Building Gaobeidian: Developing the Environmental Infrastructure of Modern Beijing

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Naohiro Kitano is a professor at the Faculty of Science and Engineering, Waseda University. Fangqi Qu is a master’s student at the Graduate School of Public Policy (GraSPP), University of Tokyo. Michael Bennon is a research scholar and program manager at Global Infrastructure Policy Research Initiative at the Center for Democracy, Development and the Rule of Law at Stanford University.

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Introduction

In 2019, Beijing Drainage Group (BDG) was in the middle of a renegotiation of the terms of its concession agreement with the city, which was only 7 years into its 30-year term. BDG had recently completed a major upgrade of its flagship Gaobeidian Wastewater Treatment Plant, which allowed the company to produce and sell reclaimed water. This was a new revenue source that prompted the city to renegotiate the concession terms with the company, which operated the sewer network and 11 treatment facilities in the city.

This was far from the first challenge BDG faced in implementing and managing Beijing’s wastewater treatment infrastructure. Few municipal systems in history have faced the scale and speed of urbanization as those faced in Beijing, which grew from a population of roughly 5 million in 1980 to more than 20 million by 2020. The city’s physical infrastructure to manage urban environmental waste was virtually nonexistent at the beginning of this period.

BDG would face no shortage of environmental challenges and would need to constantly grow the city’s capacity to treat urban waste while simultaneously reforming the institutions that manage this infrastructure. Perhaps more importantly, Beijing residents would need to adjust their own behavior, not only to use a new sanitation system, but also to build and pay for it.

Beijing’s flagship water treatment facility, Gaobeidian, would expand and evolve along with the networks of sewers, people, and institutions that fed into it.
The PRC’s Early Environmental Development

In 1949, there were roughly 6,000 kilometers of drainage pipelines in all of the People’s Republic of China (PRC) and only four small water treatment plants nationwide, none of which were in Beijing. Today, the PRC has more wastewater treatment capacity than any other country on earth. In 2019, there were 4,140 operating wastewater treatment plants in the PRC, discharging more than 66 billion cubic meters (m$^3$) of treated wastewater. The country’s wastewater treatment rate that year was 96.8% in the PRC’s urban areas and 93.6% in rural areas.

The PRC’s path toward its current water treatment sector was much more rapid, but the country largely followed a similar development path to countries that had developed before it. Economic growth and rapid urbanization led to a degrading water and air environment, which eventually led to disasters and a rising public consciousness of environmental issues. Leveraging international support, the PRC developed institutions and infrastructure networks to allow for more sustainable forms of development.

Up until the mid-20th century, the sanitation sector in Peking (now Beijing) evolved from a “night soil” circular economy dating back to the Qing dynasty. Night soil merchants collected waste from city districts and made fertilizer to sell to rural farmers outside the city. City residents were not particularly happy with this system, and only in part because it was not hygienic. “Gangs” of night soil merchants fought over territory and then charged monopoly rates for their services. In 1951, the Chinese Communist Party institutionalized the service. This circular economy continued in some parts of the greater Beijing metro area until the 1980s, when it was rapidly rendered untenable by development.

Early Gaobeidian Siting

The site for the Gaobeidian Wastewater Treatment Plant was perfectly situated for a central treatment node for Beijing. The site was originally identified in 1955 by a Soviet designer named M. S. Rybnikov, who was seconded to Beijing’s municipal government. Rybnikov was part of a larger team of Soviet designers tasked with helping city officials develop a citywide urban construction master plan, which was completed in 1958. See Figure 1 for the location of the Gaobeidian site in the context of modern Beijing.

The construction of an initial primary treatment plant at the Gaobeidian site began later that year. However, the plant’s capacity was only 200,000 cubic meters per day, and since it was limited to primary treatment, the treated water from the plant was used for wastewater irrigation. The limited capacity and low level of treatment would soon prove inadequate for rapidly urbanizing Beijing.

An environmental disaster in the early 1970s attracted nationwide attention and brought a new sense of urgency to Beijing’s environmental management infrastructure. Throughout the winter, large quantities of dead fish surfaced in Guanting Reservoir downstream from Beijing, and there were cases of people becoming poisoned from eating fish from the reservoir and connecting
waterways. The events refocused the PRC national government, which hosted its first National Conference on Environmental Protection in 1973. That year, planning began for a pilot secondary wastewater treatment plant at Gaobeidian with a capacity of 2,000 cubic meters ($m^3$) per day, which began operating in 1980.

