drainage Systems • Manage Sludge as Environmental and Financial Priority

ure 4.1 and discussed in the following chapters. The themes are interrelated and must be in balance for urban water utilities to perform efficiently.

Notes

1. Water treatment and wastewater treatment plants currently have around 30 to 50 percent excess capacity, as shown in Chapter 2. Assuming
2. See Table 7.7 for sector financing information. The 2006–10 sector investments are estimated at RMB 430 billion.

the same planning inefficiencies hold for water supply and drainage networks due to the absence of asset management planning, current sector investment inefficiency is conservatively estimated at 25 percent. Between 2006–10, the estimated sector investment is RMB 430 billion; 25 percent of this amount is RMB 107 billion.



Goal-Based Sector Governance

China can get better performance from its water utilities by improving the rules, policies, and effectiveness of national and provincial government organizations. Areas for improvement include:

- Increasing policy coordination and agency effectiveness at the national and provincial levels
- Moving from physical targets—such as pipelines and treatment plants—to policy goals, including ecosystem restoration, safe drinking water, and efficient utilities
- Setting realistic standards that are affordable, enforceable, and that create incentives for utilities to advance the policy goals

Figure 5.1 provides a schematic of the key themes in this chapter

The chapter describes the national institutions and outlines the key laws, policies, and directives governing urban water utilities. Like most large countries, China has a complex and decentralized system for the governance of urban water services; different agencies at different levels of government have overlapping functions and different perspectives. In the following section, we recommend establishing a “Na-

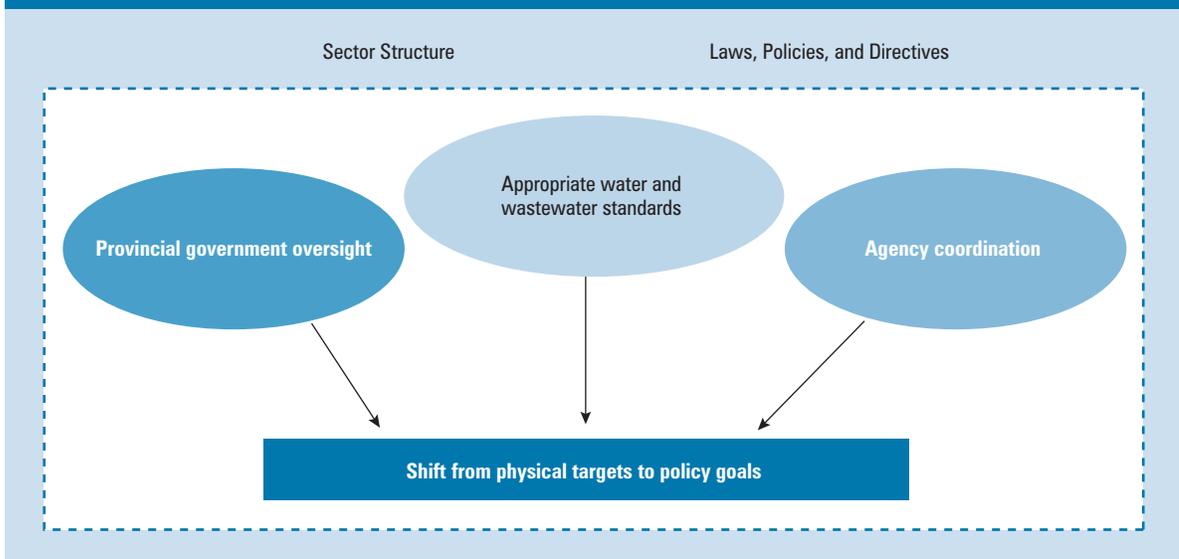
tional Water and Sanitation Committee” to help resolve policy coordination problems.

Better coordination among national agencies would help to define and monitor policy goals that go beyond the construction of infrastructure. We suggest some higher level policy objectives and monitoring indicators, including:

- Restoring ecosystem functions in rivers, lakes, and coastal waters
- Protecting public health by providing safe drinking water
- Delivering more efficient provision of utility services

Setting and enforcing realistic standards that take into account the wide variety of economic development and environmental settings is central to achieving policy objectives. This chapter points out that China’s water supply and wastewater standards meet or exceed the highest international standards, and proposes more explicit use of less stringent “transitional standards” that allow low-capacity cities to meet national standards over time. The chapter concludes by recommending that provincial governments improve policy coordination, increase funding, and build capacity for the provincial agencies that oversee urban water utilities.

FIGURE 5.1 Overview of Chapter Five

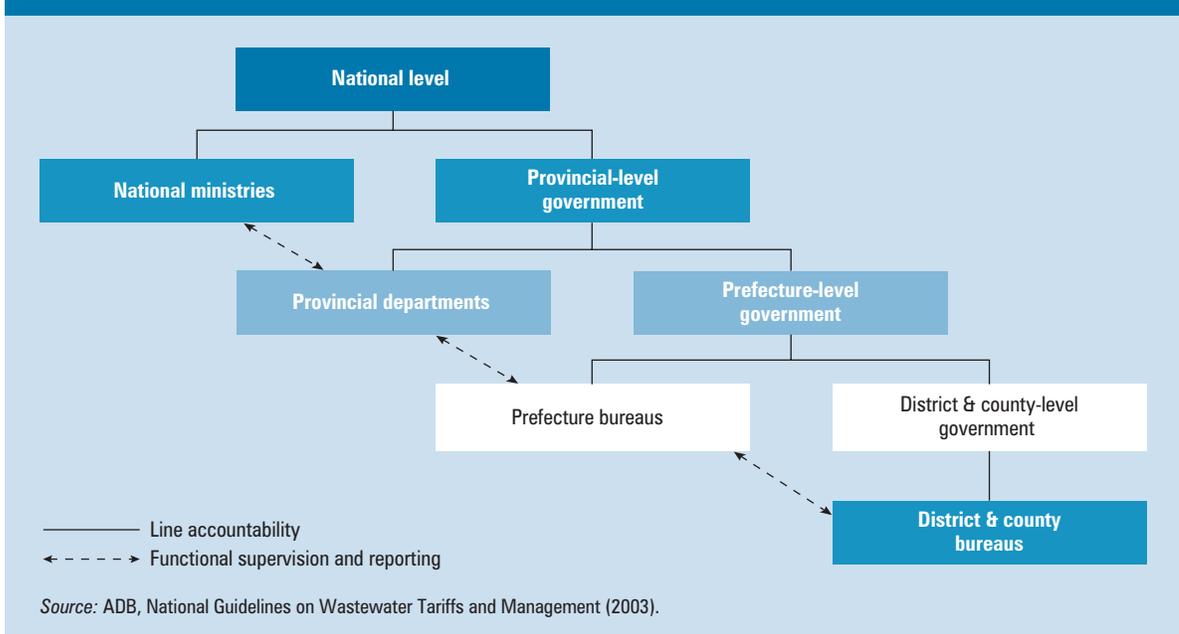


Overview of Sector Governance Structure

China has four basic levels of administration: national, provincial, prefecture, and county

(see Figure 5.2).¹ National governments oversee provinces, and provincial governments oversee prefectures. The prefecture government and its agencies have two functions: (1) they directly govern the prefecture-level city

FIGURE 5.2 Overview of Government Administration



and provide public services; and (2) they oversee county-level governments within their jurisdiction. Each province, prefecture, and county has an urban area which serves as the center of administration, and is referred to in this study as a “city” or a “municipality.” The actual provision of municipal services is the responsibility of the city and is discussed in Chapter 6. As shown in Figure 5.2, each agency has two lines of reporting: (1) line accountability to the responsible government entity (prime minister, governor, or mayor); and (2) functional supervision and reporting to the agency above it.

This chapter focuses on national and provincial organizations and policies, while

Chapter 6 deals with municipal-level agencies and urban water utilities. The term “agency” is used in the general sense to mean a government organization, whether it is a national ministry, state-level agency, provincial department, or municipal bureau in the Chinese context. The description of key national government agencies, and their functions with respect to the urban water sector, is presented in Box 5.1. Important attributes of Chinese government administration are discussed below.

Fiscal Decentralization

The fiscal system in China is highly decentralized. Municipal governments are respon-

BOX 5.1 Agencies Involved in the Urban Water Sector

Government. The State Council of the People’s Republic of China is the highest body of state administration. The State Council is composed of the premier (also known as prime minister), vice-premiers (or Vice-Ministers), state councilors, ministers in charge of ministries and commissions, and the auditor-general. China’s government is headed by the premier and his group of vice premiers, each of whom are responsible for specific ministries. The provincial government is headed by a governor, who also has a group of vice governors responsible for specific provincial departments. The national and provincial governments have the same set of agencies. All of the national agencies described below are of equal administrative rank, but NDRC and MOF have broad and influential mandates.

National Development and Reform Commission (NDRC). NDRC provides overall economic development policy, utility price policies, and guides China in the transition to a market economy. NDRC also administers the “State Bond” program, which is the most important national concessionary finance program for the urban water sector.

Ministry of Finance (MOF). MOF manages national government financial resources, budget allocations, and supervision of the country’s financial system.

Ministry of Construction (MOC). MOC is responsible for establishing policies, issuing directives, and supervising the management of municipal public utilities, including urban water utilities.

State Environmental Protection Agency (SEPA). SEPA is responsible for managing the environmental quality of air, land, and water. It oversees environmental impact assessments; develops and monitors water quality improvement plans; and proposes and enforces municipal and industrial wastewater discharge standards.

Ministry of Water Resources (MWR). MWR is responsible for establishing policies, issuing directives and supervising the management of water resources, as well as overseeing the provision of flood control and irrigation services. It is in charge of integrated water resource management, including water use and (in conjunction with SEPA) water quality management.

Ministry of Public Health (MOPH). MOPH is responsible for ensuring the safety of municipal water supply services in conjunction with MOC and SEPA.

sible for ensuring adequate funding for their public utilities by setting adequate tariffs, transferring funds from the municipal budget, and directing commercial bank loans to utility companies. Municipal agencies are funded by their municipal governments and often administer large budgets. Although they take policy guidance from provincial and national agencies, the municipal agency directors are heavily influenced by the municipal governments' priorities and directives. Municipal construction agencies, for example, often administer large budgets on behalf of the municipal government. In contrast, provincial and national government agencies play primarily an advisory and monitoring role in the provision of urban public utility services. National and provincial agencies have the power to set policies, guidelines, and standards for municipal utilities, but their ability to actually enforce these directives through legal or fiscal controls is limited.

Developing Legal System

China's legal system is developing along with its market economy, but the political culture does not lend itself well to strict legalistic enforcement of standards and regulations. China does have, however, a unified political system led by the Communist Party, and the evaluation of government officials is based primarily on their accomplishments and compliance with government policies. For example, China established a national policy of urban wastewater treatment through a State Council Directive in 2000.² This helped to mobilize cities throughout China to start the construction of wastewater treatment plants at an exceptionally rapid pace. Mayors and their municipal agencies were motivated by the urgency of the wastewater problem, but they also knew that their per-

formance evaluation and future promotion potential would be based partly on success in infrastructure construction. One of the challenges for China is to develop a similar incentive system for ensuring sustainable and efficient delivery of municipal services.

Key Laws, Policies, and Directives

The legal and policy context for China's urban water sector has changed dramatically over the last decade, and the national government is actively promoting reforms to meet future challenges. The general legal framework at the national level is in place, complemented by policies issued by the State Council and directives issued by national and provincial agencies. The key elements are as follows:

National Laws. The "Law on the Prevention and Control of Water Pollution" was promulgated in 1984 and provides the legal foundation for water pollution control. The law was amended in 1996 to include (a) a requirement for cities to provide centralized treatment for both municipal and industrial wastewater; and (b) improved industrial water pollution control, including adopting clean technologies and controlling the mass of pollutants discharged (as opposed to only effluent concentrations).

The 1988 Water Resource Law was fundamentally amended in 2002 to focus on comprehensive water resource management. The law stresses the importance of the "user-pays" principle, and the need to conserve water by promoting water-saving technologies and controlling demand. The 2002 amendments call for integrating water quality considerations into water resource management, and empowers the Ministry of Water Resources and its line agencies to play a more proactive role in water quality management alongside SEPA.

State Council Policies. As noted in Box 5.1, the State Council is the highest administrative body in China. Policy statements by the State Council represent official government policy and set national priorities and objectives. The key policies related to water are:

- *“Circular on Strengthening Urban Water Supply, Water Saving, and Water Pollution Prevention and Control (2000).”*

This historic circular has set the agenda for the period 2000–10 and calls for China to (a) improve water supply planning and promote water conservation; (b) enforce the existing “Law on Water Pollution Prevention and Control” and aim to achieve at least a 60 percent urban wastewater treatment rate by 2010; (c) promote market-oriented tariff reforms to help attract private capital; and (d) improve sector governance and regulation.

- *“Decision on Reforming the Investment System (2004).”* This decision allows and promotes nongovernment entities to invest in new areas of the economy, including municipal public utilities. It also provides more flexibility and encourages enterprises to raise capital through debt and equity markets. It also relaxes the government’s review process for new investments.

Ministerial Directives. The ministries provide directives that advise and guide lower level agencies on how to implement national level laws and policies. Although the directives are not legally binding in a strict sense, the lower-level agencies are expected to study, adapt, and apply the directives to specific situations. Some of the key directives, which indicate how the sector is evolving, are presented below:

- *Establishment of Wastewater Companies.* In 1999 NDRC,³ MOC, and SEPA issued a notice to “Improve Wastewater Collection Capability and Establish Sound Collection and Treatment Practices” (Notice 1992). The notice called on cities to establish wastewater companies, collect wastewater fees as part of the water supply bill, and start constructing wastewater treatment plants.
- *Market Reform Policies.* The “Circular on Accelerating the Marketization of Urban Utilities” (MOC, December 2002) encourages domestic and foreign investment in urban public utilities through a variety of ownership arrangements such as sole ownership, joint venture, or partnerships. The “Circular on Accelerating the Commercialization of Urban Wastewater and Solid Waste Treatment” (MOC, NDRC, and SEPA, September 2002) provides specific references to wastewater treatment plants and promotes arrangements such as build-operate-transfer (BOT), joint ventures with municipal utilities, and transfer-own-transfer (TOT).
- *Regulatory Reform Policies.* With the deepening of market reforms in the sector, the government recognized the need to strengthen monitoring, regulation, and oversight of the sector. In 2004, the MOC issued Decree 126 regarding “Management Measures for Concession of Public Utilities,” which laid the basic ground rules for competitive and transparent awards of public utility concessions. This was followed by another MOC Opinion in 2005 on “Strengthening Monitoring on Municipal Public Utilities,” which empha-

sized the supervisory role of the municipal and provincial governments, the need to improve laws and regulations, and capacity building for utility regulation. The opinion also noted the need to moderate the reform pace in order to balance efficiency and equity.

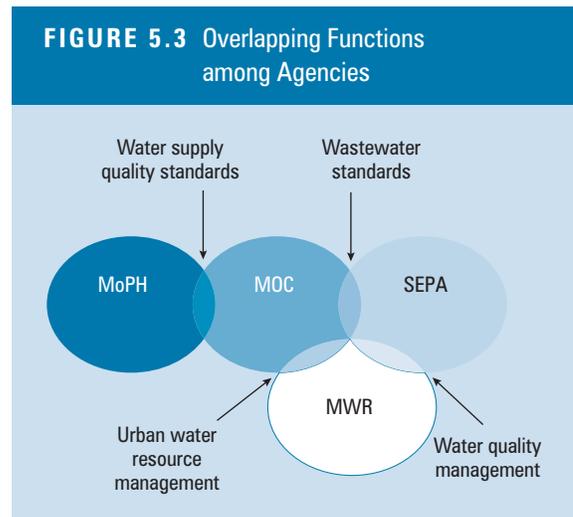
Improving National Policy Coordination

The provision of urban water services involves many different issues that, similar to other countries, are the domain of different government agencies in China. Coordination involves ensuring the policies, plans, and regulations are consistent, and managing input from the various government agencies involved in urban water services. This study recommends that coordination be improved in China, and suggests the establishment of a “National Water and Sanitation Committee” under the leadership of a vice prime minister.

Need for Improved Coordination

Differences of opinion and perspective among different sector agencies—and other stakeholder groups—are natural and necessary for good governance in the urban water sector. The following paragraphs review some of the key tensions that currently exist among national agencies, which are shown schematically in Figure 5.3.

MOC-SEPA Coordination on Wastewater Standards. SEPA is responsible for setting municipal and industrial effluent standards. As an environmental agency, its perspective is focused on improving environmental quality. MOC is responsible for supervising urban water utilities; it places a high priority on utility financial and operational perform-



ance. As discussed in the next section, the application of stringent wastewater discharge standards puts significant pressure on smaller and low-income cities, which may actually undermine efforts to improve wastewater management. Reconciling the need for environmental protection with ensuring the performance and sustainability of utilities is critically needed.

SEPA-MWR Coordination on Water Quality Management. The 2002 Water Law provided MWR with a mandate for integrated water resources management, including water quality. SEPA has historically been responsible for ambient water quality standards, water quality monitoring, and developing water quality improvement plans. SEPA still has the sole responsibility for industrial pollution control and monitoring and enforcing wastewater discharge standards. Both agencies have legitimate and important roles to play in water quality management. Water resources cannot be managed without considering water quality, and water quality management cannot take place without considering pollution control. Finding ways in which MWR, SEPA, and MOC

can work together in planning the best way to protect China's water environment will be key to meeting policy objectives.

MWR-MOC Coordination on Urban Water Resources Management. The 2002 Water Law also prompted the establishment of "Urban Water Affairs Bureaus," which are responsible for supervising all water-related activities within a city, including water supply, wastewater, flood control, and drainage. Some large cities such as Beijing, Shanghai, and Shenzhen have created such bureaus under the leadership of the local water resources bureau. As shown in Figure 5.2, agencies typically have one line of functional reporting and supervision to a higher level agency. Water affairs bureaus need to report to both MWR- and MOC-affiliated agencies, with the most direct line to the MWR. Creating water affairs bureaus allows water to be managed in an integrated manner, but there still need to be strong linkages with the MOC on issues related to utility management.

MOC-MOPH Coordination on Water Supply Quality Standards. MOPH proposed new draft water quality standards in 2001, and MOC issued draft water quality standards in 2005. As discussed in the next section, the National Standards Commission and MOPH have prepared draft standards that are expected to be approved in 2007.⁴ Monitoring drinking water quality falls under the jurisdiction of both sector agencies. Coordination between MOC and MOPH in setting, monitoring, and enforcing drinking water quality standards is important for the sector.

Coordination with NDRC on use of State Bond Funds. As discussed in Chapter 7, state bonds are grants or low-interest loans pro-

vided to cities for infrastructure development, including water infrastructure. The state bond program is administered by NDRC. MOC, SEPA, and MWR and their affiliated agencies at the provincial level also have legitimate interests in the financing of urban water infrastructure. Combining the sectoral expertise of the line agencies with NDRC's administration of the state bond program is necessary to ensure that concessionary finance is effective in promoting policy objectives.

Improving Coordination Mechanisms

National-level policies are formulated by the State Council. Since the Council includes members from all key ministries, each agency involved in the urban water sector is provided an opportunity to provide input on national policies. The administrative system makes it challenging, however, for different agencies to work together to craft integrated policies for consideration by the State Council. Moreover, each agency is allowed to issue directives within the scope of its perceived mandate without necessarily informing or obtaining the approval of other related agencies. We identified three broad options for improving coordination within the national government:

Establish a New Agency. A new agency could be established with most of the important functions related to urban water services such as setting and monitoring wastewater and water supply standards, setting ambient water quality objectives, administering national concessionary finance programs, and providing technical leadership. In the 1970s, when efforts to improve the environment in the United States were stalling, the government established the Environmental Protection Agency, which

became the leading national agency for water and wastewater. Based on feedback during study consultations, however, creating a new agency in China does not appear practical due to efforts to control the size of the national government and the complexity of realigning agency responsibilities.

Reallocate Responsibility Among Existing Government Agencies. There are various scenarios for changing the mandates of the key agencies to consolidate more functions in fewer agencies. Although this would potentially reduce the need for coordination, it may be politically difficult as agencies are reluctant to cede their authority. Vesting an agency with new authority without explicitly redefining the role of the agency that was formerly responsible can also create confusion. This study does not recommend any specific reallocation of responsibilities. If improved policy coordination cannot be achieved in the future, then consideration should be given to reallocating functions to reduce the number of agencies involved in the sector.

Establish a National Water and Sanitation Committee. This study recommends that the State Council establish a National Water and Sanitation Committee under a deputy prime minister. The main role of the committee would be to provide coordination among the sector agencies. The committee would not be a new agency, but rather a formal committee composed of representatives from relevant government agencies, as well as other stakeholder groups, with one ministry appointed as the secretariat. Its mandate would be limited to water supply and sanitation (including wastewater) in both rural and urban areas. The committee could meet on a monthly or quarterly basis, with

specialized ad hoc working groups, and would have the general functions of policy coordination and monitoring of sector performance and development. Of particular importance would be the compilation, analysis, and synthesis of information across different sector agencies, ideally resulting in annual reports on water supply and sanitation.

Shifting from Physical Targets to Policy Goals

China's policy environment in the sector is evolving quickly, but is still heavily focused on the rapid construction of infrastructure. Although increases in the stock of infrastructure are required, the physical works are only a tool to achieve broader policy goals. Prior to the 1980s, China had a planned economy where governments and state-owned enterprises were provided with physical production targets and their performance was evaluated based on production quotas; economic efficiency was not necessarily a priority.

The legacy of the planned economy still has a profound impact in today's China. National, provincial, and municipal governments often focus on constructing infrastructure rather than efficiently providing good service to meet China's broader policy goals. For example, MOC's annual yearbook records information related to physical infrastructure (e.g. kilometers of pipelines or treatment plant capacity) and sources of financing, but does not provide indicators on utility financial performance, compliance with standards, or operational efficiency. Provincial governments apply pressure on cities to construct wastewater treatment plants, but there is only limited effort to ensure comprehensive collection and adequate wastewater treatment.

These deficiencies are recognized within the government. Developing the necessary institutional arrangements to shift the focus from construction to efficiently setting and meeting policy goals, however, is a complex endeavor. A useful starting point is a clearer articulation of the policy goals and the specific parameters by which these goals would be monitored. Table 5.1 provides some examples for consideration.

Strengthening Provincial Government Oversight

Provincial government agencies have important roles to play in overseeing municipal utilities, including:

- Approval of municipal tariff adjustments
- Approving large investment projects
- Overseeing compliance with water supply and wastewater standards
- Helping to channel concessionary finance through the state bond program

Improving the capacity and funding of provincial agencies to better execute their existing mandates is important to achieving China's objectives. Similar to the national government, it is also important to improve coordination among provincial agencies. We suggest new institutional arrangements at the provincial level, including either:

- Creating a "Provincial Water and Sanitation Committee" to improve coordination
- Establishing a "Provincial Water Office" to consolidate functions in one agency

Role of the Provincial and Prefecture Governments. The provincial government has

TABLE 5.1 Examples of Broad Policy Goals

Policy Goal	Parameter
Restoring Ecosystems in Rivers, Lakes, and Coastal Areas	• Meeting time-bound water quality and ecosystem improvement targets
Protecting Public Health by Providing Safe Water	• Improvements in water safety as demonstrated in holistic assessments
Efficiently Providing Utility Services	• Continuous improvements in key utility operational and financial parameters

historically played an advisory and oversight role to the municipalities, maintaining control through the selection and approval of municipal leaders. This approach was formulated after the founding of the People's Republic of China in 1949 to enhance central government authority in a large and regionally diverse country, while at the same time allowing municipal governments to creatively respond to local issues. The Chinese fiscal and administrative system is relatively decentralized, with most of the tax revenues collected and spent at the local government level. The central government provides overall policy direction in the infrastructure sector, but allows considerable discretion to local governments in the pace and extent in which they implement general policies.

The prefecture government is under the supervision of the provincial government, but also administers its own prefecture-level city and oversees counties within its jurisdiction. Each county-level city or county-town (i.e. the capital of the county) reports to the mayor of the prefecture—who is also simultaneously the mayor of the prefecture-level city. In turn, the mayor of the prefecture reports to the provincial governor. There are 287 prefecture-level cities,⁵ 374 county-level cities, and

1,636 county capital towns. Hence, a significant part of the oversight activity actually takes place at the prefecture level.

Need for Provincial-Level Oversight. Cities and their utilities need to be supervised by a higher level of government to ensure compliance with national and provincial policies and standards. The provincial government is generally the best place for comprehensive utility oversight for the following reasons:

Provinces are the Right Size. Given China's size, comprehensive utility oversight at the national level is impossible. Conversely, municipal utility oversight at the prefecture

level is complicated by the large number of prefectures (287) and the limited amount of utility regulatory and oversight expertise in China. In addition, the 287 prefecture-level cities cannot provide oversight of their own utilities, which defaults to the provinces. The provinces in China are equivalent in size and population to many countries around the world. In most countries, the national government agencies play the key regulatory and oversight roles for the urban water sector. The MOC has also emphasized that the provincial construction agencies should "be responsible for guiding and supervising municipal public utility monitoring within their jurisdictional regions."⁶ Box 5.2 pro-

BOX 5.2 Role of National Government Agencies in Colombia

In Colombia, urban water services are provided by more than 1,700 decentralized and diverse municipal utilities. Although the majority of these water utilities are government-owned, private sector participation has been introduced in 14 of the largest cities and several medium and small municipalities. Monitoring and controlling such a large number of suppliers in the water sector calls for rigorous organization. Colombia has opted for a largely centralized approach, which is briefly summarized below:

- Water standards:
 - The Ministry of Social Protection (MPS) sets potable water standards on a national basis
 - National wastewater effluent standards are set by the Ministry of Environment, Housing and Urban Development (MAVDT)
- Tariffs and service standards:
 - Service standards such as coverage, continuity, and customer services are defined by the local government or by providers themselves
 - Since 1991, the Water and Sanitation Regulatory Commission (CRA) has been responsible for developing tariff rules, efficiency indicators, and coordinating the service quality standards.
- Monitoring and Enforcing:
 - The Domestic Utility Services Superintendency (SSPD) is responsible for monitoring and enforcing compliance with water, tariff, and service standards.

Alongside its role of monitoring and enforcing compliance, the SSPD uses benchmarking to assess the performance of water utilities in Colombia. For example, reports on water quality are released annually by the SSPD and made available to the general public. This benchmarking information assists policy makers when designing regulation and national standards. The benchmarking is also used by the general population, visitors, and non-governmental organizations to understand and improve water services in Colombia.

Source: Prepared by Castalia for this study.

vides information on the role of national agencies in Colombia, which is equivalent in population to many provinces in China.

Conflicts of Interest for Municipal Agencies. As shown in Figure 5.2, municipal agencies report to both the municipal government and their parent agency at the next highest level of government. For example, in a prefecture-level city, the municipal environment bureau reports to the mayor and the provincial environment bureau. In the event of environmental noncompliance of a wastewater treatment plant, the municipal environment bureau is often hesitant to inform the provincial environment bureau, as it may negatively affect the position of the mayor or their colleagues in the construction bureau. These conflicting roles often inhibit the flow of information upwards. Since provincial agencies do not report to municipal governments, they should tend to be more objective in their monitoring and enforcement activities.

The oversight responsibility of the provincial governments includes (a) municipal utility supervision through the Construction

Bureau; (b) approving large investment programs through the DRC; (c) reviewing and approving water and wastewater tariffs through the Price Bureau or DRC; and (d) formulating regional water pollution control and water resource management plans through the Water Resource Bureau and/or EPB. Hence, the provincial government already has significant oversight responsibilities for prefecture-level cities. The provincial government also monitors the prefecture government's oversight of county-level cities and towns.

Constraints on Provincial Agencies. Provincial government agencies already have some important oversight responsibilities, as summarized in Table 5.2, but the agencies face constraints in exercising their mandates, including:

Weak Incentive and Enforcement Mechanisms. In many countries, legal and financial penalties are often used by higher levels of government to drive the behavior of municipalities. China, however, has a non-legalistic oversight system that evaluates municipal leaders based on their overall compli-

TABLE 5.2 General Supervision Responsibilities of Provincial Agencies

Provincial Agency	General Supervision Responsibility
Provincial Construction Department	Supervise municipal utilities
Provincial DRC	Approve large investment projects
Provincial Price Department	Approve municipal tariff adjustments
Provincial EPB	Approve environmental impact assessments Monitor and enforce discharge standards Develop water quality improvement plants
Provincial Water Resources Department	Manage regional water resource infrastructure Allocate water resources within province
Provincial Public Health Department	Monitor and enforce drinking water quality

ance with national policies and achievement of planning targets. Threatening a municipal government with financial or legal sanctions will typically only occur in the most egregious of situations. One of the challenges for China is to develop an incentive system for ensuring sustainable and efficient delivery of municipal services. Evaluating the operational and financial performance of utilities is much more complex than simply verifying infrastructure construction. Programs for evaluating and benchmarking urban water utility performance are generally weak at all levels of government in China.

Low Supervision Budgets. Many of the key provincial agencies, including construction and environmental agencies, do not have large budgets and have limited staff and expertise. Their municipal-level counterparts in the large cities, who implement projects or actually monitor and enforce regulations, generally have access to more on-budget and off-budget financial resources. For example, municipal construction bureaus have large capital projects and are actively involved in real estate development. Provincial authorities, in contrast, rely primarily on a limited provincial government budget to undertake their activities. The shortage of funds can inhibit comprehensive regulatory oversight, staff development, and attracting top-level professionals.

Strengthening Provincial Government Oversight Capacity. Provincial governments, with the support and encouragement of the national government, could take the following steps:

- *Increase Agency Funding and Capacity.* In most cases, provincial agencies would need to bolster capacity and receive funding before assuming a more

active and effective role. The appropriate level of funding would vary based on the particular province and agency, but would be a small fraction of the money that is invested in urban water infrastructure. Funding could come from a combination of general provincial budget and/or charges on municipal utilities. National agencies could take a lead role in helping to develop programs to build the capacity of their counterpart provincial agencies.

- *Establish Provincial Utility Benchmarking Programs.* Public utility management and regulation at both the municipal and provincial levels is hindered by the absence of systematic and reliable data to evaluate utility performance. Over the past decade, international experience in the use of water and wastewater utility benchmarking has grown and there are now accepted methodologies for evaluating utility financial and operational performance (see Box 5.3). Provincial government agencies could take the lead in ensuring comprehensive utility benchmarking programs. In most cases, it would probably be more effective to subcontract or enter into partnerships with professional organizations to actually undertake the benchmarking.
- *Improve Oversight of Municipal Tariff Regulation.* The provincial price bureau, often under the provincial DRC, typically has the authority to review and endorse tariff adjustments approved by municipal governments. The review process, however, is often perfunctory and undertaken with the view of the impact on inflation and how the tariff compares with other cities. The review process can be expanded to

BOX 5.3 Water Utility Performance Benchmarking

Water sector performance assessment and benchmarking helps a regulator to quantify the relative performance of water utilities. Using well-established empirical procedures, the regulator can measure performance, identify performance gaps, suggest actions, and provide resources to overcome such gaps. The performance data collection is needed not only for the current operations, but also for documenting past performance, establishing a baseline for productivity improvements, and making comparisons across water and wastewater utilities. Rankings on the basis of performance indicators can inform (a) utility managers of their performance vs. other utilities; (b) policy makers; (c) fund investment providers (multilateral organizations and private investors); and (d) customers regarding the cost-effectiveness of different water utilities. The International Benchmarking Network for Water and Sanitation (IBNET) and other similar performance assessment tools are used by many national, regional, and municipal water regulators around the world.

Source: Prepared by Alexander Danilenko (2006), World Bank.

evaluate the process and analytical rigor by which municipalities set tariffs, and ensure that the best practice for economic regulation is utilized.

- *Proactively Manage National Concessionary Finance Programs.* Provincial governments could develop mechanisms to supervise and guide national concessionary finance programs within their provinces. As discussed in Chapter 7, the NDRC-administered state bond program and China Development Bank (CDB) provide concessionary finance to the water and wastewater sectors. These two programs should be significantly promoted or scaled up. However, provincial authorities should develop mechanisms to ensure that the funding is channeled to municipalities that can effectively utilize the funds and meet well-defined performance criteria.
- *Oversee Private Sector Participation (PSP).* As discussed in Chapter 8, many cities and their municipalities in China are struggling with the decision whether to enter into a partnership with a private water company, and

how best to structure and monitor the contract. The authority of the provincial government regarding municipal arrangements with private companies is ambiguous. To protect the interest of the public and the municipality, however, we suggest that provincial government agencies, either through the DRC or construction department, establish clear procedures and rules for provincial review of public-private partnerships.

- *Improve Provincial Policy Coordination.* Similar to the national government, provinces should establish a “Provincial Water and Sanitation Committee” composed of relevant government agencies and headed by a vice governor. We suggest that some provinces establish a “Provincial Water Office,” which would take over functions related to utility regulation and oversight that are currently scattered across different agencies. The office would have the mandate and funding to improve municipal and provincial regulation by developing enhanced procedures and regulatory tools, and leading reforms

in the sector. The office could also support large-scale training and capacity-building programs related to utility management and regulation at the municipal level.

Setting Appropriate Water and Wastewater Standards

Standards are a key tool in converting policy goals into action. China should aim to have standards that are:

- *Affordable* to ensure the service is financially sustainable
- *Enforceable* to allow regulators to compel compliance with unambiguous requirements
- *Efficient* to meet policy objectives in a least-cost manner

China's water supply and wastewater discharge standards do not fully meet these criteria. Every society aspires to have a perfect environment with high public health standards and unpolluted water resources. However, unrealistic standards and nonenforceable regulations can be harmful if they create an attitude of indifference among utilities, industries, and regulators. Standards and regulations should be tailored to match the environmental requirements, as well as the level of economic and administrative capacity. This section proposes the following approaches to standards:

- Use transitional standards for low capacity cities to allow them to improve service as they develop economically
- Improve water safety and ambient water quality through more comprehensive approaches, such as holistic

water safety assessments and watershed management

Municipal Wastewater Discharge Standards

Existing Standards. China has well-developed environmental quality standards for surface waters, as shown in Annex 2. Both SEPA and MWR have extensively surveyed the receiving water bodies and classified the quality of different river stretches (see Figure 3.3). The wastewater discharge standards for industries and municipal wastewater treatment plants are also provided in Annex 2. Table 5.3 provides a summary of the standards.

The provincial EPB is responsible for determining which standard to apply for a municipal wastewater treatment plant. Secondary treatment (i.e. involving biological treatment) is a minimum requirement for all cities. Class 1A standards are required for plants discharging into sensitive receiving water bodies. Meeting Class 1A requires additional treatment to reduce nutrients and suspended solids. Box 5.4 discusses a recent SEPA guidance note that requires all cities in key water resource protection areas to meet Class 1A standards.

Analysis of Existing Standards. Three issues—affordability, enforceability, and efficiency—affect the application of wastewater standards.

TABLE 5.3 Summary of China's Municipal Wastewater Discharge Standards

	Class 1A	Class 1B	Class 2
BOD (mg/l)	10	20	30
SS (mg/l)	10	20	30
Total-P (mg/l)	0.5	1.0	3.0
Total-N (mg/l)	15	20	30 (NH-3N only)

BOX 5.4 Application of Discharge Standards in China

In 2005 SEPA issued Circular No. 110, which provides guidance on the application of discharge standards for municipal wastewater treatment plants. Key points include:

1. All plants that discharge into important river basins and enclosed water bodies such as lakes or the Bohai Sea shall be required to meet Class 1A standards. Important river basins include, among others, the Hai, Huai, Huang, and Liao basins; these basins include most of the cities in North China.
2. Plants that discharge into Class III water bodies or Class II sea areas are required to meet Class 1B standards. (See Annex 2 for information on water quality classes).
3. Other areas may meet Class 2 standards, and gradually increase control requirements based on local conditions.

An analysis done by the World Bank for a 100,000 m³/d wastewater treatment plant in a poor city in the Liao River Basin indicated that a shift from Class 1B to Class 1A standards would result in a 15 percent increase in total life cycle costs. The reduction in BOD is insignificant, but the percentage of nitrogen and phosphorus removed would increase from around 75 percent to 90 percent. Nutrient pollution from agricultural runoff in the Liao River Basin is a major problem yet still largely uncontrolled. Reducing pollution from agricultural sources would potentially be much more cost-effective than upgrading to Class 1A standards. Moreover, like many cities in China, this particular city has no existing wastewater treatment plant, but is expected to immediately construct a complex and expensive facility and achieve discharge standards that most cities in Europe and North America are not required to meet.

Source: Adapted from SEPA, "Discharge standards for municipal wastewater treatment plants" Circular 110 (2006).

