China

BEIJING NO.9 WATER WORKS EXPANSION PROJECT (L/A No. CXVIII-P86)

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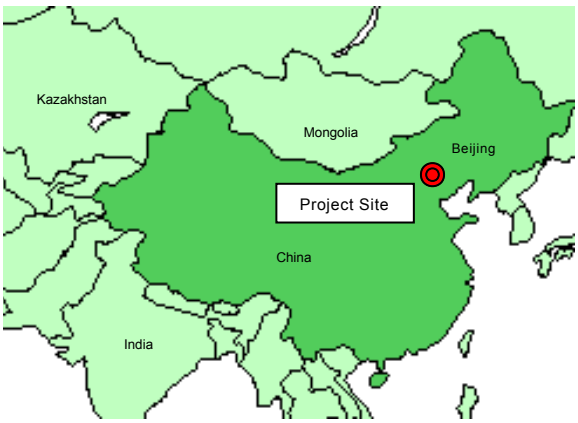
Field Survey: March 2007

1. Project Profile and Japan's ODA Loan



Site Map: Beijing


Facilities at Water Purification Plant No. 9 built through Phase III of the project

1.1 Background

In China, which has been experiencing rapid economic growth, urbanization has been marked following restructuring of the nation's industrial structure. Beijing, the nation's capital, is one of the cities that have been undergoing urban development most rapidly. The permanent population of Beijing City surpassed 10 million for the first time in 1986, increasing to 12.59 million at the time of the project start in 1996, and reaching 14.93 million at the conclusion of the project in 2004.

Beijing City has experienced a long-term decline in annual precipitation. Yearly averages were 621 mm from 1956-1979, 543mm from 1980-2000, and only 410mm in 2005. Moreover, Beijing experiences low levels of precipitation when compared to China's average annual precipitation of 660mm, the nationwide average of 631mm in 2005, or the 887mm average for major Chinese cities. In terms of water resources other than groundwater, Beijing has three large-scale dams that were constructed in the 1950s. Of those, the Guanting Dam (with a

storage capacity of 4.16 billion m^3) has suffered not only from a reduction in the amount of water stored, but also a marked degree of contamination upstream, such that since 1998 water from the dam has no longer been potable. The Miyun Dam (storage capacity 4.37 billion m^3)—which together with groundwater is one of Beijing's main water sources—has been storing far less water (min. reservoir storage level: 700 million m^3) on account of a continuing water shortage in the past 11 years. With such problems in the backdrop, one of the most important areas where efforts are being made include the supply of drinking water from the Huairou Dam (storage capacity approx. 100 million m^3) to central Beijing city, the conveyance of water from Hebei Province, the preservation of surface water, and the conveyance of water from the Changjiang river basin by way of *nanshui beidiao* project (meaning to bring water from the South to the North).

Under such conditions, international yen loans were used to finance the Project for Equipping Beijing Water Purification Plant No. 9. Phases I (1988-1995) and II (1989-1996) of the project each provided the surface water purification plant with treatment capacity of 0.5 million m^3 per day, adding up to a total treatment capacity of 1 million m^3 per day. In addition to expanding the water supply, the city has been seeking to transition from using urban groundwater as a water resource to harnessing surface water from the suburbs.

1.2 Objective

The project aims to increase the water supply capacity by 0.5 million m^3 per day and to improve the water supply situation in Beijing by implementing Phase III expansion of Water Purification Plant No. 9 together with development of related water conveyance and distribution facilities thereby contribute to relive the tightening water demand and supply and to the future increase in water demand in Beijing.

1.3 Borrower/Executing Agency

Borrower: Government of the People's Republic of China

Executing Agency: Beijing Public Utilities Agency

(In 1999, the executing agency was changed to the Beijing Municipality Management Commission)

1.4 Outline of Loan Agreement

Loan Amount/Disbursed Amount	14,680 million yen/12,161 million yen
Exchange of Notes /Loan Agreement	December 1996/December 1996
Terms and Conditions - Interest Rate - Repayment Period - Procurement	 2.1% 30 years (grace period 10 years) General untied
Final Disbursement Date	June 2004
Main Contractors	Beijing Huacheng Zhongsheng Import & Export Co., Ltd. (China) /Beijing Golden Fu Li International Trade Center (China)
Consultant Contracted	Nihon Suido Consultants Co., Ltd. (Japan)
Feasibility Studies (F/S) etc.	Former Project (signing of loan) Water Supply Improvement Project of Beijing City (August 1988) Water Supply Improvement Project of Beijing City (2) (May 1989) F/S (Execution Period) Beijing General Municipal Engineering Design & Research Institute (May 1995)

2. Evaluation Results (Rating: A)

2.1 Relevance (Rating: a)

2.1.1 Relevance at the time of appraisal

In 1995, when the nations' government policy was being hammered out for China's Ninth Five-Year Plan (1996 - 2000), 260 out of 548 cities nationwide were suffering a water shortage. In 160 cities where the water shortage was particularly acute, 40.9 million people's lives were strongly affected. For this reason, the plan set out as one of its objectives the increasing of water supply to 40 million m^3 per day nationwide, and the expansion of water supply capacity for Beijing City was a part of that objective.

Under the direction of these national government policies, the Beijing City Ninth Five-Year Plan (1996-2000) established the current project as a key element for expanding water supply capacity out of the overall efforts to enhance the city's infrastructure. At the time of the initial project appraisal, the water supply capacity

for the central districts of Beijing City was 2.3 million m^3 per day. Judging from demand predictions, if the present project were not undertaken, whereas supply capacity in the year 2000 would be 2.4 million m^3 per day, maximum daily demand would reach 3.01 million m^3 in 2000, leaving a shortfall of some 610,000m^3 per day. As such, the outfitting of water purification plants and expansion of the water supply capacity were indispensable to maintain urban functionality.