The institution that would eventually become BDG was also initiated during this early environmental history of the city. It was initially called the Wastewater Station Management Office under the city’s Municipal Engineering Bureau. It was later renamed the Wastewater Treatment Research Management Office when it took on a role of researching wastewater treatment technologies for the city.

**Official Development Assistance Comes to the PRC**

Deng Xiaoping’s “reform and opening-up” period in the PRC, which began in late 1978 and early 1979, would go on to completely change every sector of the PRC’s economy. The reforms implemented by Deng Xiaoping have since been credited as the primary drivers of the PRC’s economic development in the following decades. One of the earliest reforms would open many sectors in the PRC to managed foreign investment, and the wastewater sector was an early target. Beginning in the late 1980s, the PRC’s wastewater and environmental management sectors
became an early recipient of official development assistance (ODA) programs from Japan, Europe, and multilateral institutions such as the World Bank.

The PRC’s opening to development assistance coincided with a rapid increase in the demand among the PRC’s cities for centralized urban water treatment facilities. The PRC’s economic reforms led to rapid growth, increasing foreign direct investment, and equally rapid urbanization. In Beijing, environmental concerns about wastewater treatment and pollution intensified in the early 1980s.

In the wastewater and environmental protection sectors in particular, the PRC leveraged ODA and other bilateral or multilateral sources of financing for development. Between 1986 and 2005, the PRC borrowed $17.87 billion for urban development and environmental protection projects. Lenders included Japan ($5.9 billion), the World Bank ($6.18 billion), the Asian Development Bank ($2.58 billion), other bilateral lenders ($2.31 billion), and commercial lenders ($0.9 billion).

**Official Development Assistance History and Challenges in the PRC’s Environment Sector**

As investment in the PRC’s environment sectors ramped up in the 1980s and 1990s, there was clear alignment between the PRC’s national government, local project sponsors, and international development partners on the broad goal of environmental protection and remediation. There was far less consensus on exactly how to achieve those goals.

Should environmental management be largely a responsibility of the government? Or should it be a shared responsibility of communities? How much should the PRC’s economic growth be slowed to protect the environment? Should environmental outcomes be pursued through market-oriented inducements such as taxation or subsidies, or should there be greater reliance on regulations and state-led initiatives? Many of the questions that the PRC faced are common to environmental protection and mitigation initiatives around the world. The PRC, and Beijing in particular, was unique mainly because of the scale of the problem and the speed at which economic growth and rapid urbanization occurred.

International development institutions also needed to determine the best way to help the PRC achieve its environmental objectives, and their approaches varied significantly. International donors could direct their aid toward developing critical environmental infrastructure projects such as the Gaobeidian Wastewater Treatment Plant, but even if a donor focused on loans or grants for infrastructure projects, it had to prioritize between large capital investments or the networks of pipes and drainage systems that make a system functional. It would also need to determine whether focus should be on capital investment or assistance with longer-term system maintenance.

There has also been considerable debate in the development community about whether capital investment is even the most productive use of scarce concessional funding in the environmental
management sector. The development of physical treatment infrastructure is obviously necessary, but also insufficient, to create and support a sustainable environmental management system. Some researchers argued that donor funds were better spent on providing education and capacity development resources for public officials to better implement programs locally.

Other development programs approached capacity development at the institutional level by helping developing economy governments build new wastewater management agencies and assisting with organizational design. Perhaps most importantly, they sought to assist governments in structuring wastewater institutions so that they had the authority and funding necessary to accomplish their mission. The crux has often enough been creating a funding source via taxes or user fees that was sufficient to provide and maintain environmental infrastructure (Perard 2018).

International donors, in particular, must strike a balance with respect to funding sources. High subsidies from international donors allow new sanitation programs to move forward very quickly, but may become unsustainable when those subsidies are inevitably reduced.

In her review of development practices in the PRC’s environmental management sector, Katherine Morton described the practices of Japan’s development agencies as having more of an engineering approach, focusing on supporting physical project development. She characterized the World Bank’s approach during the same period as somewhat more of a market-institutional approach, in that it focused somewhat less on developing physical infrastructure projects and somewhat more on institutional reform. The smaller United Nations Development Programme is characterized as the human development approach because it focused more on capacity building through training, technology, and information programs (Morton 2005).