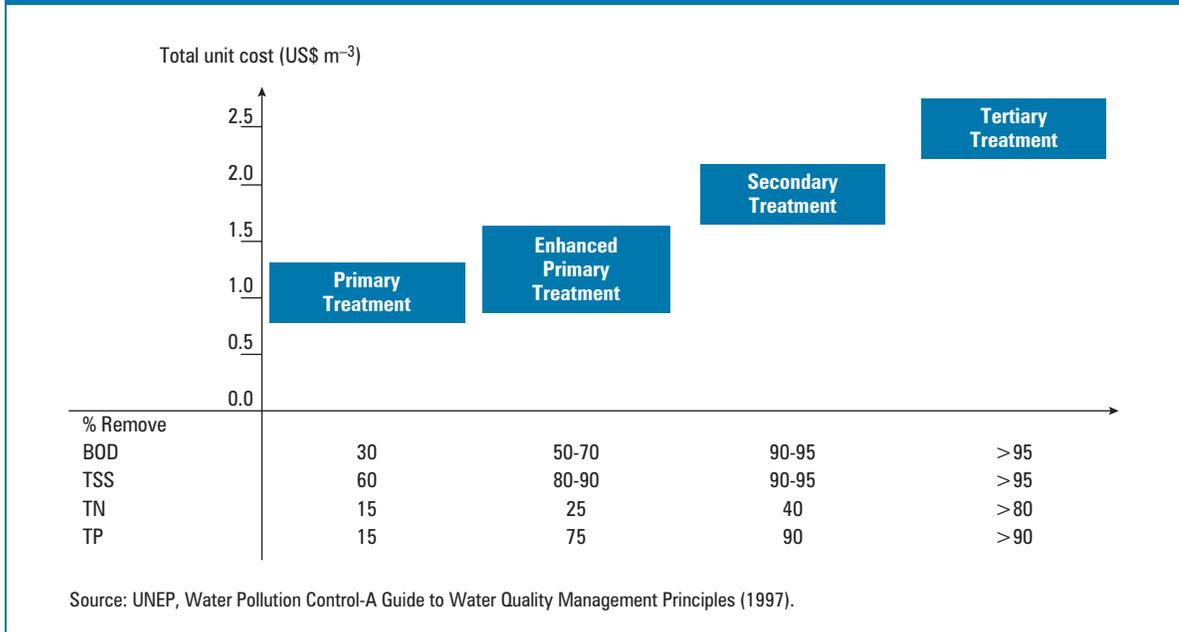
Affordability. Many of the smaller and lower income cities (including larger towns) may not be able to afford secondary wastewater treatment, let alone Class 1A standards requiring tertiary treatment. In addition to the investment costs, sustaining operations is a major challenge for these cities. The larger and richer cities can afford to, and should be required to, comply with the national discharge standards; it may take the low-capacity cities in China a decade or more to achieve comprehensive wastewater management. Two ways to help overcome financial constraints for low-capacity cities are (1) provide the cities with subsidies, and (2) use transitional standards to lower costs.

Box 5.5 shows the difference in costs between different levels of wastewater treatment in the United States and Europe. The costs in Box 5.5 represent the full capital and operating costs of wastewater collection and

treatment. They are not directly comparable to China due to the difference in purchasing power parity. Box 5.5 shows diminishing marginal returns in terms of pollution reduction as the level of treatment increases.

Enforceability. The procedures for determining which wastewater standard to apply in China are relatively clear, and summarized in Box 5.4. All cities must meet a minimum of Class 2 discharge standards; Class 1A or Class 1B standards may be required based on the well-defined surface water quality class of the receiving water body (see Annex 2). Each municipality thus has well-defined obligations that it must fulfill. This is similar to the United States or European Union, where all cities must have a minimum of secondary treatment or higher based on the receiving water body. However, the level of economic development in the U.S. and E.U. is much higher than in China, and many cities have received

BOX 5.5 Full Cost Wastewater Pricing For Different Treatment Levels in U.S. and Europe
(Includes collection and treatment costs)



significant subsidies from national governments to help construct wastewater facilities. High levels of wastewater treatment may not be affordable for many low-capacity cities. This complicates enforcement; environmental regulators may be hesitant to issue sanctions or compel cities to construct facilities that are clearly beyond their technical and financial capacity to sustain.

Efficiency. Two issues undermine the efficiency of the existing water pollution control regime in China. First, some cities invest in high levels of wastewater treatment that are expensive to construct and operate, while other lower income and smaller cities postpone construction of treatment plants or do not fully operate them. As shown in Box 5.5, there are decreasing returns in terms of pollution reduction per unit investment as higher levels of wastewater treatment are utilized. There are many cases in China where a large city has expensive tertiary

treatment, but is surrounded by smaller cities and towns that may not be able to afford expensive plants or construct drainage networks. Second, little attention is paid to controlling nonpoint sources of water pollution. These are major sources of water pollution and include agricultural runoff loaded with fertilizers and pesticides; livestock operations, in particular pig farms; urban runoff; and industries outside of municipal boundaries. Focusing on obtaining uniformly high levels of wastewater treatment in cities may be administratively easy, but it is not economically efficient to ignore other sources of pollution. Larger pollution reductions for the same cost could potentially be achieved by controlling nonpoint sources.

New Approaches for Wastewater Standards. Some new approaches for balancing affordability, enforceability, and efficiency are suggested below:

- *Use Transitional Standards.* Cities and towns that are not able to afford Class 1 or 2 discharge standards could start by ensuring full collection of wastewater and low-cost treatment. As the level of economic development improved, these cities could upgrade their treatment facilities and transition into compliance with national standards. There are a wide variety of low-cost treatment methods that come close to meeting Class 2 standards and could be utilized on an interim basis. This study suggests that provincial government agencies work with cities to develop appropriate wastewater treatment approaches on a case-by-case basis to treat 100 percent of the city's wastewater as soon as possible at an affordable level. The result would be an overall reduction in urban water pollution and lower costs.
- *Manage Water Quality on a Watershed/River Basin Basis.* Environmental protection bureaus in most provinces have prepared master plans for water pollution control for important basins. For example, with the financial assistance of the European Union, a comprehensive plan was prepared for the Liao River Basin in Liaoning Province. What is lacking, however, are management systems that include administrative and financial mechanisms to ensure that priority pollution activities within a basin are implemented. Municipal governments that can afford to, or have progressive political leadership, will respond to these plans. However, many important pollution control activities are underfunded and thus not fully implemented.

Drinking Water Quality Standards

The raw water sources for many of China's cities are heavily polluted. Much of the water treatment technology is rudimentary, and there are deficiencies with many of the water supply distribution systems. Although Chinese urban residents are fortunate that the reliability and coverage rate of water supply is quite high, the quality of the water is sometimes questionable. As noted in Chapter 2, there is limited public information available to judge the quality of the tap water in Chinese cities. The majority of urban residents—even in the Category 1 cities—do not drink water directly. Rather, the water is used for cooking, cleaning, and washing. If it is used for drinking, it is almost always first boiled. Drinking boiled water is both a cultural tradition and a response to the uncertain quality of the water from the tap.

Drinking Water Standards. Standards for drinking water (GB5749-85) were first promulgated in 1985. The 1985 standard covered 35 conventional indicators, including:

- Microbiological, in particular coliform bacteria
- Toxicological, such as heavy metals like arsenic and chromium
- General chemical parameters, such as iron and hardness
- Physical parameters, such as color, turbidity, and taste

The 1985 standard focused primarily on ensuring that drinking water quality does not produce immediate and obvious public health problems, particularly gastrointestinal diseases. The 1985 standards were equivalent to U.S. or E.U. standards that were in effect during that period. Since 1985, both

the U.S. and E.U. have revised their drinking water standards to take into account other contaminants, many of which increase the risk of cancer. New emphasis has been placed on synthetic organic compounds, such as pesticides and solvents. New biological pathogens have also been identified as priorities, such as giardia and cryptosporidium. Both MOC and MOPH have responded to this trend and proposed new standards. In 2001, the MOPH issued a proposed new standard with 96 contaminants. MOC followed in 2005 with a new recommended standard that includes 101 contaminants.⁷

The agency ultimately responsible for setting national standards in China is the "Standardization Administration," which in conjunction with the MOPH issued a new drinking water standard (GB5749-2006) that takes effect on July 1, 2007.⁸ The new standard increases the total number of controlled items from 35 to 106. The standard contains 42 items that are classified as "regular parameters;" applies to the whole country; and represents minor upgrades from the 1985 standard (GB5749-85). The remaining 64 "nonregular parameters" will only apply to cities that meet certain criteria. The nonregular parameters include less common microbiological and toxicological compounds, particularly pesticides and synthetic organic compounds. As of early 2007, the criteria for cities that must meet all requirements have not been specified, but will presumably apply to larger and more affluent cities. By 2012, all cities must meet the standards for both "regular (42) and nonregular (64)" parameters.

Analysis of Drinking Water Standards. The approach taken by the new standard (GB5749-2006) contains some elements that this study recommends for the wastewater

sector. The standard is flexible in that it distinguishes between higher and lower capacity cities, and provides discretion to the provincial government regarding how to apply the standard (42 or 106 parameters). The standard also requires all cities to provide a reasonable minimum quality of water by complying with all regular parameters, which addresses the core issues. Finally, the standard uses a transitional approach, which allows a city to gradually upgrade their facilities by 2012. Although the new standards are an innovative policy tool, the following analysis identifies important issues that will still need to be taken into account.

Affordability. The China Water Works Association estimates that in order to upgrade treatment facilities to meet the proposed new standards for approximately 20 percent of water supply systems (100 million m³/year), at least 50 billion RMB (\$6.25 billion) will be required.⁹ New sophisticated treatment technology will be needed, including activated carbon filtration and ozone disinfection. Some large cities such as Chongqing, Guangzhou, Shanghai, and Hangzhou have already started to upgrade their treatment plants. The cost of improving distribution systems or protecting and upgrading raw water sources is not included in this estimate.

Although some high-capacity cities may be able to meet the new standard by 2012, compliance will be out of reach for most of China's lower capacity cities. The costs for upgrading just the treatment plants for the large cities will be large. Many lower capacity cities will struggle financially and technically to fully comply with the 42 "regular" parameters by 2012. The extent to which additional costs can be recovered through user

tariffs may be limited. In China, water supply and wastewater tariffs are included on the same water bill. As cities expand their wastewater infrastructure and recover more costs from users, the water bill will increase. As noted in Chapter 7, the rate at which the water bill can increase is limited by concerns about social acceptability.

Enforceability. It will be a challenge to monitor and enforce compliance with the 2007 drinking water standard. The large number of parameters and advanced laboratory analysis required will make monitoring difficult. As noted in Chapter 2, the current drinking water quality monitoring system is relatively weak, and increasing the number of parameters will make monitoring more complex. Countries that have adopted similar standards, such as the United States, have found that compliance monitoring and enforcement is very challenging.

Similar to wastewater, if achieving the drinking water standards is financially unviable then enforcement becomes more difficult. Public health regulators may be hesitant to issue sanctions or compel cities to meet standards that are beyond their technical and financial capacity to achieve. Hence, even if the monitoring data exists to show noncompliance, the standards may not be enforceable for lower capacity cities.

Efficiency. Water standards are one element that determines overall water safety. The World Health Organization (WHO) has developed a framework for safe drinking water that is presented in Box 5.6. A comprehensive economic cost-benefit analysis for the new Chinese standard was not undertaken. An economic cost-benefit analysis would examine the health and economic impacts associated with the standard, and com-

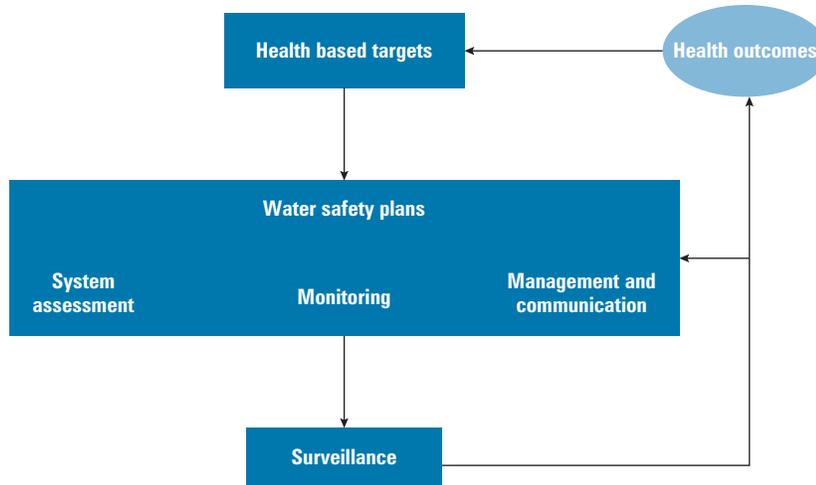
pare the benefits with the costs in terms of additional capital and operating costs. Rather, the standards are based on general WHO guidelines and examples from other countries.

Most utilities in China will respond to more stringent water standards by using more advanced and expensive treatment processes. Although upgrading treatment plants may be necessary in some cases, there also are many other ways of improving water safety, including protecting the source of the raw water supply; improving transmission and distribution systems to minimize infiltration; expanding operational monitoring; and improving emergency management procedures. The WHO guidelines note that since incremental improvements and prioritizing action in areas that pose the greatest overall risk to public health are important, there are advantages to adopting a “holistic” grading scheme for the relative safety of drinking water supplies.

New Approaches to Water Supply Standards. Some new ideas for balancing affordability, enforceability, and efficiency are suggested below:

- *Adjust the Transitional Period.* The new drinking water standard has elements of flexibility, transition, and discretion that can be used to make it more effective. This study suggests that a realistic time frame for compliance with the full standard (106 items) for high-capacity cities would be 2012 at a minimum. In the meantime, provincial governments should strengthen their monitoring capacity to ensure that all cities comply with the 42 “regular parameters” as soon as possible. The dates at which lower capacity cities

BOX 5.6 World Health Organization Framework for Safe Drinking Water



Health-Based Targets. These should be established by a high-level authority responsible for health in consultation with others, including water suppliers and affected communities. As part of an overall water and health policy, they should take into account the overall public health situation and contribution of drinking water quality to disease due to waterborne microbes and chemicals. They must also take into account the importance of ensuring access to water, especially among those who are not served.

System Assessment. The final water quality delivered to the consumer will be based on a number of factors, including raw water sources and activities in the watershed, transmission infrastructure, treatment plants, storage reservoirs, and distribution systems. Understanding the changes in water quality throughout the system is a complex but essential task.

Operational Monitoring. This type of monitoring focuses on frequent and scheduled monitoring to ensure that the water supply system is operating properly, and to take immediate corrective actions if needed. Operational monitoring should be based on simple and rapid observations such as turbidity, coliform counts, chlorine residual, etc. More complex tests are generally taken as part of the surveillance monitoring.

Management and Communication. A management plan details system assessment and operational monitoring and monitoring plans. The plan describes actions in both normal operation and during “incidents” that pose a public health threat.

Surveillance. The surveillance agency is responsible for an independent and periodic review of all aspects of safety, whereas the water supplier is responsible at all times for regular quality control. Surveillance contributes to the protection of public health by assessing compliance with water supply plans and promoting improvements in the quality, quantity, accessibility, coverage, affordability, and continuity of drinking water supplies.

WHO notes that national drinking water standards should be based on a variety of environmental, social, cultural, and economic conditions affecting potential exposure, and that this may lead to national standards that differ considerably from WHO’s own guidelines. A program based on modest but realistic goals—including fewer water quality parameters of priority health concerns—may achieve more than an overambitious one, especially if the targets are upgraded periodically.

Source: World Health Organization, Guidelines for Drinking Water Quality (2004).

would be required to meet the full standard should be realistic and could be left to the discretion of provincial governments.

- *Establish a System for Grading Drinking Water Safety.* We suggest that provincial agencies undertake comprehensive and systematic evaluations of the safety of municipal drinking water systems and grade their performance. The information should be made public, and municipalities are encouraged over time to improve their performance. Box 5.7 shows how this approach is used in New Zealand.

Summary of Strategic Directions

The strategic directions for national and provincial government identified in this chapter are summarized below:

- *Improving National Policy Coordination.* Key policy functions related to public utility management (MOC), environmental management (SEPA), concessionary finance (NDRC), public health protection (MOPH), and water resources management (MWR) need to be better integrated to improve policy coherence. Rather than creating a new agency, we recommend that a “National Water and Sanitation Committee” be established under the leadership of a deputy prime minister to improve policy coordination and serve as a focal point for matters related to urban and rural water supply and sanitation issues.
- *Shifting from Physical Targets to Policy Goals.* National and provincial governments should set policy-based goals that reflect higher level objectives and identify parameters for measuring progress. The objectives should be related to (a) ensuring efficient delivery of urban water services; (b) improving the quality and ecosystem functions of China’s rivers, lakes, and coastal waters; and (c) protecting public health and sustaining economic growth through water supply services. Government policies and programs should be structured to achieve these higher level objectives rather than physical targets related to infrastructure construction.
- *Enhancing Provincial Government Oversight.* Provincial governments have an important, but often neglected, role in sector governance. Provincial governments should increase the authority, budget, and capacity of provincial government agencies to oversee the sector, including (a) monitoring utility performance; (b) supervising municipal tariff regulation; (c) managing national concessionary finance programs; and (d) overseeing private sector participation. Provincial governments could improve policy coordination by establishing a “Provincial Water and Sanitation Commission,” or creating a new “Provincial Water Office” that would consolidate all key urban water regulatory functions into one office.
- *Setting Appropriate Water and Wastewater Standards.* Setting standards that are affordable, economically efficient, and enforceable is fundamental to achieving national policy objectives. For wastewater discharge standards, transitional standards should be used for low capacity cities that require full waste-

BOX 5.7 Grading the Safety of Water Supply Systems in New Zealand

The Ministry of Health (MoH) is the regulatory body responsible for the regulation of public health in New Zealand under the Health Act 1956. Following problems with drinking water supplies, in 1992 it began a strategy to improve the quality of drinking water and the management and monitoring of quality standards. The strategy, which follows the World Health Organization guidelines for safe drinking water, allocates the following responsibilities to the MoH:

- Setting safety standards for drinking water
- Providing a management plan and guidelines for meeting the standards
- Ensuring that adequate barriers to potential contamination are in place to minimize risk to public health
- Grading water supplies of all communities of over 500 people (smaller supplies may be graded in the future)

The grading provides a measure of the extent to which a community drinking water supply achieves and ensures a consistently safe and wholesome product. The grading is simple and easy to understand since it consists of two letters:

- The first letter (a capital letter from A down to E, with the exception of the highest grade, which is A1) represents the source and treatment grading.
- The second letter (which is lower case) represents the grading of the water in the distribution zone. Systems that incorporate a bulk water distribution zone have two separate distribution grades: one for the bulk water distribution zone, and one for the community reticulation zone. Each community has a minimum grading requirement that depends on its size.

The grading assessment is based on the following categories:

- Water source
- Treatment
- Distribution
- Risk of contamination
- Final drinking water quality

After an examination is carried out by drinking water assessors (designated by the Ministry of Health), grading questionnaires are completed in conjunction with the drinking water supplier. Compliance with the standards is assessed on a running annual basis.

The Ministry of Health is also responsible for publicly communicating the grading results by issuing press releases and annual reports, such as the "Microbiological Quality of Drinking Water." In addition, the MoH manages a national database of all community drinking water supplies, which contains a record of the details of each water system and monitoring data, as well as a Register of Community Drinking Water Supplies, which is available in all public libraries.

The implementation of the water quality grading system has led to significant improvements in the quality of the water supply in New Zealand. Its simplicity and availability have made it a useful tool for public information, so that when communities were awarded a low grade, public pressure resulted in efforts and political commitments to increase the quality of water supply. While only 50 percent of the communities had water supply systems that complied with the standards in the late 1990s, by 2007 about 75 percent of the communities were in compliance.

Source: Prepared by Castalia for this study.

water collection but allow for low-cost treatment. Water quality management efforts should be focused on prioritizing and implementing pollution control efforts from a river basin perspective. The new drinking water standards allow cities to transition to full compliance by 2012, but this date should be flexibly applied for lower capacity cities. Water safety grading schemes, which include but go beyond water quality compliance monitoring, should be used to evaluate municipal water systems.

Notes

1. The four-level hierarchy is the common simplification of a more complex system. For example Beijing, Shanghai, Tianjin, and Chongqing are referred to as “municipalities,” but have similar status to a province. There are around 23 sub-provincial municipalities such as Dalian, Shenzhen, Ningbo, etc., which have a higher status than a prefecture. There are also county-level “cities,” which have a higher status than regular counties.
2. State Council “Circular on Strengthening Urban Water Supply, Water Saving, and Water Pollution Prevention and Control” Issued November 7, 2000.
3. In a move symbolic of China’s transition to a market economy, the SPDC name was changed to National Development and Reform Commission (NDRC) in 2003.
4. See the article “China Revises National Drinking Water Standard” in the on-line magazine *China.org*: <http://french.china.org.cn/english/government/196216.htm>.
5. This includes the four municipalities of Beijing, Tianjin, Shanghai, and Chongqing.
6. See MOC’s (2005) “Opinion on Strengthening Monitoring on Municipal Public Utilities” (Jiancheng No. 154), which states: “Construction administrative authorities of all provinces and autonomous regions shall be responsible for guiding and monitoring the municipal public utility monitoring within their jurisdictional regions.”
7. See Footnote 4 above.
8. Ibid.
9. See the article “China’s new standard for drinking water creates billion-dollar market” in the Peoples Daily On-Line at http://english.people.com.cn/200511/07/eng20051107_219462.html.

6

Improving Utility Governance and Structure

Municipal governments and their utilities operate within the framework provided by national and provincial policies. Within this framework, municipal governments can improve the performance of urban water utilities by:

- Ensuring that service standards, tariffs, and fiscal support are properly balanced to allow utilities to recover their costs
- Putting pressure on utilities to consistently lower costs and improve service
- Adjusting the geographical scope and functions of utilities to improve efficiency, particularly for wastewater

China's vast size, combined with decentralization, has resulted in a rich diversity of arrangements for providing municipal services. This section explores and describes that diversity, and recommends ways to improve the structure and governance of municipal utilities. As background, it presents generic models for understanding the existing municipal sector structure. Balancing service standards, tariffs, and fiscal transfers is a difficult process, particularly in large cities. The chapter analyzes how this is done in China and suggests new approaches, including quasi-autonomous public utility boards or commissions. Many utilities in

China still function as government departments rather than modern commercial utilities. The chapter's third section discusses how municipal governments can instill a culture of "competitive utility management" by first empowering utilities, and then insisting on accountability through monitoring, transparency, customer orientation, and involving the private sector.

Urban water is both a "network industry" and a "natural monopoly." As a "network industry," the quality and cost of service depends heavily on the complex system of pipes and pumping stations. Many Chinese cities have fragmented the responsibility for wastewater between government drainage departments and wastewater treatment companies. The chapter's fourth section encourages Chinese cities to consolidate drainage collection and treatment functions, and operate the service as a network utility business similar to water supply. As a "natural monopoly," there tends to be increasing economies of scale—up to a point, for urban water services. Most Chinese cities, however, independently provide water services within their boundaries regardless of their size. The final section encourages municipal governments to exploit opportunities for aggregating urban water services and achieving greater efficiency.

Overview of Municipal Sector Structure

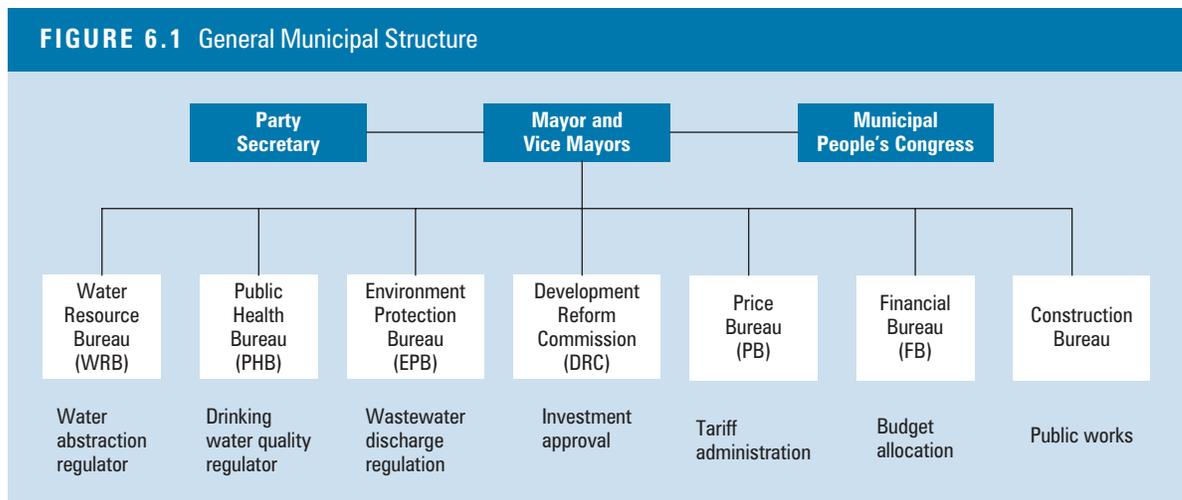
Under the former planned economy in China, the municipal government was responsible for all economic activity within its jurisdiction. Government agencies with specific mandates evolved to manage the planned economy, including industrial development, housing, pricing of goods and services, and allocation of resources. With the rapid development of the market economy in China, municipal governments now focus on providing essential public services, supervising public utilities, and promoting the local market economy. In the public utility field, municipal governments are in the process of transition from being less of a service provider and more of a service regulator, but the legacy of the planned economy era still remains, and in some cases hinders the development of modern water and wastewater utilities.

Figure 6.1 presents the administrative structure of a typical Chinese city. Box 6.1 provides a brief description of the functions of the different municipal agencies. Given the diversity and number of cities in China,

the typical models presented in this report are necessarily generic. The descriptions are intended to provide a basis for analysis and general strategic recommendations. Annex 3 provides some diagrams on how specific cities organize their urban water services, and reflects the actual complexity and diversity at the municipal level.

A Typical Hierarchy

This section explains the typical hierarchy in municipal government. Typically, the hierarchy includes a “leading group” under the leadership of the mayor, a parent bureau responsible for overseeing the utility; a water resources bureau or a separate raw water supply company with the water resources bureau as the parent bureau; wastewater utilities, usually provided either by a municipal wastewater company, a private company, or a joint venture between a private company and a municipal wastewater company; a price bureau that administers the tariff adjustment process for urban water utilities; an environmental protection bureau, which monitors wastewater discharges; and a public health bureau, which monitors water supply quality.



BOX 6.1 General Functions of Key Municipal Agencies

Construction Bureau. The construction bureau is responsible for overseeing the provision of basic infrastructure for a city, including roads, parks, water, wastewater, solid waste, gas, heating, etc. It also often plays an important role in guiding real estate development. There are usually departments for public works such as roads, parks, drains, solid waste, and utility companies for water, wastewater treatment, and heating. There is a wide variety in the ways cities are organized to provide infrastructure services. In large cities, a construction commission may be responsible only for policy and planning, while a construction bureau (the terms urban management bureau or municipal engineering bureau are also used) is responsible for construction and management.

Development and Reform Commission (DRC). The DRC evolved from the former planning commission, and is responsible for approving all municipal government investment proposals and leading the reform from a planned economy to a market economy. All major infrastructure investments must be reviewed and approved by the DRC. The DRC also takes a leading role in allocating and managing investment funds for government-sponsored investment projects, including foreign-funded projects.

Municipal Finance Bureau (MFB). The finance bureau is responsible for overseeing the financial affairs of the city, including taxation, budget allocation and control, and disbursement of foreign funds. It provides equity contributions for water and wastewater investments, as approved by the DRC, and in some cases allocates operating budget support for urban water utilities.

Price Bureau. In the past, the price bureau administered the pricing system for all goods and services. Its role has been gradually transformed to administering public utility prices and managing local inflation. In many cities, the price bureau has been incorporated into the DRC, acknowledging that economic reform requires market forces to determine prices.

Environmental Protection Bureau (EPB). The EPB is responsible for overall environmental management in the municipality, including approving environmental assessment reports, monitoring and controlling industrial discharges into both the environment and municipal drainage system, and monitoring municipal wastewater treatment plants.

Water Resources Bureau (WRB). The WRB is responsible for flood control, riverbank works, irrigation, and development of raw water supplies. Since water resource infrastructure tends to be large scale, the provincial WRBs are generally large and well-funded. Municipal WRBs focus more on local flood control, irrigation, and intercity canals. In some cities, the municipal WRB has been transformed into a “water affairs bureau” responsible for water and wastewater services.

Mayor’s Leading Group. All significant government decisions ultimately fall under the jurisdiction of the mayor and the set of vice mayors, collectively referred to as the “leading group.” There are typically three to five vice mayors, including an executive vice mayor. Each vice mayor is responsible for specific government agencies. Policy coordination between the different government agencies is expected to take place within the leading group under the leadership of the mayor.

Parent Bureau. All urban water utilities have a “parent bureau” that is responsible for overseeing the utility. The parent bureau appoints and monitors the senior management of the utility and provides service regulation. All issues requiring a decision from the leading group or other municipal government agencies are typically done through the parent bureau, including (a) budget allocations from the MFB, (b) investment approval by the DRC, and (c) tariff adjustments

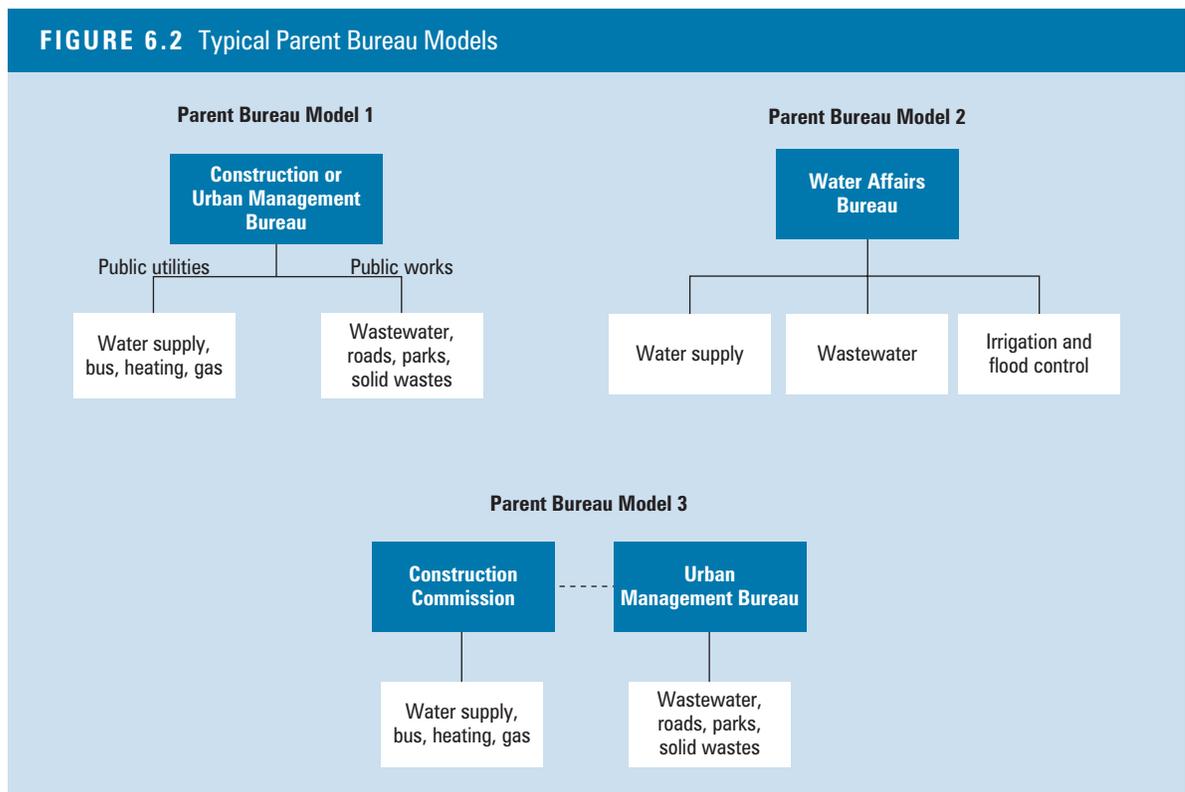
by the price bureau. Decisions by these government agencies are usually discussed and approved by the vice mayor and if necessary the leading group. There are three common arrangements for parent bureaus (see Figure 6.2).

- **Model 1: Water and Wastewater Have the Same Construction Parent Bureau.** This is the most common arrangement for smaller cities. The wastewater and water supply utilities report to same bureau. The bureau oversees all of the public works and utility companies in the city.
- **Model 2: Water and Wastewater Have the Same Water Affairs Parent Bureau.** Some large cities—such as Beijing, Shanghai, and Shenzhen—have created “water affairs bureaus” that are responsible for all aspects of urban

water management, including water, wastewater, flood control, water reuse, and raw water supply.

- **Model 3: Water and Wastewater Report to Different Parent Bureaus.** Some large cities have separated the policy and implementation functions for urban construction and management into two bodies. A “construction commission” provides policy and planning, and sometimes directly oversees municipal utility companies. An “urban management bureau” supervises public works departments such as roads and parks, and in some cases may also supervise water and wastewater utility companies.

Organization of Water Supply Utilities. Raw water supply is usually provided by the water resources bureau or a separate raw



water supply company with the water resources bureau as the parent bureau. Table 6.1 shows the common methods of organizing water supply service. The most common model involves a municipal water supply company providing both treatment and distribution services. Many cities are turning to the private sector to help with water supply treatment, either through a BOT (build-operate-transfer), TOT (transfer-operate-transfer), or joint venture with the municipal water supply company. In a few cases, there are joint ventures with municipal water supply companies for the complete service.

Organization of Wastewater Utilities. The organizational structure of wastewater utilities is more complicated than water supply, and is discussed in detail in a later section. Table 6.2 provides a general overview of how

wastewater services are organized. In most large cities, each district has its own drainage department. Wastewater treatment is usually provided either by a municipal wastewater company, a private company, or a joint venture between a private company and a municipal wastewater company. In some cases, mainly in small cities, one municipal wastewater company may provide both collection and treatment. Wastewater reuse companies, when they exist, are usually subsidiaries of the company providing wastewater treatment.

Tariff Regulation. This includes the rules and organizations that set, monitor, enforce, and adjust tariffs for urban water utilities. For water and wastewater tariffs, the utility company submits the tariff application to the parent bureau, which reviews and adjusts as necessary, and then forwards the

TABLE 6.1 Water Supply Utility Models

Frequency	Treatment Plant	Distribution Network
Most Common	Municipal Water Supply Company (MWSC)	
Common	Private Company or JV with MWSC	MWSC
Less Common	Joint Venture Between MWSC and Private Company	

TABLE 6.2 Common Wastewater Utility Models

City Size	Local Drains	Main Drains	Wastewater Treatment
Larger Cities	District Drainage Department (DDD)	Municipal Wastewater Company (MWWC)	
Larger Cities	DDD	MWWC	Private BOT or JV with MWWC
Larger Cities	DDD	Municipal Drainage Department (MDD)	Private BOT
Smaller Cities	MDD		Private BOT
Smaller Cities	MWWC		

application to the price bureau. The price bureau does not actually make decisions on tariffs but rather administers the tariff adjustment process. For the tariff adjustment process, an expert advisory group composed of officials from key agencies is established, often under the direction of the DRC, to provide an opinion on the proposed tariff adjustments. Public hearings are held, and the price bureau forwards a tariff recommendation to the mayor's leading group for a decision. The final tariff adjustment is approved by the provincial price bureau (for a prefecture-level city) or the prefecture price bureau (for a county-level city). In addition to the utility's revenue requirements, other important factors in the tariff-setting process are the level of local inflation and public acceptability.

Service, Environmental, and Public Health Regulation. This includes ensuring that the utility meets the defined service standards and complies with applicable environmental or public health regulations, such as wastewater discharge standards and water supply quality standards. The parent bureau is responsible for defining and monitoring service standards, and is also the front line agency for monitoring compliance with regulations. The EPB undertakes monitoring of wastewater discharges and the municipal public health bureau (PHB) monitors water supply quality. When a utility breaches a standard, the conflict between the parent bureau and the regulatory agency is often referred to the leading group for resolution.

Municipal Utility Fiscal Policy

This includes the fiscal principles and practices of the municipal government with respect to utilities, including capital contributions, operating subsidies, and tax incen-

tives. Municipal government funding of water and wastewater utilities is important for two reasons:

- *Capital Funding:* Cities typically make equity contributions to water and wastewater companies and provide capital funding for drainage departments.
- *Operating Budget:* Cities provide operating budgets for drainage departments, and occasionally provide funding support for water supply and wastewater companies in financial distress.

The parent bureau requests budget support to the MFB on behalf of the company or department during the annual budget planning process. As discussed in Chapter 7, there is an “urban construction and maintenance tax” in Chinese cities that automatically goes for urban infrastructure. In addition, the municipal government can transfer general budget funds to the parent bureau. The allocation of government funds is determined by the leading group and implemented by the MFB. In most cases, the budget is transferred from the MFB through the parent bureau to the company or department.

Facilitating Cost Recovery

Municipal governments in China can ensure that their utilities recover costs and provide sustainable service by improving mechanisms for setting service standards, tariffs, and fiscal transfers. In this study, utility cost recovery means that a utility has sufficient revenues to meet its obligations and needs, such as O&M, debt service, and making a

contribution to finance capital works. Chapter 7 discusses how most urban water utilities in China are struggling with cost recovery, particularly for wastewater.