The present project was Phase III of the Project to Equip Beijing Water Purification Plant No. 9, a follow-up to Phase I and II,[1] which had accomplished a great deal. Based on the above, execution of this project was very much consistent with the needs and national development policies at the time of project appraisal.

2.1.2 Relevance at the time of evaluation

National policy at the time of evaluation entailed sustained investment in urban infrastructure facilities as a countermeasure to the water supply shortage in cities nationwide. Increased demand was not the only reason for expanding water supply in the city, as the importance of countering water resource shortages and promoting rationale usage of ground and surface water was also stressed. For example, in China's Tenth Five-Year Plan (2001-2005), at the same time that construction of water irrigation facilities were to counter long spells of drought, the plan was to increase water supply capacity by 40 billion m^3 per year (approx. 1.1 billion m^3 per day) as a means to solve the shortage in water resources. In addition, the Ministry of Construction's Tenth Five-Year Plan (2001-2005) pointed out the fact that the water supply was insufficient to meet nationwide urban demand, as well as the fact that the pollution of water resources was becoming severe. The plan therefore sought to continuously increase investment in water purification plant facilities in the urban areas.

In addition, the Beijing City's Tenth Five-Year Plan (2001-2005) pointed to the issue of a continuing tight and insufficient water supply, and determined that it would be necessary to seek to improve services and management of the city's

[1] Phase II expansion work for Water Purification Plant No. 9 and renovation of related facilities was conducted through a yen loan project entitled "Water Supply Improvement Project of Beijing City (1) (2)" (L/A concluded: August 1988; total amount: 15,480 million yen). The project built water intake facilities to handle 1 million m^3 per day, and water purification facilities handling 500,000m^3 per day. The present project will expand water purification capacity by 500,000m^3 per day, for a total capacity of 1.5 million m^3 per day.

water supply. In the Beijing Municipal Waterworks Project Development Plan, which determined policy for the city's water supply sector, by means of such things as the new construction project for Water Purification Plant No. 10 (an adjunct to the current project) and the construction to expand the Tiancunshan water purification plant, both of which were intended to increase the supply capacity based on surface water, the plan was to increase water supply capacity by 680,000 m^3 per day using surface runoff in town areas. The present project was the first project to be conducted in this end. Furthermore, in the Beijing City Master Plan for Years 2004-2020 (revised FY2005), long-term water supply demand by 2020 was forecast to be 5.163 billion m^3, [2] and even if the above water purification plans were completed, there would be a shortage of some 2.2 billion m^3. The plan called for 800 million of the shortage to be covered through recycled wastewater, and 1.2 billion m^3 to be covered by *nanshui beidiao* projects (projects bringing water from the South to the North). For this reason, by 2020, it was determined that 16 water purification plants would need to be distributed throughout the heart of the city. Roughly 2 million m^3 per day of water supply capacity would be newly provided through the new construction or restructuring of five of those water purification plants. The plan therefore called for an aggregate 4.57 million m^3 of waterworks supply capacity for downtown Beijing.

Therefore, while outfitting water purification plants to manage surface water in Beijing over the long-term, it is also necessary to increase water supply capacity. As such, the relevance of the current project remains high.

[2]The breakdown is as follows: water for agricultural use (12.2), water for domestic use in agricultural areas (0.73), water for domestic use in urban areas (15.6), industrial water (9.0), ambient water, (12.1), water supply losses (2.0). However, for figures in parentheses, the unit is 100 million m^3.

2.2 Efficiency (Rating: b)

2.2.1 Outputs

Table 1. Project Outputs (Comparison of Plan and Actual Performance)

Plan	Actual Performance
(1) Expansion of water intake facilities: Reinforcement of the intake capacity of the Huairou Dam (installation of two variable intake pumps, new installation of automatic screens, expansion of chlorinator facilities, automatic control devices, valves, electric facilities, etc.).	(1) Expansion of water intake facilities: as planned.
(2) New installation of raw water conveyance pipes between the Huairou dam and Water Purification Plant No. 9 (Aperture 2200mm dia. x 42km copper pipe; water conveyance capacity 525,000m^3 per day)	(2) New installation of raw water conveyance pipes: as planned.
(3) Expansion of water purification facilities: Water purification plant No. 9 (increase to 1.5 million m^3 per day over the existing treatment capacity of 1 million m3 per day). Rapid sand filtration method using a slope-free horizontal flow sedimentation basin (filtration using anthracite and granulated activated carbon)	(3) Expansion of water purification facilities: nearly as planned. (To cope with the future increase in treatment load, a sloped sedimentation basin was installed, replacing the previous horizontal basin with a sloped basin.)
(4) Water distribution network: 1400-2200mm dia. copper pipes, total length 48.3km	(4) Water distribution network: Aperture 1600-2200mm dia. copper pipes, total length 191.8km (relative to the plan, the extended distance was roughly 143km, roughly four times that of the original plan).
(5) Consulting services: Support with bidding and construction management	(5) Consulting services: As planned.

The planned output for the present project was as shown in Table 1. Outside the provision of the water distribution network, results achieved were nearly on target.

Regarding the water distribution network, roughly four times the planned distance was laid out. The reason for this is that at the time of the appraisal for this

project, there were no concrete plans to construct beltways No. 4 and No. 5, and so there were no plans for laying down the water distribution pipes in the ground under these beltways. Later on, however, once the plans to construct the beltways took shape, [3] construction of water distribution network following the course of those roads was added to within the scope of the present project because of the need to rationalize the waterworks network provisions project for the entire region while distributing network along those roads. Moreover, another reason that the length of water distribution pipes laid out was extended was that the water mains for Xinei and Denei in Xicheng District were also added in order to accommodate new demand arising after the start of the project. These steps represent the fact that flexible measures were taken to accommodate rapid urban development, and the fact that the measures were established with eyes fixed on the future. Judging from the fact that cost savings could be realized compared to the approach of building infrastructure piecemeal, the changes in project scope were deemed to be valid.