National and International Interests

In the 1980s and 1990s, researchers also proposed various ways to assess the effectiveness of these various approaches to environmental development. Robert Keohane proposed a framework for evaluating the effectiveness of an international environmental aid institution based on three unique challenges facing international environmental initiatives (Keohane 1996).

The first challenge is a difference in concern: international development institutions and their donors often have very different objectives for environmental projects than borrowers. This divergence also affects the second group of challenges for these initiatives, which are contracting problems. Contracting problems for environmental aid projects arise because both the international aid institutions and the borrowers are concerned that the other party will renege on their commitments during the program and must seek contracting solutions, often absent the rule of law, to reassure each other (Mori 2011).

For example, borrowers may fear that aid organizations will not follow through with planned funding after significant, costly reforms or policy changes have been implemented locally. Likewise
international lenders naturally fear that borrowers will renege on their environmental actions or reforms once funding is disbursed.

The final set of challenges Keohane described is straightforward but extremely common for international environmental aid projects: capacity. Almost by definition, recipients of environmental aid programs lack the technical, political, or institutional capacity to deliver on the program in question (World Bank Group 2017).

Underlying each of these challenges are the diverging interests of donor countries and borrowers in international development programs, which are particularly pronounced in the environmental aid sector. Environmental aid programs exist because donor countries want borrowers to do more to protect the local and global environment than borrowers would otherwise do. Relative to economic development programs, borrowers and international donor institutions have more conflicting priorities in environmental programs (Hashimoto 1994), and each party in the relationship has a greater incentive to maximize its gains at the expense of the other.

Because of this natural conflict, concerns regarding “conditionality” were even more pronounced for environmental aid projects compared to other development sectors. Conditionality refers to donors exchanging financial aid in the form of loans for policy reforms that the borrower must implement. If borrowers fail to follow through on some of the agreed-upon policy reforms, international lending institutions may withhold disbursements or take this into account in future lending decisions. A key determinant of the success of conditionality programs is the willingness of lenders to enforce policy commitments relative to borrower incentives to abandon them.

The Gaobeidian Phase I Project

In 1984, the Beijing municipal government approved a massive two-phase expansion plan for the Gaobeidian plant. Each phase would increase the plant’s capacity by 500,000 m³ per day (Qu et al. 2019). The United Kingdom’s Overseas Development Administration initiated a technical cooperation project with the city to bring in consultants to help with design and pilot plant studies for the first phase. To finance this project, the PRC government entered into negotiations with the Japanese government for ODA financing as part of a broad package of infrastructure development projects.

During a visit to the PRC in early 1988, Japan’s Prime Minister signed a treaty for the Sino-Japan Friendship Center for Environmental Protection. In August 1988, the PRC’s Ministry of Foreign Trade and Economic Cooperation signed a loan agreement with Japan’s Overseas Economic Cooperation Fund to finance the Gaobeidian Phase I project. The ¥2,640 million for the project included an interest rate of 2.5% over a 30-year term and a 10-year grace period. The PRC would cover the remaining CNY118 million of the project’s cost estimate (for a total project cost of CNY195 million).
Building Gaobeidian: Developing the Environmental Infrastructure of Modern Beijing

Phase I of the Gaobeidian project faced early challenges and some cost overruns, but was successfully completed. Hang Shijun, the designer of the Gaobeidian Phase I project, joked afterward that Gaobeidian was a “project that started with weeding” (Li 2015).

The project was initially delayed for several years while sufficient local funding was appropriated. The Beijing municipal government was able to accelerate the procurement timeline by 19 months to make up for some of this delay, and contracted the Beijing Municipal Engineering Corporation to build the project.

Japan also offered to assist with the initial technical designs, but Beijing opted instead to complete the design work internally. “At that time, I was still young and very ambitious, so I refused decisively,” said Hang Shijun. “On the positive side, our team had been trained [through implementing the project]. We have been on a very difficult path, so we always remember solid. But the bad side is that we spent too much energy and time, and everyone was exhausted” (Hang 2018).

