Initial Environmental Examination (Draft)

October 2013

PRC: Guangdong Chaonan Water Resources Development and Protection Demonstration Project

Prepared by the Chaonan District Government, Guangdong Province, for the Asian Development Bank.

CURRENCY EQUIVALENTS

(Interbank average exchange rate as of October 2012)

Currency Unit	–	yuan (CNY)
CNY1.00	=	US$0.1633
US$1.00	=	CNY6.1229

ABBREVIATIONS

ADB	–	Asian Development Bank
BCA	–	Chaonan Bureau of Civil Affairs
BCR	–	Chaonan Bureau of Cultural Relics
BLM	–	Chaonan Bureau of Land Management
CSC	–	construction supervision company
CNY	–	Chinese yuan
CDG	–	Chaonan district government
CDRC	–	Chaonan Development and Reform Commission
CFB	–	Chaonan Finance Bureau
CAB	–	Chaonan Auditing Bureau
CEB	–	Chaonan Education Bureau
EPB	–	environmental protection bureau
CFoB	–	Chaonan Forestry Bureau
CHCB	–	Chaonan Housing and Construction Bureau
DFR	–	draft final report
DI	–	design institute
EA	–	executing agency
EIA	–	environmental impact assessment
EMP	–	environmental management plan
EHS	–	environmental, health, and safety
EMS	–	environmental monitoring station
EPD	–	Environmental Protection Department
FGD	–	focus group discussion
FIRR	–	financial internal rate of return
FSR	–	feasibility study report
GDP	–	gross domestic product
GPG	–	Guangdong provincial government
GRM	–	grievance redress mechanism
IA	–	implementing agency
IEE	–	initial environmental examination
IPSA	–	initial poverty and social analysis
LAR	–	land acquisition and resettlement
LRD	–	Land Resources Department
LARP	–	land acquisition and resettlement plan
LARO	–	District Land Acquisition and Resettlement Office
LB	–	Chaonan Labor Bureau
LIEC	–	loan implementation environmental consultant;
MEP	–	Ministry of Environmental Protection
MHC	–	Ministry of Housing and Construction
MOF	–	Ministry of Finance
mu	–	Chinese land unit of measure
NDRC	–	National Development and Reform Commission
NRW	–	nonrevenue water
O&M	–	operation and maintenance
PMO	–	project management office
PPCU	–	project public complaints unit
PPTA	–	project preparatory technical assistance
PRC	–	People's Republic of China
PSA	–	poverty and social analysis
RP	–	resettlement plan
SMG	–	Shantou municipal government
SPS	–	Safeguard Policy Statement
UMB	–	Urban Management Bureau
TOR	–	term of reference
TMB	–	Chaonan Traffic Management Bureau
WRB	–	Chaonan Water Resources Bureau
WSC	–	Chaonan Water Supply Company
WSP	–	water supply plant
WWTP	–	wastewater treatment plant

WEIGHTS AND MEASURES

kg	–	kilogram
km	–	kilometer
m^2	–	square meter
m^3	–	cubic meter
mu	–	$1/15^{th}$ of a hectare
ha	–	hectare (10,000 m^2)
MW	–	megawatt (1 million watts)
t	–	ton (1,000 kg)

NOTES

In this report, "$" refers to US dollars.

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I. EXECUTIVE SUMMARY

1. **Background.** This initial environmental examination (IEE) was prepared for the proposed Chaonan Water Resources Development and Protection Demonstration Project (the project) in Chaonan District of Shantou Municipality, Guangdong Province of the People's Republic of China (PRC). The IEE has been prepared in accordance with the requirements of the Asian Development Bank's (ADB) Safeguard Policy Statement (SPS, 2009) on the basis of (i) the domestic environmental impact assessment (EIA) report prepared by the Shantou Municipal Environmental Science Research Institute (the EIA Institute) and approved on 30 September 2013; (ii) the Chaonan Wastewater Pollution Control Plan (2013); (iii) the project feasibility study report (FSR); (iv) social and economic assessments conducted under the project preparatory technical assistance (PPTA); and (v) discussions between the ADB missions, the PPTA consultants, the Guangdong provincial government (GPG), and the Chaonan district government (CDG).[1] The expected project outcome is improved and equitable water supply services to urban and rural residents in Chaonan District. The project has three outputs: (i) improved water resources protection, (ii) improved water supply infrastructure, and (iii) strengthened institutional and staff capacity. The project is classified by ADB as category B for environment, requiring the preparation of an IEE. Under the PRC's Management Guideline on EIA Classification of Construction Projects (Ministry of Environmental Protection [MEP], 2008), the project is classified as category A.

2. **Project rationale.** Water source protection and supply of clean water are critical issues for Chaonan District. Located in the southwest of Shantou Municipality, with a population in 2011 of 1.33 million (including 1.13 million rural residents), it is the poorest of Shantou's seven districts and counties.[2] In 2010, the district gross domestic product (GDP) per capita was 59.1% of the municipal average, 29% of the provincial average and 45% of the national average. In 2010, over 429,600 residents did not have access to tap water; and over 400,000 residents were using unsafe or untreated drinking water. Groundwater in Chaonan contains high fluoride content (>8 milligram per liter [mg/L]) in some areas compared with the national limit of 1.0 mg/L which causes widespread dental fluorosis and skeletal fluorosis.[3] Total water demand is expected to reach 288,800 cubic meters per day (m^3/d) by 2020 and 331,423 m^3/d by 2025, but current water supply capacity is only 135,000 m^3/d. High rates ($\geq$50%) of nonrevenue water (NRW) losses occur due to poor management and aging pipeline infrastructure, which has also resulted in energy loss, high water tariffs, and low service coverage. The current water supply capacity is far from meeting water demand.