Inadequate coordination among multiple municipal government agencies is one reason why many Chinese cities struggle with utility cost recovery. Some cities are able to coordinate the decisions of multiple agencies to achieve a sustainable balance, but many are not. Cities throughout the world face similar problems. This section recommends that China start experimenting with new approaches for improving municipal utility governance, including:

- Municipal public utility boards with the power to set tariffs, approve capital

spending programs and financing strategies, and oversee utility management

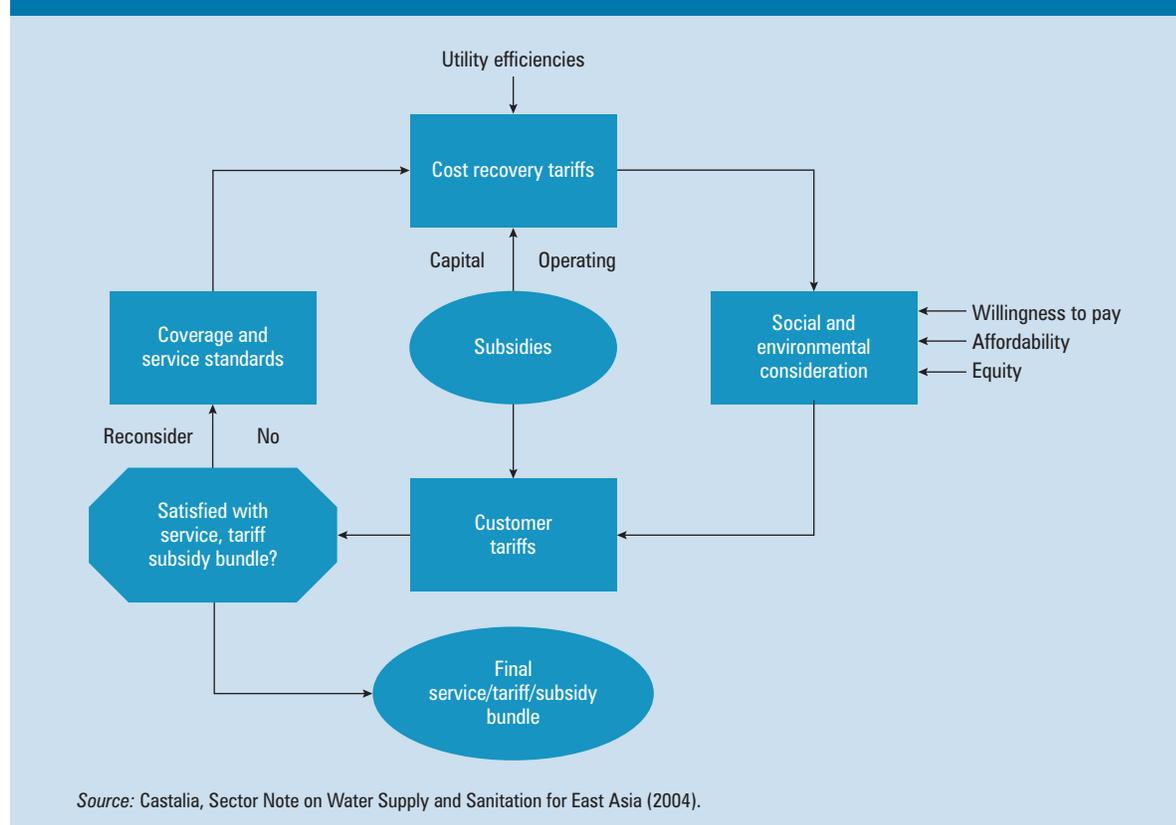
- Municipal utility advisory groups with the mandate to advise the municipal government on key utility management issues

The board or advisory group concept could potentially be extended to other municipal utilities such as gas, district heating, and public transport.

Getting Services, Tariffs, and Fiscal Support Right

Figure 6.3 sets out a process that shows how governments can achieve a sustainable balance between services to be provided, tariffs, and fiscal support. The diagram shows that

FIGURE 6.3 Balancing Service Standards, Tariffs, and Subsidies



Source: Castalia, Sector Note on Water Supply and Sanitation for East Asia (2004).

once service standards are set, with a given level of efficiency the cost of providing services is essentially determined. The cost of service must be met from tariffs, unless governments are willing to either provide capital or use fiscal transfers to keep tariffs at socially acceptable levels. The approach outlined in Figure 6.3 is straightforward, but there are many factors that may lead the process to establish an inconsistent mix of service objectives, tariffs, and fiscal support. It is common for tariffs or fiscal transfers to be inadequate to cover the costs of service at the level set by the standards. The two major constraints stem from political commitment and institutional coordination, each of which is discussed below.

Political and Institutional Constraints to Recovering Costs. Some municipal leaders may not want the utility to have an adequate combination of tariffs and fiscal support for the following reasons:

- Short-term political considerations may outweigh the need to raise tariffs or allocate more fiscal resources. The costs of raising tariffs or allocating more fiscal resources will be felt immediately, while the benefits of maintaining and renewing utility assets take some time to materialize.
- Some municipal governments may actually want a lower-cost, lower-quality service package rather than pay a high cost to achieve compliance with inappropriate national standards.
- Some municipal governments may not want to subsidize inefficiency, with the intention of driving down costs by reducing the amount of cash available to the utility.

The lack of coordination and capacity among government agencies is a key reason why cities in China have problems getting the bundle of services, tariffs, and fiscal support right. There are number of agencies, operating under the leading group, with each influencing a utility's ability to recover costs. The level of coordination between these agencies and within the leading group is not sufficient in many cases to ensure sustainable urban water services. Moreover, many urban water utilities are subservient to the parent bureau and do not take an active and independent role in facilitating coordination. Following the steps presented in Figure 6.3, typical agency coordination and capacity problems include the following:

Setting Appropriate Service Standards. As discussed in Chapter 5, the application of China's wastewater discharge standards and proposed new water supply quality standards may need to be adjusted to provide affordable and enforceable transitional standards for low-capacity cities. Even within the current standards, however, municipal governments and their utilities have flexibility to make important decisions regarding service levels, such as combined or separated stormwater and wastewater drains, level of flood protection, reliability of the water supply, etc. The utility parent bureau, with approval from the DRC, typically makes these decisions. The utility is then required to make the infrastructure investments, but the municipal government often does not have a clear idea of the associated costs or how they will be recovered.

Maximizing Efficiency. Many Chinese urban water utilities do not have strong incentives to operate efficiently. The third section in this chapter discusses how to make Chinese utilities more efficient by empower-

ing them to take control of core corporate functions, while simultaneously increasing their accountability, transparency, and customer orientation. Managing wastewater as a network utility business (section four), exploiting opportunities for service aggregation and economies of scale (section five), and appropriate private sector participation (Chapter 8) are also methods for improving efficiency and lowering costs.

Full Cost Recovery Tariffs. Based on the targeted service levels, and the investment and operational efficiency of the utility, the full cost recovery tariffs can be calculated. This requires the utility (or its consultant) to undertake comprehensive technical and financial modeling, but these skills are often lacking in Chinese utilities or their parent bureaus. The tariff calculations are often done after the investments are made, and based on standard formulas rather than comprehensive financial modeling.

The cost recovery tariff can be assessed against social and environmental considerations. If the government considers the resulting tariff to be too high, then it can provide capital or operating fiscal support to lower the tariff. Setting the type and level of fiscal support involves trading off the social desirability of restraining tariffs against other fiscal priorities. Programming fiscal support to utilities in Chinese cities is typically done as part of the overall budgeting process by the municipal finance bureau, under the direction of the leading group. Although the utility parent bureau can make a request to the municipal government, the budgeting is usually done as part of a more comprehensive budget process and often without explicit consideration of the funding needs of the utility.

For a given level of fiscal support, the government can then design a tariff that allows for cost recovery while achieving social ob-

jectives. The challenge in most Chinese cities, however, is that the level of fiscal support is not always clear or dependable. In addition, the tariff setting process managed by the price bureau (or DRC) considers other factors such as local inflation and social acceptability. The tariff ultimately is decided by the mayor and his leading group, which may have political reasons for limiting tariffs. Often, the result is tariffs that—given actual fiscal transfers—may be inadequate for the utility to recover its costs.

Approaches to Improving Municipal Utility Governance. A government may embark on serious water sector reforms, setting service standards, tariffs, and fiscal transfers that are appropriate and consistent. It may demand efficiency from its urban water service providers. But the real challenge is making these reforms last. There are strong incentives and plausible justifications for governments to change policy or fail to execute its functions properly over the long run. An essential part of locking in good reforms often involves governments choosing to limit their own flexibility by designing institutional arrangements that protect reforms and limit direct political involvement in utility management and regulation.

Cities throughout the world face municipal utility governance challenges similar to China, and some have devised institutional arrangements to help overcome these problems. Box 6.2 shows that even within one state in the United States, California, there are many ways of organizing the governance of a utility. The following approaches could be considered for cities in China with municipally owned public utilities, and apply not only to urban water but potentially to other utility services, such as gas, district heating, and public transportation.

BOX 6.2 Municipal Governance Models in California

Provision of urban water services in California is the responsibility of the local government. The services must meet the minimum requirements of the federal government as stated in the Clean Water Act and Safe Drinking Water Act. State agencies are responsible for ensuring municipalities comply with national standards and have the authority to promulgate more stringent standards as appropriate. Local governments have different approaches to providing urban water services, as demonstrated below for the four largest water utilities in the state:

Municipal Utility Commission: Los Angeles. The Los Angeles Department of Water and Power (LADWP), the largest municipal utility in the nation, was established more than 100 years ago to deliver reliable, safe water and electricity supplies to some 3.8 million residents and businesses in Los Angeles. As a revenue-producing proprietary department, LADWP transfers about 7 percent of its annual estimated electric revenues and 5 percent of its water revenues to the city of Los Angeles general fund. LADWP's operations are financed solely by the sale of water and electric services. Capital funds are raised through the sale of bonds. No tax support is received. A five-member Board of Water and Power Commissioners establishes policy for LADWP. The board members are appointed by the mayor and confirmed by the City Council for five-year terms.

Municipal Utility Advisory Board: San Diego. The San Diego Water Department provides water to over 1.2 million customers, as well as selling bulk treated water to neighboring cities. The Metropolitan Wastewater Department provides collection and treatment services for the City of San Diego, as well as treatment services for 15 other cities. The San Diego City Council is responsible for economic regulation of both departments and authorizes tariff adjustments. San Diego also has a "Public Utilities Advisory Commission" appointed by the mayor and confirmed by the City Council. The commission advises the city government on water and wastewater issues. Both the Water Department and Wastewater Department operate on funds from tariffs and service charges; its funds are administered in an enterprise account separate from the City of San Diego's General Fund. The city issues both separate water supply and wastewater revenue bonds.

Municipal Utility Board-East Bay Municipal Utility District (EBMUD). The utility provides water to 29 cities with over 1.3 million, and 640,000 people in 8 cities, in the eastern part of the San Francisco Bay Area. EBMUD is a special utility district separate from any city government. It is governed by a seven-member Board of Directors. The directors are elected for four-year terms. The board has the power to set tariffs and provides economic regulation and management oversight. EBMUD relies primarily on user fees, although it does have the authority to issue a surcharge on property taxes to provide for drainage services and issues its own bonds.

Private Company: San Jose Water Company. The San Jose Water Company is a privately owned utility listed on the New York Stock exchange serving over 1 million people, as well as providing services to other cities such as billing or distribution system monitoring. The City of San Jose has entered into a contract with San Jose Water to provide water supply services, but economic regulation is provided by the California Public Utilities Commission (see below).

California State Public Utilities Commission (PUC). The Commission regulates privately owned telecommunications, electric, natural gas, water, railroad, and passenger transportation companies. It is responsible for ensuring that customers have safe, reliable utility services at reasonable rates and are protected against fraud. Over six million Californians receive water and wastewater services from private companies. The PUC monitors their operations, sets water rates, and ensures compliance with water quality standards.

- *Municipal Utility Board.* Many large cities throughout the world have elected to establish quasi-independent boards appointed by the municipal government and responsible for the governance of their city's water and wastewater utilities. Typical functions include setting tariffs, approving capital investment programs and financing strategies, appointing management, and monitoring compliance with regulatory and service standards. This model is often used in large cities with government-owned utility companies or departments. The approach allows a reasonable level of expertise and accountability to develop among board members. There are various ways of selecting board members, for example:
 - Nongovernment specialists appointed by the mayor based on professional expertise, such as legal, financial, engineering, business, etc.
 - Government officials appointed by the mayor or based upon their position in the government
 - Elected or nominated members from different jurisdictions or interest groups
 - A combination of the above

Because board members typically do not have to satisfy interest groups on issues other than water, and are generally appointed, they have more freedom to take at least a medium-term perspective toward the utility business. The expertise of the board can contribute to improved utility efficiency in operations and capital planning. The effectiveness of a municipal board, however, ultimately depends on the selection of qualified board members, and the government's willingness to allow the board a sufficient level of autonomy and provide the necessary

level of fiscal and tariff support. Box 6.3 explains how Singapore has adopted this approach with the Public Utility Board (PUB)

- *Municipal Utility Advisory Group.* In cities where the formal establishment of a water board would not be politically possible, an alternative approach is to create a formal "advisory group." This would be a formal group with a clear charter. The same options for selecting board members also apply to advisory group members. The group would provide formal recommendations to the mayor's leading group on the similar issues as a board. Typical functions include setting tariffs, approving capital investment programs and financing strategies, appointing management, and monitoring compliance with regulatory and service standards. It is interesting to note that the Singapore PUB has mainly advisory powers, but is extremely influential given the expertise of its members and the government's commitment to provide high quality, sustainable water services.

Private Participation and Municipal Utility Governance

The majority of urban water services in China are provided by either government departments or municipal utility companies that operate as public service corporations. Chapter 8 describes how private participation is expanding rapidly in China. Most private participation in China has been in the form of BOT contracts for water supply or wastewater treatment plants with municipal utilities or the city. There are also an increasing number of joint ventures between private companies and municipal water supply utilities.

BOX 6.3 Singapore Public Utilities Board

The Public Utilities Board (PUB) was established in 1963 and was originally responsible for providing the country's utility services, including water, power, and gas. In 2001, the board's regulatory authority for electricity and piped gas industries was transferred to the Energy Market Authority of Singapore. At the same time, the water and drainage functions of the Ministry of the Environment (now called the Ministry of the Environment and Water Resources) were transferred to the board.

PUB is a statutory board under the Ministry of the Environment and Water Resources (MEWR). It is the water agency that manages Singapore's water supply, water catchment, and sewerage in an integrated way. Statutory boards of the Singapore government are organizations that have been given autonomy to perform an operational function. They usually report to one specific ministry.

PUB is governed by an 11-member board of directors and is chaired by a permanent secretary of the MEWR. The other board members include the PUB chief executive, and nine members appointed by the MEWR and drawn from business, academic, and engineering fields. The PUB has full corporate autonomy, but relies heavily on the government for financial support. The government funds the capital development and operating expenditures for drainage and wastewater treatment. In 2004, 23 percent of the PUB's operating expenses were provided by a government operating grant, and 85 percent of its capital expenditures were funded by the government. PUB makes recommendations regarding tariffs and budget transfers to the MEWR. The government is responsible for budget allocations and tariff setting based on the recommendations of MEWR and the PUB.

PUB was named "Water Agency of the Year" at the Global Water Awards 2006, and is considered one of the most technologically advanced water utilities in the world, with low rates of non-revenue water, desalination projects, watershed management, and advanced wastewater reuse programs. However, it is under pressure to improve its financial sustainability and control costs. In 2004, PUB was reorganized to improve efficiency and adopted a new approach termed "price minus." The price minus philosophy aims to inspire PUB employees to be cost-conscious and adopt a value-creation approach in decision making. PUB seeks to bring maximum value to customers at a minimum cost by doing more with less. Price minus is not a cost-cutting exercise; rather, it seeks increased value to partners and customers while driving down costs at the same time.

Source: From PUB Website: <http://www.pub.gov.sg>

The emerging partnership between private companies and municipal water utilities throughout China makes the need for improving municipal utility governance even more urgent. Private companies with contracts for BOT plants will demand payment for services, regardless of the financial health of the municipal utility. If the government does not adjust overall sector funding levels, through tariffs or fiscal transfers, then the financial situation of the municipal utility may deteriorate. Likewise, companies involved in joint ventures with municipal utilities will require adequate returns on their investment. If municipal gov-

ernments are not prepared to ensure this, then the joint venture will not be sustainable.

Fostering Efficient Urban Water Utilities

Many of China's urban water utilities perform below their potential because of a lack of pressure to improve performance. Although the water supply and wastewater business is typically classified as a "natural monopoly," there are ways that municipal governments can help ensure that utilities

strive to consistently lower costs and improve performance, including:

- Empowering utilities with more authority so they can be held accountable
- Closely monitoring performance
- Promoting transparency and customer orientation
- Judicious use of private sector participation
- Adjusting utility scope and scale to take advantage of economies of scale

Empowering Municipal Utilities

Many utility companies are under the direct control of their parent bureau, and operate more as a government department than a company. While this may be appropriate for smaller cities, larger cities generally need more professional and specialized management. Moreover, since parent bureaus are part of the municipal government, they are more likely to respond to short-term political pressures than autonomous and commercialized utility companies. Some urban water utilities in China, particularly in larger and richer cities, are already close to being international standard water companies. Most companies, however, still operate under the direct control of the parent bureau. These utility companies should be empowered to take over core corporate functions such as strategic master planning, capital improvement programs, developing financing and cost recovery plans, human resource development, and crafting appropriate private sector arrangements. The managers of a utility have to be held accountable for continuous improvements in performance. For this, they must be given the authority to propose strategic initiatives and manage the utility under the guidance of the municipal government. Box 6.4 shows a

typical situation in Chongqing between the parent bureau and urban water utilities.

Monitoring Performance

Good information on operational and financial performance is necessary to place competitive pressure on utilities. This information can be used to compare performance with other similar utilities and to track improvements over time for a single utility. As discussed in Chapter 2, information on utility performance is very limited in China. Many utilities do not collect adequate information, nor are they required to do so by the municipal governments. Moreover, even when information exists it is often not shared with the public, provincial agencies, or even within the municipal government. Chapter 5 called for the provincial government to initiate province-wide utility benchmarking programs. Municipal governments, in parallel, should insist on enhancing utility performance monitoring programs.

Transparency and Customer Orientation

Although public hearings for tariff adjustments are organized by the price bureau, public involvement and knowledge of key utility planning and management issues is typically limited. To generate competitive pressure, the information must be easily available to the public. Urban water utilities should be required to have open and transparent decision-making processes on key issues. This would involve opening up parent bureau or utility board meetings, making meeting minutes available to the public, and developing stakeholder and customer outreach programs to solicit opinions on key issues. Many urban water utilities could improve their customer support functions and better monitor overall customer satisfaction

BOX 6.4 Challenges Faced by Water Supply and Wastewater Companies in Chongqing, China

Under a World Bank-financed project, consultants were contracted to provide institutional strengthening services to two water companies and three wastewater companies in Chongqing.

Overall, the companies were found to be functioning well within the existing regulatory framework. They possessed many positive attributes. The two water companies were providing water 24 hours per day, and the three new wastewater companies (treatment plus main conveyance) were actively engaged in constructing needed assets. The companies had existing policies, practices, and procedures in place to support operation, and all were adhering to enterprise accounting systems. The companies' leaders were talented and dedicated, and the staff highly motivated.

Initial assessments found, however, that none of the companies had sufficient authority to manage themselves autonomously, although the water company enjoyed somewhat more autonomy. All were constrained by local government influences that limit the companies' practical control over key management functions. The operational companies were overstaffed and underskilled, and their planning processes were largely "reactive;" planning was mainly geared chiefly to responding to government-driven operating goals, guidelines, and priorities. The organizational structure of the companies did not confer business planning, budgeting, and tariff responsibility on these units. The operating utilities operated largely as cost centers with parent bureaus doing the planning and tariff analysis for them.

The consultants assisted the companies in five key areas: business planning, financial management, tariff forecasting, water and wastewater operations, and human resources management. The consultants concluded that although technical assistance can support companies in overcoming technology and management constraints, the application of additional technical assistance will produce diminishing results unless policy constraints to the companies achieving full autonomy are not released.

Source: MWH consulting firm, Institutional Strengthening and Training Report for World Bank-financed Chongqing Project (2005).

levels. The results of performance benchmarking programs should be available to the public and the press. Annual reports, financial statements, and capital improvement plans should also be made publicly available through Internet websites.

Private Sector Involvement

Chapter 8 discusses in detail how the private sector can help improve the competitiveness of municipal urban water utilities. The threat of private sector involvement can often make municipal utility management and workers act in a more competitive fashion just to keep their jobs and positions. Alternatively, when a municipal utility is striving to improve performance, it may turn

to a private company to provide some services, e.g. outsourcing tasks such as meter reading, drain cleaning, or hiring management consultants to stay competitive.

Adjusting Utility Scope and Scale

Adjusting the types of services and the service area of a water utility can often provide quick gains in efficiency. The next section discusses how integration of wastewater collection and treatment can improve transparency and efficiency of the overall service, and the following section discusses how creating larger urban water utilities that cover multiple jurisdictions can generate economies of scale that drive down costs. Another variation on this theme is that large cities

may wish to create medium-sized utility companies, which would allow the municipal government to easily compare the performance of the companies and generate competitive pressures for improvement.

Managing Wastewater as a Network Utility Business

The prevailing view in China is that drainage is a public good and wastewater treatment is a commercial activity. Consequently, drainage services are typically provided by a government department and a company is re-

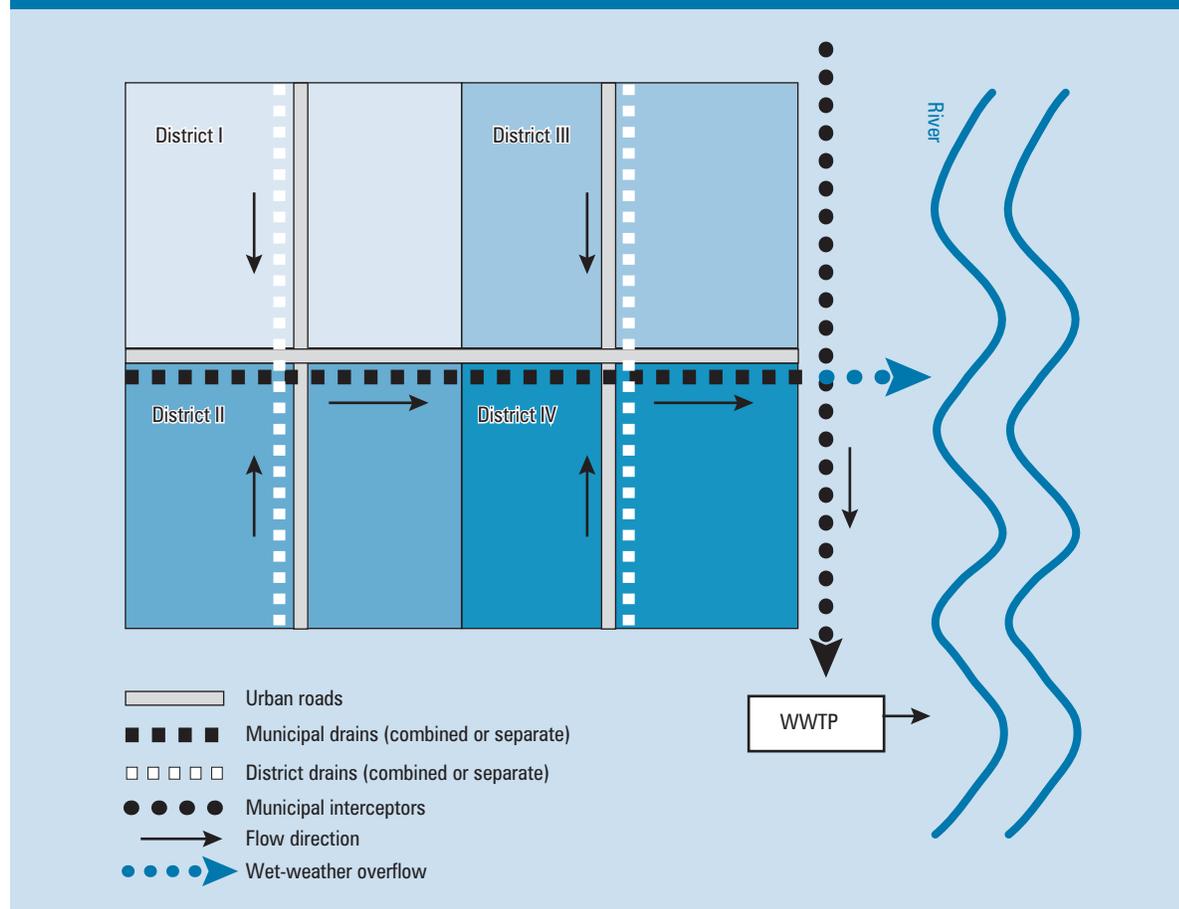
sponsible for wastewater treatment. This approach is contrary to typical international practice, where wastewater is managed as network utility business, including collection, conveyance, and treatment; and there is partial or full cost recovery for the full service.

Ideally, wastewater management should be the responsibility of only one utility. Since cities in China may have institutional constraints to quickly merging departments and companies, interim approaches are suggested at the end of this section.

Fragmented Service Delivery

Figure 6.4 shows the typical layout of an urban drainage system in a Chinese city. (Box 2.3 de-

FIGURE 6.4 Example of a Municipal Drainage System



finer wastewater terms used in this study.) There are currently many ways of organizing wastewater services in a city (See Table 6.2). In general, the larger the city, the more districts and the more fragmented the drainage collection. The service fragmentation seen in many cities—based on an historical evolution of a complex system—is as follows:

District Drainage Departments (DDD). A Chinese city is composed of multiple districts, typically ranging from two to six districts based on the size of the city. Each district government has its own drainage bureau that is responsible for drainage along its streets. The district road department is typically responsible for the construction of roads and drains, and then turns over the operation of the drains to the drainage bureau. At the district level, there may be combined drains, separate sanitary and stormwater drains, or a combination of both.

DDDs are generally overstaffed and have low professional capacity. These departments, however, have an important role to play in managing wastewater. Most of the drains in a city, in terms of length, are managed at the district level. The departments are responsible for ensuring that the drains flow freely and drainage pump stations operate properly. In addition, the departments ensure proper connections to the combined, sanitary, or stormwater drainage systems.

Municipal Drainage Departments (MDD). Large roads and drains that pass through multiple districts are typically the responsibility of the municipal government. MDDs tend to be overstaffed and inefficient, but have the important role of maintaining the main drains and pumping stations in the city. MDDs also oversee the district drainage bureaus to make sure the city has an effective

overall drainage system. In the past, Chinese cities were not required to treat their wastewater and all cities used combined drains. The combined stormwater and sanitary drainage was collected and disposed into the nearest water body, such as a canal, river, lake, or ocean. With the advent of wastewater treatment, MDDs were often charged with conveying the wastewater to the treatment plant. The MDDs constructed “wastewater interceptors,” which intercepted dry weather flows (i.e. no stormwater) from combined drains and conveyed the wastewater to the plant.

Wastewater Companies. According to national policy, cities are required to establish wastewater companies that receive revenue from wastewater tariffs, and operate on a commercial basis.¹ Cities have responded to this policy in different ways. Three common arrangements include:

- The MDD is turned into a company and made responsible for wastewater treatment.
- A new municipal company is established that is responsible for wastewater treatment and interceptors.
- There is a BOT arrangement with a private company for wastewater treatment.

Sources of Inefficiency

Organizational arrangements that reduce efficiency and increase cost include fragmented responsibility, underperforming drainage departments, and inadequate funds for drainage.

Fragmented Responsibility. Most cities have a vast network of combined drains, stormwater drains, sanitary drains, and interceptors that are managed by different entities. The city of Tianjin, for example has around 5,000 kilometers of drainage pipelines. This poses numerous problems. First,

different flows are often confused, with wastewater going into the stormwater drains, and stormwater going into the sanitary drains, thus undermining efforts to collect and treat the wastewater. Second, local drainage networks at the district level are often incomplete, resulting in inadequate collection of wastewater and localized flooding. District drainage departments often lack the funds and expertise to manage the assets in a modern and comprehensive manner. Third, the operation, maintenance, and asset management of the collection network is not conducted on a systemwide basis. These problems significantly reduce the efficiency and effectiveness of the overall wastewater management program.

Integrated wastewater utilities (combing collection and treatment) are the norm in most countries. Many cities have combined their water and wastewater utilities to provide full water cycle service. Box 6.5 provides an overview of how the United States and United Kingdom organize their drainage collection systems.

Underperforming Drainage Departments.

Drainage departments are often overstaffed, underfunded, and lack professional management and technical staff. They were created in a different era when the government bureaus were utilized as sources of social welfare and support. Drainage departments understandably have problems attracting capable management and technical experts. Yet drainage is fundamental to good wastewater management.

Inadequate Funds for Drainage. Approximately two-thirds of investment costs and around half of the operating and maintenance costs of a typical wastewater system come from the complex system of drainage pipelines and pumping stations scattered throughout a city. In almost all cities, the wastewater tariff is used primarily or exclusively for wastewater treatment and funding for drainage services are provided by the municipal government. When municipal governments face fiscal constraints, many chose not to fully fund the operation, main-

BOX 6.5 Drainage Collection Systems in the U.S. and U.K.

United States. Of the more than 19,000 collection systems in the United States, the U.S. Environmental Protection Agency estimates that about 4,800 are satellite collection systems. Satellite collection refers to a situation where the municipality (or a private developer) that owns the collector sewers may not provide treatment of wastewater, but only conveys its wastewater to a collection system that is owned and operated by a different municipal entity. Municipal drainage systems are coming under regulatory control in the U.S., including satellite systems, and are being monitored for overflows that discharge into the environment. As stormwater management for water quality purposes is becoming increasingly important in the U.S., there is a growing trend to establishing single-purpose “stormwater utilities,” which charge users based on the estimated amount of runoff from their property. There are over 400 stormwater utilities in the U.S. that charge based on the quantity of land and impervious surface.

United Kingdom. Water companies in England and Wales are responsible for both wastewater and stormwater collection. These private companies recover their costs for stormwater management through user fees. The economic regulator, OFWAT, does not require the companies to utilize any particular approach for charging customers, but encourages the use of site-area based charges.

Source: EPA and OFWAT websites.

tenance, and timely renewal of the drainage networks.

Forces Driving Service Fragmentation

The factors driving most cities to have multiple organizations providing different parts of the wastewater service include:

- Incorporating district drainage departments into a municipal company is problematic, as they operate under different administration systems.
- Transforming municipal or district drainage departments into modern, efficient integrated wastewater utilities would be challenging on many fronts, including culture, overstaffing, and pension obligations.
- The common perception in China is that drainage is a public good while wastewater treatment is a commercial activity and thus the two services should be managed separately.
- Integrating the various entities into one company would reveal the true cost of wastewater and stormwater management, which is likely to be more expensive than water supply.
- Carving out wastewater treatment as a separate commercial activity may help to facilitate private financing for treatment plants.
- Finally, national government policies have evolved to support separating wastewater treatment as a commercial activity to attract private financing and technical expertise.²

Options for Creating More Integrated Wastewater Utilities

Although some cities may be successful in creating modern and efficient wastewater treatment companies, some of the key chal-

lenges lie in collecting and conveying wastewater; reducing sanitary and combined sewer overflows; accessing financing; and recovering costs for the entire system, not just wastewater treatment. Maintaining fragmented responsibility for wastewater service reduces accountability and affects operational and investment efficiency. As noted above, there may be institutional constraints in some Chinese cities to shifting quickly to a single integrated wastewater utility. There are, however, a range of options to encourage a more integrated approach, some of which could be used on an interim basis. Some of these potential options are summarized in Table 6.3 and discussed below.

- *Company Ownership.* Wastewater is managed in a manner similar to water supply, with one utility company providing wastewater (and stormwater) collection and treatment.
- *Company Lease.* The ownership of drainage collection assets would remain with the municipal or district governments. The wastewater company, however, would be responsible for operating and maintaining the network through a lease contract. The municipal or district governments would be responsible for financing capital works associated with the network, but the company would play the lead role in planning and constructing the facilities.
- *District Management Contract.* The wastewater company would enter into a management contract with the drainage department(s) for the operation of the drainage system. The ownership of drainage collection assets would

TABLE 6.3 Options for Integrating Wastewater Service

Option	Drainage Network	Treatment Plant
Company Ownership	Company invests, owns and operates	Company owns and operates
Company Lease	Company leases and operates Government invests and owns (No drainage departments)	
Department Management Contract	Drainage department management contract with company Government invests and owns	
Municipal Wastewater Group	Drainage departments report to group management	Company reports to group management

remain with the municipal or district governments. The municipal or district governments would be responsible for financing capital works associated with the network, but the company would play the lead role in planning and constructing the facilities.

- *Municipal Wastewater Group.* All of the existing organizations—wastewater treatment companies, municipal drainage departments, district drainage departments, etc.—remain intact but are put under an umbrella “Municipal Wastewater Group.” The group’s management responsibility includes planning, financing, constructing, and recovering costs, as well as ensuring overall service efficiency and quality.

Exploiting Opportunities for Service Aggregation

Almost every city in China provides its own water and wastewater services independently, regardless of size. There is significant potential for improving efficiency and re-

ducing costs by (a) merging water supply and wastewater companies; (b) creating regional urban water utilities that service metropolitan areas; and (c) creating multi-city urban water utilities.

The potential efficiencies stem mainly from achieving economies of scale in the construction, financing, and management of urban water infrastructure. The transaction costs in aggregating services are often high, and the approach may be difficult in many cities. The potential benefits, however, are large in some cases. Municipal governments should aggressively exploit opportunities for aggregation where they exist.

Existing Situation

As noted in Box 3.1 there are 661 “designated cities” and 1,636 county-level towns with an average population of 60,000. Moreover, there are 18,256 towns in China that fall under the jurisdiction of the county government. China’s counties and cities have considerable fiscal and administrative authority, with the provincial or prefecture government generally only providing an oversight role. The tendency for the majority

of cities, county-towns and small towns is to develop their own water supply and wastewater utilities. Local leaders generally prefer to own and manage their own infrastructure services, and inter-jurisdictional cooperation in China is difficult due to the high degree of decentralization. Two challenges emerge from this decentralized approach: (1) servicing metropolitan areas, and (2) servicing small towns.

Servicing Metropolitan Areas. Metropolitan areas are growing quickly and have become the economic powerhouses of the country. China has at least 53 metropolitan regions anchored on cities with over 1 million people. Towns on the fringes of these metropolitan areas contain around 50 percent of the metropolitan population and play an important social and economic role in the region. Pollution-generating industries are being relocated from inner urban areas to the surrounding areas. The surrounding counties, and their towns, often lack financial and technical capacity, and cannot take advantage of economies of scale in the provision of urban water infrastructure. Tackling the water pollution and water supply challenges in the wider metropolitan region is critical in meeting China's economic development and environmental goals.

Servicing Small Towns. The majority of the over 18,000 towns do not lie within the economically dynamic metropolitan areas. Yet these urban areas are significant sources of pollution and many lack a reliable high-quality water supply. The Chinese government has placed a high priority on improving the quality of life in these towns to balance the rapidly growing urban-rural disparities. These towns, however, often have

limited resources and expertise to develop adequate urban water systems.

Potential Benefits of Aggregation

As shown in Table 6.4, there are several options for aggregating urban water services. The potential benefits of aggregation include the following:³

- Increased efficiency through economies of scale
- Enhanced professional capacity in a larger scale operation
- Improved access to finance and/or private sector participation
- Improved access to water resources and integrated water resources management

Options for Aggregating Services in China

Even when the aggregation of urban water services may provide economic benefits, there are often institutional constraints that hinder efforts to examine and pursue promising options. Box 6.6 shows that many countries in Latin America are also dealing with similar issues.

From an international perspective, China has a high level of fiscal and administrative decentralization. This potentially hinders policy measures to encourage aggregation of services. The following options, however, could be examined by municipal leaders.

- ***Combining Water and Wastewater Utilities.*** The provision of water and wastewater services are closely related, and involve the same core set of technical, management, and financial skills. Most cities in China have shied away from combining the two services, as water supply has long been organized

TABLE 6.4 Options for Aggregation

Key Characteristic		Range of Possibilities with Increasing Aggregation
Scale	What can be the scale of aggregation?	<ul style="list-style-type: none"> • Metropolitan area including core city and surrounding towns • All cities or towns in a county or prefecture
Scope	What services can be aggregated?	<ul style="list-style-type: none"> • Raw water supply • Water supply service • Water supply and wastewater • Water supply, wastewater, and energy or others (solid waste)
	What operating functions can be aggregated?	<ul style="list-style-type: none"> • Management • Planning and construction • Operations • Financing • All functions with merging of assets and staff
Process	What process can be followed?	<ul style="list-style-type: none"> • Voluntary • With incentives (financial, political, and so forth) • Mandatory

Source: Adapted from World Bank. 2005. "Models of Aggregation for Water and Sanitation Provision." World Bank Water and Sanitation Working Note 1. Washington, DC: World Bank.

as a commercial activity while wastewater is still considered a semi-public good that needs to be subsidized. Cities should consider combining the two services, particularly if they commit to managing wastewater as a commercial business. There will be transition costs, including shedding of staff and management, but there is significant potential for increased efficiencies.

- *Creating Water Utilities in Metropolitan Areas.* The potential for expanding water supply and wastewater services from the core urban area of large cities into the surrounding towns is enormous. Expanding the service area creates many administrative, financial, and governance questions, although with proper government leadership these problems can be overcome.

There are many international examples to draw upon. Box 6.7 shows how Ningbo is extending its water supply service to surrounding towns and cities.