The total project cost for Phase I significantly exceeded estimates, amounting to a total of CNY588 million by the time the project was completed. See Table 1 for the planned and final budgetary results of the Gaobeidian Phase I project.

Table 1: Gaobeidian Phase I Project Ex-Post Project Performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Original</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Project outputs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) Wastewater treatment</td>
<td>capacity 500,000 m$^3$/day</td>
<td>Achieved</td>
</tr>
<tr>
<td>2) Consulting service: Dispatch of a study group to Japan</td>
<td>Achieved</td>
<td></td>
</tr>
<tr>
<td><strong>3. Project cost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amount paid in foreign currency</td>
<td>¥2,640 million</td>
<td>¥2,598 million</td>
</tr>
<tr>
<td>Amount paid in local currency</td>
<td>CNY118 million</td>
<td>CNY482 million</td>
</tr>
<tr>
<td>Total</td>
<td>¥6,699 million (CNY195 million)</td>
<td>¥14,388 million (CNY588 million)</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>CNY1.0 = ¥34.4 (1988)</td>
<td>CNY1.0 = ¥24.46 (Average between 1990 and 1993)</td>
</tr>
<tr>
<td><strong>4. Project outcome</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction of water pollution</td>
<td>BOD: Less than 20 mg/l</td>
<td>Achieved</td>
</tr>
<tr>
<td></td>
<td>SS: Less than 30 mg/l</td>
<td>Achieved</td>
</tr>
</tbody>
</table>

BOD = biochemical oxygen demand, mg/l = milligram per liter, m$^3$ = cubic meter, SS = suspended solid.

Many bilateral loans for infrastructure projects include some procurement requirements for project contracts from the lender’s sponsoring country. In the case of Gaobeidian Phase I, however, Japan’s ODA loan included open supplier procurement, a practice more commonly used by multilateral development agencies. Because of this, Beijing was not limited to Japanese suppliers for all key project components. Equipment for the Phase I project would be competitively sourced and would come from suppliers in seven different countries, including Japan, Austria, the United Kingdom, the United States, and domestic suppliers. “It can be said that [Gaobeidian Phase I] was designed while learning,” Hang Shijun said. “No one could write bidding documents, so we specifically asked someone to teach us how to write bid documents for valves and other equipment.”

As the Phase I project neared completion, the Japanese loan program also included a capacity development program that sent three delegations of Beijing’s water treatment civil servants on exchange visits to water treatment plants in Japan. The third visit in particular included many mid-level engineers and designers who were directly involved in the Gaobeidian project. They stayed in Japan for 2 months and visited treatment facilities in Osaka, Kyoto, Kanagawa, and Tokyo.

Members of the delegations from Beijing found the capacity development programs particularly useful once the project was completed and operational. Several attendees, who would go on to play senior roles in the PRC’s wastewater sector in the coming years, established a similar role for the Gaobeidian plant as the PRC’s environmental management sector developed. The plant would become a center of excellence for civil servants in the PRC’s wastewater sector, hosting training delegations as other cities across the PRC developed their own environmental management agencies and wastewater treatment plants.

Once completed, the Phase I wastewater treatment plant operated as designed, reducing biochemical oxygen demand by 25%. The plant produced water for a cogeneration plant and for irrigation, and treated sludge for fertilizer.

**Institutional Constraints**

Despite some early success with the Gaobeidian project, Japanese ODA officials faced some institutional constraints in lending capital to the PRC’s environment sector, beyond the lack of expertise of local development agencies or state-owned enterprises (SOEs) in the sector. The PRC’s central government agencies were initially wary of working with Japan’s lending institutions and other international development institutions, for assistance. Even after major cooperative projects such as Gaobeidian Phase I became possible, the central government maintained strict, centralized control over project and lending decisions, although the PRC’s policy toward the ODA project in this regard would vary over time and by sector.

The centralized lending channel also made it more difficult for Japan’s lending institutions to incorporate input and ideas from local governments and SOEs. This resulted in local priorities for environmental projects being largely filtered through the central government, and led some in the development community to argue that international development institutions had a role to play in
mediating between national governments and local governments or stakeholders to reconcile the priorities of the two. Similar institutional challenges would arise for the World Bank’s first major environmental project in Beijing, which began while Gaobeidian was under construction.