2.2.2 Project period

Whereas the execution period planned at the time of the appraisal was to run 57 months from October 1996-June 2001, in fact the project ran 105 months from December 1996-August 2005. The project was therefore delayed 48 months (the project ended when construction was completed). Part of the reason for the delay was that obstacles to the procurement of domestic funding in the initial period of the project led to temporary procedural setbacks, but the real reason was the above-described construction of distribution pipes for Beijing's fourth beltway and fifth beltway. The execution period, not including the extended portion of the water distribution pipes, came to 73 months, or 128% (an additional 16 months) over the planned period. The change in scope for this project has been deemed appropriate, but if one were to evaluate the efficiency of the project period, one should compare target and actual figures excluding the period for the water distribution pipe extension. That said, while the roughly 48km of initially planned water distribution pipes were planned to be laid out over a 57-month period, in actuality, 191km, or roughly four times that distance, of water distribution pipes were laid out in approximately twice the target period. As such, the efficiency was actually higher than the target figure.

[3] Large-scale redevelopment of surrounding regions have been promoted, focusing on the construction of an athletes' village and stadiums for the Olympics, as well as the construction of new housing complexes and office buildings.

2.2.3 Project cost

Total project costs projected at the time of the appraisal came to 31,998 million yen. Of that amount 14,668 million was to be financed through yen loans, 14,680 million yen through foreign currency, and 17,316 million yen through domestic currency. Compared to that, actual project costs totaled 38,290 million yen (of which 12,161 million yen was financed through yen loans, 12,161 million yen through foreign currency, and 26,048 million yen through domestic currency. The fact that project costs rose above target can be largely attributed to the extension in water distribution pipes (total length was 119% above target). Given that, a reasonable way to estimate project efficiency is to add the supplementary costs of 6.797 billion yen corresponding to the distribution pipe extension to initial target costs. The result of this calculation, 38,795 million yen, indicates that actual figures in this way came to 98% of revised target costs. Thus, project costs can be deemed to have been largely as planned.

Furthermore, because the foreign currency financing fell below projected figures while domestic currency expenditure greatly exceeded target, an inflation-driven steep price rise in the cost of materials and fluctuation in currency exchange (namely, a cheap yen) can also be seen as contributing factors in the higher project costs beyond those attributable to the extension of water distribution pipes.

2.3 Effectiveness (Rating: a)

2.3.1 Water supply achievements within Beijing City[4] and the role of this project

As shown in Table 2, the volume of daily maximum and average water supply in Beijing tended to increase up to 1999, but this reverted to a downward trend in the year 2000. In 1998 and years thereafter, all projected water usage figures were not met. This can be attributed to a variety of factors including the following: 1) a decline in demand for industrial water owing to the fact that factories (and in particular, chemical plants) were moved to the suburbs; 2) results of the Beijing

[4]Beijing city is composed of 13 districts and five counties, but the sphere over which Beijing Water Supply Group Company supplies water encompasses all of Dongcheng district, Xicheng district, Chongwen district, Xuanwu district, Chaoyang district, Haidian distict, Fengtai district, Fangshan district, Tongzhou district, Daxing district, Huairou district, Miyun county, and Yanqing county, and part of Mentougou district and Changping district.

municipal government's exhortations to citizens to conserve water[5]; 3) water conservation achieved by switching from the formerly used large-collective group water meters to individual household-use meters starting in 2000; 4) water conservation achieved by raising water rates; 5) increased use of recycled wastewater originating from sewage or sprinkling;[6] and 6) the beneficial effect of water conservation measures on industrial water usage, the government promoted the setting of industry targets for water usage productivity (water demand per unit of production), resulting in improved industrial water resource usage (water demand per unit of production). However, demand is still projected to turn back upwards for a number of reasons. The water conservation effect experienced in the industrial sector will likely to decrease. Many individually-owned wells are being improperly treated, leading to poorer water quality; accordingly, these will have to be replaced with water from the water utility system. Finally, the demand for domestic water and water for business offices is projected to continue to rise.

The water supply capacity for the city over all increased from 1996, prior to project execution, to 2000, and in 2000 was far greater than projected (2.40 million m^3 per day). Thereafter, owing to a reduction in water supply capacity at municipal purification plants using ground water and the decommissioning of deteriorating water purification plants, in 2000 and thereafter, actual water supply capacity decreased, and new contributions to water supply capacity were offset by losses in water supply capacity elsewhere.

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5 Appeals to conserve water took various forms, including information campaigns run through television commercials and newspapers, and education on water conservation in schools.

6 Recycled wastewater has been introduced into nearly all the major hotels in the city.

Table 2. Planned and actual water supply within Beijing City

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Max. water supply ($10,000m^3$/day)	Plan	231	249	266	284	301	—	—	—	—	—	—
	Actual	225	240	227	264	241	235	234	234	226	242	241
Average water supply ($10,000m^3$/day) [1]	Plan	167	178	189	200	210	—	—	—	—	—	—
	Actual	193	196	197	203	201	191	184	194	202	208	201
Amt. supplied for consumers[2] ($10,000m^3$/day)	Plan	127	136	145	153	162	—	—	—	—	—	—
	Actual	128	134	137	146	142	125	124	127	137	135	138
Amt. supplied for industrial use ($10,000m^3$/day)	Plan	39	42	44	47	49	—	—	—	—	—	—
	Actual	35	34	33	31	27	21	16	24	22	24	25
Water supply capacity (10,l000 m3 / day)	Plan	230	240	240	240	240	—	—	—	—	—	—
	Actual	246	262	262	302	303	272	267	263	238	265	265
Facilities utilization rate (%)[3]	Max.	91.6	91.5	86.5	87.4	79.5	86.4	87.6	89.0	95.0	91.3	90.9
	Avg.	78.6	74.7	75.1	67.2	66.3	70.2	68.9	73.8	84.9	78.5	75.8

Source: Beijing Waterworks Group

Note 1: Target figures combine water volumes for citizen and industrial use, but actual figures also include other forms of use, including municipal water utilization.