- *Creating Multi-City Water Utilities.* Smaller cities and towns outside the vicinity of metropolitan areas can also benefit from a partnership with larger and more experienced utilities. As shown in the Brazil example (Box 6.6), cities can often be induced to form partnership arrangements with outside utilities to provide a variety of services, such as concession contracts, leases, or management contracts. These services could potentially be provided by either the private sector or the municipal utilities, which want to expand their business.

BOX 6.6 Municipal and Regional Water Services in Latin America

Prior to 1990, many Latin American countries—including Argentina, Chile, Colombia, Panama, and Peru—organized their water industries as national monopolies under the direct control of the central government. Growing dissatisfaction with the performance of the national monopolies, combined with wider pressure for devolution across all areas of government, created the conditions for a move toward more decentralized control in the 1980s and 1990s.

On the whole, decentralization was not a studied response to the specific problems of the water sector, but rather the byproduct of wider state reform. In countries such as Argentina, Colombia, and Peru, this has entailed a sudden fragmentation of the industry into literally hundreds of small municipal providers.

A number of problems have since arisen. The first of these is the loss of economies of scale. Aside from the investment economies, the scarcity of resources may also make it undesirable to dilute technical capacity across a large number of service providers. The questionable commercial viability of many of the business units is closely related, which leads to difficulties in attracting private sector investment. Finally, municipal control of the sector has made it difficult to drive regulation and PSP from the center. Brazil, however, offers an interesting contrast.

Water supply in Brazil is the constitutional responsibility of the municipal government. However state-level (i.e. provincial level) water companies service around 80 percent of the urban population. These companies were created as a result of voluntary agreements with municipalities that gave the companies the right of service provision. The agreements were facilitated by the national government, which offered an attractive investment financing package for municipalities through a national program named “PLANSA.” The recent expiration of the PLANSA agreements has left a great deal of legal ambiguity regarding state vs. municipal responsibility for water service.

Source: World Bank. 2005. “Ten Years of Water Service Reform in Latin America.” World Bank Paper No. 3. Washington, DC: World Bank.

Summary of Strategic Directions

The strategic directions identified in this chapter are summarized below.

- ***Streamline Utility Governance to Facilitate Cost Recovery.*** Chinese cities should experiment with new models of utility governance that can better balance service standards, tariffs, and where necessary fiscal transfers. Some options are (a) municipal utility boards; and (b) municipal utility advisory groups.
- ***Foster Efficient Water Utilities.*** Municipal utilities, particularly in large cities, should be empowered to take over core

strategic functions, which in many cases are currently the responsibility of the parent bureau. With increased authority, the government should also hold utilities more accountable through improving performance monitoring, insisting on transparency and customer orientation, and where appropriate using the private sector to enhance utility efficiency.

- ***Manage Wastewater as a Network Utility Business.*** Many cities have fragmented the responsibility for wastewater collection and treatment. To improve efficiency, municipal governments should consider consolidating the service. Some options include (a) an integrated wastewater company;

BOX 6.7 Case Study of Ningbo, China

The Ningbo Water Supply Company (NWSC) currently serves 1.3 million people in the four core urban districts with a treatment capacity of 820,000 m³/day. In the surrounding suburban districts, 1.3 million people obtain water from 29 small town water supply systems with an estimated capacity of 610,000 m³/day, or through self-supply with an estimated capacity of 460,000 m³/day. Due to poor groundwater quality, all of the small town and self-supplied water systems draw upon local surface water sources, which are heavily polluted and subject to salinity intrusion.

The Ningbo municipal government has decided to tackle the problem from a regional perspective and has developed a long-distance water transfer scheme to bring water to the city and its surrounding areas. The municipal government has also directed NWSC to incorporate the small town water supply systems, supply water to all industries, and improve service quality. The incorporation of the small towns and self-supplied users should benefit them through higher water quality and service, tapping into economies of scale in investment and management expertise, and overcoming financing constraints.

The municipality is still working through the terms of the incorporation with the small towns, and is considering three options: (1) transfer of assets and service responsibility; (2) management of the small town system while ownership of assets remains with the suburban district government; and (3) sale of treated water to the small towns. With the assistance of a World Bank loan, Ningbo is developing a 50-kilometer ring main for the treated water, with the core urban area inside the ring main, and the surrounding small towns provided through outward radiating spokes from the ring main.

Source: World Bank, Ningbo Water and Environment Project Appraisal Document (2005).

(b) a wastewater company with a lease contract for drainage; (c) management contracts between drainage departments and wastewater company; and (d) a consolidated “Wastewater Group,” where all organizations report to the same management.

- **Exploit Opportunities for Service Aggregation.** Economies of scale and greater efficiency can potentially be achieved through (a) combining water and wastewater utilities; (b) forming metropolitan urban water utilities; and (c) creating multi-city urban water utilities. Municipal governments should consider whether such aggrega-

tion is appropriate or advisable, and pursue opportunities where they exist.

Notes

1. See the “Notice to Improve Wastewater Collection and Establish Sound Collection and Treatment Practices” issued in September 1999 by NDRC/MOC/SEPA (Notice 1992).
2. See the 2002 MOC/NDRC/SEPA “Circular on Accelerating the Commercialization of Urban Wastewater and Solid Waste Treatment” which discusses the commercialization of wastewater treatment, but not collection.
3. Excerpted from World Bank. 2005. “Models of Aggregation for Water and Sanitation Provision.” World Bank Water and Sanitation Working Note 1. Washington, DC: World Bank.



Moving Up the Utility Financial Sustainability Ladder

Most Chinese urban water utilities receive significant financial support from the municipal government. While it might seem that this support would strengthen the water sector, this chapter suggests that in fact greater utility self-reliance would be a better strategy. Less reliance on government funds and more on user fees and capital markets can generate strong forces for improving efficiency and ensuring sustainability because:

- User fees are generally more reliable than government transfers.
- Utilities will be more accountable to users.
- Governments are less able to direct self-reliant utilities to pursue short-term interests at the expense of longer term objectives.
- Capital markets—a vital source of investment capital for the sector—require financial discipline, transparency, and accountability.

Box 3.3 in Chapter 3 presents the concept of a “financial sustainability ladder.” Utilities that rely exclusively on government funding for capital and operating expenses are at the bottom of the ladder; utilities that generate sufficient revenues from user fees

and finance investments through capital markets are at the top. This chapter provides the following strategic guidance on how China’s urban water utilities can move up the financial ladder. In essence:

- Municipal governments should always ensure that utilities recover their costs through user fees. However, by providing capital contributions, governments can limit a utility’s costs, and so limit the required tariff levels.
- Over time, user fees should increase, municipal capital contributions decrease, and utilities should rely more on domestic debt markets.
- National concessionary financing programs should be expanded and restructured to provide incentives for cities to comply with policy objectives.

Government must ensure the right bundle of service levels, utility efficiency, tariffs, and fiscal transfers to have sustainable urban water services. Chapters 5 and 6 examined the policies and institutional arrangements at the national, provincial, and municipal level that are necessary for “getting the bundle right.” This chapter focuses on tariff levels and fiscal transfers.

Achieving Utility Cost Recovery

Many urban water utilities in China experience financial and operational stress because:

- User fees are well below the full cost recovery level, forcing utilities to rely on unreliable municipal capital contributions and government payments.
- Even when provided, government payments are not enough to fill the gap between the true cost of service and the revenue from users.
- Concerns about affordability for the lowest income groups, and social acceptability, limit the extent and rate at which tariffs can be increased.
- Tariff structures are not optimized to provide the correct economic signals and increase utility revenues.

The financial and operational performance of urban water utilities can be improved by:

- Ensuring that water and wastewater utilities (including drainage bureaus) can meet their financial obligations through user fees only, with government funding limited to capital contributions.
- Adjusting tariff structures to ensure more reliable and higher utility revenues.
- Developing better low-income support programs, which allow tariffs to be increased at a faster pace.

Inadequate Utility Cost Recovery¹

The term “utility cost recovery” as used in this study means that a utility can meet its revenue needs from a combination of user

fees and government transfers. Cash costs typically include operation and maintenance, debt service, and asset renewal. A return on equity is also required if there is a private equity investment. Box 7.1 explains the financial terms and concepts used in this report in more detail. The general status of Chinese water utilities is described below.

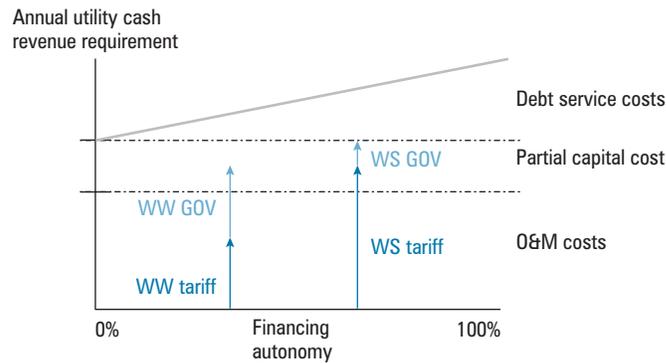
Water Supply Utilities. The figure in Box 7.1 shows the financial status of typical water supply utilities in China. The utilities receive capital contributions from the municipal government and borrow from domestic banks, and thus have a moderate level of financing autonomy. They also rely mainly on user tariffs, and thus have a high level of revenue autonomy. Water supply utilities generally have a moderate cost recovery ratio, as the combination of user fees and government payments (when they occur) typically result in inadequate revenue to cover costs. This is reflected in Table 2.3, which shows that two-thirds of water supply utilities did not make an accounting profit in 2004. The water supply utilities generally cope by foregoing asset renewal investments.

Wastewater Utilities. Wastewater service in most cities is fragmented between drainage departments and wastewater companies. Drainage departments rely exclusively on government payments and capital contributions, and thus have no revenue or financing autonomy. Drainage departments also have a low cost recovery ratio, as government payments are typically inadequate to cover maintenance and asset renewal needs.

Wastewater companies generally have moderate levels of financing because they receive some capital contributions from the

BOX 7.1 Concept of Utility Cost Recovery

Using a cash-needs approach, the following figure schematically represents a utility's annual revenue requirements.



Revenue Autonomy: $\text{Tariff}/(\text{Tariffs} + \text{Government payments})$

Financing autonomy: $\text{Debt}/(\text{Debt} + \text{Government contribution})$

O&M Costs. Represent the minimum amount of cash necessary to maintain operations at a reasonable level over a short-term perspective.

Partial Capital Costs. Utilities generally try to have enough cash from revenues to finance minor capital works. Major capital projects are typically financed through a combination of cash from revenues, debt, and/or municipal government contributions.

Debt Service. Debt service refers to the cash necessary to make principle and interest payments on debt obligations. As the amount of utility debt financing increases, debt service increases. Some lenders also require utilities to establish “reserves” in the event of an unexpected business shock. If the municipal government provides contributions for capital works, then debt service is reduced.

Financing Autonomy. This concept reflects the percentage of investment financing that comes from loans or internal cash versus government contributions. Sixty percent financing autonomy means that 60% of the funds come from loans or utility cash reserves, and 40% from government equity contributions.

Revenue Autonomy. This shows the percentage of annual revenue that comes from user fees versus government payments. A ratio of 60% percent means that 60% of the revenue comes from users and 40% from government payments.

Utility Cost Recovery Requirement. This is the amount of cash necessary to meet O&M, defined partial capital costs, and debt service requirements. The higher the level of financing autonomy, the greater the debt service, and the higher the required utility cost recovery level.

Utility Cost Recovery Ratio. This is the ratio of actual utility revenues from user fees and government payments divided by the utility's cost recovery requirement. A ratio of 60 % means that the utility's revenues (from user fees and government payments) only meets 60% of its requirements.

Full Cost Recovery. This is the amount of cash necessary to meet all of a utility's needs, assuming no government financial support; that is, no government payments or capital contributions to the utility.

government and also borrow from commercial banks. The wastewater companies typically have moderate levels of revenue autonomy and rely on a combination of user fees and government payments. The combination of wastewater tariffs and government payments typically result in moderate cost recovery ratios. Wastewater companies cope by foregoing asset renewal, maintenance, and in some cases just not operating the treatment plant.

The figure in Box 7.1 shows the financial status of a typical wastewater sector, including both drainage departments and wastewater companies, in a Chinese city. The overall level of cost recovery, financing, and revenue autonomy is low. This precarious financial situation can potentially undermine China's national wastewater management program. Table 7.1 summarizes the general financial status of urban water utilities in China.

Asset Renewal. Many of the water supply distribution and wastewater drainage networks in Chinese cities need to be renovated. As discussed in Chapter 9, utilities need to establish modern asset management programs to ensure that asset renewal is done in a systematic and cost-effective manner. The current system of tariff setting in China is based on the objective of having the utility make a small accounting profit as reflected in the

company's income statement, where depreciation is typically taken as a proxy for the capital costs. Depreciation, however, is based on historical costs and many of the assets are so old that the accounting valuation is of little use. Developing asset management plans that accurately assess the renewal costs are essential to a utility's long-term sustainability.

Low User Fees. Since 1998, water supply and wastewater tariffs have increased throughout China. The weighted average water supply tariff has risen from 0.93 RMB/m³ in 1998 to 1.36 RMB/m³ in 2004 (see Table 7.2). The rate of tariff increase is approximately equal to China's overall growth in GDP over the same period. Although the increase in tariffs may have increased water utility revenues, the overall financial position of water utilities appears to have deteriorated over the period 1998 to 2004 (see Table 2.3). This may be attributable to higher O&M and debt service costs associated with the water supply investment boom during the 1990s. Wastewater tariffs have also risen significantly since 1998 when few cities had wastewater tariffs. By 2005, 475 of the 661 designated cities have wastewater tariffs, but many of the cities have very low rates, with close to 25 percent having tariffs less than 0.3 RMB/m³.

Figures 7.1 and 7.2 show the weighted average water supply and wastewater tariffs based upon a selection of 128 cities in 2005.

TABLE 7.1 Summary of Urban Water Utility Financial Status in China

Utility Type	Utility Cost Recovery	Revenue Autonomy	Financing Autonomy
Water Supply Company	Medium	High	Moderate
Wastewater Company (Mainly Treatment)	Medium	Medium	Medium
Drainage Department	Low	Low	Low

TABLE 7.2 Weighted Average Water Supply Tariffs by City Category
(Unit: RMB/m³)

Average Water Tariff	1998	2004	% Increase
Category I: Super Cities	1.00	1.72	72
Category II: Medium Cities	0.93	1.33	43
Category III: Developing Cities	0.85	1.24	46
National Average	0.93	1.36	47

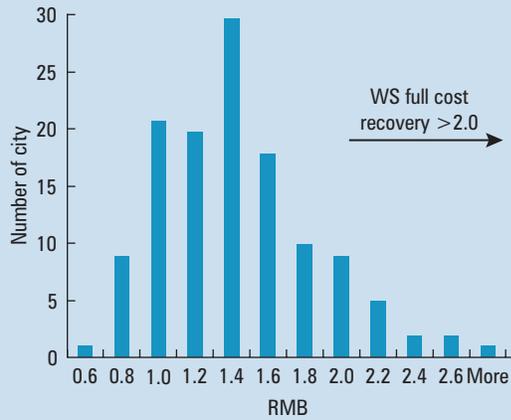
Source: China Water Works Association Yearbooks (1999) and (2005).

Based on a review of World Bank-financed projects, this study estimates that the indicative full cost recovery weight-average tariff for water supply should be a *minimum* of 2.0 RMB/m³, and 3.0 RMB/m³ for wastewater. These estimates assume commercial loans

are used to finance capital works, and user fees are adequate to cover O&M, debt service, and annual asset renewal requirements. The estimate for water supply excludes the cost for developing the raw water supply (i.e. water resource engineering fee), which can vary significantly depending on a specific city’s circumstances. The cost of raw water supply development is typically heavily subsidized through a local or provincial water resources bureau. The estimate for wastewater includes both collection and treatment.

The two figures indicate that water supply tariffs are generally below full cost-recovery levels. Wastewater tariffs are generally not adequate to even meet wastewater treatment costs, which are estimated to range from 1.0 to 1.5 RMB/m³. A utility can derive revenues from other sources besides a volumet-

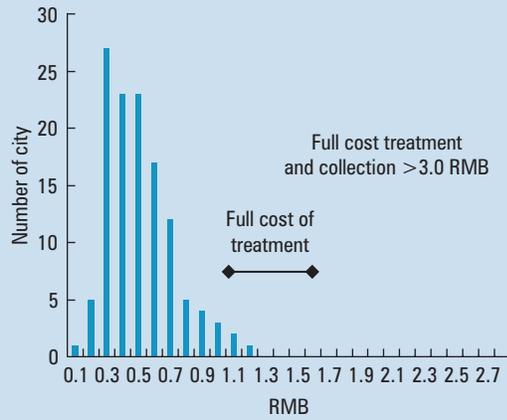
FIGURE 7.1 Water Supply Tariffs (RMB/m³)



	Category I	Category II	Category III
Average	1.72	1.33	1.24
Std. dev.	0.57	0.38	0.36
Minimum	0.88	0.70	0.60
Maximum	2.80	2.50	2.20

Based upon 128 sample cities, as of July 2005. See Annex 3 Technical Notes for Analysis.

FIGURE 7.2 Wastewater Tariffs (RMB/m³)



	Category I	Category II	Category III
Average	0.65	0.40	0.32
Std. dev.	0.22	0.19	0.14
Minimum	0.22	0.08	0.10
Maximum	1.05	1.17	0.65

Based upon 128 sample cities, as of July 2005. See Annex 3 Technical Notes for Analysis.

ric tariff, including fixed fees, developer contributions, bulk water sales, etc. From a utility perspective, the important parameter is total revenues. Nevertheless, the weighted average tariff provides a good general indicator of the level of cost recovery from users.

Box 7.2 provides an international comparison of water supply tariffs and cost re-

covery levels. China's water supply average tariff is RMB1.36/m³ (\$0.17). Taking into account purchasing power parity, the adjusted price is \$0.68, which is below the full cost recovery tariff level for a typical OECD country. Box 7.2 also indicates the likely range for cost recovery in developing and industrialized countries. Cost estimates are lower for

BOX 7.2 International Comparison of Cost Recovery Ranges for Water Supply

Indicative Tariff Levels. The following table indicates the ranges for probable degree of cost recovery in the developing and industrialized countries. Cost estimates are lower for developing countries, reflecting lower labor costs. The estimates are for water supply only, and do not include wastewater.

Tariff Levels	Developing Countries	Industrialized Countries
<\$0.2/m ³	Tariff insufficient to cover basic O&M costs	Tariff insufficient to cover basic O&M costs
<\$0.2–\$0.4/m ³	Tariff sufficient to cover operation and some maintenance costs	Tariff insufficient to cover basic O&M costs
<\$0.4–\$1.0/m ³	Tariff sufficient to cover O&M and most investment costs	Tariff sufficient to cover basic O&M costs
>\$1.0/m ³	Tariff sufficient to cover O&M and investment needs in the face of extreme shortages.	Tariff sufficient to cover full cost of modern water systems in most high-income cities.

Probable Degree of Cost Recovery. The following table provides information on the extent to which tariffs meet cost recovery objectives by income level.

Groups of Water Utilities	Percentage of Utilities Whose Average Tariffs are:		
	Too Low to Cover O&M	Enough to Cover O&M	Enough for O&M and Partial Capital
Global	39	30	30
High Income	8	42	50
Upper Middle Income	39	22	39
Lower Middle Income	37	41	22
Lower Income	89	9	3

Source: World Bank, "Water Electricity, and the Poor," Komives et al. (2005)

developing countries, reflecting lower labor costs. The estimates are for water supply only, and do not include wastewater.

User Cost Recovery for Wastewater Services. Approximately two-thirds of investment costs and around half of the operating and maintenance costs of a typical wastewater system come from the complex system of pipelines and pumping stations scattered throughout a city. The common perception in China is that drainage (i.e. collection of stormwater and wastewater) is a pure public good, and the funding and operation of the drainage facilities should be provided by the government through a traditional public department approach. Wastewater treatment, however, is viewed as a commercial activity by which payment can be made for the treatment services rendered and should be provided by a commercial company. In almost all cities, the wastewater tariff is used for wastewater treatment, and funding for drainage services is provided by the municipal government. Since many municipal governments face severe fiscal constraints, many chose not to fully fund the operation, maintenance, and timely renewal of the drainage networks.

The classification of drainage as a public good can be contested. Drainage of wastewater can be considered as an extension of the water supply service and subject to a user-pays principle. It is more difficult to apply a strict “user-pays” principle to stormwater drainage. In many countries, stormwater services are paid for by a property tax based on the size of the property, assuming that the amount of stormwater runoff is related to property size. This approach would not work well in China, as most people live in apartments and municipal governments do not levy property taxes.

Another perspective is that the municipal government can pay the utility for the service provided.

Social Acceptance

The extent and pace to which water and wastewater tariffs can be raised is based primarily on social acceptance. Social acceptance depends on a number of political, cultural, and economic factors, including the overall percentage of household income used to pay for water services. Box 7.3 provides an overview of water tariff levels in OECD countries as they relate to household income levels.

Household Incomes. The general range of what is often considered “affordable” for water services is 3 to 5 percent of household income.² Figure 7.3 shows the financial impact of different tariff levels based upon the annual household income in China. The average 2004 urban household disposable income in China was approximately 28,000 RMB. With an estimated 2004 average combined tariff of about 2 RMB/m³ (1.36 RMB/m³ for water supply and 0.64 RMB/m³ for wastewater), the percentage of water charges to the annual household income is only around 1 percent.³

If the tariff increases to 3.5 RMB/m³—which is this study’s *minimum* estimated cost recovery tariff for water supply and wastewater treatment, water charges will represent 1.7 percent of the average household income. However, at that level, two low-income groups—about 20 percent of total urban residents—will pay more than 3 percent of their household income (that is, above the dashed line in Figure 7.3). The full cost recovery tariff for water and wastewater services is probably closer to 5 RMB/m³ or higher. The full cost recovery level would

BOX 7.3 Social Acceptability of Water Tariffs in OECD Countries

Many OECD countries have seen a real increase in household water charges in recent years. The factors behind this trend include continued pollution of water resources (necessitating more expensive treatment), combined with additional national legislation and EU directives that require higher standards of wastewater treatment. This trend toward higher prices is likely to continue and will therefore continue to generate pressure on the perceived affordability issue of water services in OECD countries.

There are several methods available for measuring the affordability of water services. "Macro-affordability" indicators are developed by relating national average household water charges to either average household income (disposable or gross) or average household aggregate expenditure. "Micro-affordability" indicators disaggregate the former by income groups. Available evidence of affordability indicators suggest that, in about half of the OECD countries (15 out of 30), affordability of water charges for low-income households is either a significant issue now or might become one in the future, if appropriate policy measures are not put in place.

Macro and Micro Affordability Indicators, Selected OECD Countries				
Countries	Year	Macro Indicator: Percentage of Household Income	Micro Indicator: Burden of lowest Income (%) ¹	
England & Wales	99–00	1.2	3.75	
Mexico	2000	n.a.	3.84	
Hungary	1999	2.1	2.53	
Scotland	99–00	0.7	2.24	
France	1995	0.9	2.18	
Netherlands	1999	1.4	2.38	
Denmark	1998	1.1	1.9	
Italy	1995	0.7	0.9	
USA	2000	0.5	2.18	

Note: Representing 10 percent or less than 10 percent lowest income group.

The trade-offs between efficiency and equity objectives of water services usually occur when moving from an unmeasured to metered charging structure, when rebalancing tariffs away from fixed charges toward volumetric charges, and when increasing fees and tariffs toward full-cost pricing. There is considerable experience in OECD countries with policy measures to address water affordability for vulnerable groups, while attempting to make water pricing reveal the full economic and environmental costs of water services.

Social measures to address affordability issue can be categorized into two groups: (1) income support measures and (2) tariff-related measures. The income support measures tackle individual customer's ability to pay from the income side through income assistance, water services vouchers, tariff rebates and discounts, bill re-phasing and easier payment plans, arrears forgiveness, etc. Tariff-related measures keep the size of water bills low for certain groups (e.g. refinement of increasing-blocking tariffs, tariff choice, tariff capping). A common approach, called a "life-line tariff," is to provide qualified low-income households with low rates up to a certain quantity (for example, 10 m³ per month per household).

Source: OECD, "Social Issues in the Provision of Water Services," (2003).

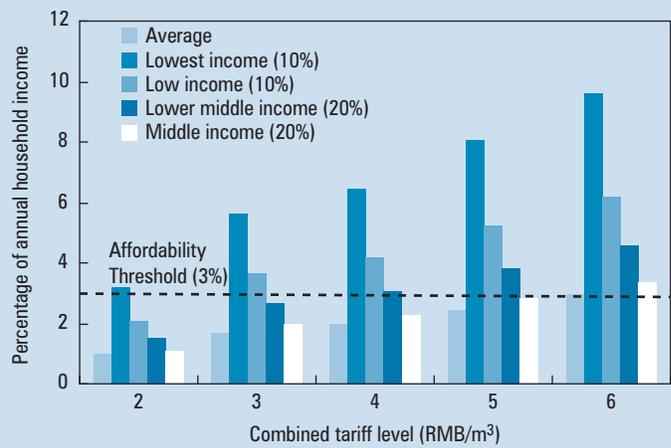
still be affordable to 60 percent of total urban residents (i.e., under the dashed line).

Based on this analysis, there appears to be considerable potential for increasing tariffs in Chinese cities from the 2004 average of 2.0 RMB/m³. The lowest 10 percent income group, however, had an average disposable income of only 8,500 RMB. If the tariff reaches 5 RMB/m³, water charges would consume about 8 percent of annual income. Moreover, Figure 7.3 is for the average household across China, but there are significant differences among cities in China. For example, the average household income in a rich city could be above 40,000 RMB, while for a poor city it might be closer to 20,000 RMB.

Most Chinese cities have programs for low-income households where the cost of basic services, such as water and electricity, are explicitly considered in a monthly stipend for eligible households. Increases in water tariffs could potentially be accommodated through this instrument. One drawback, however, is that there are many migrants who may not have official status in the city and thus are not eligible for low-income assistance. Moreover, the income supplement approach requires the household to exercise budget discipline—which may or not occur, and could still result in financial difficulties paying the water bill. As shown in Box 7.3, there are other programs that can help low-income groups.

Social Acceptability. Even if a tariff is “affordable,” it may not be socially acceptable. There are a number of social concerns in Chinese cities that may limit the rate and extent of tariff increases. First, as China moves toward a market economy, families are expected to pay for many essential services that were once free. These include housing, medical care, education, and basic utility ser-

FIGURE 7.3 Combined Tariff as Percentage of Household Income in 2004



See Annex 3, Technical Notes, for Analysis.

vices. Although Chinese household incomes are rising rapidly, so are basic expenses; many urban families feel beleaguered with their new financial obligations. Second, as discussed in Chapter 3, there is growing urban inequality in China as migrants flood into cities and a new class of rich urbanites develops. Increasing prices for utility services, without putting in place effective programs to help low-income residents, may reinforce concerns about inequality and fairness. Third, given the low levels of transparency and perception of inefficiency associated with municipal utility companies, the public may be reluctant to pay for services unless they are confident their money is used in an efficient and accountable manner. These three factors may cumulatively work to dampen the pace at which water and wastewater tariffs can be increased.

Tariff Structures

The tariff structure is important in allocating the cost of service, as well as sending eco-

nomic signals about the resource value of the water. The establishment of a tariff level and structure typically has the following objectives: (1) cost recovery, (2) economic efficiency, (3) equity, and (4) affordability. Chinese cities, with the encouragement of the national government, are experimenting with new types of tariff structures to address its severe water problems. The multiple objectives in setting water tariffs, however, are often in conflict, and Chinese cities are struggling with striking an appropriate balance among the different criteria. Table 7.3 provides an illustrative example of the tariff structure for Tianjin. Water tariffs in China typically have the following attributes:

Volume-Based Charges. Both water and wastewater tariffs are based on the actual quantity of water delivered, with the wastewater tariff included on the water supply bill. The water supply company typically remits the wastewater tariff to the local finance bureau, which then passes it on to the wastewater company, often through the parent agency such as the construction bureau. A notable exception is self-supplied industries, where it is not possible to collect wastewater fees directly from the water supply company. Self-supplied water accounts for around 12 percent of total urban water supply on a national level, and in some cities in the north of China it can account for up to

TABLE 7.3 Water and Wastewater Tariff History in Tianjin (Unit: RMB/m³)

Tariff	Users	2000	Jan 01–Aug 01	Sept 01–Sept 02	Oct 02–Dec 03	2004
Water Supply	Residential	1.4	1.8	2.2	2.6	2.9
	Administrative	1.8	2.2	3.0	3.6	4.4
	Industry	1.8	2.2	3.0	3.8	4.6
	Commercial	2.2	2.6	3.0	3.8	4.6
	Financial & Construction	2.2	2.6	3.4	3.8	4.6
	Hotel & Recreation	2.4	3.5	5.0	5.0	5.6
	Special Sector	2.4	3.5	6.0	9.0	18
Wastewater	Residential	0.2	0.4	0.4	0.5	0.6
	Administrative	0.4	0.6	0.6	0.8	1.0
	Industry	0.2	0.4	0.4	0.8	1.0
	Commercial	0.4	0.6	0.6	0.8	1.0
	Financial & Construction	0.4	0.6	0.6	0.8	1.0
	Hotel & Recreation	0.4	0.6	0.6	0.8	1.0
	Special Sector	0.4	0.6	0.6	0.8	1.0

Source: Tianjin Construction Administration Commission (2006).

30 percent. Collection of wastewater fees from self-supplied industries can be problematic, as the wastewater companies typically do not have the authority to collect the tariffs directly. In some cases, the environmental protection bureau, which regulates industries, or the water resources bureau collects the wastewater fees on behalf of the wastewater company.

Metering. The majority of Chinese urban residents live in apartment blocks. In the past, water companies used “bulk meters” that measured the flow into the apartment building, and the building management was responsible for paying the water bill. China now has a policy of universal household metering, and water companies are rapidly installing meters. Some cities are experimenting with pre-paid debit cards that residents must put into their meters in order to continue to receive service.

Movement toward a Two-Part Water Supply Tariff. There is a move to a two-part tariff for water supply, which includes: (1) a fixed capacity charge based on the size of the connection to cover fixed costs and a certain degree of cost recovery for investments; and (2) a variable charge based on the volume of water used. Since 1999, at least fourteen pilot cities have adopted a two-part tariff for water supply.⁴

Increasing Block Tariffs as a Demand Management Tool. A number of pilot cities have also adopted increasing block tariffs for domestic users to promote water conservation. For example, each household is allocated 10 m³ per month and all water delivered within this amount is charged the standard domestic rate. For the next increment of water from 10–20 m³/ month, the

tariff is doubled. Wastewater fees, however, do not have an increasing block rate. The objective of the increasing block tariff is to send economic signals reflecting the scarcity value of water, while ensuring that water to meet basic needs remains affordable.

Cross Subsidies. There are significant cross-subsidies in Chinese water tariffs. Industrial and commercial users subsidize residential users. In a survey of cities across China, the average ratio of the non-domestic tariff to the domestic tariff was approximately 1.5. Cross-subsidies are partly a vestige of the planned economy, when state-owned-enterprises subsidized basic domestic services. Cross-subsidies are also used to help with social affordability, as raising tariffs for industrial and commercial users may be politically easier than residential users in many cities.

Water Resource and Water Development Tariffs. In addition to tariffs for the water supply and wastewater utilities, the water bill also typically includes a water resource fee and a water development fee. The water resource fee goes to the local water resources bureau, which has overall responsibility for water resources management. The water development fee is based upon the allocated cost of the raw water supply infrastructure. Often, the raw water supply infrastructure—such as reservoirs and conveyance facilities—is heavily subsidized by the government at either the municipal or provincial level. In a few cases, however, the water development fee can be quite high; for example, in Tianjin the fee is RMB 1.5/m³ (\$0.18).

Polluter-Pays Principle. Wastewater tariffs in China are based on volume of wastewater discharged, typically measured on

the quantity of water supplied. An Asian Development Bank study on wastewater tariffs recommended that in the future, Chinese cities transition to a two-part tariff for industry and certain types of commercial establishments.⁵ The two-part tariff would be composed of (1) volume charges and (2) pollutant loading charges. The pollutant loading charges, which are used in many OECD countries, could be either (a) set on the classification of the industry/commercial establishment with an appropriate adjustment factor for the volume of the wastewater; or (b) the actual measure or estimated mass of pollution discharged on a case-by-case basis.

Achieving Utility Cost Recovery

In order to improve the performance and sustainability of urban water utilities, this study recommends the following approaches:

- **Utilities Should Recover Their Costs Through User Fees.** Many urban water utilities still rely on municipal government payments to partially cover their costs. Water supply and wastewater tariffs should be increased, and tariff structures adjusted to ensure utility cost recovery. Municipal governments can adjust a utility's costs, and thus the

extent of tariff increases, through their capital contribution policy. The following guidelines are presented:

- **Wastewater Tariffs Should Pay for Drainage.** Cities should increase the wastewater tariffs so that it covers the utility's cost for drainage services. Even though stormwater and sanitary drainage are two different services, they are provided by the same utility (and in the case of combined drains, through the same pipeline network). The municipal government will probably need to still provide equity contributions to fund major drainage capital works, but at least all O&M and minor capital works should be covered through user fees.
- **Tariff Structures Should Be Optimized.** Tariff reforms should be accelerated with more usage made of two-part tariffs (fixed and variable), and wastewater charges based on both volume and pollutant loading. Two-part tariffs would allow cities to more vigorously pursue demand management efforts without undermining a utility's revenue base. Wastewater charges based on flow and pollutant loading would increase wastewater revenue and provide better economic signals to dischargers.
- **Develop New Low-Income Assistance Programs.** To address affordability and social acceptance issues, cities should experiment with new support programs such as vouchers, rebates, lifeline tariffs, etc.

TABLE 7.4 Suggested Municipal Government Capital Contribution Policy

Type of City	Water Supply	Wastewater
High Capacity	No Capital Contributions	Limited Capital Contributions for Drainage
Low Capacity	Limited Capital Contributions	Capital Contributions for Drainage
	National Concessionary Finance	National Concessionary Finance

Accessing Domestic Credit Markets

This section first reviews municipal infrastructure spending and financing in general,

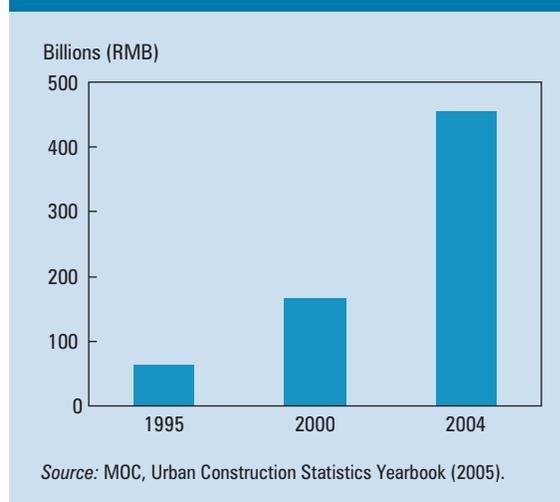
followed by a focus on urban water, and suggests that urban water utilities should be empowered to make more use of domestic debt markets. The key points are:

- Chinese cities are experiencing a boom in infrastructure construction that is expected to continue, particularly for urban water. Financing infrastructure is a major concern for municipal governments due to their limited fiscal resources and inability to borrow directly.
- The urban water sector relies on a mix of financing sources, including the municipal government, domestic banks, national and international concessionary finance, and the private sector.
- China's booming economy has created the potential for urban water utilities to rely more on domestic debt markets and less on government. Greater use of credit markets would improve utility financial discipline, transparency, and accountability. Increasing cost recovery, mainly from users, to improve revenue reliability and debt service capacity is the key to accessing debt markets.

Municipal Infrastructure Spending

Annual municipal infrastructure spending has increased dramatically over the last decade, as shown in Figure 7.4. Water and wastewater accounted for only 11 percent of total spending in 2004. The largest sector was roads and bridges at 44 percent. Many factors account for the explosion of infrastructure construction, including the (a) rapid increase in urban population and economic development; (b) backlog of deferred infrastructure investments incurred before

FIGURE 7.4 Total Annual Expenditure for Urban Construction and Maintenance



China's economy reached the current high growth stage; (c) the government's expansionary fiscal policy as a method of stimulating domestic demand and reducing dependency on export-led growth; and (d) recognition by China's leaders that infrastructure provides a necessary foundation for economic development.

Municipal Financing Sources

Table 7.5 provides a breakdown of sources for urban infrastructure funding for Category I and III cities. Around 90 percent of the funds are used for construction, with the balance going toward maintenance. Since urban water utilities are part of the overall municipal infrastructure sector, and the construction bureau often serves as the parent bureau (see Chapter 6), the following paragraphs look at municipal infrastructure funding sources in general.

Land Transfer Fees. Category I cities rely on land transfers to finance around 30 per-

TABLE 7.5 Urban Infrastructure Fund in 2004 (US\$: million)

Fund Sources	Category I Cities % of total	Category III Cities % of total
Urban Maintenance and Construction Tax	6	9
Municipal Financial Allocation	8	13
Domestic Loan	26	18
Land Transfer Fee	30	22
Self-raised	20	17
Others*	10	20

Source: MOC, Urban Construction Statistics Yearbook (2005)

cent of their urban infrastructure needs, taking advantage of their booming property markets and the government's control of land. Category III cities have less property development potential, and thus the potential for land sales is more limited and accounts for 22 percent of total funds. The long-term prospect for financing infrastructure development through land sales is unclear but will probably be constrained by two factors. First, the national government is exercising stricter control over local land development to preserve agricultural land and minimize social unrest due to dislocation. Second, much of the prime real estate has already been developed, and as the real estate market evolves over time the quality and value of the land available may decrease.