The Beijing Environment Project

In parallel with the two phases of the Gaobeidian project, the World Bank initiated a partnership project to improve the environmental management of Beijing. The Beijing Environment Project would run from 1991 to 1999 and assist with restructuring and creating new government entities to manage Beijing’s wastewater and other environmental systems. The project included World Bank loans and credit assistance of about $125 million and was also supported by a Japanese grant of ¥226 million (World Bank 2000).

The objectives of the Beijing Environment Project were to improve the city’s environmental management and planning capabilities and to implement specific pollution abatement efforts. The project covered a broad range of environment sectors, from industrial pollution to sewer and solid waste management. Because of the initiative’s broad cross-sectoral objectives, the World Bank focused specifically on improving planning and management capabilities.

The project supported the development of roughly 25 kilometers of sewer network infrastructure as well as the PRC’s first sanitary landfill development, but one of its key sub-initiatives was to improve the institutional development of Beijing’s sanitation sector. Under the project agreement, Beijing created the Beijing Drainage Company (BDC) by spinning off the existing office from the municipal engineering bureau. Initially, the agency had no standalone authority and the change was purely organizational, but as the project progressed, the city gave the company additional autonomy and implemented a sewerage tariff to cover operating costs.

These later changes significantly strengthened the BDC’s ability to act as an independent sewer agency. They were in part the result of ongoing World Bank discussions with Beijing on a second environmental project loan to support the city’s efforts, which was to begin shortly after the first project ended in 1999.

At the project’s conclusion, World Bank staff noted that most of the project’s physical development goals had been achieved and some institutional reforms had been completed. They also noted the challenges caused by Beijing’s rapidly changing political and urban environment and some difficulties in achieving the project’s institutional and planning objectives:

The primary emphasis given to the objective of improving the environmental planning and management reflects the uncertainty of the strategic and institutional contexts of the investment components of the project, as well as the critical importance of the objective. It appears, however, that [the Beijing city government] did not fully agree on the relative importance of the objective nor was the Bank able to articulate how various parts of the project support this objective. (World Bank 2000)
Building Gaobeidian: Developing the Environmental Infrastructure of Modern Beijing

**Gaobeidian Phase II**

The Beijing Environment Project would run parallel to a massive expansion of the Gaobeidian Wastewater Treatment Plant. Planning for the second phase of the Gaobeidian project began shortly after phase I became operational. Financing for phase II was provided by the Swedish International Development Corporation (SIDA), with a loan of kr1,473 million, alongside a commercial loan from the Nordic Investment Bank. Supplier contracts for the second phase of the project were limited to European Union companies as a provision of the loan.

The phase II project reached financial close in 1994 and completed construction in 1999, making Gaobeidian the largest wastewater treatment facility in the PRC. As the project progressed, SIDA agreed to provide additional financing to add training facilities to expand the capacity of the Gaobeidian center of excellence as demand for capacity development in the PRC’s wastewater sector increased.

Despite rapid growth since Gaobeidian Phase II, Beijing’s sewage treatment capacity and capability were increasingly strained by growing urbanization. Sludge treatment became a serious problem. In the early years of Gaobeidian, sludge could be disposed through agricultural use, but that changed as Beijing grew and citizens became more concerned about sludge disposal. “In the 1980s and 1990s,” Yang Xiangping, former manager of the Gaobeidian Wastewater Treatment Plant, said, “I kept clamoring for the sludge to be disposed of and a sludge treatment plant to be built” (Shanghai Donghai Electrical Co. 2017).

**Olympic Preparations, Institutional Reforms**

In the period following the completion of the Gaobeidian Wastewater Treatment Plant and the Beijing Olympics in 2008, many reforms were implemented in the city wastewater sector, and the city’s water treatment infrastructure was rapidly expanded (Cosier and Shen 2015). During this period, the World Bank’s Second Beijing Environment Project was also underway, which included funding and capacity development assistance for the institutional development of the Beijing Drainage Company. In 2002, the company was restructured to include some additional facilities and agencies and became the Beijing Drainage Group (BDG). By the end of the project, BDG was responsible for treating 95% of the wastewater generated in downtown Beijing, operating 11 wastewater treatment facilities, 70 pumping stations, and more than 4,000 kilometers of sewer networks.