Note 2: All non-industrial use water, including water for daily living, the service industry, and public facilities.

Note 3: The "maximum" utilization rate refers to maximum water supply divided by water supply capacity. "Average," in this context, refers to average water supply divided by water supply capacity.

Table 3 Actual water supply and facilities utilization rate for Water Purification Plant No. 9

	2002	2003	2004	2005	2006
Water supply capacity ($10,000m^3$/day)	150	150	150	150	150
Max. water supply ($10,000m^3$/day)	130.4	134.3	127.6	136.9	138.3
Avg. water supply ($10,000m^3$/day)	92.5	95.1	87.3	91.3	98.8
Facilities utilization rate (max) (%)	86.9	89.5	85.1	91.3	92.2
Facilities utilization rate (avg.) (%)	61.7	63.4	58.2	60.9	65.9

Source: Beijing Waterworks Group

Relative to daily maximum supply volume for Beijing City as a whole, the facilities utilization rate tended to be right around 90%, except in the year 2000. This can be said to be a rather high utilization rate (see Table 2). The utilization rate for Water Purification Plant No. 9 tended to be around 85% for the years 2002 and thereafter. While this too is a high rate of utilization, it does provide for a certain amount of reserve capacity (see Table 3).

The facilities utilization rate for Beijing as a whole relative to the daily average water supply volume was above 66% even in its lowest point in 2000 and rose to as high as 85% in 2004, which is a high rate of utilization (see Table 2). The reason that the facilities utilization rate was high despite the fact that new water purification plants were put into operation and that demand did not rise dramatically can be attributed to the recent decommissioning of deteriorated water purification plants. Meanwhile, the utilization rate of Water Purification Plant No. 9 was only around 60% (see Table 3). This was because surface water was in short supply due to a water shortage in recent years and because it is meant to supply future demand. Furthermore, it is apparent that the utilization rate for facilities furnished through Phase III of the project was somewhat greater than Water Purification Plant No. 9 as a whole (see Table 4). This is attributed to the fact that as an emergency measure outlying groundwater resources were newly developed and utilized while the Miyun Dam was retained as a water resource for Phases I and II on account of a recent water shortage (see Section 2.3.4 below).

As a point of contrast, Japan's facilities utilization rate for the nation overall averages 65.11% (Japan Water Works Association Year 2005), Tokyo's rate is 64.9%, and the average for the ordinance-designated city is 59.0%. When cast against these Japanese figures, the 60% rate achieved by Water Purification Plant No. 9 suggests an appropriate level of operation that leaves room to spare for times of accidents or facilities renewal.

Table 4. Phase III Water supply figures and facility utilization rates for Water Purification Plant No. 9

	2001	2002	2003	2004	2005	2006
Water supply capacity (10,000m^3/day)	(50)	(50)	(50)	50	50	50
Avg. water supply (10,000m^3/day)	29.2	30.7	36.3	37.0	37.8	38.0
Portion provided by ground water (10,000m^3/day)	0	0	11.0	36.4	37.0	33.2
Portion supplied by surface water (10,000m^3/day)	29.2	30.7	25.3	0.6	0.8	4.8
Facilities utilization rate (Avg.) (%)	(58.4)	(61.4)	(72.6)	73.9	75.5	76.0

Source: Beijing Waterworks Group

Note: Figures in parentheses indicate stages where the actual water supply capacity was unclear because throughput was being attended to incrementally.

2.3.2 Water-supplied Population

If figures are confined to Beijing City limits, both actual and target figures for water diffusion were 100%. The per-person average water consumption (water for domestic consumption) continued to grow up until 1999, but starting in 2000 year-on-year figures largely declined. The water-supplied population overall tended to increase.

Table 5. Water diffusion rate and water-supplied population within Beijing City

		1996	1997	1998	1999	2000	2001	2001	2003	2004	2005	2006
Water Diffusion Rate (%)	Plan	100	100	100	100	100	100	100	100	100	100	100
	Actual	100	100	100	100	100	100	100	100	100	100	100
Water-supplied population (10,000 people)		530	536	538	542	556	556	648	646	664	922	1,424

Source: Beijing Waterworks Group

Note: The water-supplied population up until 2004 represents an estimate arrived at by dividing Beijing city's supply volume into the average consumption for an average (four-person family) household. Starting in 2005, however, the water-supplied population was arrived at when possible using meters for individual households. This difference in calculation method accounts for the sudden jump from 2004 to 2005.

2.3.3 Water quality

For the standard of water quality, in addition to the national health standards for potable water, the Beijing Waterworks Group established 15 new indicators as its own corporate standards. In water quality studies conducted by the company up

until now, all of the standards have been satisfied. Judging from the 31-item water quality measurement results provided at the time of the evaluation, water output by this project satisfied all of the indicators set forth. Moreover, other than the fact that the water is somewhat hard, the water compares favorably with Japan's drinking water quality. The water purification plants are providing safe drinking water.

