ECONOMIC ANALYSIS

A. Introduction

1. Chaonan District, a county-level administrative division of Shantou Municipality in Guangdong Province, has been experiencing rapid economic growth since its establishment in 2003. However, due to its large rural population and less-developed industry and services, the district's economy and fiscal revenue fell far behind the developed regions in Guangdong Province and even below the national average. Its per capita gross domestic product in 2011 was only CNY16,379, which was about 32% of the provincial average of CNY50,807 or about 46% of the national average of CNY35,198. The per capita annual net income of rural households in 2011 was CNY5,076, which was about half the provincial average of CNY9,372 or 72% of the national average of CNY6,977.

B. Rationale

2. To meet the need for future development of Chaonan District, the water supply facility is the critical infrastructure to be improved. Current water supply capacity is about 135,000 m^3/day, which is far from meeting both the current and future demand for domestic and industrial uses in the district. The current district water supply network comprising three major water supply systems can barely serve 70% of the district population—mainly urban and peri-urban residents, but cannot guarantee 7-day, 24-hour services. These three systems are not connected to each other, which prevent them from functioning complementarily and make the district water supply system incomplete. Besides, water transfer and distribution pipes in Chaonan are owned by townships and villages, but not by the district. This fragmented ownership of water transfer and distribution pipes has hindered the Chaonan district government (CDG) in improving water transfer, distribution efficiency, and water quality. Provision of quality water to all the district people is one of the most important goals of CDG.

3. The project will help Chaonan District increase its water supply capacity from 135,000 m^3 per day to 282,000 m^3 per day by (i) expanding, upgrading, and building new water supply plants; (ii) installing water delivery and distribution pipelines; (iii) providing equipment for operation and maintenance (O&M) of water treatment and supply infrastructure; (iv) establishing a water quality monitoring center to underpin water quality control; and (v) installing water meters at about 38,000 households to improve the district's monitoring of water use. The project will consequently enable CDG to meet demand for water of all the people and help it improve the critical infrastructure necessary for future development of the district.

C. Demand Analysis

4. Water demand for the project period of 25 years was estimated based on projected population growth and projected consumption by different users, i.e., residents, and agricultural, industrial, and other commercial entities. The Chaonan population to be covered by the project at present is 1.23 million. This baseline population is assumed to increase by 0.8% to 2.1% in different project areas based on respective area-wise population increases in previous years. Per capita water demand (i.e., 130 liters per day) and household size (i.e., 5.4 members) were assumed to remain the same. Fifty percent of households are assumed to be connected to

water supply in the first year of operation, 70% in the second year, and 100% thereafter. Water loss was assumed to be 30% of water production.[1]

D. Assumptions

5. The economic analysis of the project was carried out by comparing with- and without-project scenarios following the Guidelines for the Economic Analysis of Projects (1997) of the Asian Development Bank (ADB). The assumptions used for the analysis include the following:

(i) The project life is 25 years, including construction; the salvage value at the end of the project life is zero. These are conservative estimates of the lifespan of the constructed water treatment plants and water distribution pipes.
(ii) The construction will start in 2014; and the capacity utilization of the three water treatment plants will be 60% in 2018, 80% in 2019, and 100% in 2020.
(iii) Economic costs and benefits are expressed in constant 2013 terms with an exchange rate of CNY6.05 = $1.00, and are valued in local currency using the world-price numeraire.
(iv) Taxes and duties, interest, subsidies, and price contingencies are excluded from the economic cost; and physical contingencies are included.
(v) Economic costs and benefits for nontradable goods are derived by adjusting their values by the standard conversion factor of 0.987, which is consistent with the standard conversion factor used in recent ADB-financed projects for the People's Republic of China (PRC); and the shadow wage rate factors of 1.0 for skilled labor and 0.67 for unskilled labor.
(vi) The opportunity cost of capital adopted in the analysis is 12%, which represents the opportunity cost of capital of the PRC.

E. Least-Cost Analysis

6. Least-cost analysis was conducted to identify a least-cost method in water treatment based on the average incremental economic costs over the project's life. A discount rate of 12% was applied to calculate the average incremental economic costs. Two different water treatment methods, i.e., horizontal flow sedimentation tank and settling pond with inclined pipes, were selected through the engineering assessment and preliminary cost comparison by the design institute. The investment and O&M costs of those two options were converted into economic costs by using the above conversion factors. The average incremental economic cost using the former method was estimated at CNY0.058 per m^3 against the cost using the latter method at CNY0.062 per m^3. As a result, the horizontal flow sedimentation tank method was selected for the project.

F. Economic Cost

7. The project cost comprises investment and O&M costs. The investment cost consists of civil works, equipment, materials, other related expenses (e.g., design and implementation supervision), and physical contingency. The investment cost will mostly finance an expansion of the Qiufeng water supply plant, an upgrade of the Jinxi water supply plant, construction of the Longxi water supply plant, and installation of water transfer and distribution pipelines. The O&M cost includes costs for workers, chemicals and agents for water treatment, utility, water treatment plant maintenance, and administration. Financial costs are converted into economic

[1] Based on recent ADB-financed projects in the PRC. Available at: http://www2.adb.org/Documents/RRPs/PRC/40634/40634-01-prc-ea.pdf

values by excluding taxes and duties, and price contingencies; and applying appropriate conversion factors to nontradable goods and labor. The investment cost was estimated at an economic net present value (ENPV) of CNY704.4 million and the O&M cost at an ENPV of CNY141.4 million.