At the outset of the project, the World Bank conducted an institutional study for BDG, which envisaged that the institution would operate similarly to a traditional wastewater company and manage all water treatment activities for the city. The Beijing municipal government reviewed the recommendations but preferred a different approach in which the city was ultimately responsible for the sanitation system. BDG would be a major operator of the city’s infrastructure, but the city would also contract out the development and operation of some treatment facilities to other private companies (World Bank 2011).
One of the issues was the matter of the sewerage tariff, which was still priced at a rate in which BDG was unable to cover all its costs. The municipal government preferred to keep this structure in place for the time being and supplement BDG’s revenues with cash contributions from the city as needed. This would also enable the city government to continue collecting the sewerage tariff directly rather than through BDG. Beijing’s sewerage tariff was already increasing at a very high rate over the course of the second Beijing Water Project (see Figure 2), and the city was likely concerned that this increase would accelerate further if it were BDG’s only source of cost recovery.

![Figure 2: Beijing Citywide Sanitation Capital Investment and Sewerage Tariffs](image)

LHS = left-hand scale, RHS = right-hand scale.


The national government had already passed regulations that would have allowed full cost recovery tariff pricing for municipal utilities, but the Beijing municipal government was concerned that implementing such a program would only lead to further acceleration of tariffs. Rates had already increased from CNY0.1 per m$^3$ in late 1997 to CNY0.9 per m$^3$ in 2004, well above the national average.

Still, the Beijing municipal government’s plan for BDG was a different arrangement from that preferred by the World Bank, which was included as a financial covenant in the loan for the second Beijing Water Project. Currently, the sewerage tariff is collected by the city, which then pays BDG a fee to operate the system based on the amount of wastewater treated. The city would also provide an additional cash subsidy if the fee did not cover operating costs, and the city assumed responsibility for paying BDG’s debt obligations, including those to the World Bank. The World Bank preferred a more traditional utility structure in which the tariff would be collected directly by BDG, which would be regulated by the city and would have the authority to increase tariffs as needed to fund its operating costs and debt service.
Ultimately, the World Bank agreed to the city’s requested modification of the institutional arrangement between BDG and the city.

Despite initial disagreements over the tariff and collection, institutional reforms at BDG appeared to be working well. In 2003, Yang Xiangping, former manager of the Gaobeidian wastewater treatment facility, reported:

The banks were willing to cooperate with us to jointly build the drainage facilities in Beijing. Therefore, in the past few years, we can see that we have received loans amounting to 7 billion yuan, and we have a certain degree of confidence in solving the difficulty of capital shortage. At the same time, we have also accelerated the speed and quality of construction. On the other hand, these wastewater treatment plants that were built before have improved efficiency through unit price operation and institutional reform. After the sewerage tariff is determined, the government collects the money and conducts unit price calculation with us, so there has been a great breakthrough in the operating mechanism. (Yang 2003)

Institutional reforms at BDG were underway while the scope of the company’s operations increased at an unprecedented pace, as BDG worked to expand capacity in line with Beijing’s development commitments as part of the city’s bid to host the 2008 Olympic Games. Between the completion of the Gaobeidian Phase II project in 1999 and 2009, BDG’s system-wide treatment capacity grew from 1.09 million m³ to more than 2.8 million m³. See Figure 3 for BDG’s treatment capacity over time and by type.

The World Bank’s Second Beijing Environmental Project ran from 2000 to 2010 and consisted of a $349 million loan alongside a $25 million grant from the World Bank. The original goals of the
Building Gaobeidian: Developing the Environmental Infrastructure of Modern Beijing

A project focused on improving air quality by converting some of Beijing’s scattered coal–fired power plants to natural gas boilers, in addition to improvements to the city’s wastewater network and the construction of some secondary wastewater treatment facilities.

**From Integrated State-Owned Enterprise to Concession Agreement**

Three years after the completion of the World Bank’s second environmental project, the Beijing municipal government began taking steps to transition BDG from a fully integrated SOE into an independent utility under a contractual arrangement with the city. The transition was part of a “Three-Year Action Plan” for wastewater system development which the city published in 2013.

The plan included two important objectives. One was the institutional reforms for BDG mentioned earlier. The other was to begin the development of recycled water capability for the city’s sanitation network.