2.3.4 Mitigation of the stress on underground water resources

At the time of the appraisal, JBIC emphasized the fact that this project could contribute to conserving Beijing City's groundwater, and future policy set forth by Beijing Public Utilities Agency and construction divisions on the Chinese side, which control the total amount of water obtained from groundwater sources, confirm this fact. Whereas In phases I and II of the project, water intake was exclusively from the Miyun dam, with water being conducted to water purification plants by gravity flow. By contrast, according to plans for the Phase III expansion project, while some of the water was to flow down from the Miyun dam in the same manner as just described, some was also to be pumped in from the Huairou dam, with water being conducted using pumps. In terms of operations, water was to be normally taken primarily from the Miyun Dam, with water being drawn from the Huairou Dam only in the summer season when demand spiked. The policy was therefore geared to conserving ground water utilization within the city by using surface water in this way.

Rainfall has continued to be light over Beijing City starting in 1999, and the atmospheric temperature has also risen (Figure 1). For this reason, the Huairou Dam has experienced a water shortage, and the water stored at the Miyun Dam has fallen from 4.0 billion m^3 (4.3 billion m^3 at its peak) to a mere 1.0-1.6 billion m^3 (700 million m^3 at its minimum). Under such circumstances, groundwater usage from within the city has temporarily risen, and in 2003 the Beijing Waterworks Group obtained permission to use groundwater. Through domestic financing 42 wells were dug in the vicinity of the Huairou dam, and groundwater usage was initiated. For this reason, the degree to which the Beijing Water Supply Group Company depends on groundwater for the overall water supply increased temporarily starting in 2003 (see Table 6).

This trend has arisen on account of temporary measures adopted to accommodate a water shortage. If Water Purification Plant No. 9, which was established with the aim of processing surface water, can raise its normal rate of operations for surface water up to the current maximum supply volume of 1.383

million m^3 through adequate rainfall, then it should be possible to keep ground water utilization within the city to a level of 460,000m^3 per day (Fig 2). In the future, a balance of operations between ground water and surface water will be sought after. For example, if were not possible to draw in enough water because of low levels in the Yangtze River, or if hit by a drought, then groundwater would be used. However, for the most part, the plan will be to increase treatment capacity for surface water as far as possible, to then secure surface water, and to prioritize its usage, thereby securing a stable water supply.

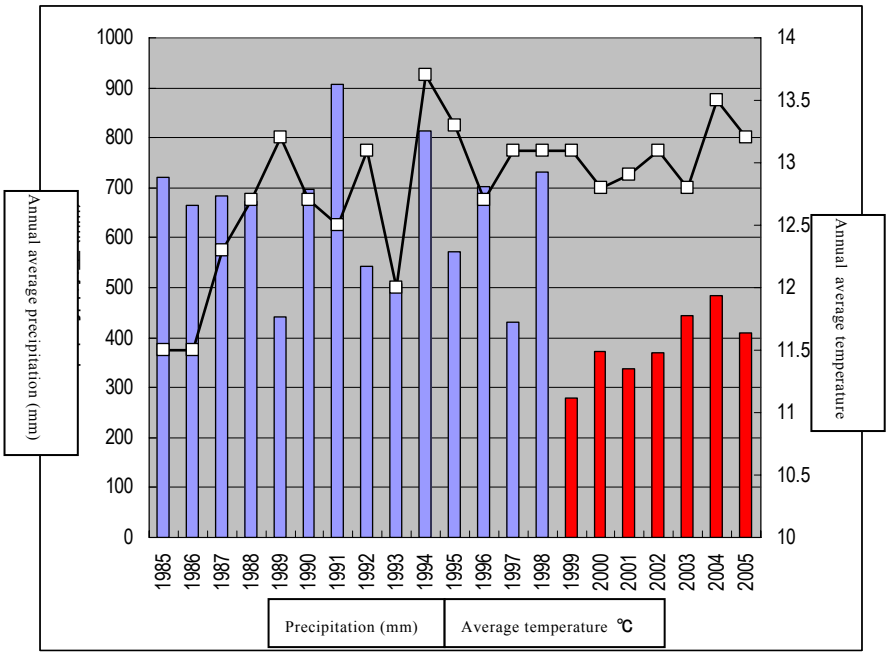

Fig 1 Meteorological conditions around the Beijing city area in recent years
Source: Chinese Statistical Yearbook

Table 6. Changes in the ratio of groundwater to total water intake within Beijing City
(Units: 100 million m^3 per year)

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Gross water intake		6.72	6.93	6.98	7.14	7.16	6.82	6.79	6.49	6.81	7.19	7.36
Intake of surface water		3.33	3.77	3.87	4.17	4.35	4.06	4.07	3.69	2.59	2.72	3.12
Ground water intake	Total	3.39	3.16	3.11	2.97	2.81	2.76	2.72	2.80	4.23	4.46	4.24
	Downtown	3.39	3.16	3.11	2.97	2.81	2.76	2.72	2.40	2.90	3.11	3.03
	Suburbs								0.40	1.33	1.35	1.21
Usage rate of ground water (%)	Total	50.5	45.6	44.5	41.6	39.3	40.5	40.1	43.1	62.1	62.1	57.6
	Downtown	50.5	45.6	44.5	41.6	39.3	40.5	40.1	37.0	42.6	43.3	41.1
	Suburbs								6.2	19.5	18.8	16.4

Source: Beijing Waterworks Group

Note 1: Water intake only from the Beijing Waterworks Group. Does not include water drawn from privately owned wells.