Domestic Loans. Governments in China are not allowed to borrow directly, either through commercial banks or municipal bonds.⁶ Municipally owned utility companies, or special purpose urban infrastructure investment companies (UDICs), are allowed

to borrow. Domestic bank lending accounts for approximately 25 percent of all municipal infrastructure funds. Category I cities make greater use of domestic loans than Category III cities, indicating their generally higher level of creditworthiness.

Chinese banks have a high degree of liquidity and are anxious to lend to creditworthy borrowers. Many banks, however, do not have high modern credit analysis expertise; loans to the public utility sector are often made at the request and with the implicit guarantee of the municipal government. The People's Bank of China typically limits loan maturity to eight years for capital investments, and three years for working capital.⁷ Utility companies often struggle to repay the short-term debt, and it is quite common for the utilities to make interest payments only and periodically roll over the principle. The principle rollover effectively turns short-term debt into longer-term debt, but also increases the interest rate risk, as well as the risk that the bank may call in the principle payment at an inopportune time.

Urban Development Investment Companies (UDIC). Since municipal governments are not allowed to borrow directly in China, many cities have established UDICs, which invest in infrastructure on behalf of the municipal government. These companies receive preferential access to property development rights, and thus are able to secure loans from domestic banks. At least in the short term, this model works well in Category I cities with booming property markets such as Shanghai, but it may not be viable for most cities in China. The Shanghai UDIC model has some similarities with special purpose investment vehicles in other counties. Box 7.4 compares arrangements in New York and Shanghai, with the funda-

BOX 7.4 Special Purpose Municipal Investment Vehicles in Shanghai and New York

The Shanghai UDIC was established in 1992 as a municipal investment and stock-holding company to raise funds on behalf of the Shanghai Municipal Government. The company has invested in over 40 large infrastructure projects (mostly for water and wastewater), and at present has total assets of more than 240 billion RMB (\$30 billion).

In the core urban areas of Shanghai, there are four water supply companies. The Shanghai Municipal Sewerage Company (SMSC) is responsible for major drainage works and wastewater treatment plants, and is the holding company for three operating companies. The assets and shares of the water supply and sewerage companies are consolidated on the balance sheet of the Shanghai Water Assets Operation and Development Company (SWAOD), which is the water/wastewater subsidiary of the Shanghai UDIC. SWAOD is responsible for raising funds for the investment programs of these companies, and shoulders part of the debt service burden. SWAOD receives its funding from a variety of sources, including some funds transferred from its owner, UDIC.

The World Bank has been actively involved in the Shanghai urban water sector since the late 1980s. As part of an adaptable program loan approved in 2003, the World Bank has been supporting SWAOD to develop the first corporate bond issue in the wastewater sector in China. This bond issue of 1.5 billion RMB was issued in mid-2006. The World Bank has also supported the Shanghai UDIC in its development of a “district financing vehicle” (DFV) to mobilize financing and provide project management support to the surrounding districts in Shanghai for their urban environmental infrastructure. A new DFV subsidiary of the UDIC was established in 2005 with this special purpose objective.

The New York City Municipal Water Authority was created in 1984 as a public benefit corporation for the purpose of issuing debt through revenue bonds to finance capital improvements for the water and sewer system. A second public benefit corporation, the New York City Water Board was also formed to lease the water system from New York and to maintain the system for a term of 40 years or for the life of the outstanding revenue debt. The Board was also granted the authority to set rates and charges as necessary to meet its operating, maintenance, and debt service requirements. The actual service delivery is provided through the New York City Department of Environment.

The arrangements were developed with a view to isolating the credit of the water and sewer system from that of the city (which at the time was rated Baa) by providing bankruptcy protection and automatic rate setting. To protect it from bankruptcy, (a) the Board and Authority did not have the ability to file for bankruptcy; (b) the lease agreement established the Board’s ownership of the revenues; (c) the city’s annual lease payment was subordinated; (d) financing agreements provided for an operating reserve fund and debt service fund; and (e) the systems revenues could not be combined with the city’s should the city declare bankruptcy.

With regard to tariff setting, the legal structure provided for independent third parties, the rate consultant and consulting engineer, to ensure that the rates were not subject to political manipulation. Additional protection measures included the following: (a) if the Board did not set adequate rates, the Authority could petition for the appointment of a receiver on behalf of the Board; (b) cash flow requirements were monitored on a monthly basis and rate adjustments made as necessary over the course of the year; (c) rate setting was formula driven, with rates and charges equal to 115% of projected debt service plus 100 % of operating expenses, and required reserves; and (d) in order to take on additional debt, revenues for the last two years and for the next five years, as projected by the rate consultant, had to pass the previous test.

Sources: World Bank, Shanghai Urban Environment Management Project (APL-2) Project Appraisal Document (2005); and World Bank, “Private Participation in Infrastructure in China.” Bellier et al. (2003).

mental difference that the New York City Water Authority repays its debt through user fees that are closely monitored and controlled by lenders.

Municipal Financial Allocations. Municipal governments provide funding for infrastructure through their general budget. In 2004, this accounted for 13 percent of total funding for infrastructure in Category III cities, but only 8 percent in Category I cities. Category I cities have more access to other sources of funding, and thus rely less on scarce municipal financial resources.

Urban Construction and Maintenance Tax. The urban construction and maintenance tax is a local tax levied on the VAT, consumption tax, and business tax, and is assessed at 7 percent of each respective tax in urban areas. The tax revenue is typically reserved for maintenance purposes only, such as for road or drains. The tax typically accounts for 6–9 percent of total funds.

Self-Raised and Other Funds. Self-raised and other funds refer to revenue that is not included in the official municipal budget and includes “self-owned” funds by local governments, enterprises, and institutions. Private sector investment falls under this category. The category “others” includes foreign direct investment, utility fees, water resource fee, etc. These two categories account for 30 to 40 percent of all infrastructure funding, yet are not well-defined or understood. This highlights the fact that information on municipal finance in China is typically not very transparent.

Wide Variance in Infrastructure Per-Capita Spending. Table 7.6 shows that Category I cities have annual per-capita in-

TABLE 7.6 Per-Capita Urban Infrastructure Fund by City Type

City Type	Average (RMB)
Category I	2,428
Category II Cities	1,107
Category III Cities	672

Source: MOC, Urban Construction Statistics Yearbook (2005).

frastructure spending of RMB 2,500, approximately four times higher than the Category III cities, and double the Category II cities. This wide variance in infrastructure funding underscores the difficulties that low-capacity cities have in financing and affording municipal infrastructure.

Financing Urban Water Infrastructure

Financial information for urban water cannot be easily disaggregated from the infrastructure statistics. Table 7.7 lists the key financing sources and their approximate

TABLE 7.7 Indicative Ranges of Urban Water Financing Sources, 1991–2005

Financing Source	Water Supply (%)	Wastewater (%)
Municipal Government	20–30	40–50
Domestic Banks	20–30	10–20
State Bond Program	10–20	20–30
Private Sector	10–20	10–20
China Development Bank	10	5
International Financial Institutions (WB, ADB, JBIC)	5	10

See Annex 3, Technical Notes, for Analysis.

financing percentages. The table was assembled from sources of variable reliability, and thus indicative ranges are provided. The actual mix of financing sources will vary from city to city.

Municipal Government. For water supply, this study estimates that around 20 to 30 percent of total funding comes from the municipal government (or a UDIC) in the form of an equity contribution. For wastewater, almost all drainage infrastructure is funded through the municipal government (or a UDIC). Wastewater treatment is considered more of a commercial good and the municipal government typically provides less financial support. Overall municipal government financing for wastewater could be as high as 50 percent.

Domestic Banks. State-owned commercial banks are estimated to provide around 20 to 30 percent of the financing for water supply, but less for wastewater. The water supply companies, and the wastewater treatment companies, are commercial entities and have the potential capacity for repayment. Since many of the drainage collection works are managed by public bureaus, they do not have the ability to borrow directly from commercial banks.

Private Sector. The role of the private sector is discussed in Chapter 8. We estimate that around 10 to 20 percent of water supply and wastewater financing has been provided by private companies. Most of the private sector investment in wastewater has been for BOT treatment plants.

International Financial Institutions. The major international financial institutions

in the sector over the last 10 years have been the World Bank, Asian Development Bank (ADB), and the Japan Bank for International Cooperation (JBIC). Over this period, World Bank loans have totaled around \$1.8 billion, with \$1.5 billion for the wastewater sector and \$300 million for water supply. The ADB has committed around \$1.0 billion in financing for the sector, approximately split between wastewater and water supply.⁸ JBIC also has a large water sector program in China. In total, however, the international financial institutions have probably only financed between 5 and 10 percent of overall urban water infrastructure costs since 1991.

State Bond Program and China Development Bank (CDB). The state bond program is administered by NDRC, and provides concessionary finance to support around one-quarter of all investments in the urban water sector. The CDB is the national development bank and has also been very active in the sector. Chapter 6 discusses these important funding sources in more detail.

Increasing Debt Financing

China's strong economy has created a high level of liquidity in the domestic banking system, and Chinese banks are encouraged to lend to creditworthy municipal utility companies. This has created a golden opportunity for water utilities to tap into domestic credit markets to finance investments. Utility companies in many economically advanced countries take on high levels of debt, often 60 to 70 percent of total assets, because they operate in a low-risk environment. Chinese utilities, in contrast, typically have much lower debt to asset ratios, and rely heavily on the municipal governments for finance. Chinese urban water utilities should

also strive to make more use of domestic debt markets, particularly the banking system, but also potentially corporate bonds or borrowing from pension or insurance funds.

Because municipal governments in China cannot borrow directly and there are many competing uses for governments funds, financing capital works through debt is generally more attractive than government contributions. Moreover, to the extent that utility debt service is paid by user fees, debt financing is more economically efficient as the users pay directly for the service, whereas municipal government funds come through general taxation. Many cities are also turning to equity investors, through stock markets or private deals, to fund investment programs. Equity financing is generally more expensive than debt financing, because equity investors need to take into account higher risks. Companies are legally obligated to service their debt obligations before they issue dividends, and thus equity investors face higher risks. Greater use of credit markets would improve utility financial discipline, transparency, and accountability as lenders would take an interest in the financial health of a utility. Municipal governments and their utilities should therefore:

- ***Improve Access to Debt Markets By Increasing Cost Recovery.*** Most Chinese banks are hesitant to lend directly to utility companies because of concerns about repayment capacity. Increasing cost recovery, mainly from users, would increase a utility's capacity to service debt, as well as improve revenue reliability. Chinese cities should transform their financially stressed utilities into creditworthy enterprises that can fund most of their capital program through commercial

debt. As China's financial markets evolve and become market-oriented and sophisticated, improving the credit status of municipal utilities will become even more important.

Improving Concessionary Finance Programs

This section reviews financing support provided by the national government for the sector, and discusses ways in which that support could be improved. The national government has two primary instruments: the China Development Bank (CDB), and the state bond program. Each program plays an important role in the urban water sector but each also has its limitations. For example, CDB provides long-maturity commercial-based loans, but can only be accessed by creditworthy cities or utility companies. State bond funding provides low-interest loans or grants, but the program is not well-structured to meet policy objectives.

In order to meet sector financing needs, particularly for low-capacity cities, the national concessionary finance programs should be expanded and restructured to provide incentives for good utility performance.

The China Development Bank Program

The market for long-term infrastructure debt financing in China is dominated at the national level by the China Development Bank (CDB). CDB is a "policy bank" that acts as an intermediary for the central government. At the end of 2004, CDB's total loan portfolio was valued at RMB 1,409 billion (\$175 billion), of which 22 percent is for water resources, environment, and public utilities. CDB's water supply and wastewater

loans, reported at RMB 13.5 billion (\$1.7 billion) and RMB 5.3 billion (\$0.66 billion) respectively, constitute only 1.5 percent of CDB's 2004 total portfolio.⁹ CDB has provided around 10 percent of water supply and 5 percent of wastewater sector funding.

CDB is pursuing an aggressive growth policy and plans to significantly expand its loan portfolio over the next decade.¹⁰ As part of this expansion, it is targeting the urban infrastructure sector, and has recently signed two separate Memorandums of Understanding (MOUs) with the Ministry of Construction and the State Environmental Protection Agency, each with indicative financing amounts of RMB 50 billion (\$6.2 billion). The memorandum with the MOC focuses on urban resource conservation and town development. The memorandum with SEPA is focused primarily on environmental priorities under the 11th Five Year Plan.

In the absence of municipal bonds, CDB operates as a financial bridge between the municipal government and the capital market. Local governments have not established a standardized credit system and effective risk prevention mechanisms: they lack the creditworthiness, conditions, and relevant policies necessary for bond issuance. CDB raises funds by means of financial bonds. These are issued in the name of the projects involved to promote institutional improvement, cultivate the concept of creditworthiness in local finance, and thus create the necessary conditions to issue municipal bonds in the future. The bonds are guaranteed by the central government and are typically oversubscribed.¹¹

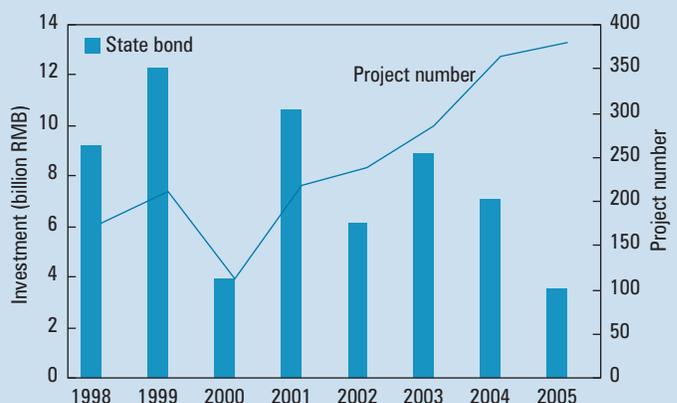
The State Bond Program

The state bond program was initiated in 1998 with the objectives of stimulating domestic demand and promoting economic develop-

ment in less economically developed regions. The bonds are issued by the Ministry of Finance, and then distributed by the National Development and Reform Commission (NDRC) as long maturity, low-interest loans, which in some cases may be converted to grants. Between 1998 and 2004, around RMB 900 billion (\$115 billion) was disbursed through the state bond program. The future of the program is unclear; increasing financial deficits at the central government level have started to raise concerns about the risks associated with the program. The issuance of state bonds declined from RMB150 billion (\$18.8 billion) in 2002 to RMB110 billion (\$13.8 billion) in 2004. Although the overall program may decrease in the future, NDRC has indicated that urban water and environmental protection will continue to remain a priority.

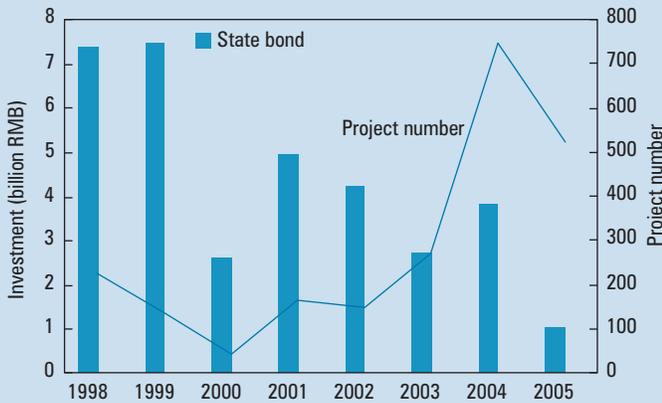
Figures 7.5 and 7.6 show the evolution of the state bond program's financing for wastewater and wastewater infrastructure. Around RMB 61 billion (\$7.5 billion) of state bond funding has been directed to the wastewater sector, accounting for around one-

FIGURE 7.5 State Bond Program Funding for Wastewater



Source: Study Research Brief, "Analysis of State Bond Program for Urban Water" by Tsinghua (2006).

FIGURE 7.6 China State Bond Program in Water Supply Sector



Source: Study Research Brief, "Analysis of State Bond Program for Urban Water" by Tsinghua (2006).

quarter of total investments. The original NDRC policy was to focus state bond funds on wastewater treatment, while municipal governments were responsible for the networks. In addition, cities were required to start collecting wastewater tariffs. After a few years, NDRC realized that cities were not investing enough in networks, and adjusted the state bond program to focus on networks on the assumption that the private sector or the city could finance treatment plants based upon future tariff revenues. State bond funding for water supply infrastructure, which totals around RMB 34 billion (\$4 billion), accounts for around 10–20 percent of total water supply investments.

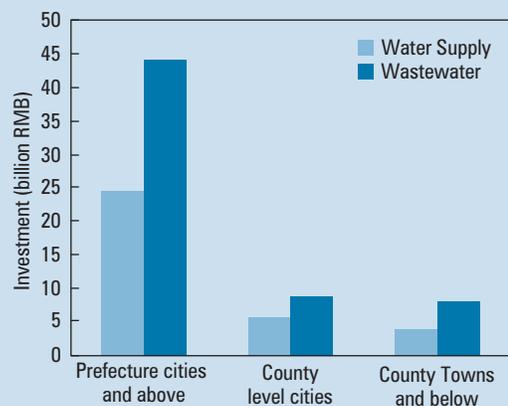
As of 2005, the state bond program had financed over 2,200 water supply projects with an average investment of 15 million RMB (\$2 million), and close to 2,000 wastewater projects with an average investment of 31 million RMB (\$4 million). Figure 7.7 shows that over two-thirds of total financing in both water supply and wastewater were directed at prefecture (or higher level) cities.

Program Limitations

Both CDB and the state bond program have been important sources of finance for the urban water sector, but also have some limitations in their use as policy instruments, as described below:

CDB Only Finances Creditworthy Projects. CDB is the only commercial bank with the mandate to provide long-maturity loans that are essential for infrastructure finance. Although CDB is a “policy bank,” it is expected to operate in a commercial manner and only extends loans to borrowers it considers creditworthy. Consequently, CDB has lent more for water supply than wastewater, as water supply companies are generally on a stronger financial footing than wastewater companies. In addition, CDB also tends to lend more to high capacity cities, which have more credit capacity than low capacity cities. CDB is a useful policy tool for bringing financial market discipline to utilities, and thus promoting transparency, account-

FIGURE 7.7 China State Bond Program in Water Supply and Wastewater by City Size



Source: Study Research Brief, "Analysis of State Bond Program for Urban Water" by Tsinghua (2006).

ability, and efficiency. It is not, however, in a good position to help low-capacity cities finance their infrastructure needs, particularly for wastewater.

State Bond Funds Do Not Target Low-Capacity Cities. The state bond program, in contrast to CDB, is designed to provide concessionary finance to lower capacity cities and less creditworthy projects. More state bond funds have gone to wastewater than water supply. Most of the state bond funding has been directed toward prefecture-level cities. Due to constraints on funding, and the needs of prefecture-level cities, the program has provided only limited support to county-level cities and towns. However, the lower capacity cities and towns have the greatest need for concessionary finance, particularly if they are expected to comply with high standards for drinking water quality and municipal wastewater treatment.

Lack of Incentives for Good Performance. The state bond program does not provide significant policy leverage in the urban water sector. The program distributes national government funding, but with minimal impact on creating proper incentives to improve sector performance. Although the provincial government assists in the allocation of state bond funds, project implementation is left to the municipal government. The program lacks clear eligibility criteria, rigorous appraisal procedures, strict compliance monitoring, and effective evaluation techniques. The large number of projects, over 4,200 since 1998, and relatively small financing amount for each project provide little leverage over the city. Moreover, administration at the national and provincial levels is very streamlined and covers multiple sectors, not just urban water.

International Examples of Concessionary Finance

Most OECD countries have structured concessionary finance programs to support the urban water sector, particularly for wastewater, which is considered more of a “public good” than water supply. Box 7.5 provides a summary of the U.S. program, which originally relied on “construction grants” and then shifted to state-administered revolving funds. Box 7.6 presents a summary of the Brazilian financing program for reducing pollution in river basins, which relies on an “output-based aid” approach. Rather than providing construction grants, the Brazilian government pays cities for actual pollution reduction. In most cases, national governments attempt to structure concessionary finance programs to try to create the right incentives for cities to respond to national policies.

Improving China’s Concessionary Finance Programs

The financing needs in the urban water sector are large and growing, and lower capacity cities in particular need the assistance of the national government. In many countries—most of them considerably richer than China—the national government provides significant financial support to cities for water and wastewater investments. The provision of concessionary finance provides an opportunity for the government to provide the right incentives for good performance. This study recommends that China:

- ***Develop Dedicated, Structured Concessionary Finance Programs.*** There are many options for improving the efficiency (or restructuring) the state bond and CDB programs. The

BOX 7.5 Financing Wastewater and Water Supply Infrastructure in the United States

Construction Grant Program. In the United States, the Water Pollution Control Act of 1948 first established a grant program to assist localities with planning and design work, and authorized loans for treatment plant construction. In 1956, a construction grant program replaced the loan program. Progress in the construction of wastewater treatment plants was slow, and water quality continued to deteriorate. In the Federal Water Pollution Control Act Amendments of 1972, Congress totally revised the existing clean water law and established national standards for treatment, mandating that all publicly owned treatment works achieve a minimum of secondary treatment or more stringent treatment by July 1, 1977. Grants were administered by the federal Environmental Protection Agency (EPA) and were provided through states to local municipalities in a complex three-step process (feasibility, design, and construction). In the mid-1980s, grants for wastewater treatment plant construction were a target of government budget cutters, and Congress authorized a shift to state revolving funds starting in 1991. One of the perverse incentives under the construction grant program was that many municipalities overinvested in treatment plant facilities as they received matching grants from the federal government ranging from 50 to 75 percent of total project costs.

State Water Pollution Control Revolving Funds (SRF). Under the SRF program, federal capitalization grants are provided annually to all 50 states. These grants are used as seed money for state-administered loans for water quality projects. States provide matching funds equal to 20 percent of the federal capitalization grant and use the SRF to provide a range of loan assistance to communities, including construction loans made at or below market rates (interest-free loans are permitted), refinancing of local debt obligations, and loan guarantees or purchasing of insurance. Loans are typically to be repaid to the SRF within 20 years, beginning one year after project completion, and the locality must dedicate a revenue stream (from user fees or other sources) to repay the loan to the state. States may use 4 percent of their capitalization grants for administrative expenses. States manage SRFs using EPA guidance and regulations, assisting construction of municipal water pollution control facilities (as under the previous grant program) and implementation of programs to reduce nonpoint source pollution and clean up degraded estuaries. Like the grant program, states decide which projects will receive assistance, using a priority ranking system that considers water quality conditions and other factors reflecting a state's policies and now also includes financial elements such as interest rates and the recipient's dedicated source of repayment. Communities of all size are eligible to seek SRF assistance, and small communities have no special priority. Nonetheless, since 1989, 63 percent of all loans and other SRF assistance (23 percent of total funds loaned) have gone to small communities.

Cities have made substantial progress toward meeting the goals and requirements of the law, and more than 90 percent of community wastewater treatment plants provide secondary treatment or better. Yet, water quality reports continue to indicate that wastewater treatment plant discharges are a significant source of water quality impairment. The SRF authorizations provided in 1987 expired in 1994, but pressure to extend federal funding has continued, in part because estimated investment needs remain high (more than \$180 billion). Congress has continued to appropriate funds, and the anticipated shift to full state responsibility has not yet occurred. From 1972 through 2005, Congress appropriated more than \$75 billion in assistance for wastewater treatment plant construction, including \$24 billion in SRF capitalization grants since 1989. States and localities have invested approximately the same in non-federal resources. The success and popularity of the wastewater SRF program led Congress to use it as the model for establishing a drinking water SRF program in 1996; it has provided \$8.6 billion in project aid.

Source: Claudia Copeland, U.S. Congressional Research Office with authors' elaboration.

BOX 7.6 Brazil's River Basin Restoration Program

In 2001, the Brazilian Government through the National Water Agency (Agencia Nacional De Aguas-ANA) established a program to promote the restoration of water quality in key river basins. The program is called PRODES (Programa Nacional De Despoluicao de Bacias Hidrograficas). It provides payments to wastewater plant owners—either public or private—that demonstrate effective wastewater treatment. Rather than provide grant money to finance the construction of the facilities, PRODES spreads the payments out over a 5-to-7-year period contingent on effective operation of the wastewater treatment plant, which is certified by an independent third party. The program is sometimes referred to the “treated sewage purchase program.” It rewards efficiency and results.

To be eligible for PRODES financial support, the wastewater treatment plant must be located in a river basin where there is a legally established and operational “Basin Committee.” The plant must be part of the investment program approved by the Basin Committee and it must meet the discharge requirements specified by the committee. The National Water Agency, utilizing national government funds, will pay up to 50 percent of the total estimated cost of the wastewater treatment plant, based on a predetermined formula set to reflect actual pollution reduction levels. In 2002, PRODES was presented with 148 proposals with an estimated cost of R\$1 billion, with 40 percent from ANA’s budget.

The PRODES program is one variant of a type of support referred to as “output-based aid,” where payment is made for services rendered and not to finance the construction of infrastructure. This puts the burden on the investor and operator to meet the standards and provides a strong incentive for performance.

Source: ANA Presentation at World Bank Water Week Conference, 2003.

study recommends that the following principles guide the reforms:

- National government funding for the urban water sector should be significantly increased.
- More funding should be channeled to low capacity cities and towns.
- Provincial governments should take the lead in designing and administering concessionary finance program(s).
- The program(s) should be structured to provide the right incentives, with carefully designed eligibility criteria, appraisal procedures, and monitoring and evaluation activities.
- A range of financing instruments should be considered, including loans, grants, revolving loan program, credit enhancements, and output-based aid.

Summary of Strategic Directions

The strategic directions for enabling urban water utilities to move up the financial sustainability ladder identified in this chapter are summarized below:

- **Achieve Utility Cost Recovery.** Urban water utilities should be allowed to recover their costs through user fees. Municipal governments can adjust a utility’s cost, and thus the extent of tariff increases, through capital contributions. Wastewater fees should cover at least the O&M and asset renewal costs of drainage services. Water supply and wastewater tariffs will need to be significantly increased in most cities, but the impact on users can be managed

by optimizing tariff structures to increase economic efficiency and utility revenues, and designing low-income assistance programs.

- ***Improve Access to Debt Markets By Increasing Cost Recovery.*** Debt is the preferred form of financing for urban water utilities. Most Chinese utilities, however, have low credit capacity. Chinese cities should transform their financially stressed utilities into credit-worthy enterprises that can fund most of their capital program through commercial debt. As China's financial markets evolve and become market-oriented and sophisticated, improving the credit status of municipal utilities will become even more important.
- ***Develop Dedicated, Structured Concessionary Finance Programs.*** The level of national government funding for the urban water sector should be increased. The existing state bond and CDB programs should be restructured into sector-specific programs to provide better incentives for improving utility performance and meeting national goals. The principles that should guide reforms include a focus on low-capacity cities and towns, provincial government leadership, creating good

incentives through program design, and using a broad range of financial instruments.

Notes

1. Since financial information on water and wastewater utilities is not readily available in China, much of the general analysis in this section is based on general experience of the World Bank in conducting financial appraisals for Bank-financed project. See Annex 1 for a list of World Bank-financed projects.
2. See the World Bank publication "Water, Electricity, and the Poor" by Komives et al. (2005), p. 41.
3. See Annex 3 Technical Notes, Figure 7.3 for more information.
4. See the World Bank-MOC Report "North China Water Quality Management Study. Component E: Regulatory and Institutional Study" (2006).
5. See the ADB report on "Final Report on National Guidelines in Urban Wastewater Tariffs and Management Study" (2003).
6. See the ADB report on "Managing Urban Change: Strategic Options for Municipal Governance and Finance in China" (2000).
7. See the 2003 report by Bellier et al. "Private Participation in Infrastructure in China" (2003).
8. See the 2005 ADB report on "PRC Water Supply, Sanitation, and Waste Management Portfolio Review."
9. From the 2006 Tsinghua University Brief on the CDB/state bond program. (Internal Document)
10. Based on the Bank's interview with CDB on May 17, 2006.
11. From CDB webpage at www.cdb.com.cn

8

Using the Private Sector to Help Improve Municipal Utility Performance

Private participation can potentially help municipal urban water utilities improve performance, accountability, transparency, and reinforce the municipal government's commitment to cost recovery. Private participation in China's urban water sector has grown rapidly over the last 10 years. Private participation has generally involved (a) investments in water supply and wastewater treatment plants; (b) joint ventures between a private company and the municipal utility company; and (c) a focus on high-capacity cities.

China's cities and municipal utilities can better utilize private participation to help improve efficiency and performance in the following ways:

- Select a private participation option that complements an overall reform process
- Ensure BOT treatment plant contracts allocate risks properly and do not undermine the financial viability of the network business
- Commit to achieving utility cost recovery—with or without private participation
- Utilize a wider variety of private participation models, particularly non-investment approaches such as affermage, leases, and management contracts that increase efficiency and lower costs

Box 8.1 provides definitions for the terms used in this chapter. The first section looks at trends in China, and shows that the private sector is primarily involved in BOT treatment plants, although joint ventures between private companies and municipal utilities are becoming more common. The second section underscores the need for cities to understand that engaging the private sector is not a panacea for resolving more fundamental utility governance problems, but an appropriate private participation option can potentially help expedite and lock in reforms. The third section stresses the need for BOT treatment plant arrangements to fit into an overall network business plan. The final section identifies the potential for using non-investment forms of private participation, such as affermage, leases, and management contracts to help improve utility efficiency without necessarily requiring the private company to take the investment risk.

Private Participation Trends in China

Data on private participation is difficult to obtain in China since there is no authoritative national database. This study draws upon two major sources: (1) a market survey in 2004 conducted by *Global Water Intelligence (GWI)*

BOX 8.1 Definition of Key Private Participation Terms

Water Services. Water services include any aspects of providing water supply, wastewater management, or reclaimed water use.

Arrangement. Rules and institutions establishing and enforcing the rights and obligations of the operator, customers, the contracting authority, and other government authorities with respect to water services. The rules are set out in contracts, laws, regulations, licenses, and related documents. Examples include management contracts, affermage, leases, concessions, divestiture, and build-own-transfer (BOT).

Operator. A private domestic or foreign company or government-owned company operating outside of its jurisdiction and providing services under an arrangement. In this study, municipal water utilities operating outside of their city and seeking to maximize their profits are considered an operator.

Joint Venture or Mixed Capital Company. An arrangement under which the operator is partly owned by the contracting authority, and in which the two parties jointly share most of the risks.

Management Contract. An arrangement under which the operator provides management services to the utility in return for a fee.

Affermage Contract. The operator operates and maintains water assets at its own expense but does not finance investment in infrastructure assets. The government delegates the management of the water service to the operator in return for a specified fee, often based on the volume of water sold. The private company's profit is equal to revenue from the fee, less operating and maintenance costs.

Lease Contract. Similar to an affermage contract, the operator operates and maintains water assets at its own expense but does not finance investment in infrastructure assets. The operator retains revenue from the customer tariff and pays the contracting authority a specified lease payment.

Concession Contract. An arrangement in which the contracting authority is the legal owner of the infrastructure assets (at least after the contract ends), but the operator is responsible for financing and managing investment, as well as operating and maintaining the business.

Divestiture. An arrangement in which the operator is the legal owner of the infrastructure assets for an indefinite term and is responsible for financing and managing investment, as well as operating and maintaining the business.

Build-Own-Transfer (BOT) Contract. Typically used for water supply or wastewater treatment plants. An operator finances, builds, owns, and operates the facilities for a specific period of time, after which ownership is transferred back to the contracting authority. BOT payments are typically based on the volume of water treated at the plant.

Design-Build-Operate (DBO) Contract. Similar to a BOT, but the contracting authority provides financing and retains ownership of the facilities during the contract period.

Transfer-Own-Transfer (TOT). Similar to a BOT, but the contracting authority sells an existing facility to the operator for a specified period of time (transfers). When the contract period ends, ownership reverts back to the contracting party.

Source: Adapted from the World Bank Toolkit on Private Participation in Water Services (2006).

that identified 126 projects; and (2) a survey reported in a Tsinghua University report that identified around 300 projects. The two sources collected and presented information in different ways. Although both sources are valuable, a detailed picture of private partici-

pation is still lacking. Both the GWI and Tsinghua reports are incomplete surveys, and thus the extent of private participation in China is probably higher than indicated in the tables below. This chapter therefore focuses primarily on general trends.

Rapid Private Participation Growth

Table 8.1 summarizes the extent of private participation in China as of 2004 based on the GWI report. Using the GWI report, Figure 8.1 shows the evolution of private participation, which started in the early 1990s and has experienced rapid growth over the last five years. International companies were the first to enter the market, but domestic companies have become more active since around 2000. Although the data in Figure 8.1 are somewhat erratic, the general trend is increasing participation by domestic firms. The GWI data clearly missed many of the smaller domestic transactions. Many international companies have established Chinese subsidiaries or joint ventures with domestic companies, so the distinction between international and domestic companies is increasingly becoming blurred. Private investment accounts for around 10 to 20 percent of all water supply and wastewater investments over the last decade.

Private Participation in Water Supply

Table 8.1 from the GWI survey indicates that most of the private participation for water

supply takes the form of water supply treatment projects. The data from the Tsinghua study, as shown in Table 8.2, presents private participation from the perspective of who owns the assets. Around half of the private participation projects involved stock transfers from the municipal utility company to private investors, with the utility maintaining management control. The motivation for stock transfer is apparently to raise funds and also develop a broader constituency for ensuring the sustainability of the utility. Joint ventures, divestitures, and BOT/TOT are also common arrangements. The Tsinghua data do not clearly distinguish where the private participation activity involves water treatment only, or both treatment and distribution. Based on Table 8.1, however, it appears that most private participation involves water treatment plants only.

Private Participation in Wastewater

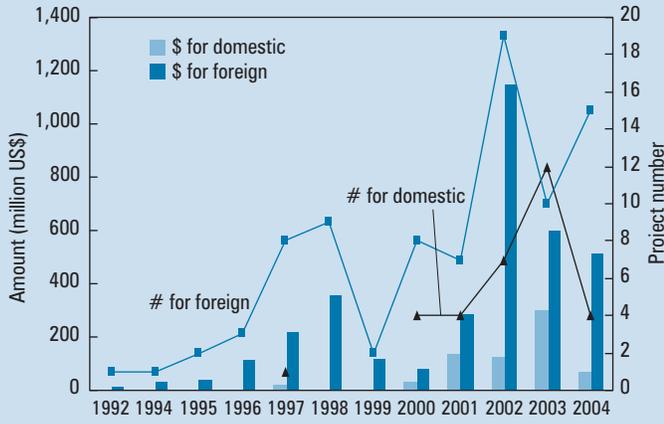
Private participation has been mainly limited to wastewater treatment. Table 8.3 shows that BOTs are the most common arrangement, but joint ventures, stock transfers, and

TABLE 8.1 Investment by Project Type

Project Type	Number of Project	% of Total Private		
		Participation Projects	Project Costs (RMB million)	% of Total Costs
Water Supply Treatment	61	48	16,152	45
Wastewater Treatment	44	35	8,560	24
Water Supply and Distribution	11	9	5,160	14
Others	10	8	5,704	16
Total	126	100	35,586	100

Source: Global Water Intelligence, "Water Market China" (2005).

FIGURE 8.1 Private Participation Investment Trends



Source: Global Water Intelligence, "Water Market China" (2005).

divestiture of treatment facilities also occur. The number of reported wastewater treatment projects in Table 8.3 (166 projects) is much higher than in Table 8.1 (44 projects) for two reasons. First, wastewater treatment plant construction is proceeding rapidly. The GWI results were based on a survey conducted in 2004, whereas the Tsinghua data

TABLE 8.3 Private Participation in the Wastewater Sector

Type of Private Participation	Number of Projects	Percent
BOT or TOT for treatment facilities	119	72%
Joint Venture between municipal utility and private company for wastewater treatment	17	10%
Stock Transfer: Partial sale of wastewater treatment company shares	15	9%
Divestiture: Sale of municipal wastewater treatment facilities to private company	15	9%
Total	166	100%

Source: Study Research Brief, "Progress on China's Urban Water Marketization Reform, Tsinghua (2006).

was based on a 2006 survey. Second, the Tsinghua survey was much more likely to capture smaller domestic private participation than the GWI report, which was prepared for an international audience.

TABLE 8.2 Private Participation in the Water Supply Sector

Type of Private Participation	Number of Projects	Percent
Stock Transfer: Partial sale of municipal utility shares	66	51%
Joint Venture between municipal utility and private company: treatment and (sometimes) distribution	41	32%
Divestiture: Sale of municipal utility facilities to private company.	15	12%
BOT or TOT for treatment facilities	7	5%
Total	129	100%

Source: Study Research Brief, "Progress on China's Urban Water Marketization Reform, Tsinghua (2006).