The recycled water plan was to start with a major upgrade project for the Gaobeidian wastewater treatment plant. BDG completed the project in 2016 to make Gaobeidian a reclaimed water plant, while keeping the plant’s treatment capacity at 1 million m$^3$ per day. The plant began producing reclaimed treatment water late that year, although broader water reclamation would remain low in the PRC in the coming years due to low quality and the inability to compete with conventional water supply prices. See Figure 4 for the Gaobeidian Treatment Plant’s treatment volumes over time.

**Figure 4: Gaobeidian Wastewater Treatment Volume per Year**

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual treated wastewater (million m$^3$)</th>
<th>Annual production of reclaimed water (million m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>2014</td>
<td>350</td>
<td>250</td>
</tr>
<tr>
<td>2015</td>
<td>300</td>
<td>200</td>
</tr>
<tr>
<td>2016</td>
<td>250</td>
<td>150</td>
</tr>
<tr>
<td>2017</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>2018</td>
<td>150</td>
<td>50</td>
</tr>
<tr>
<td>2019</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>2020</td>
<td>50</td>
<td>0</td>
</tr>
</tbody>
</table>

m$^3$ = cubic meter.

Building Gaobeidian: Developing the Environmental Infrastructure of Modern Beijing

The concession contract for BDG was to have a 30-year operating duration. The concession required BDG to operate Beijing’s sanitation system and its portfolio of wastewater treatment plants in accordance with the city’s initial Three-Year Operating Plan and to develop and implement a new three-year operating plan every 3 years in coordination with the city government. The concession agreement transitioned the relationship between BDG and the city into one resembling a regulated investor-owned utility. BDG would provide water treatment services to the city, and the unit price for treatment would be determined by a rate-based formula consisting of an operating cost component, a capital investment component, and an 8% profit margin for BDG.

The transition from integrated SOE to regulated utility also allowed BDG to diversify its financing options for network expansion and some other capital projects. After the completion of Gaobeidian phase II, BDG continued to leverage ODA to finance new wastewater treatment facilities through the World Bank and bilateral sources. By 2006, BDG leveraged international assistance to finance additional new plants in Jiuxianqiao, Qinghe, Lugouqiao, and Wujiacun. Under its new concession, BDG would move to rely more heavily on domestic sources of financing for capacity expansions. It took out long-term loans from the China Development Bank and issued medium-term notes domestically for smaller capital investment projects. See Table 2 for a complete list of BDG’s treatment facilities and ODA lending sources and Table 3 for a financial summary.

### Table 2: List of Beijing Drainage Group’s Wastewater Treatment Plants

<table>
<thead>
<tr>
<th>No.</th>
<th>Wastewater Treatment Plant (WWTP)</th>
<th>Capacity (’000 m³/day)</th>
<th>Year Completed</th>
<th>International Lender Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gaobeidian WWTP (Phase I)</td>
<td>500</td>
<td>1993</td>
<td>Japan ODA</td>
</tr>
<tr>
<td>1</td>
<td>Gaobeidian WWTP (Phase II)</td>
<td>500</td>
<td>1999</td>
<td>Sweden government loan/Nordic Investment Bank</td>
</tr>
<tr>
<td>2</td>
<td>Jiuxianqiao WWTP (Phase I)</td>
<td>60</td>
<td>2000</td>
<td>France government loan/export credit</td>
</tr>
<tr>
<td>2</td>
<td>Jiuxianqiao WWTP (Phase II)</td>
<td>140</td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Qinghe WWTP (Phase I)</td>
<td>200</td>
<td>2002</td>
<td>Sweden government loan/Nordic Investment Bank</td>
</tr>
<tr>
<td>3</td>
<td>Qinghe WWTP (Phase II)</td>
<td>200</td>
<td>2004</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Qinghe WWTP (Phase III)</td>
<td>150</td>
<td>2012</td>
<td></td>
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<tr>
<td>4</td>
<td>Wujiacun WWTP</td>
<td>140</td>
<td>2006</td>
<td>World Bank</td>
</tr>
<tr>
<td>5</td>
<td>Lugouqiao WWTP</td>
<td>100</td>
<td>2004</td>
<td>World Bank</td>
</tr>
<tr>
<td>6</td>
<td>Xiaohongmen WWTP</td>
<td>600</td>
<td>2015</td>
<td>World Bank</td>
</tr>
<tr>
<td>7</td>
<td>Beixiaohai WWTP (Phase I)</td>
<td>40</td>
<td>1990</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Beixiaohai WWTP (Phase II)</td>
<td>60</td>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Qinghe Second WWTP</td>
<td>500</td>
<td>2015</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Gaonaun WWTP</td>
<td>200</td>
<td>2018</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Dingfuzhuang WWTP</td>
<td>300</td>
<td>2016</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Huaifang WWTP</td>
<td>600</td>
<td>2016</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>4,290</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors’ calculations.
### Table 3: Select Financial Information for the Beijing Drainage Group, Fiscal Year Ending September 2019 (CNY million)