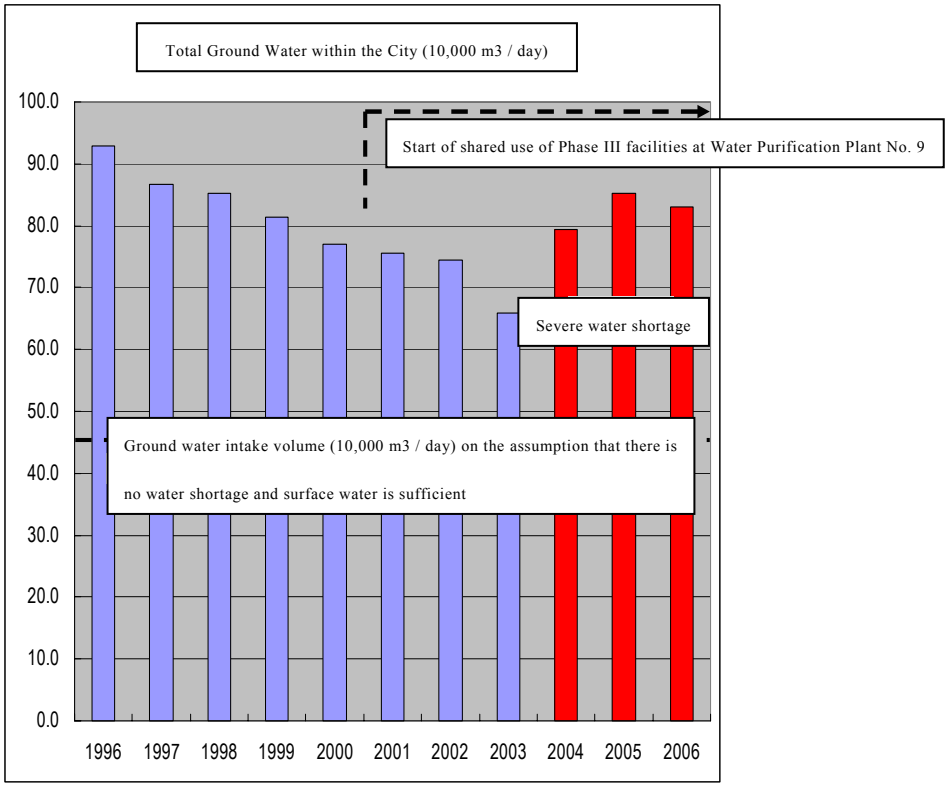

Fig. 2 Groundwater intake from downtown Beijing. Source: Beijing Water Supply Group Company supplementary questionnaire answers. Note: The dotted line represents an estimate of urban groundwater intake in the case of Water Purification Plant No 9. raising its surface water treatment capacity up t the current daily maximum level (1,383 million^3 per day)..

2.3.5 Internal Rate of Return (IRR)

2.3.5.1 Financial Internal Rate of Return (FIRR)

Taking income from fees as profit, construction costs, operation and maintenance (O&M) costs, and taxes as cost, and the project life as 28 years, then FIRR at the time of the appraisal came to 5.49% based on JBIC data. By contrast, the same calculation performed at the time of the evaluation was 5.67%. Thus, FIRR was slightly higher than initially projected at the time of the appraisal (see Table 7)[7]

[7] Calculated on the assumption of needing a yearly increase of 2% to reach an operation rate of 80%. After the year 2007, fees would remain the same level as in 2006.

Table 7. Revenue and operation and maintenance costs for the present project

Item	2000	2001	2002	2003	2004	2005	2006
Fee revenue (10,000 yuan)	15,801	23,058	29,584	39,203	42,352	49,078	43,411
O&M costs (10,000 yuan)	7,610	9,975	15,421	22,780	28,705	29,835	27,145

Source: Beijing Waterworks Group

2.3.5.1 Economic Internal Rate of Return (EIRR)

EIRR calculations were not performed at the time of the appraisal, but at the time of the evaluation, economic benefits were calculated using the Willingness To Pay (WTP) index for the increase in water quality and water pressure wrought through the present project. The WTP index was calculated through a survey of beneficiaries conducted on citizens and business persons in the service and industrial sectors. [8] In order to ascertain the benefit of this project over Beijing city's entire water supply network, regarding the added convenience of higher water pressure, the study targeted water supply volume for Water Purification Plant No. 9 as a whole; and regarding the improvement in water quality, the study targeted water supply volume increased through Phase III of the project. Moreover, because the operation rate was forecast to increase, just as when calculating FIRR, supply water volume was calculated based on the assumption the average water supply would increase 2% per year until reaching a facilities utilization rate of 80%. From the above EIRR was estimated to be 15.55%, and it was judged that benefits from the project were sufficient.

2.4 Impact

2.4.1 Beneficiaries' appreciation of water pressure and water quality

A study of beneficiaries was performed through individual person-to-person interviews. (For this purpose, beneficiaries consisted of both Beijing citizens and places of business—that is, governmental institutions and enterprises from the manufacturing and services industry.) There were 367 and 100 responses from

[8] In the study of beneficiaries, we used responses to the question of "How much would you pay to avoiding to go back to the water pressure and water quality prior to the project?" (response provided as percentage of the current water fees) as WTP.

citizens and business venues, respectively. Twenty percent of citizens responded that water quality had improved since the project was undertaken[9], regarding survey items for mineralogical fur, odor, taste, color, or other miscellaneous characteristics, more respondents marked "none" or "little" after the project compared to before the project. With respect to water pressure and water flow, whereas only 50% of those surveyed indicated that "Water is being supplied continuously/there is no problem with water flow," 80% (an increase of 30 percentage points) indicated this sentiment after the project. Finally, whereas 7% of respondents before the product felt that "Water volume was weak at peak times and sometimes stopped" or "Water flow was weak and sometimes ran out," after project completion the number dropped to 4%. As such, one can say that this project made a certain contribution to stabilizing the water supply in Beijing City. In addition, a roundtable discussion with beneficiaries disclosed that whereas before the project, water pressure often dropped in summer and people had to transport and store water for cooking, water pressure had now stabilized, and household labor had been reduced.