Water Supply and Wastewater Treatment Plants Predominate

The tables above show that the market is dominated by water supply and wastewater treatment projects. Prior to 2002, foreign companies were only allowed to invest in raw water supply, water treatment, and wastewater treatment.¹ Private sector involvement in a treatment plant is a logical choice for many companies in China. Treatment services are well-defined and the conditions and terms of payment, including price, can be determined up-front to assess whether a project is feasible. The private company does not have to take the commercial risk involved with low tariffs, but rather will be paid by the

municipal utility for services the company provides. The attractions to the public authority are also clear. The municipal utility or government does not have to finance the construction of the treatment plant. In addition, utilizing a private participation arrangement insulates wastewater treatment from wastewater collection, which is often still managed mainly as a public works program rather than a utility service. Many municipal governments also feel that it is preferable to have a private company responsible for wastewater treatment rather than try to utilize an often inefficient and technically weak drainage department.

Joint Ventures with Municipal Utilities are Common

Table 8.4 from the GWI survey indicates that the most common entity is a “municipal joint venture,” which is a combination of a local municipal utility and a private company. The Tsinghua data indicates that joint ventures are prevalent for water supply (Table 8.2). The Tsinghua data indicates that BOTs are the most common arrangement for wastewater treatment (Table 8.3). However, many of these BOTs may also be

joint ventures between the municipal utility and a private company.

Joint venture arrangements help to reduce risk for the private company because it shares the same financial risk as the municipality itself. Contract adjustments are generally easier when both sides are suffering financially, rather than when one party is benefiting. A municipal joint-venture may, however, take away some of the incentives for efficiency and cost reductions as the municipal utility is essentially entering into a contract with itself. Such arrangements can work, and may be appropriate in some cases, but they require a good regulatory system to ensure they function properly.

Water Supply Distribution Market Opening Up

In 2002, the national laws were modified to allow foreign companies to invest in the construction and management of urban water distribution and wastewater collection systems, but they must do so through a joint venture with a Chinese partner holding a majority share.² Large international companies quickly took advantage of this opening, with Suez investing in Chongqing, and Veolia entering into joint ventures in Shenzhen and the Pudong District of Shanghai. Box 8.2 provides a summary of illustrative and high-profile water supply joint ventures in China. As of 2004, at least 20 companies have invested in water distribution projects. The potential for investment in the water supply business is large, since it provides private developers with the opportunity to apply their expertise in distribution system operations and commercial practices to extract efficiencies and ultimately profits. For the wastewater business, including both collection and treatment, private companies are still reluctant to enter into the market due to the severe shortage of sector funding.

TABLE 8.4 Types of Entities in Private Arrangements

Entity Type	Number of Projects
Municipal Joint Venture	76
Foreign Company	12
Domestic Company	12
Unknown	26
Total	126

Source: Global Water Intelligence, “Water Market China” (2005).

BOX 8.2 Integrated Water Projects with Private Partners

Investment in concessions combining production and distribution networks first started in the 1990s. The market for these types of projects took off in 2002 when the government issued revised foreign investment guidelines that took utility networks off the “prohibited list” of sectors. Earlier projects were able to work around the restrictions, as they were considered to be small-scale experiments. Two recent projects in Shanghai Pudong and Shenzhen, undertaken as joint ventures with Veolia Joint Ventures, are on a much larger scale.

Shanghai Pudong. In 2001, the Shanghai Water Bureau invited foreign companies to acquire a stake in the Shanghai Pudong Water Company (SPWC), one of four water supply companies serving Shanghai. Pudong, Shanghai’s economic center, has 1.7 million people and a daily water demand of 1.2 million m³/day. The distribution network covers 319 km². The Shanghai Municipal Government sought a single foreign company as a partner to acquire a 50 percent stake in SPWC for a 50-year period. Veolia, the winning bidder, will undertake water supply, distribution, and commercial services through the new joint venture company. The bidding was based on the amount offered for the existing assets, although consideration was also given to the ability of the company to improve management and extend capacity. Veolia offered a price of \$240 million, considerably higher than the other bidders and three times the estimated net asset value of SPWC. The contract contains no special provisions relating to tariffs, and the joint venture company will use the city-wide tariffs determined by the Shanghai Municipal Government.

Shenzhen. In late 2003, Beijing Capital and Veolia acquired a 45 percent stake in Shenzhen Water Group (SWG) for 50 years at a price of \$400 million. The JV company provides water supply and distribution services, management and customer services, and collection and treatment of wastewater to Shenzhen’s Economic Zone. SWG currently has a water supply capacity of 1.7 million m³/day and wastewater treatment capacity of 1.1 million m³/day. The contract was awarded through a competitive bidding process.

Source: Global Water Intelligence, “Water Market China” (2005).

Private Participation Concentrated in High-Capacity Cities

Table 8.5 shows the distribution of private participation by city category, and indicates that private participation investments have

been concentrated in Category I cities. There are a number of private participation projects in Category II cities, which can also include affluent medium-sized cities. The level of private participation activity in Category III cities is limited both in terms of number of projects and investments. The GWI market survey utilized as the source of data for this analysis, however, may not have included some of the private participation projects in the smaller cities. Private companies may be hesitant to engage in low-capacity cities due to the low level of economic development, constraints on sector funding, and the associated investment risk.

To date, most private participation in China has included equity investments, and has naturally flowed to Category I cities and

TABLE 8.5 Distribution of Private Participation Activity by City Type

City Type	# of Projects	% of Total Projects	Projects Costs (\$ million)	% of Project Costs
Category I	54	43	23,576	66
Category II	54	43	10,440	29
Category III	18	14	1,560	4
Total	126		35,576	

Source: Global Water Intelligence, “Water Market China” (2005).

affluent Category II cities. Investments have also tended to focus on activities where commercial risk can be minimized, such as BOT arrangements for water and wastewater treatment plants. Other options for exploiting private sector involvement that does not require investment—such as lease contracts or management contracts—have not been fully explored. These options may be especially appropriate for low-capacity cities, or wastewater services, which carry a high degree of financial risk for investors.

Engaging with the Private Sector as Part of the Reform Process

The government needs to ensure the correct bundle of service standards, utility efficiency, tariffs, and government transfers in order to have sustainable urban water services. This holds true whether the service is provided by a government department, municipal utility company, a joint venture, or a private company. In China, most of the private participation arrangements do not displace the municipal utility, but rather the private company becomes a partner with the municipal utility, either through a contractual arrangement for a treatment plant or through a joint venture in the business.

Engaging in a partnership with a private company can potentially bring benefits, including financing, expertise, and improved efficiency. As importantly, including a private partner can bring another party into the policy discussion that has a vested interest in utility financial sustainability and performance. Engaging with the private sector alone, however, will not resolve the more fundamental problems associated with municipal utility governance. Municipal governments

should first commit to an overall reform plan, and then determine if, and how, to utilize the private sector to facilitate the reform agenda.

The World Bank has prepared a “toolkit” on private participation in the water sector that distills experience from around the world. Some summary highlights from the tool kit that are relevant to China are presented in Box 8.3. The key message is that private participation should be an instrument to achieve reform goals, and the private participation arrangement should be carefully selected and designed to achieve those goals.

Engaging with the private sector can either be part of the solution or part of the problem in helping to improve urban water services. Private participation, particularly if it involves financing, quickly brings out the true cost of the service as private companies require a return on investment commensurate with the risk. Municipal governments, in contrast, typically do not require a return on investment and thus provide an implicit subsidy. Private participation often involves an upgrading of the service that may entail greater overall costs, even if that service can be provided at a lower cost by a private operator. Municipal governments must make a commitment to ensure the right bundle of services, efficiency, tariffs, and fiscal support when they engage the private sector. In some Chinese cities where municipal governments are not making adequate commitments to reform, the following scenarios may arise:

- BOT contracts require payments for water supply or wastewater treatment, which in the absence of increased sector funding can reduce funds available to improve water supply or drainage networks.

BOX 8.3 World Bank Toolkit on Private Participation

The World Bank has prepared a toolkit on “Approaches to Private participation in Water Services” that distills international experience and provides guidelines for approaching private participation. Some key points related to the Chinese situation include:

- *Understand Municipal Utility Limitations.* When utilities are not performing well, either financially or operationally, the root causes are often in the system of rules and incentives, which can cause decision makers to act against the public interest. For example, municipal leaders may know that higher tariffs are necessary for good service, but refuse to allow the increase, because the political and social pain of the increase will be felt immediately, whereas it may be years before the higher revenues translate into better service.
- *Private Participation Potential.* Often reform fails because governments have not been able to change the system of government regulation and control, which is the heart of the problem. By engaging a private firm and giving it defined responsibilities for the provision of water services, governments widen their reform options. A private firm can potentially help in transforming decision making and accountability by better aligning the interests of all parties, government and private, with the public interest. Engaging a private firm can potentially (a) create a focus on service and commercial performance; (b) make it easier to access finance; and (c) boost policy clarity and sustainability.
- *Selecting a Private Participation Option.* There are a wide variety of private sector participation options, with different allocations of responsibility and risk between the public and private parties. Designing the arrangement is not just a matter of choosing between pre-specified options. A good process will (a) identify the key risks involved in providing the service; (b) determine which party is best placed to bear each risk; and (c) design an arrangement that allocates the risk accordingly.

Source: World Bank, *Approaches to Private Participation in Water Services* (2006)

- Joint ventures between municipal utilities and private companies share the same financial fate. If revenues are not adequate to generate sufficient returns to the shareholders of the private company, then the long-term viability of the venture is at risk.

BOT Treatment Plants as Part of a Network Business

BOT arrangements for water supply and wastewater treatment plants in China are extensive and growing. If properly structured, and undertaken within a sound overall sector

framework, this can potentially bring benefits, including financing, expertise, and lower costs. This section highlights two issues that are critical to effective arrangements:

- The risks associated with treatment plant performance and costs should be fully understood and allocated to the party best able to manage the risks.
- Municipal governments should ensure funding is sufficient to cover both treatment costs and network costs.

Need Proper Risk Allocation

A challenge for any BOT contract is understanding and allocating risk between the municipality and the operator. If the risks are

high or poorly understood and allocated to the operator, then sophisticated operators will increase the price. If during operations either the municipal government/utility or the private company reaps a disproportionate share of the benefits or costs, the contract is unlikely to be honored and will probably require a renegotiation or collapse.

Many of the risks can be addressed through good planning to quantify the issues and sophisticated contracts to allocate the risk. This is not always done in China, partly due to the lack of experience, as well as lack of incentives to ensure efficient private participation arrangements. Many of the BOT contracts have not been competitively bid, nor open to public scrutiny. The national government has recognized these problems, and MOC has prepared guidelines for issuing contracts, prepared model contracts, and called for strengthening government supervision of private participation arrangements.³ Adoption of these guidelines by local governments, however, is still incomplete.

Box 8.4 provides a summary of illustrative and high-profile water supply BOT projects. The Chengdu and Beijing cases described in Box 8.4 reflect the dilemma many cities face in determining how to structure an appropriate off-take agreement for water supply plants. The higher the minimum guaranteed purchase quantity (e.g., m³/day), the less risk the operator takes; conversely, the lower the guaranteed purchase quantity, the more favorable for the municipal utility. Poor raw water quality and droughts are also important risks that are often not taken into account in contracts.

Cities awarding BOT wastewater treatment projects have struggled with understanding and allocating risks associated with low flows and pollutant loading. In some cases, cities have guaranteed a high average daily minimum inflow—for example,

70 percent of design capacity, only to find that actual flows are less than predicted due to inadequate collection systems and/or poor flow estimates. Pollutant concentrations are also an important risk. If the pollutant loadings are higher or lower than expected, actual operational costs are affected. For example, high BOD concentrations will increase the aeration costs and high suspended solid concentrations will increase sludge handling costs. In 2006, the Ministry of Construction issued a “Model Concession Agreement for Urban Wastewater Treatment” that deals with some of these risks, but the use of the model agreement is voluntary.⁴

Ensure Sector Cost Recovery

A BOT contract locks the municipal government or utility into making set payments to the operator. The treatment plant, however, is just one part of a much larger network business that includes water supply distribution or wastewater collection. Unless overall funding to the overall business increases—through user fees or government transfers—the quality and sustainability of the service may be undermined.

As shown in Table 8.6, the wastewater treatment fee throughout China is insufficient to cover the actual BOT contract price. In some cases, the revenue from the fee may cover the contractual obligations as all water users in the city must pay the wastewater treatment fee, even if their wastewater is not treated. For example, a BOT treatment plant may only cover half the city, but all of the city residents pay the fee.

Table 8.6 indicates that wastewater fees are being channeled to the BOT operator, and in many cases the municipal government must also subsidize the operator. The result is that investment and operation of

BOX 8.4 High-Profile BOT Projects in China

Shanghai. In 1996, the contract for the Da Chang water treatment plant was awarded to a consortium of Bovis Construction and Thames Water Overseas Ltd. It was the first wholly owned BOT project in the water sector in China and the first to secure limited recourse financing. The project was signed before many governing regulations became effective and broke new ground politically and institutionally. Subsequent projects have built upon the experience gained by both sides with Da Chang.

The contract was signed with the Shanghai Municipal Waterworks Company (SMWC) and included a 400,000 m³/day treatment plant and pumping station. The deal was negotiated directly with the Shanghai Municipal Government and did not undergo a competitive bidding process. A municipal circular specified the supply and off-take responsibilities of the related utility companies, and the municipal government provided the concessionaire with a Letter of Support to confirm its commitment and facilitate debt financing. The project was structured to cover the BOT consortium's interest and principle on bank loans, and repayment of investors' equity with a fixed return of 15 percent. The tariff that the Thames consortium charged SMWC was higher than the retail water tariff for domestic consumers at the time (RMB 1.03). The central government authority—the State Development Planning Commission—did not review and approve the contract at the time.

In 2002, the Chinese State Council declared that guaranteed rates of return were illegal for private utility contracts. The commitment to a 15 percent rate of return specified in the Thames contract was withdrawn and the two sides entered into renegotiation. These ended with Thames decision to sell its stake back to the local water company in 2004.

The Chengdu No. 6 water treatment plant BOT (400,000 m³/d with a 27 km long transmission main) was approved in 1998 and was the first “official” BOT project implemented under the national BOT circular—and still the only BOT project to be recognized by the central government in the water sector. The project was awarded through competitive bidding to a Vivendi-Marubeni consortium. The Asian Development Bank played an important role in both formulating the structure of the project and in providing financing.

Project revenues were backed by a take-or-pay guarantee from the municipal water company, Chengdu Water Company. The concession agreement was signed by the consortium and the Chengdu Municipal Government. One problem encountered has been the gap between estimated and the much lower actual demand for water. The city does not need the entire contracted volume of water, but is abiding by the contract and looking for ways to increase demand, including extending the distribution system to satellite cities and encouraging industries to switch from the unsustainable use of groundwater to the municipal supply.

The Beijing No. 10 Water Plant project was awarded through competitive bidding to the Anglian-Mitsubishi Consortium in 2002, and includes the construction of a water treatment plant with a capacity of 500,000 m³/a day, and construction of 76-km raw water pipeline. The bids were awarded on the basis of lowest tariffs, with a guaranteed minimum level of water supply to the Beijing Municipal Waterworks Company. Above this amount, the water company would not be obliged to use the water supplied by the plant, and the consortium would therefore bear the market risk. The bidding for the project was very competitive, and the winning bid had an unexpectedly low price (1.4 RMB/m³). The central government was not involved in the project, and the Beijing Municipal Government was not a direct signatory to any of the project contracts. The project ran into problems securing financing with local and international banks, due mainly to the low tariffs and the high level of market risk, and appears unlikely to proceed.

Source: Global Water Intelligence, “Water Market China” (2005).

TABLE 8.6 Wastewater Treatment Fee and BOT Price (RMB/m³)

	Average BOT Price	Average Wastewater Fee	Ratio Region (%)
Municipalities under Central Government	0.99	0.75	76
Coastal Areas	0.80	0.55	68
Northeast	0.55	0.46	83
Middle and West	0.50	0.33	66

Source: Study Research Brief, "Progress on China's Urban Water Marketization Reform, Tsinghua (2006).

the important drainage network depends on often unreliable and insufficient municipal government transfers. The situation for water supply treatment plants is similar, although perhaps not as dramatic, as water supply companies and municipal governments have stronger incentives for maintaining the distribution networks that deliver water to the customer.

Utilizing Non-Investment Private Participation Arrangements

With or without private financing, municipal governments and their utilities can tap into private sector expertise to improve efficiency, service quality, and lower costs. Primarily to mobilize financing, Chinese policy encourages private participation. This approach has the following constraints:

- Improving utility performance, not financing, is the challenge in some cities.
- Private firms will not invest in unprofitable areas, such as wastewater

drainage or water utilities that are not financially viable.

- Private firms are reluctant to invest in low-capacity cities.

There are a number of arrangements for tapping into the benefits of private participation without requiring private investment, such as lease, affermage, management, and design-build-operate contracts.

Limitations on Private Sector Investments

The prevailing view in China is that private companies need to "pay-to-play" if they wish to be active in the urban water market. Most private participation takes the form of private financing and operation of water supply or wastewater treatment plants; in cases where the private sector is involved in joint water supply business ventures, the private partner usually brings significant capital into the joint venture (see Box 8.2). Notwithstanding the potential benefits of equity investments, there are limitations or drawbacks that should also be taken into account, including the following:

Equity Costs. In well-functioning financial markets, equity is always more expensive than debt. This is because companies are required to meet their obligations to lenders before paying dividends to shareholders. Shareholders, who provide the equity, take higher risks than lenders and therefore demand higher returns.

Transaction Costs. Utilizing private investment also entails considerable transaction costs. The investor needs to be carefully, and preferably competitively, selected and the process can be controversial. If in the future, the operator decides to withdraw,

then there are inevitable legal and financial complications that must be dealt with. In the end, the municipal government and utility must decide whether the operator can bring sufficient cost reductions and service improvements to justify the higher financing costs, transaction costs, and risk. In many cities, this threshold may not be met.

Unprofitable Businesses. Private investors will not invest in non-commercial ventures. Wastewater drainage in most cities is operated as a non-commercial activity, and neither wastewater tariffs nor government payments are adequate to generate acceptable returns on investment in drainage networks. As shown in Table 2.3, around 60 percent of the water supply companies in China recorded net losses in 2004, indicating that many cities may not offer the prospect for good returns on investment.

Low-Capacity Cities. Table 8.5 shows that relatively small amounts of private investment have gone into Category III cities. Lower capacity cities are naturally less attractive to private sector investors than larger, more affluent

cities. Higher risk levels in low-capacity cities will make the cost of private sector investment even higher, and therefore less likely.

Developing Non-Investment Arrangements

Fortunately, the limitations to private sector investment do not necessarily exclude cities from using private expertise to enhance efficiency, lower costs, and improve service. Table 8.7 shows some common private participation arrangements. The table demonstrates that there are a wide variety of private participation options—many of which do not require investment—that can be used to increase efficiency and potentially reduce costs, such as management contracts, design-build-operate (DBO) contracts, leases, etc. The actual range of options is much broader than indicated in Table 8.7, as tailored private participation arrangements can be made for each situation. Box 8.5 presents an interesting example of a mixed public and private capital for a water utility in Colombia.

Non-investment arrangements have significant potential in China, particularly for low-capacity cities or in cases where improv-

TABLE 8.7 Responsibility Allocation for Common Arrangements

Arrangement	Asset Ownership	Capital Investment	O&M Costs	Commercial Risk	Contract Duration
Arrangements Not Requiring Private Investment					
Management	Public	Public	Public	Public	Short
Affermage	Public	Mainly Public	Private	Mainly Public	Medium-Long
Lease	Public	Mainly Public	Private	Mainly Private	Medium-Long
DBO Treatment Plant	Public	Public	Private	Mainly Public	Medium
Arrangements Requiring Private Investment					
Concession	Public	Private	Private	Private	Long
Divestiture	Private	Private		Private	Indefinite
BOT Treatment Plant	Public	Private	Private	Mainly Public	Long

BOX 8.5 Mixed Capital Company in Cartagena, Colombia

Cartagena, located on the Caribbean coast, is one of Colombia's larger cities with a population of around one million inhabitants. In 1993, the Mayor decided to liquidate the municipal utility, which was providing low levels of service, was over-staffed and inefficient, and was unable to finance an estimated \$230 million worth of new investments necessary to improve service and expand coverage. The Cartagena District Council decided to create a "mixed-capital," or joint venture, company for the operation and management of the water system. A private operator from Barcelona Spain (AGBAR) was chosen as the operator owning 46 percent of the shares, with Cartagena District owning 50 percent, and private shareholders the remaining 4 percent. This privately managed joint venture company was named Aguas Cartagena (ACUACAR). Although this model is commonly used in Spain, this was the first time such an arrangement had been tried in Latin America.

ACUACAR's Board of Directors is composed of five members, two nominated by Cartagena District, two nominated by AGBAR, and one nominated by the private shareholders. Decisions in the Board have to be approved by at least four members, effectively meaning that the District and AGBAR must reach consensus. The General Manager of ACUACAR is nominated by AGBAR and needs to be approved by the Board.

Originally, ACUACAR had an operations and management contract for a period of 26 years. The contract included various performance targets that required ACUACAR to improve the quality of service and maintenance, reduce unaccounted-for-water, and improve the collection rate. It stipulated that 50 percent of net income would be declared as dividend to shareholders. In addition, AGBAR would receive a management fee calculated as a percentage of revenues and set to decrease over time. The District retained the responsibility for financing future capital investment needed to expand water and wastewater coverage, while ACUACAR was responsible for implementing capital expenditures.

The 1995 arrangement between ACUACAR and the District evolved over time and now takes the form of a partial concession contract, known as an "operation with investment" contract, under which significant investments are undertaken by ACUACAR to expand coverage and improve the operating efficiency of the networks. A major part of the investments are provided by the municipality (with financial support from the national government) with the balance by ACUACAR. The operator, bolstered by improved cash generation, mutually agreed annual tariff increases, and growing consumer confidence has taken a pragmatic, step-wise approach to investment. Over a six year period, more than \$47 million (or 35 percent of total investments) has been invested by ACUACAR without contractual mandates. Under this new arrangement, the operator invests up to a level that can be recovered from tariffs, with the rest of the investments coming from local and national governments.

The ACUACAR arrangement has produced significant improvements, including:

- *Physical:* water coverage increased from 68 percent to 99 percent, and sewerage from 56 percent to 85 percent; drinking water quality standards are consistently met; and 24 hour service coverage increased from 65 percent to 100 percent.
- *Commercial:* Modern commercial and management information services were introduced; all customers are metered; and staffing has been reduced from 1300 employees to around 270.
- *Customer Service:* ACUACAR now has three offices within reach of all customers; customers can pay their bills in banks and supermarkets; and attention to customer concerns and complaints has increased.

Source: Libhaber et al (2003). "A Public-Private Partnership for the Provision of Water and Sewerage Services in Cartagena, Colombia: Looking Back at the First Seven Years," Internal Report, The World Bank.

ing utility performance—and not financing—is the main problem. Some underutilized but promising arrangements and where they would be applicable are discussed below. Box 8.1 provides more detailed descriptions of each arrangement.

- *Management Contracts.* Where the primary objective of the city or the utility is to improve utility performance. The operator is typically paid for time inputs only, with incentive features, such as bonuses if targets are met or penalties in the case of poor performance.
- *Affermage Contracts.* Where there is considerable investment risk, and tariffs are not sufficient to cover the O&M costs. The operator is paid a fee for service delivery (such as cubic meters of water), which is de-linked from tariff revenues.
- *Lease Contracts.* Where there is considerable investment risk, but tariffs are at least sufficient to cover O&M costs. The operator is allowed to keep the tariff revenue but then pays the contracting authority for the right to use the infrastructure assets.
- *DBO Treatment Plant Contract.* Where the utility has attractive financing for construction, but looks to the operator to minimize cost and operate efficiently. Potential attractions include (a) costs may be lower than a BOT due to better financing terms; or (b) costs may be lower because of operator efficiency and expertise in considering all aspects of design, construction, and operation together.

The list above is just the commonly used options for non-investment arrangements. There are many different ways of putting to-

gether a private participation arrangement, with varying degrees of private investment and operational involvement. Box 8.5 provides an interesting example of a mixed capital arrangement in Cartagena, Colombia.

Summary of Strategic Directions

The strategic directions for private participation identified in this chapter are:

- *Use private participation as an instrument of reform.* Private participation arrangements in the urban water sector can either be part of the problem, or part of the solution. Municipal governments should commit to an overall reform plan, and then determine if, and how, to utilize the private sector to facilitate the reform agenda. The private participation arrangement should be carefully selected and designed to achieve the reform objectives.
- *Ensure BOT Arrangements Fit Into a Network Business.* BOT arrangements for water supply and wastewater treatment plants in China are extensive and growing. Two factors are critical to success: (1) cities should ensure funding is sufficient to cover both treatment and network costs; and (2) risks associated with treatment plant performance and costs should be fully understood and allocated to the party best able to manage the risk.
- *Use More Non-Investment Arrangements.* Private companies currently need to “pay-to-play” in China. Requiring private companies to invest in infrastructure may not be necessary or feasible in some cities. Alternative arrangements that do not require

investment but can improve performance and lower costs should be explored, including management, affermage, lease, and DBO contracts.

Notes

1. "Water Market China" by Global Water Intelligence (2004).
2. "Water Market China" by Global Water Intelligence (2004).
3. Three major circulars from the Ministry of Construction (MOC) have defined the overall policy: (1) *MOC Circular No. 272 (2002): Quickening*
4. See the following brief from Pinsent Masons law firm for information on the model agreement: www.pinsentmasons.com/media/728836048.pdf

the Process of General Adoption of Market Principles for the Municipal Public Utilities Sector; (2) *MOC Decree No. 126 (2004): Management Measures for Concession of Urban Public Utilities;* and (3) *MOC Opinion 154 (2005): Strengthening the Monitoring of Municipal Public Utilities.* They address the general principles of granting and structuring private participation arrangements, private participation management guidelines, and the need for municipal monitoring of private participation agreements.

9

Improving Capital Planning to Reduce Costs

The urban water business is capital-intensive, so good decisions on infrastructure investment can lower costs and improve service. Many cities and utilities in China do not plan their capital investments well. This poor planning is often rooted in inappropriate policies, institutions, and incentives. Another factor is that China's urban water business is developing quickly, and utilities are still building up their expertise and learning lessons from international and domestic experiences. This chapter starts by describing the importance of capital investment efficiency, and then highlights how Chinese utilities can reduce costs and improve performance by applying the following modern planning approaches:

- *Integrated Resource Planning* to select the best package of supply and demand management options to meet a city's water needs
- *Asset Management Planning* to systematically and cost-effectively renovate water distribution and wastewater collection networks
- *Strategic Planning and Management of Drainage Networks* to achieve the most cost-effective manner of reducing pollution and ensuring financial sustainability
- *Managing Sludge as an Environmental and Financial Priority* to ensure the environmental benefits from wastewater treatment are not dissipated through inappropriate sludge management
- *Integrating Industrial Pollution Control into a Municipal Wastewater Management System* to achieve the overall least-cost solution to water pollution control and to improve wastewater utilities' compliance with effluent and sludge standards

Capital Planning for Water Utilities

Capital planning decisions in the urban water sector are exceptionally important. The water sector is the most capital-intensive utility in the economy. Even in countries with developed urban water systems, annual investments average around 40 percent of revenues, whereas the next most capital-intensive utility sectors—electric services and communications—only average around 15 percent.¹ Moreover, most of the assets in the water sector have a very long life, with facilities such as pipelines typically lasting 50 years or longer. Making well-informed

capital investment decisions has a profound effect on service quality, cost, and affordability. Box 9.1 provides a discussion of capital costs for water services in England and Wales.

As Chinese cities accelerate capital spending on urban water infrastructure—estimated to exceed over RMB 400 billion (\$50 billion) during the 11th Five-Year-Plan period—it is imperative to improve the quality of capital planning. Around 70 percent of the investments will be for water supply distribution and drainage networks, yet the level of attention and expertise applied to

network planning in China is low. Water supply and wastewater treatment plants account for the remaining 30 percent of the sector's capital program. Choices about wastewater treatment technology are influenced by relatively high national discharge standards, which increases costs. Many cities are also upgrading their water treatment plants with advanced and expensive technology to respond to new drinking water quality standards.

Capital planning requires long-term forecasts of population and economic growth. These forecasts, coupled with government

BOX 9.1 Capital Costs in the Water Industry: England and Wales

A significant portion of a water service provider's costs are accounted for by capital costs. To estimate the true economic cost, it is necessary to know the value of the infrastructure assets, the rate at which the assets need to be replaced, and the required rate of return on assets. Most utilities have poor information on their asset values, because the assets are long-lived, and episodes of inflation and technological change often mean that the recorded book value bears little relationship to the real asset value. Depreciation rates may be a poor estimate of the rate at which assets actually need to be replaced, and there is often ambiguity about the appropriate rate of return.

In England and Wales, water utilities were required to calculate Modern Equivalent Asset (MEA) values, and use techniques designed to estimate the real cost of renewing and replacing assets over time. There has also been empirical work on estimating the cost of capital, which has resulted in a regulatory determination of the rate of return to be used in tariff setting. Since water technologies do not differ greatly around the world, it is probably reasonable to use England and Wales data as a basis for estimating the real economic cost structure of water service provision.

Capital costs amount to 80 percent of the total cost of water provision. Almost all of this cost is sunk in infrastructure assets, which helps explain why the water sector is such a strong natural monopoly. It also means that to achieve full cost recovery through tariffs, a provider could be expected to need a working ratio of 0.20. In other words, if total costs are 100, then capital costs will be 80 and operating and maintenance costs will be 20. If a tariff is to cover total costs, it will be 100 also.

The water industry in England and Wales achieves full cost recovery through a tariff that produces a working ratio of 0.5. The explanation for this apparent contradiction is that when the British government privatized the water industry in 1989, it realized that to set tariffs at a level that would allow utilities to earn a return on capital on the full depreciated MEA value would result in tariffs more than doubling. This would have been politically unacceptable, so the government decided to set tariffs to allow a return on only a fraction of the assets that existed at privatization. In 2004, the depreciated MEA value was GBP 204 billion, compared to the regulatory value for tariff setting of GBP 32 billion. The result was that the government sold the water companies for a small fraction of MEA book value, effectively locking in the pre-existing implicit subsidy policy by not requiring a return on existing assets.

Source: Castalia, "Sector Note on Water Supply and Sanitation for East Asia" (2004)

policies, affect water demand and wastewater generation. The evolution of demand for these services influences the sizing and phasing of capital works projects. Long-term forecasts in China are difficult due to rapid population and economic growth in most Chinese cities. Most cities and their utilities in China do not pay enough attention to accurate demand forecasts, but rather rely on standard values, such as per capita water use, and short-term city master plans. The result is often facilities that are either oversized or undersized, and a lack of appreciation of risks for future service provision.

Using Modern Water Supply Planning Processes²

Water supply planning in China and elsewhere has evolved over time and is becoming more sophisticated. Past planning efforts focused on constructing infrastructure to supply water. Current Chinese policies advocate using a variety of options to meet water needs such as demand management, conservation, water reuse, reallocation between agricultural and urban uses, etc. This section suggests that new methodologies should be used to select the best combination of options to meet a city's water needs, taking into account economic, financial, environmental, and political factors.

Historical Approach to Water Planning

During the 1990s, many Chinese cities dramatically overestimated future water demand and constructed water treatment plants with excess capacity. Figure 2.6 shows that the installed treatment plant capacity is equivalent to 250 percent of total daily water

production, indicating that on a national level treatment plants are about twice as large as necessary. This nonessential investment in treatment plant capacity raises overall service cost without generating benefits. Although China has been able to control the growth in water demand over the past decade, the overinvestment in water treatment plants also reflects a deficiency in water supply planning.

The water resource and construction bureau planners of the 1990s used a traditional supply planning approach that emphasized maintaining system reliability, while assuming that water demand is a "given" and cannot be altered. This approach assumes a high level of system reliability and risk (i.e., avoidance of water shortages at all costs). The final plan typically recommends construction of large-scale water development schemes and construction of new water supply infrastructure by the water utility. Because such planning is conducted internally, the public, outside experts, and other government agencies typically have little or no involvement in the planning process.

New Water Policies and Programs

China's cities, particularly in the arid north and west, are running short of water resources. In 2004, the MWR reported that seasonal water shortages affect more than 400 of China's 669 cities, and around 110 cities are facing serious water shortages requiring drastic water use restrictions.³ The national government has responded to this challenge with new policies, with the clearest policy statement set out in the historic 2000 State Council Circular on "Strengthening Urban Water Supply, Water Saving and Water Pollution Prevention and Control." Box 9.2 presents the key points related to urban water supply planning and management in

BOX 9.2 Water Supply Planning in State Council Decree No. 36 (2000)

The key points are:

Section 2: Comprehensive planning to optimize and guarantee urban water supply

- In the formulation of regional water resource plans, urban water use shall have first priority.
- Urban water plans shall include medium and long-term perspectives, considering water demand and supply, water resources, water conservation, protection of water resources, water reuse, and where necessary large-scale inter-basin water diversions.
- Improve groundwater management, control groundwater overabstraction, and conjunctively manage surface water and groundwater.
- Encourage the use of non-traditional water resources such as wastewater reuse, rainwater harvesting, use of saline water, and desalinization.

Section 3: Encourage water conservation and build water efficient cities

- Optimize the economic structure and city plan to match local water resource and environmental conditions.
- Promote and enforce urban water savings, with clear targets for water use and savings.
- Water-short cities shall close and move water-intensive industries, and enforce industrial water-use efficiency
- Promote domestic and commercial water conservation through design of buildings and water-saving equipment.
- Reduce leakage in urban water supply distribution networks.

Source: State Council Circular on Strengthening Urban Water Supply, Water Saving and Water Pollution Prevention and Control (2000).

the circular. Government agencies at the national, provincial, and municipal levels have responded and the following new policies and actions are being pursued:

- National and provincial water resource bureaus are constructing large inter-basin projects, the most notable of which is the south-north water diversion project—potentially the most expensive water project in history.
- Cities throughout China have established “water conservation offices,” with the mandate to set and enforce plans for domestic, commercial, and industrial water use. Water conservation statistics are now published in the MOC’s Construction Yearbook.

- MOC encourages cities in the arid north and west to reuse at least 20 percent of treated wastewater within urban areas.
- Local and provincial governments are closing or moving inefficient and water-intensive industries; new industrial developments must demonstrate that they are “water-friendly.”
- Some large cities are experimenting with increasing water supply block tariffs to dampen demand.

Limitations on Policy Implementation

Although government agencies are vigorously pursuing China’s national water policies, a number of challenges are emerging, such as:

- Inter-basin diversion projects are not always planned in the most economically efficient manner. Cost recovery levels are low and financial sustainability is often problematic, and environmental and social impacts may not be fully factored into the planning process. Large water resource development schemes are typically heavily subsidized. Recovering even partial costs from users is difficult due to the limitation on the extent and rate at which urban water supply tariffs can increase.
- Many urban wastewater reuse projects are not well-planned. Common problems include (a) supply exceeding demand, particularly during the rainy season when the demand for landscape irrigation is low; (b) wastewater reuse plants frequently not meeting the quality requirements of industrial customers; and (c) wastewater reuse companies requiring large subsidies and struggling financially due to low reclaimed water tariffs and demand.⁴
- Increasing block tariffs may dampen water demand, but they potentially also reduce water utility revenues, thus putting financial stress on the utilities.
- Groundwater management efforts are complicated by the reluctance of large industries to switch from low-cost groundwater to higher cost municipal water supplies, as well as the lack of effective controls on agricultural groundwater use in many areas.

Developing an Integrated Approach to Urban Water Supply Planning

The initiatives identified above—water transfers, wastewater reuse, demand management through pricing, groundwater management, water conservation, and others—are all vi-

able options for meeting urban water needs in the right context. The challenge Chinese cities and agencies have is in developing a process for selecting the right combination of options so that the integrated package best meets the city’s, or region’s, economic, financial, environmental, and social objectives. During the 1980s, many electricity and natural gas utilities faced similar challenges and responded by developing a process known as “integrated resource planning.” This approach has been adopted by sophisticated water utilities around the world, and should be pursued by Chinese cities as well. The major attributes of integrated planning are presented in Box 9.3.

Asset Management Planning: Optimizing Network Investments

Planning, operating, and maintaining adequate water supply distribution and drainage collection networks are fundamental to the cost and quality of urban water services. In China and elsewhere, the networks are often neglected because they are buried underground. This section suggests that Chinese utilities move quickly to adopt modern asset management techniques to guide the rehabilitation of their vast pipeline networks and other infrastructure.

Importance of Networks

Networks are critical but often neglected elements in the delivery of urban water services. Inadequate water distribution networks can result in water losses and lower pressure, contamination of water supply, and higher operating costs. Reducing water losses in the distribution network can often forestall or eliminate the need to develop new and ex-

BOX 9.3 Integrated Resource Planning (IRP) Concepts

Water agencies in China and throughout the world are facing supply issues that are very different from the past. Plentiful supplies of water are no longer available, even in “water-rich” regions. Environmental constraints, political realities, financial constraints, and public desires have all changed the traditional supply-side planning scenarios. IRP is not a well-defined procedure for developing optimal water management plans. Instead, it is a conceptual approach that must be developed further into a planning process specific to the context. The key attributes of the process include the following:

- It is conducted in an open and participatory manner, with an emphasis on the cooperation of the many institutions and stakeholder groups involved in water resource policy and planning.
- It identifies a broad range of traditional and innovative supply-side and demand-side alternatives for meeting a city's water needs, such as water transfers, water reclamation, water trading, groundwater storage, desalinization, demand management through pricing, industrial and domestic water conservation techniques, desalinization, etc.
- It establishes multiple criteria for evaluating options, including economic, financial, social, and political, and explicitly recognizes uncertainty and risks.
- It considers multiple long-term and short-term scenarios, includes drought management as part of the plan, and accepts that 100 percent reliability of water supply may not be economically efficient.
- It evaluates the different combinations of options, or the “resource mix,” against multiple criteria in a systematic and transparent manner.