G. Economic Benefit

8. The expected benefits from the project include (i) health benefit of water users; (ii) reduction of water transfer cost per unit of water; (iii) reduction of labor for fetching water; and (iv) improvement in productivity and production capacity of private sectors, such as agriculture and industry, through improved workers' health conditions, and better water availability. The project is considered pro-poor because those who benefit most from it are the residents of rural and peri-urban areas where the proportion of poor households is larger. For estimation of economic benefits, a contingency valuation method based on willingness-to-pay estimation was employed due to the lack of data and difficulty in quantifying aforementioned benefits. Economic benefits from the project were estimated using residents' willingness to pay of CNY4.3 per m^3, which was derived from the social and economic survey.[2] The ENPV for the project was estimated at CNY992.5 million.

H. Economic Cost–Benefit Analysis

9. The ENPV of the net benefit was estimated at CNY146.8 million. The economic internal rate of return (EIRR) was estimated at 15.1%. As the EIRR is higher than the economic cost of capital of 12%, the project is considered economically viable. Estimated economic cost and benefit for the project are shown in Table 1.

I. Sensitivity Analysis and Switching Values

10. The sensitivity analysis was carried out to examine impacts of the following four adverse scenarios: 10% benefit reduction, 10% investment cost increase, 10% O&M cost increase, and 1-year delay in project implementation. The project remains economically viable in the face of any single event. However, if those four adverse events happen simultaneously, the EIRR would decrease to 9.6%. Switching values were computed to identify an exact threshold where the project's economic viability becomes risky. The project would remain economically viable within a 14.8% reduction in benefit, 20.8% increase in investment cost, or 103.8% increase in O&M cost. In case of simultaneous occurrence of benefit reduction and investment cost increase, the project's economic viability would be maintained if the change were within 8.7%. In case of simultaneous occurrence of investment and O&M cost increase, the economic viability would be maintained if the change were within 17.4%. In case of simultaneous benefit reduction, and investment and O&M cost increases, the project would remain economically viable if the change were within 8.0%. The sensitivity analysis confirmed robustness of economic viability of the project, in general. Among the four adverse events, the project would be most sensitive to a benefit reduction.

[2] The willingness to pay is relatively high for the PRC. However, the sensitivity analysis confirmed that the economic internal rate of return of 12% would be maintained in case of revenue reduction by up to 14.8%, which can be converted as a reduction of the water price by CNY0.64 per m^3 (i.e., CNY3.66 per m^3) keeping the quantity of water sales constant.

Table 1: Economic Internal Rates of Return

Year	Benefit	Cost			Net Benefit
		Investment Cost	O&M Cost	Total Cost	
2014	0.0	20.2	0.0	**20.2**	**(20.2)**
2015	0.0	181.4	0.0	**181.4**	**(181.4)**
2016	0.0	181.4	0.0	**181.4**	**(181.4)**
2017	0.0	181.4	4.1	**185.5**	**(185.5)**
2018	133.0	181.4	16.9	**198.3**	**(65.3)**
2019	177.3	262.0	25.3	**287.3**	**(109.9)**
2020	221.7	33.8	28.2	**62.0**	**159.6**
2021	221.7	33.8	30.0	**63.8**	**157.9**
2022	221.7	33.8	30.3	**64.1**	**157.6**
2023	221.7	33.8	30.6	**64.4**	**157.3**
2024	221.7	33.8	31.0	**64.7**	**156.9**
2025	221.7	0.0	32.0	**32.0**	**189.6**
2026	221.7	0.0	32.2	**32.2**	**189.5**
2027	221.7	0.0	32.2	**32.2**	**189.5**
2028	221.7	0.0	32.2	**32.2**	**189.5**
2029	221.7	0.0	32.2	**32.2**	**189.5**
2030	221.7	0.0	32.6	**32.6**	**189.0**
2031	221.7	0.0	32.6	**32.6**	**189.0**
2032	221.7	0.0	32.6	**32.6**	**189.0**
2033	221.7	0.0	32.6	**32.6**	**189.0**
2034	221.7	0.0	32.6	**32.6**	**189.0**
2035	221.7	0.0	33.1	**33.1**	**188.5**
2036	221.7	0.0	33.1	**33.1**	**188.5**
2037	221.7	0.0	33.1	**33.1**	**188.5**
2038	221.7	0.0	33.1	**33.1**	**188.5**
NPV	**992.5**	**704.4**	**141.4**	**845.7**	**146.8**
EIRR					**15.1%**

( ) = negative, O&M = operation and maintenance.
Source: Asian Development Bank estimates.

Table 2: Results of Sensitivity Analysis

Scenario	EIRR (%)	ENPV (CNY million)
1. Base case	15.1	146.8
2. 10% benefit reduction	13.0	47.5
3. 10% investment cost increase	13.5	76.3
4. 10% O&M cost increase	14.8	132.6
5. 1-year delay in project implementation	12.5	28.8

EIRR = economic internal rate of return, ENPV = economic net present value, O&M = operation and maintenance.
Source: Asian Development Bank estimates.

Table 3: Switching Values

Scenario	Percentage (%)
1. Benefit reduction (BR)	14.8
2. Investment cost increase (ICI)	20.8
3. Operation and maintenance cost increase (OCI)	103.8
4. BR and ICI	8.7
5. BR and OCI	12.9
6. ICI and OCI	17.4
7. BR, ICI, and OCI	8.0

Source: Asian Development Bank estimates.

J. Distribution Analysis

11. A distribution analysis was carried out to assess distribution of net economic benefits among water users in Chaonan District, the government, and labor. Based on the financial net present value and the ENPV, the net present value of the economic net benefits of the project to the economy as a whole was estimated at CNY1,057.9 million. The largest beneficiary group would be water users, i.e., mostly residents of Chaonan District who would gain a net present value of CNY854.0 million. Among the residents, those in rural areas who would gain access to treated water are expected to be the largest beneficiary. The net economic benefits accrued to the government would be CNY173.0 million, and to labor it would be CNY30.9 million.