The present project increased capacity in Beijing city 500,000m^3 per day out of a supply of roughly 2.60 million m^3 per day. While the importance of that should not be dismissed, it is difficult to ascertain the impact of this project alone on Beijing. Moreover, because the substitution of old water purification plants that had originally been using groundwater is also a factor, with the exception of economic development districts with a direct water supply, one cannot conclude that the impact on water pressure and water quality described above is solely attributable to this project.

2.4.2 Displacement of residents

According to the executing agency, the number of relocated households was expected to be 300 households. During the project implementation 104 households were replaced as the first phase of the relocation. Disbursement of compensation from the municipal government and the provision of housing were performed by the Chaoyang District Government where Water Purification Plant No. 9 is located. Thus, this aspect of the project did not encounter difficulties.

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[9] According to the survey of beneficiaries, 49% of respondents felt that water quality was "exceptionally good" or "good" prior to project execution. By comparison, evaluations of water quality post-project reported 20% stating there had been an improvement in quality, and 56% stating that it was about the same.

2.5 Sustainability (Rating: a)

2.5.1 Organization responsible for operation and maintenance

At the time of the appraisal it was assumed that the Beijing Waterworks Group would be entrusted with operation and maintenance. Starting August 26, 1999, however, that entity's name was changed to the Beijing Water Supply Group Limited Liability Company. Moreover, in 1999, the Beijing Public Utilities Agency was dissolved as part of structural reforms, and so direct control fell to the Beijing Municipality Management Commission.

2.5.2 Operation and management system and technical capacity

There are currently ten subsidiaries under the Beijing Waterworks Group. One of those is the Beijing City Water Purification Plant No. 9 Co, which conducts operation and maintenance for the water purification plant and water intake facilities. Water distribution, fee collections, and operation and maintenance are managed by a separate subsidiary of the Beijing Waterworks Group.

At the time of the appraisal, the Beijing Waterworks Group had sufficient experience and expertise, and it was felt that there were no particular issues in terms of technical capacity. As of the time of the evaluation, the engineers in the department that manages such things as pumps, chlorine injection and water quality tests are handling the facilities for Phases I, II, and III of the present project in one batch. The number of people involved is broken down in Table 8.

Table 8. Breakdown of employees at Water Purification Plant No. 9 by occupational category (Unit: person)

Occupation	Management	Technicians	Equipment operators and technical workers	Office workers	Total
No. of People	95	28	265	113	492

Source: Beijing City Water Purification Plant No. 9 Co.

Out of 95 personnel in management, 44 are also engineers, and of those, five are high-level engineers and 12 intermediate level engineers. In addition, out of 28 technicians, two are high-level engineers, and 10 are intermediate level engineers. Engineers and skilled workers receive periodic training, and a qualifications certification program has been established to ascertain whether the workers possess a certain level of specialized knowledge and skills. Moreover, in order to improve their technical capabilities, there is a testing laboratory (experimental research institute) which collaborates with universities, research institutes, and other special organizations with the aim of constantly raising skill levels. In addition, technical manuals and guidelines are furnished for each work station and are managed as well.

From all the above measures, it is estimated that the executing agency possesses sufficient technical capacity.

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Water from Water Purification Plant No. 9 is drinkable water provided there are no problems with related facilities like distribution pipes or other tanks, and this same "drinkable water" is to be provided to the Olympic Village. The Olympic Village is adjacent to Water Purification Plant No. 9, which will be supplying all of its water. In addition, the scale of water supplied to the athletes' village will be 50,000 tons per day. For that reason, water pipes 300-2200mm in dia. will be laid out over a total distance of roughly 30km.

Also targeting the upcoming Olympics, training is being conducted centering on technical staff. As for facilities, as a result of adding facilities introduced from France during Phase II to raise the treatment capacity of the grit chamber, treatment capacity has risen. And cleaning is being performed to handle grit chamber in Phase III facilities.

2.5.3 Ratio of the uncollected rate[10] and ratio of water leakage[11]

The uncollected rate was nearly constant, but the leakage rate increased dramatically starting in 2000. According to the Beijing Waterworks Group, the main reasons for the increased leakage rate were increased water pressure within the water distribution pipes, the extension of water distribution pipelines, and the fact that deterioration of facilities and maintenance work did not catch up with expansion of the service region. Looking at this issue from a worldwide perspective, Tokyo has a 3.6% leakage rate, London is at 26.0%, and Moscow and Madrid both suffer roughly 10% leakage rates. While Beijing's leakage rate is not terribly high, it is hoped that facility improvement and operation and maintenance work can be promoted.

10 The "uncollected rate" is the ratio of volume of water for which fees were not collected relative to the amount of purified water provided.

11 The "leakage rate" is the ratio of the leaked water (for which fees could not be collected) relative to the amount of purified water provided.

Table 9 Beijing Municipal Waterworks uncollected rate and leakage rate (Unit: %)

		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Uncollected rate	Plan	8.7	8.7	8.7	8.7	8.7	16.7	16.7	16.7	16.7	16.7	16.7
	Actual	10.5	8.6	8.9	8.2	11.9	16.2	17.4	15.2	16.7	16.7	16.5
Leakage rate	Plan	8	8	8	8	8	16	16	16	16	16	16
	Actual	10.0	8.1	8.3	7.6	11.3	15.5	16.7	14.5	15.9	16.0	15.8

Source: Beijing Waterworks Group

2.5.4 Water rates

The water rates for Beijing City are as shown in Table 10. Rates have been adjusted to improve financial status and to help achieve continuous operation and maintenance. According to the implementing agency, the water rate has been adjusted in line with general price escalations. Therefore, there is no particular problem with social receptivity to the increased rates at the present time.