IRP develops the best “integration of options” to allow the city to meet its water supply needs, while creating a flexible plan that allows for changing economic conditions. The IRP process is typically conducted every five years or as necessary.

Source: “Urban Water Demand and Management Planning” by Duane Baume, et. al. (1998).

pensive raw water supply and treatment facilities. Inadequate drainage networks can result in increased flooding, infiltration of drains by groundwater or stormwater (in the case of sanitary drains), and discharge of untreated wastewater into the environment.

Why Networks are Allowed to Decay.

Water and drainage networks tend to be neglected because most of the pipelines are buried, and can continue to function in the short term even if they are in desperate need of renovation. As a capital-intensive industry with low operating and high capital costs, water utilities can continue to function even when revenues are only sufficient to cover operating costs by temporarily ignor-

ing asset renewal needs. In contrast, when a utility in a less capital-intensive industry such as electric power falls short of revenue, it cannot purchase fuel, production is curtailed, and a crisis is created. Deferred asset renewal and maintenance in the water sector, however, inevitably catches up with the utility in lower service levels and even larger and more expensive capital programs.

Large Network Investment Requirements.

The 11th Five-Year-Plan estimates necessary investments in drainage networks alone at around RMB 190 billion (\$24 billion). Investment needs for water supply distribution networks are also large. Investment needs take different forms, including (a) ex-

panding network coverage to outlying areas; (b) upgrading and renovating networks within established areas; and (c) for drainage works, separating combined drains and/or constructing wastewater inceptors. Careful planning and optimization of network investments will have an important impact on service quality and affordability.

The Concept of Asset Management Planning

Upgrading water and drainage networks in an efficient manner is a formidable challenge. A utility may have thousands of kilometers of buried pipes that were installed

over decades. Many of the pipes may be of unknown age, material, and condition; moreover, the importance of any specific pipe or asset on overall service performance is often only dimly perceived. Water utilities have responded to this challenge by utilizing an approach known as “Asset Management Planning” (AMP), which is described in Box 9.4. AMP is also utilized in other infrastructure sectors, particularly in transport. AMP is applicable to all of the utility’s assets, and not limited to the networks. Water utilities face a special challenge, however, in that the basic information on the network is often lacking.

BOX 9.4 Asset Management Planning (AMP)

By utilizing AMP methods, utilities can minimize the total cost of acquiring, operating, maintaining, and replacing their capital assets, while achieving desired service levels. Basic elements include:

Collecting and Organizing Information. An inventory of assets typically include (a) descriptive information, including age, size, material, and location; (b) assessment of asset condition, along with information on operating, maintenance, and repair history, and the assets’ expected and remaining useful life; and (c) asset value, including historical cost, depreciated value, and replacement cost.

Analyzing Data to Set Priorities. Utilities use analytical techniques to identify trends, help assess risks and set priorities, and optimize decisions on maintenance, repair, and replacement. For example, managers use life-cost analysis to decide which assets to buy considering total costs over the life of the assets, not just the initial purchase price. Life-cost analysis takes into account factors such as installation costs, operating efficiency, maintenance needs, etc. to get a cradle-to-grave picture of asset costs. Managers also use risk assessment to determine how critical the assets are to their operations, considering both the likelihood that an asset will fail and the consequences in terms of costs and impact on the utilities desired level of service if the asset does fail. Based on this analysis, managers set priorities and target resources accordingly.

Integrating Data and Decision-Making Across the Organization. For example, financial and engineering data should be compatible and each asset should have a unique identifier that is used throughout the utility. All appropriate units within an organization should participate in key decisions, which ensure that relevant information is considered and encourages managers to take an organization-wide view when setting goals and priorities.

Linking Strategy for Addressing Infrastructure Needs to Service Goals, Operating Budgets and Capital Budgets. The utility’s goals for its desired level of service—such as product quality standards, frequency of service disruptions, customer response time, etc.—are the driving consideration in its strategy for managing its assets. Decisions on asset maintenance, rehabilitation, and replacement are, in turn, linked to the utility’s short-term and long-term financial needs and reflected in the operating budget and capital improvement plan.

Source: U.S. General Accounting Office, “Water Infrastructure: Comprehensive Asset Management Has Potential to Help Utilities Identify Needs and Plan Future Investments,” (2004).

The importance of comprehensive asset management for water utilities has only recently gained prominence in OECD countries, and is still not fully appreciated in China. If successfully applied in China, AMP would reap enormous benefits, including:

Higher Levels of Capital Efficiency.

Collecting, sharing, and analyzing data on capital assets has allowed utilities to make more informed decisions on how best to manage the assets. In particular, utilities are using AMP to allocate their maintenance resources more effectively and make better decisions about when to rehabilitate or replace existing assets. This is of particular importance in China, as water and wastewater utilities throughout China embark on massive renovation of their networks.

Stronger Basis for Tariff Increases. AMP provides the foundation for justifying tariff increases to help pay for needed improvements. Asset renewal should represent a significant part of a utility's annual revenue needs. The current system of tariff setting in China is based on the objective of having the utility make a small accounting profit as reflected in the company's income statement, where depreciation is typically taken as a proxy for the capital renewal costs. Depreciation, however, is based on historical costs, and many of the assets are so old that the accounting valuation is of little use. In fact, the lower the asset value, the lower the depreciation cost, and typically the lower revenue a Chinese utility is entitled to. Developing AMPs that accurately assess the asset renewal costs will assist the utility in securing an adequate revenue stream to ensure sustainability—and benefit the consumer and the city in the long run.

In order to reduce overall service costs, Chinese cities and their water utilities should develop modern asset management programs before major rehabilitation works are undertaken. Since AMP is a relatively new concept, high-capacity cities should work with experienced consulting firms to develop modern AMPs as examples for other cities in China.

Strategic Planning and Management of Drainage Networks

Drainage networks have an important role to play in urban wastewater management, both in terms of overall cost and water pollution control. This section suggests that Chinese cities should carefully consider whether separate drainage collection systems can be justified, both from a financial and water pollution control perspective. In support of pollution control, many cities need to pay closer attention to the performance of the drainage system and stormwater quality management.

Existing Situation

Older urban areas in China use a combined drainage system, but many cities now favor constructing separate stormwater and sanitary drainage systems (see Box 2.2 for a description of wastewater terminology). A MOC/SEPA 2000 “Circular on Urban Sewage Treatment and Pollution Control” suggests:

“. . . for new urban areas, separate stormwater and sanitary systems shall be considered. In older urban areas where renovation is difficult, combined drains shall be maintained with reasonable interception rates (i.e., percentage of wet weather flow conveyed to treatment

plant). Combined systems should be adopted in cities with little precipitation. For sensitive receiving water bodies, cities should consider collection and treatment of the initial stormwater flush.”

This guidance is generally sound. However, it does not elaborate on what factors should be taken into consideration for “separating” drains or “treating” stormwater flush. Due to the paucity of information on drainage networks at the national level, it is not possible to estimate the percent of combined or separated networks, nor their geographical distribution in China. Based on World Bank project experience, most drainage systems appear to be a mixture of separate and combined areas, and the general tendency is for cities to construct separate systems in new development areas (see Box 2.4 on Tianjin’s drainage system).

Combined vs. Separate Drainage Systems

Combined sewers overflow during heavy rain, with only part of the wastewater con-

veyed to the wastewater treatment plant and the remainder discharged into a nearby receiving water body. The general view in China is that separate stormwater and wastewater drainage results in less pollution because, theoretically, there are no combined sewer overflows (CSO) when it rains. The view that separate networks are superior was widely held throughout the world until recently. For example, the 1972 United States Clean Water Act recommended separate drainage networks. Over the last decade, however, the impact of urban stormwater runoff in contributing to pollution loads has become clear, and there has been a reevaluation of the relative benefits of the two systems. The emerging scientific consensus is presented in Box 9.5.

Drainage and Water Pollution Control

In China, wastewater sector performance is generally evaluated on the quantity of wastewater treated. Information on the reduction in pollutant loading (e.g., tons of BOD) is usually not highlighted in performance assessments. The performance of the drainage

BOX 9.5 Comparison of Separate and Combined Drainage Collection Systems

Based on an extensive literature review, a recent study concluded that:

- A separate system does not necessarily result in less pollution to the environment than a combined system. Separate systems appear to be better at removing BOD and nutrients, but combined systems are superior in reducing heavy metals and settleable solids.
- Increasing the capacity and performance of the wastewater treatment plants shifts the balance of the benefits toward the combined system.
- Stormwater treatment (efficient overflows, retention reservoirs, constructed wetlands, etc.) are applicable in both systems.
- Separate systems require two networks, which makes it inherently more expensive to construct and maintain, even with the costs of interceptors and CSOs in the combined system. An effective combined system typically requires higher treatment plant capacity.

Source: Brombach et al, “A New Database on Urban Runoff Pollution: Comparison of Separate and Combined Sewer Systems, in *Water Science and Technology* (2002).

system is hardly monitored or considered in the evaluation of an urban wastewater management system in China. The performance of the drainage system, however, is a critical part of the water pollution control infrastructure. Box 9.6 shows some of the main drainage collection parameters that are monitored in other countries, and should become part of China's water pollution control regulatory system as well.

Improving Drainage Networks in China

China could improve the efficiency and sustainability of water pollution control as follows:

- Lower capacity cities should utilize combined drainage systems to reduce overall costs. Higher capacity cities should carefully analyze whether a separate, combined, or hybrid drainage system provides the best combination of cost and pollution reduction, and in parallel develop a long-term strategy for stormwater quality management.
- Performance measures on drainage systems should be collected, analyzed, and made available to the public. MOC should prepare guidelines on how to help cities analyze and upgrade the performance of their drainage collection systems in a cost-efficient manner.

BOX 9.6 Drainage Collection Systems and Water Pollution Control

Many OECD countries have come to the realization that wastewater treatment plants are only one dimension of urban water pollution control. To achieve their water quality objectives, they also need to focus on the following issues:

- *Stormwater Quality Management.* Stormwater contains pollutants from urban runoff such as oil and grease from streets, fertilizers and pesticides, and with combined drains wastewater from combined sewer overflows (CSOs). For separate systems, cross-connections between stormwater and sanitary drains are widespread, and there are many instances of individuals or business negligently or accidentally pouring pollutants into a stormwater drain. Typical approaches include constructing stormwater retention areas where the stormwater can be treated by a treatment plant or natural wetlands; strict drain connection regulations and enforcement; and public education.
- *Combined Sewer Overflows (CSOs).* During rain events, combined drains overflow, sending pollution into the environment. Regulatory agencies in some countries are now requiring utilities to monitor and report the frequency and magnitude of CSOs, and where necessary to develop CSO reduction programs.
- *Sanitary Sewer Overflows (SSOs).* Even when drainage systems are separated, sanitary sewers are prone to overflow due to blockage, pumps not operating properly, undercapacity, etc. Regulatory agencies in some countries are now requiring utilities to monitor and report the frequency and magnitude of SSOs, and where necessary to develop SSO reduction programs.
- *Infiltration and Inflow (I&I).* Infiltration of groundwater or inflow of stormwater into sanitary drains can undermine the performance of a wastewater management system by (a) increasing costs of wastewater treatment; (b) increasing the frequency of SSOs; and (c) increasing the required capacity of pipes and wastewater treatment plants.

Integrating Industrial Pollution Control Into a Wastewater Management System⁵

China's national pollution control efforts focused first on industry, and then later on municipalities. Grafting the existing industrial pollution control regime onto the new reality of municipal wastewater management poses many challenges. This section suggests that wastewater utilities should be more active in managing industrial dischargers, including utilizing pollution-based charges.

Industrial Water Pollution Control in China

During the 1990s, one of China's environmental priorities was controlling industrial water pollution. Since then, dramatic progress has been made. Figure 2.7 shows that total pollutant discharge by industries has decreased from around 16 million tons of COD in 1995 to around 5 million tons in 2004. Industrial wastewater still accounts, however, for around half of all wastewater flows and one-third of COD discharges in China. This remarkable achievement is in response to a national government policy requiring all large industries to have wastewater treatment by 2000, as well as economic restructuring and use of clean technology,

SEPA and EPBs at lower levels of government have had a strong regulatory and monitoring role in the control of industrial wastewater, but have had less influence in the control of municipal domestic wastewater, which is typically the responsibility of the local construction bureau and its associated utilities. This division of responsibility functioned during the 1990s. With the ad-

vent of centralized municipal wastewater treatment plants after 2000, two issues have emerged: (1) how to find the least-cost combination of industrial and municipal wastewater treatment; and (2) how best to monitor and regulate industries. These two issues are discussed below.

Overall Cost Minimization

Annex 2 presents the industrial pollution standards (GB8978-1996), which can be grouped into two categories: (1) discharge into the environment or a municipal drainage system without a municipal wastewater treatment plant (Levels 1 and 2); and (2) discharge into a drainage system with a municipal wastewater treatment plant (Level 3). In addition to the general industrial pollution control standards, there are also some specific industry standards.⁶

The challenge for many cities is to integrate the existing industrial pollution control approach into a broader municipal wastewater management system, which includes both domestic and industrial wastewater. Most large industries within municipal systems built their own wastewater treatment facilities before centralized municipal plants were constructed. Industries can also elect to pre-treat (if necessary) to meet Class 3 standards for discharge to a municipal wastewater treatment plant. The Class 3 standards also have COD (300 mg/l) and suspended solid limits (400 mg/l). Large municipal wastewater treatment plants, however, can generally treat standard pollutants such as BOD or suspended solids at lower costs and more reliability than smaller industrial treatment plants.

Currently, wastewater utilities have limited incentives to encourage more pollutant loading from industries. In most cities, the wastewater tariff is based only on flow, and

receiving higher levels of pollution would increase operating costs without boosting revenues. In Chapter 7, we encouraged cities to establish wastewater tariffs based on both flow and pollutant loading, as well as fixed and variable costs. In most countries, pollutant loading (or trade effluent) charges are applied to industrial customers and to selected commercial customers discharging trade effluent, especially, restaurants, laundries, etc.; that is, the volume charge is not simply water volume discharged, but instead a measure of pollution volume (load). The industrial classification reflects the type of industry and therefore the characteristics of the trade effluent discharged by individual customers in that group or “band.” This avoids the need for sampling of individual companies effluent and makes the charges easier to administer and more predictable from the customer perspective.

For larger industrial customers, a more sophisticated approach should be used. A suitable tariff structure for the municipal wastewater treatment plant that reflects the relevant prices by unit volume and by unit of pollutant load can guide each industry in minimizing its total costs (for both pretreatment and municipal treatment), and lead toward a global least-cost solution for the service area as a whole. In addition, it can help the wastewater utility recover more of its costs by using excess capacity at the treatment plant. Box 9.7 illustrates how, in principle, the wastewater fee could be set for large industries. With this approach, industries would then be allowed to make the financial decision as to whether they should continue to treat onsite or discharge to a wastewater treatment plant. Several issues arise under this approach:

- The municipal wastewater utility must be allowed the flexibility to set or nego-

tiate prices and service conditions with industries, and to grant waivers to the existing limits on parameters such as BOD and SS.

- A higher level of trust and adherence to the terms of contract agreements is also required. For example, the industry's own effluent monitoring reports (hourly or daily) should be accepted as a basis for municipal wastewater charges, while the infrequent (monthly or quarterly) EPB or wastewater utility sampling results should be considered as an audit rather than as the basis for charging.
- Highly toxic substances, such as heavy metals or dangerous synthetic organic compounds (e.g., PCP), should continue to be managed at the industry through pretreatment and industrial process control.

Monitoring and Regulation

If the industrial tariff is based on discharge quality as well as discharge volume, then discharge permitting systems become essential. Even in the absence of such a charging system, the discharge permit is a very valuable tool in the wastewater management system, particularly for control of heavy metals or other toxic substances. This would require a new allocation of responsibilities between the EPB and the wastewater utility.

EPB is responsible for setting standards for the discharge of effluent to both sewers and watercourses. From the historical context, this responsibility is fully understandable, since without wastewater treatment, the sewers simply acted as conduits to convey all effluent to the nearest suitable watercourse. However, as wastewater treatment plants are added, the situation changes and it becomes important for the managers of

BOX 9.7 Applying the Polluter Pays Principle

The polluter pays principle (PPP) states that “the polluter should bear the expenses of carrying out the pollution prevention and control measures decided by public authorities to ensure that the environment is in an acceptable state.”

This is a general reformulation of the price equity principle that people should pay the costs at the wastewater treatment plant (WWTP) to treat their effluent discharge. The Mogden Formula, as applied by Thames Water in the UK, can be simplified and expressed as a charge that is the sum of a uniform flow cost and pollutant treatment costs. The pollution element varies based on the level of COD and SS in the specific discharge, relative to domestic strength effluent characteristics:

$$\text{Charge} = V + B \times Or + S \times Sr$$

Where: V = Yuan/m³ charge for collection and flow element

B = Yuan/m³ charge for secondary treatment

S = Yuan/m³ charge for sludge processing and disposal

Or = Ratio of an industry’s COD concentration to the average COD domestic

Sr = Ratio of an industry’s SS concentration to the average SS domestic

Suspended solids (SS) are included to cover those instances where it may be the determining factor, otherwise the formula (B × Or) covers the secondary treatment of COD and the cost of sludge treatment, incorporating both COD and SS removal and disposal.

The calculations, sampling, and analysis required are relatively complicated and in practice are applied to only the largest industrial polluters in a service area, and only after the wastewater utility has gained considerable experience and knowledge about industrial dischargers. The introduction of such a formula would allow industry to make their choice between two options: (1) on-site pretreatment (to remove heavy metals, toxins, etc) followed by centralized municipal treatment; or (2) advanced on-site treatment, conveyance, and disposal to the environment.

Source: ADB, “National Guidelines in Urban Wastewater Tariffs and Management” (2003).

the treatment plants to control discharges to sewers in a manner conducive to the capability of the plant to treat waste. Over-strength effluent must be prevented from entering the drainage system if it is likely to damage the treatment process or the fabric of sewers, or create undue hazards for staff working on the drainage system. This suggests that the wastewater utility should be actively involved in the licensing and monitoring of industrial wastes discharged to the municipal system.

The EPB should continue to set and enforce standards for industries discharging waste that go directly into watercourses, as

well as for discharges from municipal wastewater treatment plants. EPB should monitor the compliance of the wastewater utility in this respect, taking enforcement action as necessary in just the same way as other enterprises causing pollution are dealt with. The wastewater utility, however, should be the primary party setting and monitoring the permit conditions that optimize treatment between industrial on-site treatment and that provided by the municipal treatment plant. Since the wastewater utility may not have full legal authority to sanction industries not meeting their discharge permit requirements, the support of EPB or the par-

ent bureau may remain necessary in enforcing permit compliance.

A New Approach to Municipal Industrial Pollution Control

The overall cost of industrial and municipal wastewater treatment could be reduced, and effectiveness improved by:

- Charging industrial and commercial customers for both wastewater flow and pollutant quantity, and for large industrial dischargers, allowing the wastewater utility to directly negotiate the terms and conditions of the wastewater discharge permit.
- Empowering the wastewater utility to be the lead organization for permitting and monitoring industrial discharges to the utility's collection system, while the EPB monitors all discharges to the environment, including those of the wastewater utility.

Managing Sludge as an Environmental and Financial Priority

The many new wastewater treatment plants throughout China have helped to reduce water pollution, but have also created a widespread problem of sludge management. A wastewater treatment plant treats wastewater and discharges clean water, but there are also residual solids from the treatment process that are called "sludge" that need to be properly disposed.

The best way to treat and dispose of sludge depends on the raw wastewater characteristics, wastewater treatment process, local regulations, and numerous site-specific conditions. Furthermore, the capital costs

and often demanding operational requirements of sludge-handling facilities may equal or exceed those of the preceding (liquid) wastewater treatment facilities. Sludge-management facilities are expected to account for around 11 percent of total capital costs for the wastewater sector during the 11th Five-Year-Plan period—as opposed to 13 percent for wastewater treatment plants. Sludge management is an important environmental and financial issue that many cities and their wastewater utilities are just starting to address.

China's General Policy on Sludge Management

The 2000 MOC/SEPA Circular entitled "*Policy on Technology of Urban Sewage and Treatment Pollution Control*" provides general guidelines for sludge management. The policy calls for wastewater utilities to treat sludge as a resource. Treatment plants with capacity greater than 100,000 m³/day are encouraged to use anaerobic digestion to generate biogas, as well as reduce the volume and weight of the sludge. Cities should also explore opportunities for aerobic composting, where the compost can be beneficially reused as soil conditioner. Utilities can dispose of sludge residuals through either disposal in a modern sanitary landfill or through application on agricultural land—provided the sludge meets the required standards. Although this guidance is generally sound, there are a number of challenges:

Challenge of Anaerobic Digestion. Most large wastewater utilities around the world stabilize their sludge through a process of anaerobic digestion. This process produces biogas (mainly methane), which can be used to provide supplemental power to operate the wastewater treatment plants. The proc-

ess also helps to reduce the sludge volume and weight, which reduces final disposal costs. Many wastewater utilities in China struggle with the operation of their digestion facilities. Many installed sludge digesters do not operate because of inadequate quantities of sludge due to low BOD/SS concentrations in influent; poor quality sludge due to toxic compounds in industrial discharges; and lack of maintenance due to insufficient funds. Although the larger and more sophisticated utilities can, and do, operate their facilities efficiently, many utilities struggle with their sludge digesters. Sludge digestion facilities are capital-intensive and operationally complex.

Challenge of Composting. Some cities have turned to aerobic composting as an alternative to anaerobic digestion, often in conjunction with solid waste composting facilities. Composting generally has lower capital costs than digestion, but has higher operating costs. If the compost can be sold as soil conditioner, then part or all of the operating costs can be recovered. In areas where there are significant industrial dischargers, the sludge may contain toxic chemicals and may not be suitable for composting. Moreover, finding reliable markets for the composted sludge is often difficult.

Challenge of Sludge Disposal. Before sludge can be disposed, it needs to be stabilized and dewatered. Stabilization is provided to eliminate odor and reduce the threat to human health, and can be accomplished through either chemical, anaerobic, or aerobic processes. Dewatering is needed to reduce the weight and volume of the sludge and is usually provided by machines (centrifuges, pressure filters, etc.) or in drying beds. Wastewater utilities usually have

the option of disposing sludge in a landfill or applying the sludge onto agricultural land.

Many smaller Chinese cities do not have modern sanitary landfills, so the sludge is often disposed in open dumps. In cases where a modern sanitary landfill exists, the sludge is often not adequately dewatered, causing excessive leachate production at the landfill. Land application is an option if the sludge meets the standards for agricultural land, but the costs of conveying the sludge to the agricultural land, and proper application can be prohibitive in many cases.

Suggestions for Sludge Management

Proper planning and management of sludge from wastewater treatment plants is critical for ensuring environmental objectives and controlling costs. The following general approaches are recommended:

- **Improve Regulation of Sludge Management.** EPB and utility parent bureaus should ensure that every wastewater utility properly treats and disposes of its sludge in an environmentally safe manner.
- **Manage Sludge as a Resource in High-Capacity Cities.** High-capacity cities should develop and implement sludge management plans that make beneficial use of the sludge, such as through anaerobic digestion to produce biogas or disposal through land application. Composting is an attractive option for smaller high-capacity cities. Managing sludge as a resource may increase overall operating costs for the utility, but can result in a net benefit to society.
- **Safe Disposal of Sludge in Low-Capacity Cities.** Most low-capacity cities do not have the financial or technical capacity to manage sludge as a resource. The

transitional objective for these cities should be to minimize the cost of environmentally safe sludge disposal. Low-cost chemical stabilization and sludge dewatering methods should be employed, with disposal at a modern sanitary landfill. If a city does not have a sanitary landfill, it should be required to construct one in conjunction with the wastewater treatment project, either as a standalone facility or as part of a municipal landfill.

Summary of Strategic Directions

The following approaches to improving capital planning have been highlighted in this chapter:

- *High-capacity cities and their utilities should develop new water supply planning approaches, drawing upon integrated resource planning techniques.* This includes evaluating a wide range of traditional and innovative options and selecting the best “set of options” as evaluated against economic, financial, environmental, and social criteria. Integrated resource planning requires an open and participatory process with all institutions and stakeholders involved, and explicit recognition of uncertainty and risk.
 - *High-capacity cities and their utilities should establish modern asset management planning programs.* Asset management planning will help ensure that the renovation of water supply and wastewater collections—the largest investment challenge ahead—is done in a cost-effective manner.
- Chapter 6 called for cities to manage wastewater as an integrated network utility business. This chapter highlights a number of areas where integration of key functions is critical to meeting pollution control objectives, including:
- *Strategically plan and manage drainage networks to control water pollution.* Low-capacity cities should utilize combined stormwater and wastewater drains to control costs and help reduce stormwater pollution. High-capacity cities should carefully consider whether separate, combined, or hybrid collection networks provide the best combination of cost and pollution reduction, particularly in the context of establishing storm-water quality management programs. The performance of drainage systems should be better monitored and regulated, including combined sewer overflows, sanitary sewer overflows, and infiltration and inflow.
 - *Incorporate industries into the municipal wastewater management system.* Industries should be charged for both the flow and amount of pollution discharged into municipal drains. In high-capacity cities, utilities should be allowed to negotiate the terms and conditions of industrial discharge permits, and monitor and enforce compliance in coordination with EPB. EPB should focus on ensuring that the wastewater utility meets the applicable effluent and sludge standards.
 - *Manage sludge as an environmental and financial priority.* The regulation of sludge management by EPB should be improved. High-capacity cities should strive to manage sludge as an

energy and organic resource by utilizing digesters and land disposal where appropriate. Low-capacity cities should utilize low-cost sludge treatment processes and dispose into a modern sanitary landfill; sludge disposal should be considered as part of an overall solid waste management program.

Notes

1. Baumann, Duane, et. al., "Urban Water Demand Management and Planning" (1998)
2. Baumann, Duane, et. al., "Urban Water Demand Management and Planning" (1998)
3. See Chapter 2, Endnote 9.
4. Based on World Bank-MOC "North China Water Quality Study Report: Component C Urban Water Reuse Study" (2005).
5. This section draws heavily on the ADB report "National Guidelines in Urban Wastewater Tariffs and Management" (2003).
6. Specific standards are also enforced for several industrial sectors, for example: pulp and paper (GB3544-92), shipbuilding (GB 3552-83, GB4286-84), offshore petroleum development (GB4914-85), dyeing and finishing of textiles (GB4287-92), meat packing (GB13457-92), ammonia production (GB13458-92), iron and steel (GB13456-92), ordnance manufacture (GB14470-93), phosphate fertilizer (GB15580-95), and caustic alkali and polyvinyl chloride (GB15581-95).

10

Strategic Action Plan

China needs to improve the performance of its urban water utilities to confront the challenges of:

- Rapid urbanization
- Urban diversity
- Water scarcity and degradation
- Large capital investment demands

Improving the operational and financial performance of urban water utilities will bring significant economic, environmental, and public health benefits. This study presents a vision whereby in 2020 utilities in high-capacity cities are efficiently providing water and wastewater service that ranks among the best in the world. Utilities in low-capacity cities and towns are also efficiently providing reliable and safe water supply and collecting and treating all municipal wastewater. Lower capacity cities are complying with transitional water and wastewater service standards that offer significant improvements from current levels, while taking into account these cities' level of economic development.

To achieve this vision by 2020, governments at the national and provincial levels

need to take bold and proactive measures to establish a better sector governance framework that focuses on achieving policy objectives. City governments need to promote sound governance and sensible structures for their municipal water utilities. In the proper institutional setting, China's urban water utilities can flourish and improve their financial sustainability, better engage with the private sector, and make smart capital planning decisions.

Table 10.1 provides a summary of the themes and key strategic directions presented in this study. To implement a strategy, responsibilities need to be assigned and deadlines set. Table 10.1 suggests who should do what and by when. Designing policies, programs, and specific actions to implement the recommended strategies will require sustained attention and commitment by all levels of government, utilities, professional organizations, advocacy groups, businesses, and citizens. The Bank can assist the government in addressing the strategic issues identified in this study through Bank-financed projects, analytical and advisory services, and policy dialogue.

TABLE 10.1 Summary Strategic Action Plan			
Theme 1: Improving Sector Governance			
Strategic Direction	Approaches	Key Actors	Time Frame
Improve Policy Coordination	Establish "National Water and Sanitation Committee"	State Council, NDRC, MOF, MOC, MWR, SEPA, MoPH	2008
Shift From Physical Targets to Policy Goals	Prepare goal-based policy papers with monitoring parameters		2008–10
Set Appropriate Water and Wastewater Standards	Use transitional standards for low-capacity cities	SEPA, MoPH, MOC	2008–10
Enhance Provincial Government Oversight	Increase coordination and funding for provincial agencies Establish provincial water offices	Provincial governors and provincial agencies	2008–10
Theme 2: Improving Municipal Utility Governance and Structure			
Streamline Municipal Utility Governance	High-Capacity Cities: Municipal Utility Board/Group Low-Capacity Cities: Better agency coordination or utility reports directly to the mayor	Mayors, leading municipal agencies, and urban water utilities	2008–12
Foster Efficient Utilities	Improve performance monitoring, transparency, and customer orientation High-Capacity Cities: Empower utility by reducing the influence of the parent bureau and allow utility to take over corporate functions Low-Capacity Cities: Parent bureau provides utility with more autonomy and authority		2008–12
Manage Wastewater as Network Utility Business	Put collection and treatment under one management system, improve cost recovery, and charge for drainage services		2008–15
Exploit Opportunities for Service Aggregation	Consider metropolitan urban water utilities Consider multi-city, regional water utilities Merge water and wastewater utilities		2008–15

Theme 3: Move Up the Financial Sustainability Ladder			2008–15
Achieve Utility Cost Recovery	<p>Ensure user fees meet utility revenue requirements for O&M, debt service, and percentage of capital investments (at least equal to asset renewal). As necessary, provide capital subsidies to reduce debt service with the following guidelines:</p> <p>High-Capacity Cities: Partial drainage capital contributions Low-Capacity Cities: (a) Drainage capital contributions; (b) Partial capital contributions for water and wastewater; (c) Greater use of national grants and low-interest loans</p> <p>Revise tariff structures taking into account block tariffs, fixed and variable tariff components, and load-based wastewater tariffs</p> <p>Enhance credit status through higher levels of cost recovery so utilities can borrow more</p>	Municipal governments and urban water utilities	
Make More Use of Debt Financing	Enhance credit status through higher levels of cost recovery so utilities can borrow more		
Improve National Concessionary Finance Programs	<p>Increase national government concessionary (i.e. low-interest, long maturity loans or grants.</p> <p>Restructure state bond program (or create a new program) to provide better incentives to comply with national policies</p> <p>Allow provincial governments to take a leading role in administering concessionary finance programs</p>	State Council, NDRC, provincial governor, national and provincial agencies	2010–15
Theme 4: Private Sector Participation			
Use Private Sector to Improve Municipal Utility Performance	<p>Ensure private participation arrangement fits into an overall reform plan</p> <p>BOT arrangements should be compatible with network business requirements, with adequate funding available for both networks and treatment plants</p> <p>Use more non-investment private arrangements, including management, affermage/lease, DBO contracts</p>	Mayors, leading municipal agencies, and urban water utilities	

TABLE 10.1 Summary Strategic Action Plan (Continued)

Theme 5: Improving Capital Planning			
Strategic Direction	Approaches	Key Actors	Time Frame
Improve Utility Capital Planning	<p>Adopt more advanced water supply approaches that identify the best combination of options, taking into account economic, financial, environmental, and social objectives, and explicitly consider uncertainty and risk. Encourage participatory and transparent planning</p> <p>Develop asset management planning (AMP), with a focus on rehabilitating water distribution and drainage networks</p> <p>Strategically plan and manage drainage networks taking into account (a) separate or combined drains; (b) storm-water quality management; and (c) reducing combined and sanitary sewer overflows</p> <p>Allow wastewater utilities to actively participate in industrial pollution control through permitting, monitoring, and charging load-based charges</p> <p>Manage sludge as an environmental and financial priority</p> <p>High-Capacity Cities: Sludge digestion and explore land application</p> <p>Low-Capacity Cities: Low-cost stabilization and disposal in landfill</p>		



The World Bank's Water and Wastewater Lending Program in China (in US\$ Millions)

Project Name	Total Cost ¹	World Bank Financing			W&S Components ²			Start Date	Closing Date
		IBRD	IDA	Total	Wastewater ³	Water Supply	Other Water ⁴		
Beijing Environmental Project	298	45	80	125	31			1992	1999
Changchun Water Supply and Env Project	251		120	120	46	189		1992	1999
Tianjin Urban Development and Env Project	195		100	100	33			1992	2000
Southern Jiangsu Env Protection Project	588	250		250	76			1993	2001
Zhejiang Multicities Development Project	231	110		110		125		1993	2003
Liaoning Environment Project	338	110		110	204	24		1994	2003
Hubei Urban Environment Project	370	125	25	150	191			1995	2005
Yunnan Environment Project	308	92	25	117	137	61		1996	2004
Second Shanghai Sewerage Project	633	250		250	615			1996	2004
Third National Rural Water Supply Project	134		70	70	2	115		1997	2006
Shandong Environment Project	202	95		95	36	64		1998	2005
Guangxi Urban Envmt Project	168	72	20	92	114		22	1998	2007
Fourth Rural Water Supply and Sanitation Project	86	16	30	46		74		1999	2006
Sichuan Urban Envmt Project	325	150	2	152	179	117		1999	2007
Hebei Urban Environment Project	270	150		150	179	86		2000	2007
Second Beijing Environment Project	1,252	349		349	392			2000	2009
Chongqing Urban Environment Project	507	200		200	397	25		2000	2007
Liao River Basin Project	189	100		100	110	40		2001	2007
Huai River Pollution Control Project	207	106		106	195			2001	2007

Project Name	Total Cost ¹	World Bank Financing			W&S Components ²			Start Date	Closing Date
		IBRD	IDA	Total	Wastewater ³	Water Supply	Other Water ⁴		
Second Tianjin Urban Dev and Envmt Project	334	150		150	176	17	55	2003	2010
Shanghai Urban Envmt Project	494	200		200	345			2003	2009
Zhejiang Urban Envmt Project	333	133		133	151		10	2004	2010
Guangdong Pearl River Delta Urban Envmt Project	432	128		128	390			2004	2009
Hunan Urban Dev Project	373	172		172	102		254	2004	2010
Tai Basin Urban Envmt Project	174	61		61	117		55	2004	2009
Ningbo Water and Envmt Project	291	130		130	128	158		2005	2010
Liuzhou Envmt Management Project	189	100		100	175			2005	2011
Chongqing Small Cities Infra Improvement	265	180		180		98	58	2005	2012
Second Phase Shanghai Urban Envmt Project	423	180		180	290	58		2005	2011
Sichuan Urban Development Project	373	180		180	28		36	2006	2013
Henan Towns Water Supply and Sanitation Project	303	150		150	44	204		2006	2013
Second Guangdong Pearl River Delta Urban Project	188	96		96	89		93	2007	2012
Second Shangdong Envmt Project	270	147		147	206	34		2007	2013
Second Liaoning Medium Cities Project	325	173		173	130	132	56	2007	2013
Total (in millions)	11,319	4,400	472	4,872	5,308	1,621	639		

Notes:

1. Includes price & physical contingencies, but excludes interest during construction and front-end fee.
2. Includes proportional share of contingencies.
3. Usually excludes industrial pollution control but includes most sanitation.
4. Includes investments in canal extensions, river embankments, canal sediment dredging, flood protection etc.

APPENDIX B

Wastewater and Drinking Water Standards in China

1. Municipal Wastewater Discharge Standards (GB18918-2002)

Highest Allowable Discharge Concentration of Water Pollutants from Sewage Treatment Plants (Daily Average) Unit: mg/l					
No.	Basic Parameter	Grade I Standard		Grade II Standard	Grade III Standard
		Standard A	Standard B		
1	COD	50	60	100	1201
2	BOD ₅	10	20	30	601
3	Suspended solid (SS)	10	20	30	50
4	Animal & plant oil	1	3	5	20
5	Petroleum	1	3	5	15
6	Negative ion surface active agent	0.5	1	2	5
7	Total nitrogen (as N)	15	20	—	—
8	NH ₃ -N (as N)	5 (8)	8 (15)	25 (30)	—
9	Total P Built before Dec., 2005	1	1.5	3	5
	(as P) Built before Jan. 1, 2006	0.5	1	3	5
10	Color (dilution magnitude)	30	30	40	50
11	pH	6~9			
12	Bacillus coli (count/l)	103	104	104	—

Notes:

- Prior to 2002, Grade 1B standards applied to discharges into Class I, II, or III receiving waters, and Grade 2 standards applied to discharges into Class IV or Class V receiving waters. Lower interim standards (Grade 3) could apply for primary treatment where secondary treatment facilities are to be built in the future.
- In 2002, SEPA mandated that all cities and towns shall meet Grade 1B standards.
- In 2006, SEPA Circular 110 [2005] No. 110 states: The effluent from a municipal WWTP which is discharged into important river basins which are decided by the State and provincial government and into closed or half closed water basins such as lakes, reservoirs shall meet Class 1A discharge standard. The effluent discharged into GB3838 surface water Class III function water basins (excluding appointed drinking water sources and swimming areas) and GB3097 sea water Class II function water areas shall meet the Class 1B discharge standards.