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Revenue</td>
<td>9,626.80</td>
</tr>
<tr>
<td>EBITDA (Includes Equity Including from Affiliates)</td>
<td>6,318.25</td>
</tr>
<tr>
<td>EBIT (Includes Equity Including from Affiliates)</td>
<td>3,491.19</td>
</tr>
<tr>
<td>Net Income</td>
<td>2,113.45</td>
</tr>
<tr>
<td>Earnings from Continuing Operations</td>
<td>2,384.37</td>
</tr>
<tr>
<td>Total Debt</td>
<td>28,851.18</td>
</tr>
<tr>
<td>Total Common Equity</td>
<td>36,004.77</td>
</tr>
<tr>
<td>Minority Interest</td>
<td>4,245.49</td>
</tr>
<tr>
<td>Total Cash and Short Term Investments</td>
<td>8,460.88</td>
</tr>
<tr>
<td>Net Debt</td>
<td>20,390.31</td>
</tr>
<tr>
<td>Total Assets</td>
<td>83,189.71</td>
</tr>
</tbody>
</table>

EBIT = earnings before interest and taxes; EBITDA = earnings before interest, taxes, depreciation and amortization.


### The Renegotiation

The completion of the Gaobeidian reclamation upgrade project prompted the Beijing municipal government to approach BDG to renegotiate the terms of the company’s concession in 2019, before the start of BDG’s third Three-Year Plan. The reclaimed water that Gaobeidian could now produce was a new potential revenue source for BDG that had not originally been accounted for in the utility’s concession agreement with the city.

The city proposed an arrangement in which BDG would have an incentive to maximize the profitability of its reclamation operations, but also potentially bear some of the risk of those operations. BDG would be able to use excess revenues from the sale of reclaimed water to service its outstanding debt. A key question was whether BDG would retain some risk regarding the profitability of its reclamation activities. If the water reclamation activities operated at a loss, would the city allow BDG to seek compensation through the rate base for its sewerage tariffs or otherwise?

The renegotiated concession agreement could create additional risk for BDG, but it would also further BDG’s institutional development into an arms-length water utility for the Beijing metro area. While the concession amendments were still being finalized, BDG was preparing to make additional investments to improve its water reclamation operations and expand its treatment capacity. The company planned to finance its 2019 capital investments by issuing approximately CNY2 billion in domestic 5-year notes later that year. The notes would carry a coupon rate of 3.98%.
References


**Study Questions**

1. Contrast Japan’s general approach to the financing at Gaobeidian with the World Bank’s approach in the Beijing water project. One focused more on lending for large capital projects, where the borrower had flexibility or “ownership” of the project. The other focused on institutional development with reform requirements and funding for agency changes. What are the pros and cons of each approach?

2. How should international development institutions approach the economic sustainability of the projects or systems they support? Should Japan or the World Bank push for a higher tariff if they thought it was necessary to support Gaobeidian/BDG?

3. How should international development institutions approach project financing vs. institutional reforms in times of rapid economic and industrial change, as in Beijing in the 1990s? Absent the eventual institutional reforms at BDG, could the Gaobeidian plant have eventually become unsustainable?

4. What were the key drivers of BDG’s development as a utility and as an infrastructure development institution? How did each reform relate to BDG’s (1) local stakeholders, (2) international partners, (3) public opinion, (4) treatment infrastructure, and (5) network infrastructure?

Notes: In this publication, “$” refers to United States dollars.

ADB refers to “China” as the People’s Republic of China.

Cover photo: Naohiro Kitano.