Table 10. Beijing City water rates (Unit: yuan/m^3)

Yuan/m^3	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Daily living	0.5	0.7	1	1.3	1.6	1.6	2	2.4	2.8	2.8	2.8
Industry & commerce	0.8	1	1.3	1.6	2.4	2.4	2.9	3.2	4.1	4.1	4.1
Administrative offices									3.9	3.9	3.9
Service industry	1.2	1.2	1.5	1.8	2.8	2.8	3.8	4.2	4.6	4.6	4.6
High-class hotels	2	2	2.4	2.7	3.8	3.8	3.8	4.2	4.6	4.6	4.6
Drinking water Carwashes					10	10	16	20	40	40	40
High-class bathhouses					5-30	5-30	8-50	10-60	60	60	60

Source: Beijing Waterworks Group

2.5.5 Financial status

Beijing Waterworks Group's financial status is as shown in Table 11.

Table 11. Main financial data for the Beijing Waterworks Group years 2003-2005

Financial Data	2003	2004	2005
Current assets (10,000 yuan)	15,8191	207,330	215,905
Fixed assets (10,000 yuan)	566,980	563,615	641,507
Total assets (10,000 yuan)	898,282	995,051	1,065,941
Current liabilities (10,000 yuan)	107,306	175,364	212,898
Total liabilities (10,000 yuan)	217,399	286,773	332,338
Tangible net worth (10,000 yuan)	680,883	708,278	733,603
Sales (10,000 yuan)	107,453	162,407	186,442
Net profit (10,000 yuan)	2,517	542	-16,766
Depreciation costs (10,000 yuan)	39,915	42,656	47,680
Cash and cash equivalents at year end (10,000 yuan)	97,034	139,768	128,304
Current ratio (%)	147	118	101
Net profit margin (%)	2.34	0.33	-8.99
Return on assets (%)	0.28	0.06	-1.57
Net profit / (net profit + depreciation costs) (%)	5.9	1.3	-54.2
Depreciation costs / (net profit + depreciation costs) (%)	94.1	98.7	154.2

Source: Beijing Waterworks Group

According to the financial data for years 2003-2005, the Beijing Waterworks Group 's financial status was not altogether sound. Net profit dropped sharply in FY2005. Among the reasons cited for this drop is the fact that raw water costs and power expenses increased, the distribution network was greatly expanded, and repair costs increased for deteriorated pipes. The current ratio, a measure of stability, did not reach the established norm of 200% in any year, and it is thought that concern remains about the financial stability. In addition, profitability was also an issue, as net profit margin and return on assets are extremely low. Even so, cash flow and cash and cash equivalents at year end tended to increase, and looking at the balance of revenue and costs (see Table 7), some measure of profitability seemed to be secured. In addition, up to this point there has been no infusion of

public funds, and so sustainability is not a concern.

3. Feedback

3.1 Lessons Learned

In Beijing city, calls for citizens to conserve water are having a big effect. In projects that furnish facilities for water purification plants, because water conservation measures are an important element for conducting appropriate demand predictions, it is hoped that they will be made a part of the project. In addition, further water conservation can be expected through raising rates in cases where, as is the case in Beijing, social receptivity to increases in water rates is rather high. (Compared to increases in price levels and user income levels, if rates are set too low, incentives to conserve water do not have much effect.)

3.2 Recommendations

In the waterworks sector, which unlike the transportation sector or the mining and manufacturing sector has highly restricted resources, it is not possible to take large numbers for operation and effect indicators to mean the project was more effective. In the future, we should look into the way ratings should be performed and devise operation and effect indicators that reflect the project's special characteristics.

In the city of Beijing, because water conservation measures were promoted to counter water shortages, and because groundwater resources were being developed in outlying areas, the target figures for water supply volume and other results were not met. Moreover, in order to reduce costs and adjust plans to accommodate such things as road construction, additions to project scope and extension of project period were made. These efforts can be interpreted as examples of good governance, but on the other hand, in the present mode of evaluation in which comparisons are made with target figures, it is possible to judge that effectiveness and efficiency were low. (In the evaluation for the present project, various causes were considered and exceptional ratings were provided.) In the future, we must look into developing and adopting an evaluation method and rating method that takes into consideration circumstances relating to project execution and initiatives taken in response to those circumstances such as those above.

Comparison of Original and Actual Scope

Item	Plan	Actual
(1) Outputs		(1)
1) Expansion of water intake facilities	Strengthening of water intake capability at the Huairou dam	As planned.
	Between the Huairou Dam and Water Purification Plant No. 9 (Aperture 2200mm in dia x 42km) (steel pipes). Water conveyance capacity: 525,000 m^3/day)	As planned.
2) New water distribution pipes		Nearly as planned. (as a measure to handle the increased treatment load, a sloped design was installed)
3) Expansion of water purification facilities	Water purification plant No. 9 (in addition to existing treatment capacity of 1 million m^3/day, increased to 1.5 million m^3/day)	1600-2200 mm dia. steel pipes, length of 191.8km
4) Water distribution network	1400-2200 mm dia. steel pipes, total length 48.3km	
5) Consulting services	Assistance with bidding and construction management	As planned
(2) Period	October 1996-June 2001 (57 months)	December 1996-August 2005 [1] (105 months) December 1996 - December 2002 [2] (73 months)

(3) Project Cost		
Foreign currency	14,680 million yen	12,161 million yen
Local currency	17,316 million yen	26,048 million yen[1]
		19,251 million
	(Local currency:	yen[2]
	1,443,170,000 yuan)	(Local currency:
Total		1,780,460,000 yuan[1]
	31,998 million yen	1,315,860,000 yuan[2]
ODA loan portion		38,209 million yen[1]
Exchange rate	14,680 million yen	31,412 million yen[2]
	1 yuan - 12.00 yen (1995)	12,161 million yen
		1 yuan - 14.63 yen
		(1996-2005 averages)

Note 1: Project period and costs for the entire scope of the project.

Note 2: Project costs and period excluding the extension of the water distribution network (approx. 143km, 6,797 million).