2. Industrial Wastewater Discharge Standards (GB8978-1996)

Industrial Wastewater treatment plant effluents must conform to the National Comprehensive Emission Standards of Wastewater as presented below. Class One shall apply to any effluent discharged into natural water bodies, and Class Three to those discharged to a municipal wastewater treatment plant.

Comprehensive Wastewater Discharge Standards (Unit mg/L except pH)			
Ref.	Pollutant	Class One	Class Three
1	PH	6 to 9	6 to 9
2	SS	≤ 70	≤ 400
3	CODCr	≤ 100	≤ 500
4	BOD5	≤ 20	≤ 300
5	Oil	≤ 5	≤ 20
6	P	≤ 0.1	≤ 0.3
7	N-NH3	≤ 15	—
8	Volatile hydroxybenzene	≤ 0.5	≤ 2.0
9	Sulfide	≤ 1.0	≤ 1.0
10	Fluoride	≤ 10	≤ 20
11	Total Cu	≤ 0.5	≤ 2.0
12	Total Zn	≤ 2.0	≤ 5.0
13	Total Mn	≤ 2.0	≤ 5.0
14	Total Hg*	≤ 0.05	≤ 0.05
15	Total Cd*	≤ 0.1	≤ 0.1
16	Total Cr*	≤ 1.5	≤ 1.5
17	Cr6+ *	≤ 0.5	≤ 0.5
18	Total As*	≤ 0.5	≤ 0.5

Note: Specific standards are also enforced for several industrial sectors: pulp and paper (GB3544-92), shipbuilding (GB 3552-83,GB4286-84), off-shore petroleum development (GB4914-85), dyeing and finishing of textiles (GB4287-92), meat packing (GB13457-92), ammonia production (GB13458-92), iron and steel (GB13456-92), ordnance manufacture (GB14470-93), phosphate fertilizer (GB15580-95), and caustic alkali and polyvinyl chloride (GB15581-95).

3. Surface Water Quality Standards (GB3838-2002)

Surface water is categorized according to six classes as described below. The table of parameters is on the following page.

- Class I—Mainly applicable to the source of water bodies and national nature preserves.
- Class II—Mainly applicable to class A water source protection area for centralized drinking water supply, sanctuaries for rare species of fish, and spawning grounds for fish and shrimps.
- Class III—Mainly applicable to class B water source protection area for centralized drinking water supply, sanctuaries for common species of fish, and swimming zones.
- Class IV—Mainly applicable to water bodies for general industrial water supply and recreational waters in which there is not direct human contact with the water.

- Class V—Mainly applicable to water bodies for agricultural water supply and for general landscape requirements.
- Class V+—Not to be used

Environmental Quality Standards of Surface Water (GB3838-2002) Unit: mg/l (excluding pH)						
Ref.	Parameter	Class I	Class II	Class III	Class IV	Class V
1	pH	6 to 9	6 to 9	6 to 9	6 to 9	6 to 9
2	DO \geq	7.5 (or 90% sat)	6	5	3	2
3	COD Mn \leq	2	4	6	10	15
4	CODCr \leq	15	15	20	30	40
5	BOD5 \leq	3	3	4	6	10
6	N-NH3 \leq	0.015	0.5	1.0	1.5	2.0
7	Total Phosphorus (P) \leq	0.02 (0.01)*	0.1 (0.025)*	0.2 (0.05)*	0.3 (0.1)*	0.4 (0.2)*
8	Total Nitrogen (N) \leq	0.2	0.5	1.0	1.5	2.0
9	Copper (Cu) \leq	0.01	1.0	1.0	1.0	1.0
10	Zinc (Zn) \leq	0.05	1.0	1.0	2.0	2.0
11	Fluoride (F) \leq	1.0	1.0	1.0	1.5	1.5
12	Selenium (Se) \leq	0.01	0.01	0.01	0.02	0.02
13	Arsenic (As) \leq	0.05	0.05	0.05	0.1	0.1
14	Mercury (Hg) \leq	0.00005	0.00005	0.0001	0.001	0.001
15	Cadmium (Cd) \leq	0.001	0.005	0.005	0.005	0.01
16	Chromium (Cr6+) \leq	0.01	0.05	0.05	0.05	0.1
17	Total lead (Pb) \leq	0.01	0.01	0.05	0.05	0.1
18	Total cyanide (CN-) \leq	0.005	0.05	0.2	0.2	0.2
19	Volatile phenol \leq	0.002	0.002	0.005	0.01	0.1
20	Oil \leq	0.05	0.05	0.05	0.5	1.0
21	Anionic detergent \leq	0.2	0.2	0.2	0.3	0.3
22	Sulphide \leq	0.05	0.1	0.2	0.5	1.0
23	Coli forms (number/L) \leq	200	2000	10,000	20,000	40,000

4. Standards for Drinking Water Quality (Draft GB 5749—2006)

The Standards will replace the Standard of GB 5749-85 “Sanitary Standards of Drinking Water” on the date of enforcement. The main changes are increases in the number of parameters from 35 items of the Standard of GB5749-85 to 106 items, adding 71 items and revising 8 items, including.

- The number of microorganism indices increases from 2 items to 6 items,
- The number of drinking water disinfectants increases from 1 item to 4 items;
- The number of inorganic chemicals in the toxicological indices increases from 10 items to 21 items,
- The number of organic chemicals in the toxicological indices increases from 5 items to 53 items
- The number of sensory character and general physical-chemical indices increases from 15 items to 20 items. The standard for turbidity is revised.

4.1 Regular Parameters			
Item	Limit	Item	Limit
1. Microorganism indices		3. Sensory character and general chemical indices	
Total Coliform Bacteria (MPN/100mL or CFU/100mL)	Shall not be detected	Color (Pt-Co Color Unit)	15
Thermotolerant Coliform Bacteria (MPN/100mL or CFU/100mL)	Shall not be detected	Turbidity (NTU- Nephelometric Turbidity Units)	1 or 3
Escherichia Coli(MPN/100mL or CFU/100mL)	Shall not be detected	Odor and Taste	No strange odor and peculiar taste
Total number of bacteria colony (CFU/mL)	Shall not be detected	Visible matter	None
2. Toxicological indices		pH (pH unit)	No less than 6.5 and no greater than 8.5
Arsenic (mg/L)	0.01	Aluminum (mg/L)	0.2
Cadmium (mg/L)	0.005	Iron (mg/L)	0.3
Chromium (six, mg/L)	0.05	Manganese (mg/L)	0.1
Lead (mg/L)	0.01	Copper (mg/L)	1.0
Mercury (mg/L)	0.001	Zinc (mg/L)	1.0
Selenium (mg/L)	0.01	Chloride (mg/L)	250
Cyanide (mg/L)	0.05	Sulfate (mg/L)	250
Fluoride (mg/L)	1.0	Total Dissolved Solid (mg/L)	1000
Nitrate (measured as N, mg/L)	10 or 20 (ground water limited)	Total Hardness (measured as CaCO ₃ , mg/L)	450
Chloroform (mg/L)	0.06	Oxygen Demand (COD _{Mn} Method, measured as O ₂ , mg/L)	3 or 5 when oxygen demand of raw water is greater
Carbon Tetrachloride (mg/L)	0.002	Volatile phenol (measured as phenol, mg/L)	0.002
Bromate (When use Ozone, mg/L)	0.01	Anion Synthetical Detergent (mg/L)	0.3
Formaldehyde (When use Ozone, mg/L)	0.9	4. Radioactive Indices [?]	Value for guidance
Chlorite (When use Chlorine Dioxide as disinfectant, mg/L)	0.7	Total α Radioactivity (Bq/L)	0.5
Chlorate (When use compounded Chlorine Dioxide as disinfectant, mg/L)	0.7	Total β Radioactivity (Bq/L)	1

• MPN means most possible number; CFU means colony forming unit. Escherichia Coli and Thermotolerant Coliform Bacteria shall be further tested when total Coliform Bacteria is detected in water sample. It is not necessary to test Escherichia Coli and Thermotolerant Coliform Bacteria when total Coliform Bacteria is not detected in water sample.

• Higher Turbidity standard used when conditions of water source and purification technologies are limited.

4.2 Regular Indices and Requirements of Disinfectants in Drinking Water

Name of Disinfectant	Contact Period with Water	Limit Value of Finished Water from Plant	Residual Concentration of Finished Water from Plant	Residual Concentration at the End of Network
Chlorine gas and free chlorine preparation (free Chlorine, mg/L)	At least 30 min	4	≥ 0.3	≥ 0.05
Monochloramine (Total Chlorine, mg/L)	At least 120 min	3	≥ 0.5	≥ 0.05
Ozone (O ₃ , mg/L)	At least 12min	0.3		0.02 If add Chlorine, total chlorine ≥ 0.05

4.3 Table 3 Non-regular Indices and Limit Values of Water Quality

Item	Limit Value	Item Limit	Value
1. Microorganism indices		Chlorothalonil (mg/L) 0.01	
Giardia (unit/10L)	<1	Furadan (mg/L)	0.007
Cryptosporidium (unit/10L)	<1	Lindane (mg/L)	0.002
2. Toxicological indices		Chlorpyrifos (mg/L)	0.03
Stibium (mg/L)	0.005	Dichlorfos (mg/L)	0.001
Barium (mg/L)	0.7	Atrazine (mg/L)	0.002
Beryllium (mg/L)	0.002	Deltamethrin (mg/L)	0.02
Boron (mg/L)	0.5	2,4- Dichlorophenoxyacetic acid (mg/L)	0.03
Molybdenum (mg/L)	0.07	Dichlorodiphenyltrichloroethane (mg/L)	0.001
Nickel (mg/L)	0.02	Ethylbenzene (mg/L)	0.3
Silver (mg/L)	0.05	Dimethylbenzene (mg/L)	0.5
Thallium (mg/L)	0.0001	1,1-Dichloroethylene (mg/L)	0.03
Cyanogen Chloride (measured as CN ⁻ , mg/L)	0.07	1,2-Dichloroethylene (mg/L)	0.05
Monochloro-Dibromo- Methane (mg/L)	0.1	1,2-Dichlorobenzene (mg/L)	1
Dichloro-Monobromo-Methane (mg/L)	0.06	1,4-Dichlorobenzene (mg/L)	0.3
Dichloroacetic acid (mg/L)	0.05	Trichloroethylene (mg/L)	0.07
1,2-Dichloride Ethane (mg/L)	0.03	Trichlorobenzene (Total amount, mg/L)	0.02
Dichloromethane (mg/L)	0.02	Hexachlorobutadiene (mg/L)	0.0006
Trihalomethane	See Note 1.	Acrylamide (mg/L)	0.0005
1,1,1-Trichloride Ethane(mg/L)	2	Tetrachloroethylene (mg/L)	0.04
Trichloroacetic acid (mg/L)	0.1	Toluene (mg/L)	0.7
Chloral (mg/L)	0.01	Di(2-ethylhexyl) phthalate (mg/L)	0.008
2,4,6-Trichlorophenol (mg/L)	0.2	Epichlorohydrin (mg/L)	0.0004
Tribromomethane (mg/L)	0.1	Benzene (mg/L)	0.01
Heptachlor (mg/L)	0.0004	Styrene (mg/L)	0.02

(Continued)

4.3 Table 3 Non-regular Indices and Limit Values of Water Quality (Continued)

Item	Limit Value	Item Limit	Value
Malathion (mg/L)	0.25	Benzo(a)pyrene (mg/L)	0.00001
Pentachlorophenol (mg/L)	0.009	Chloroethylene (mg/L)	0.005
Benzene Hexachloride (Total amount, mg/L)	0.005	Chlorobenzene (mg/L)	0.3
Hexachlorobenzene (mg/L)	0.001	Microcystin-LR (mg/L)	0.001
Dimethoate (mg/L)	0.08	3. Sensory character and general chemical indices	
Parathion (mg/L)	0.003	Ammonia Nitrogen (measured as N, mg/L)	0.5
Bentazone (mg/L)	0.3	Sulphide (mg/L)	0.02
Methyl-Parathion (mg/L)	0.02	Sodium (mg/L)	200

1. For Trihalomethane (sum of Chloroform, Monochloro-Dibromo- Methane, Dichloro-Monobromo-Methane, and Tribromomethane). The sum of the ratios, which are between actual concentrations of each compound under this category and its limit values, shall not be greater than 1.



Technical Notes

Chapter 1

Table 1.1: Urban Water Market Segments

The table represents urban water market segments based on a city typology developed by the Study. *Total urban population* refers to temporary and permanent residents in urban areas, and excluding counties under the jurisdiction of prefecture level cities. Temporary residents include immigrants who have lived for over one year in the city, excluding soldiers in service and armed policemen. *GDP per capita* refers to the GDP figure for urban population. Data on total urban population is from MoC’s *China Urban Construction Statistics Yearbook (2005)*, while GDP per capita of 2004 is from *The Yearbook of China’s Cities (2005)*.

Average wastewater treatment coverage ratio is the ratio of the volume of wastewater treated over the total wastewater generated in the urban area. It is not always clear if the “volume” of wastewater reported is the actual flow into the plant or the installed capacity of the plant (which may be underutilized). The volume of treated wastewater refers to wastewater treated by both municipal treatment plants and industrial treatment plants.

Water supply coverage ratio includes both water coverage by public water utilities and self-supplied coverage. It is calculated as population served divided by total population. Municipal water supply serves 88% of total population with an access to water supply, while the actual volume of self-supplied water reaches 29% of total volume as is shown below.

	Production Capacity (10,000 m3/day)	Length of WS Pipelines (km)	Total WS (10,000 m3)	Population Served (10,000)	
Municipal WS	16,792	299,926	3,422,718	26,616	88%
Self-Supplied	7,961	58,484	1,480,037	3,724	12%
Total	24,753	358,410	4,902,755	30,340	

Coverage ratio for wastewater and water supply comes from MoC’s *China Urban Construction Statistics Yearbook (2005)*. Information on county capital towns is from MoC’s *Statistical Yearbook for County Towns (2004)*. Out of 661

officially designated cities, cities were further divided by GDP per capita threshold of US\$3,000 and US\$1,500 and the following table shows the number of cities per income category.

Income Category	Number of Cities
Rich GDP per capita > \$3000	81
Middle GDP per capita: \$1500~\$3000	224
Poor GDP per capita < \$1500	356
Total	661

Income Category	Average WWT Rate
Rich GDP per capita > \$3000	57%
Middle GDP per capita: \$2000~\$3000	35%
Poor GDP per capita < \$2000	22%
Result: Strong Correlation Between City Income and WW treatment rate.	

Similarly, cities were grouped by population category of 2 million and 0.5 million and the following summarizes the number of cities per population category.

Population Category	Number of Cities
Large Population > 2 million	28
Medium Population: 0.5~2 million	134
Small Population < 0.5 million	499
Total	661

Population Category	Average WWT Rate
Large Population > 2 million	54%
Medium Large Population: 1~2 million	51%
Medium Population: 0.5~1 million	40%
Small Population < 0.5 million	26%
Result: Moderate Correlation Between Size and WW treatment rate.	

Using the same income and population category above, correlation between GDP per capita and wastewater treatment ratio, urban population and wastewater treatment ratio were further examined and are summarized in the following tables.

The tables show that wastewater treatment rate is positively correlated with income level: the higher the income level is, the higher the treatment rate is. Similarly, it is positively correlated with population category. Following the analysis above, the table below summarizes city typology based on the income level and population and corresponding number of cities, total population and wastewater treatment ratio.

	Large Population > 2 million	Medium Population: 0.5~2 million	Small Population < 0.5 million	
Rich GDP per capita > \$3000	21	30	30	# of Cities
	90	31	0.6	# of pop (million)
	61%	55%	57%	% of WWT
Middle GDP per capita: \$1500~\$3000	5	60	159	# of Cities
	15	57	36	# of pop (million)
	38%	47%	31%	% of WWT
Poor GDP per capita < \$1500	2	44	310	# of Cities
	12	35	58	# of pop (million)
	23%	31%	21%	% of WWT

Chapter 2: Sector Achievement and Performance

Table 2.1: Percentage of Utility Service Area with Low Water Pressure

The data is provided in the *China Water Works Association 2005 Yearbook*, encompassing most of the 661 Chinese cities. Study City typology was applied in the data and the average of each category was calculated. *Ave. of Hi 25%* and *Ave. of Lw 25%* represent the average of highest and lowest quartile.

Table 2.3: Net Income to Revenue Ratio in 1997 to 2004

The figures for net profits and total revenue come from the *China Water Works Association Yearbook in 1998 and 2005*. The Yearbook does not describe exactly how net revenues are determined, or if depreciation is explicitly considered as a cost. This ratio is often referred to as “return on sales (or revenues).”

Figure 2.4: Municipal Wastewater Treatment Capacity

The 2005 MOC Yearbook makes a distinction between “municipal wastewater treatment plants” and “other wastewater treatment plants” (presumably industrial WWTPs). The wastewater treatment capacity bar charts in Figure 2.6 show the municipal WWTP capacity, i.e. 49 million m³/day in 2004. The “other WWTP” capacity was 24 million m³/day in 2004.

The 2005 MOC Yearbook provides information on “total wastewater discharge” (35,564 million m³/year). The MOC Yearbook also provides information on “actual municipal wastewater treated” (11,602 million m³/year, or 65% of installed capacity) and “actual other wastewater treated” (4,677 million m³/year, or 50% of installed capacity)

The wastewater treatment rate in Figure 2.4 is therefore calculated as follows:

- Total Annual Wastewater Discharged/ (Actual Municipal Wastewater Treated + Actual Other Wastewater Treated).
- In 2005: (35,646 million m³)/(11,602 million + 4,677 million) = 45%

Figure 2.6: Water Supply and Treatment Capacity: Municipal and Self-Supply

This figure combines data from both municipal water supply utilities and private self-supply. In 2004, for example, the national water treatment capacity for municipal utilities was 167 million m³/day; the national total for self-suppliers was 79 million m³/day. Actual water supplied by municipal utilities was 93 million m³/day, and 40 million m³/day for self-supply.

Chapter 3: Sector Achievement and Performance

Figure 3.1: China’s Economic Transformation and Urbanization

Urban as % of total population is the ratio of urban population over the total population. Urbanization data drives from population division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2002 Revision and World Population Prospects and the 2003 Revision. *GDPST % of GDP* is the ratio of secondary and tertiary GDP as % of total GDP. Both GDP and base population data is from the China Statistical Yearbook 2004.

Figure 3.2: Urbanization Trends and Projections

Urbanization rate is the ratio of population living in the urbanized areas over the total population. The data source on urbanization rate and base population (total and urban population) is *China Statistical Yearbook* (2005). China’s total urban population in 2005 is estimated to be around 550 million, according to *China Statistical Yearbook*. The urban population of 550 million is also often cited by Chinese government in various public documents. It includes not only urban population in 661 cities but also that in lower administrative levels such as county-towns and towns, which are not captured in the statistical data of 661 cities. In fact, according to the Ministry of Construction (MoC)’s *China Urban Construction Statistical Yearbook*, total urban population in 661 cities is around

341 million. Thus, over 200 million people are estimated to be living in urbanized county towns or towns.

Urbanization projection assumes that the rate of urbanization over the next 15 years is approximately 1% per annum, which has been urbanization target set by the Chinese government, 0.5 % (lower case scenario) and 1.5% (upper case scenario) per annum. With 1% of increase per annum, urban population increase from 550 million in 2005 to around 850 million in 2020. Scenario 1 in the Figure shows the urbanization rate of 0.5%, Scenario 2 and Scenario 3 are based on the urbanization rate of 1% and 1.5% respectively.

Table 3.2: Approximate Urban Water Sector Investments

Ex-post investment figure from 1996 to 2004 for water supply and wastewater is derived from the MoC's *China Urban Construction Statistics Yearbook (2005)* and GDP data from World Development Indicator. The estimated investment figure for 2006-2010 is derived from the assumption that the annual investment in water supply will increase by 10% and the investment in wastewater sector will increase by 15%.

Chapter 4: Sector Vision and Path Forward

Box 4.1: The Case of South Korea: Wastewater Treatment Capacity vs. Economic Development

Wastewater coverage ratio for Korea is from the Ministry of Environment of Korea's Statistics of Sewerage (2005). Constant GDP per capita was calculated on the purchasing power parity basis, in order to minimize distortion from the exchange rate and to reflect the real standard of living among countries. Constant GDP per capita PPP, denominated in international US\$, for Korea is was taken from the World Bank's Development Data Platform (DDP) from 1975 onwards.

PPP data for China is not yet available, although some efforts have been made to measure PPP in selected cities of China, mostly due to

the technical complexity and data collection requirements. In order to approximate China's constant GDP per capita PPP in international US\$, *purchasing power parity conversion factor* (LCU per international \$) was used from the DDP dataset. It was applied to GDP per capita in local currency unit, resulting in GDP per capita PPP in *current* international US\$. By applying deflator, the GDP per capita figure then turned into *real* international US\$ for comparison with the Korea's GDP per capita data.

However, converted constant GDP per capita PPP in international US\$ has some limits: since the same conversion factor was applied to all Chinese cities with different levels of economic development, the figure can distort the GDP per capita to some degrees, misrepresenting the standards of living in some cities. For instance, for China's developed cities, GDP per capita PPP tends to be overestimated, as the conversion factor of China's average was applied to high capacity cities, while figures for China's developing cities are underestimated.

Chapter 7: Moving up the Utility Financial Sustainability Ladder

Table 7.2: Weighted Average Water Supply Tariffs by City Category

Water supply tariff analysis covers 128 cities across China, the 1998 tariff is based on the China Water Works Association 1999 Yearbook and the 2005 data is from the H2O's report on China's water sector published in 2005 (<http://www.h2o-china.com>). The 128 cities belong to each city category as follows:

	# of Cities in Each Category	%
Category 1	17	13.3%
Category 2	85	66.4%
Category 3	26	20.3%
Grand Total	128	

The weighted average water supply takes into account different sectors (residential, commercial, industrial and special use), the amount of water use of each sector and differing tariffs applied to those sectors. The tariff excludes other cost, such as water resources fee.

Figure 7.1: Water Supply Tariffs

The data is from 128 cities reported in the H2O's report on China's water sector published in 2005 (<http://www.h2o-china.com>). The full cost water supply estimate is based on a review of World Bank-financed projects where financial analysis showed that water supply tariffs is generally 2.0 RMB/m³, or above in order to meet utility costs, including World Bank loan. Since many water companies require equity contributions from the municipal government, use full cost recovery (i.e. no government capital subsidies) should be greater than 2.0 RMB/m³.

Figure 7.2: Wastewater Tariffs

The data is from 128 cities reported in the H2O's report on China's water sector published in 2005 (<http://www.h2o-china.com>). The wastewater treatment cost of 1.0–1.5 RMB/m³ is based on World Bank-financed projects and an analysis done by the China International Engineering Consulting Company (CIECC) and presented in the 11th Five Year Plan study. The details are provided below. Note that the CIECC estimate considers depreciation but not financing charges. Since the maturity of bank loans

Indicative Cost for Typical Wastewater Treatment Plan in China

Item	RMB/m ³
Energy	0.16
Chemicals	0.10
Salary	0.08
Maintenance	0.15
Depreciation	0.40
Administration	0.09
Total	0.98

Source: CIECC, 11th Five Year Plan (2006).

(5-8 years) is typically much shorter than depreciation maturities, financing costs would drive the full cost recovery levels above 1.0 RMB/m³. Wastewater collection costs typically make up at least two-thirds of capital costs, and half of operating costs. The full cost recovery tariff level for wastewater collection and treatment is therefore at least 3.0 RMB/m³ or greater (1 RMB for treatment and 2 RMB for collection).

Figure 7.3: Combined Tariff as Percentage of Household Income in 2004

Urban households in China are categorized into seven different income groups: (1) lowest income (10 percent); (2) low income (10 percent); (3) lower middle income (20 percent); (4) middle income (20 percent); (5) upper middle income (20 percent); (6) high income (10 percent), and finally the (7) highest income (10 percent). Data for average income, income for highest and lowest quartile as well as highest and lowest 10% are provided in the World Development Indicator. Three assumptions were made in the tariff side: a) each person consumes 125 liters per day and tariff which includes both water and wastewater charge; b) tariff is on average 2 yuan per cubic meter; and c) there are 3 people in each household.

Figure 7.4: Annual Expenditure for Urban Construction and Maintenance

Total annual expenditure for urban construction and maintenance is the sum of investment of fixed assets, maintenance, debt payment, tax and fees and other expenditures. The data is derived from the MoC's *China Urban Construction Statistics Yearbook (2005)*, covering officially designated 661 cities. Investment of fixed assets accounts for 79.2% of total expenditure in 2004, followed by maintenance (10%) and debt payment (7.2%). Exchange rate was set at 1USD=8.06RMB.

Table 7.5: Urban Construction and Maintenance Fund in 2004

The table presents a list of fund sources for urban construction and maintenance, consisting of urban maintenance and construction tax, municipal financial allocation, domestic loan,

land transfer fee, self-raised and others. *Urban maintenance and construction tax* is one of local taxes imposed according to Temporary Regulations of People's Republic of China on Urban Maintenance and Construction Tax. It is levied based on actual value-added tax, consumption tax and business tax paid by taxpayer. Different rates apply different places. The rate comes to 7% in urban areas, 5% in counties and towns and 1% beyond these places. *Others* category includes foreign direct investment, various fees such as fee for expansion of municipal utilities company, tariff, and water resources fee. In order to analyze the sources of fund by city category, 15 cities in Category 1 and 20 in Category 3 were randomly selected as a sample base and the sources of fund of each city were further analyzed and the average of each source was calculated. The data is from the MoC's *China Urban Construction Statistics Yearbook (2005)*.

On the expenditure side, sectoral breakdown of urban construction and maintenance expenditure consists of: 1) non-utility (38%); 2) utility (18%); and 3) roads (44%). *Non-utility* includes expenditures on public traffic, flood control, landscaping, environmental sanitation and others. *Utility* consists of water supply, gas, sewerage and heating as indicated in the chart.

Sector	US\$ millions
Roads	24,643
Non-utility	21,681
Utility	10,112
• Water supply	2,498
• Gas	1,535
• Sewerage	4,171
• Heating	1,909

Table 7.6: Per-Capita Urban Maintenance and Construction Fund by City Type

To analyze per capita urban M&C fund by city type, sampling was done for each city category: For category II and III, 30 cities were randomly selected in each category and average per-capita urban maintenance and construction was calculated. For category I, all 21 cities were included in the calculation.

Table 7.7: Indicative Ranges of Urban Water Sector Financing Source: 1991–2005

No official data on sector financing is known to the Study team. An estimate was made as follows:

	Water Supply (RMB Billion)	Percent	Wastewater (RMB Billion)	Percent
Total	202		236	
State Bond	34	17%	61	26%
CDB	14	7%	5	2%
Private Sector	36	18%	24	10%
International Development Banks	12	6%	24	10%
Municipal Governments	53	26%	91	39%
Domestic Banks	53	26%	30	13%
	202	100%	236	100%

i) Total investment for each sector is known from the MOC 2005 Yearbook.

ii) Estimates exist for:

a) State Bond-from Tsinghua Research Brief (2006)

b) CDB funding from Tsinghua Research Brief (2006)

c) Private Sector from Global Water Intelligence Report (2004)

d) International Development Banks: World Bank (Annex 1); ADB (2005); JBIC

iii) Municipal Government and Domestic Bank funding information were not available. The following assumptions were therefore made:

a) For WS: Municipal Governments Finance 50% and Domestic Banks Finance 50%

b) For WW: Municipal Governments Finance 75% and Domestic Banks Finance 25%

Chapter 8: Using the Private Sector to Help Municipal Utility Performance

Table 8.1: Investment by Project Type

The Global Water Intelligence Report (GWI) on the China Water Market (2004) provided information on 126 projects with private participation. These projects were then analyzed and classified into the following categories: *WT* (water treatment), *WWT* (wastewater treatment), *WT+DN* (water treatment and distribution networks) and *others*.

Figure 8.1: PSP Investment Trends

The private participation data in the GWI report was further analyzed to look at trends over time and international/domestic investors. As is noted earlier, the 2004 figure includes only the first half of the year. In addition, there are six domestic projects and three foreign projects which detailed information is missing and thus are omitted in the figure.

Chapter 10: Strategic Action Plan

Table 10.1: Summary Strategic Action Plan



Glossary

Affermage: A contract under which the government delegates the management of the water service to a private company in return for a specified fee, often based on the volume of water sold. The company's profit is equal to revenue from the fee, less operating and maintenance costs. The company operates and maintains water assets at its own expense but does not finance investment in infrastructure assets.

Arrangement: Rules and institutions establishing and enforcing the rights and obligations of an operator, customers, a contracting authority, or other government authorities, with respect to water services. These rules are set out in contracts, laws, regulations, licenses, and related documents. For an example, see Management Contract or Build-Own-Transfer.

Asset Management Planning: The active management of capital assets in order to minimize the total cost of acquiring, operating, maintaining, and replacing them. This is usually achieved through the collection and organization of asset information, the analysis of asset data to set priorities, and the integration of data across the organization.

Build-Own-Transfer: Typically used for water supply or wastewater treatment plants. An Operator finances, builds, owns, and operates the facilities for a specific period of time, after which ownership is transferred back to the contracting authority. BOT payments are typically based on the volume of water treated at plant.

Category I Cities: Large and developed cities with a population greater than two million and a GDP per

capita greater than \$3,000 (RMB 24,000). Defined for this Study only.

Category II Cities: Medium-sized cities that are not in Category I or III, usually with a population in the range of 0.5 million to 2 million and a GDP per capita in the range of \$1,500 (RMB 12,000) to \$3,000 (RMB 24,000). Defined for this Study only.

Category III Cities: Small and developing cities with a population less than 0.5 million and a GDP per capita less than \$1,500 (RMB 12,000). Defined for this Study only.

Concession Contract: An Arrangement in which a contracting authority is the legal owner of the infrastructure assets (at least after the contract ends), but the operator is responsible for financing and managing investment, as well as operating and maintaining the business.

Concessionary Finance: Grants or preferential loans offered by a national or provincial government to municipal urban utilities, usually as an incentive to comply with government policy. Concessionary finance can also be offered to local governments in support of services with public goods aspects.

Coordination: Ensuring the policy decisions and implementation plans are consistent, and managing input from the various bodies involved in water sector activities.

Utility Cost Recovery: The point at which a utility is able to cover its cash costs of service through a

combination of user fees and government transfers. A utility's cash costs of service typically include operation and maintenance, debt service, and a percentage of capital expenditures. A return on equity is also required if there is a private equity investment.

Cost Recovery Ratio: This is the ratio of actual utility revenues from user fees and government payment, divided by the utility's cost recovery requirement. A ratio of 50 percent means that the utility's revenues only meet half of its requirements.

Debt Service: The cash necessary to make principle and interest payments on debt obligations. As the amount of utility debt financing increases, the debt service increases. Some lenders also require utilities to establish "reserves" in the event of an unexpected business shock. If the municipal government provides contributions for capital works, then debt service is reduced.

Design-Build-Operate: Similar to a Build-Own-Transfer, but the contracting authority provides financing and retains ownership of the facilities during the contract period.

Designated Cities: Major urban areas in China such as municipalities, capitals of prefectures, and capitals of counties. As of 2005, China had 661 designated cities.

Divestiture: An Arrangement in which the operator is the legal owner of the infrastructure assets for an indefinite term and is responsible for financing and managing investment, as well as operating and maintaining the business.

Drainage Networks: A drainage network is divided into a hierarchical system of drains. Tertiary drains (at the building level) connect to secondary drains (typically along smaller roads), which connect to primary drains (typically along larger roads)—but the classification is usually somewhat arbitrary.

Drains/Sewers: There are four types of drains: (1) stormwater drains which carry stormwater only; (2) sanitary drains which carry wastewater only;

(3) combined drains which carry stormwater and wastewater; and (4) interceptors which connect with combined drains and convey the wastewater to the treatment plant during dry periods.

Financing: Funding provided to meet expenditure requirements and to be returned to the fund-provider in the future. Funding provided as loans or equity must be repaid with interest or profit. Funding provided as grants or municipal government equity contributions does not need to be repaid.

Financing Autonomy: The extent to which a utility is able to finance investments from loans or internal cash generation as opposed to from government contributions. Sixty percent financing autonomy means that sixty percent of the funds come from loans or utility cash reserves, and forty percent from government equity contributions.

Full Cost Recovery: Revenues from user fees sufficient to meet all of a utility's needs revenues requirements assuming no financial support from government, i.e. no payments or capital contributions made by a government agency to the utility.

Government Bureaus: Municipal agencies charged with functional responsibilities such as financial affairs, construction, and water resources.

High Capacity Cities: All cities with a GDP per capita greater than \$3,000 (RMB 24,000) regardless of population size, as well as all cities with a population greater than 500,000 and a per capita GDP of at least \$1,500 (RMB 12,000). Defined for this Study only.

Joint Venture Company: An Arrangement under which an operator is partly owned by a contracting authority, and in which the two parties jointly share most of the risks.

Lease Contract: Similar to an Affermage contract, an operator operates and maintains water assets at its own expense but does not finance investment in infrastructure assets. The Operator maintains retains revenue from a customer tariff and pays the contracting authority a specified lease payment.

Low Capacity Cities: All cities that are not high capacity cities as defined above. Defined for this Study only.

Management Contract: An Arrangement under which the Operator provides management services to the utility in return for a fee.

Mixed Capital Company: A Joint Venture between the government, which provides public capital, and a private company, which provides private capital.

Municipal Fiscal Policy: The financial principles and practices by the municipal government in relation to urban water utilities, including capital contributions, operating subsidies, and tax incentives.

Municipal Utility Governance: The exercise of a municipal government's ownership interest in a utility, including determination of the scale and scope of utility service, appointment of management, the setting of service standards and the monitoring of performance.

Municipal Wastewater: Refers to wastewater produced by domestic, commercial, and industrial sources (and stormwater) within the administrative boundaries of a city.

Non-Revenue Water: Water produced and lost without revenue. Losses can be physical (for example, through leakage) or commercial (for example, through non-payment of bills). Non-Revenue water can also refer to unbilled but authorized consumption (for example, through free public taps).

O&M Costs: The amount of cash necessary to maintain operations at a reasonable level over a short-term perspective.

Operator: A private domestic or foreign company, or government-owned company operating outside of its jurisdiction and providing services under an Arrangement. Municipal water utilities operating outside of their city in China seeking to maximize their profits are considered Operators.

Policy: The government's goals for the sector, together with the principles and general practices the

government has decided the sector should follow to achieve these goals.

Pumping Stations/Overflows: Drains may require pumping stations in the networks to make them hydraulically stable. Overflows are incorporated into a combined drain to spill excess water from an overloaded pipeline (during and following heavy rain) into a convenient watercourse.

Sector Governance: The national and provincial government organizations that control and manage the sector, together with the rules and policies those organizations develop.

Service Aggregation: The grouping of municipalities or operators into a single entity for the provision of some type of urban service, such as water supply or wastewater collection and treatment.

State Bond Program: A key national concessionary finance program in China, run by the National Development Reform Commission.

Tariff Regulation: The controls on urban water utilities intended to overcome the problem that water is an essential monopoly service. Tariff regulation is the rules and organizations that set, monitor, enforce, and change allowed tariffs for urban water utilities.

Transfer-Own-Transfer: Similar to a BOT, but the Contracting Authority sells an existing facility to the Operator for a specified period of time (transfers). When the contract period ends, ownership reverts back to the Contracting Party.

Urban Water Utility: A company or government department that provides any of the following services: water supply, wastewater collection and treatment, water reuse, and stormwater drainage. A wastewater utility in China typically provides both stormwater and wastewater services.

Utility Management: Serving customers by operating existing utility systems, maintaining assets, planning and implementing new investments, and making sure that operations, maintenance, and new investment can be financed.

Revenue Autonomy: The extent to which overall cash comes from user fees as opposed to government payments. A ratio of sixty percent means that 60% of the cash comes from users and 40% from government payments.

Wastewater: Refers to both stormwater and wastewater, including domestic and industrial waste. The

two are closely linked since many Chinese cities have either fully or partially combined drainage systems.

Water Services: Includes any aspects of providing water supply, wastewater management, or reclaimed water use.



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Stepping Up: Improving the Performance of China's Urban Water Utilities

As China transitions to a market economy, municipal utilities are evolving into commercially viable companies under government oversight. Great challenges confront the reform process for China's water utilities, including rapid urbanization and emerging inequality, coupled with severe water scarcity and degradation.

Cities and their water utilities must provide services within a complex mosaic of policies and regulations provided by national and provincial governments. In China, as throughout the world, water is also a sensitive political issue. Governments are keen to provide good water service, but also attuned to the need to ensure that tariffs are socially acceptable. This report presents a strategic framework and set of recommendations for addressing these challenges and accelerating improvements in China's urban water utilities.

Drawing upon the World Bank's experience in China, as well as the Bank's global knowledge, the report provides a comprehensive assessment of urban water services, including policy, regulatory, institutional, financial, and technical issues. The report will prove a valuable resource for policy makers, utility companies, and anyone interested in the development of the world's largest water market.



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