3. **Project scope and initial environmental examination.** Project output 1 comprises nonstructural measures: (i) public awareness and learning on environment and sanitation, (ii) water conservation reforestation of about 1,682 hectares (ha) around the three major reservoir areas in the district, (iii) research on pollution prevention and control measures in the water source protection areas, and (iv) solid waste collection and treatment for two villages (Chengpo and Qiufeng) at one reservoir (Qiufeng). Output 2 comprises (i) expansion and/or upgrade of two water supply plants (WSPs) and construction of a third (including construction of two pump stations and two sludge treatment facilities), (ii) installation of about 1,000 kilometers (km) of pipeline networks, (iii) establishment of a water quality monitoring center, (iv) installation of about 37,770 household water meters, and (v) provision of operation and maintenance (O&M) equipment. Output 3 comprises nonstructural measures: (i) consulting services, training, and study tours to support project implementation, (ii) support for the establishment of a water supply control center, (iii) support for the establishment of a water resources management and three-prevention (flood control, drought relief, typhoon prevention) management center, (iv) development of a water resources protection and development action plan, and (v) establishment of a project monitoring and evaluation (M&E) system. Most of this IEE focuses on the construction and operational aspects of output 2, but subcomponents under outputs 1 (especially the reforestation program) and 3 are also reviewed.

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[1] With the national grade B EIA study certificate.
[2] 2011 Shantou Municipality Statistical Yearbook.
[3] The PRC's Domestic Drinking Water Quality Standard (GB5749-2006).

4. **Baseline environmental conditions.** The district's topography comprises a flat coastal plain and an inland mountainous region. Chaonan District has a warm, humid climate and an annual average of 1,700 millimeters (mm) of rainfall. The major river system in the district, Lian River, suffers from severe pollution. The largest water sources for the district are three reservoirs—Jinxi, Longxi, and Qiufeng, with a total storage capacity of 131.1 million m^3. Reservoir water quality remains relatively high, although the risk of eutrophication is increasing due to wastewater discharge and nonpoint pollution from agricultural activities.

5. Baseline environmental monitoring for the project was conducted by the Shantou Municipal environmental monitoring station in 2012. Sampling showed that surface water quality of the reservoirs and urban flood drainage channels are grades II and IV of the national surface water quality standard, respectively. Ambient air quality—as measured by the parameters of sulfur dioxide, nitrogen oxide, and particulate matter less than 10 μm (PM_{10})—within the areas of the proposed WSPs is grade I national standard; and areas along the pipeline routes are grade II standard. Noise levels around the WSPs and nearby villages, as well as along the main pipeline routes, are grade I of the national noise standard. One sampling site along the pipeline route, Beicheng Avenue, exceeded grade 4a noise standard due to heavy traffic. No threatened flora, fauna, or physical cultural resources are known to occur in the project area.

6. **Potential project impacts and mitigation measures.** Project impacts, mitigation measures and impact monitoring are described in an environmental management plan (EMP; Attachment 1). For the construction phase, potential construction impacts include soil erosion, impacts on reservoir water quality (from soil erosion and/or discharge of construction materials or chemicals), generation of noise, vibration, fugitive dust, and solid wastes, and community and occupational health and safety. For the operational phase, major risks include (i) for the reforestation component, water source pollution caused by top-dressing fertilizer and pesticide application after reforestation; and (ii) at Qiufeng reservoir, management of wastewater discharged from two villages, Chengpo and Qiufeng. WSP construction and/or upgrade will be limited to small areas within or near the existing WSPs, and the water supply pipelines will be directly buried along roads. It is concluded that construction-related impacts will be localized, short term, and can be effectively mitigated through the strict implementation of mitigation measures specified in the EMP and conditions to be included in the contractor community and occupational health and safety plans. Mitigation measures for project operation include prohibiting the application of pesticide and top-dressing fertilizer after reforestation; and for wastewater discharge at Qiufeng reservoir, a study to identify management solutions for point and nonpoint source pollution.

7. For the operational phase, a risk assessment was conducted and supplemented by discussions between the Chaonan project management office (PMO), the design institute, the EIA Institute, relevant government divisions, the PPTA team, and ADB. The following operational risks were identified: (i) the need to maintain continual protection of the district's water source areas; (ii) reliable energy supply and efficiency of energy use for operation of the WSPs; (iii) ensuring that water treatment processes and the treated water will comply with the PRC's Domestic Drinking Water Quality Standard (GB5749-2006); (iv) the need to strengthen the water quality monitoring capacity of the Chaonan Water Supply Company (CWSC, which will analyze 42 water quality parameters after project completion compared with the current analytical capacity of 26 parameters) and the environmental protection bureaus (EPBs); (v) ensuring that WSP staff have sufficient technical training in the water treatment process, including emergency response actions; and (vi) the need for an emergency warning system and online water source monitoring system in the event of algal blooms within the reservoirs and/or accidental spillage of chemicals or other pollutants into the reservoirs or WSPs. The proposed water supply treatment process has few potential environmental risks, and will be subject to strict operational standards. Mitigation measures to address these risks are included in the IEE and EMP, based on control measures in the domestic EIA and FSRs. The impacts and risks identified will be reduced to meet the national and provincial regulations and standards for water source protection and safe drinking water supply.

8. **Public consultation, information disclosure, and grievance redress mechanism.** Public consultation for this project was conducted in accordance with the PRC's Interim Guideline on Public Consultation for EIA (2006) and ADB's SPS (2009) requirements. Two rounds of public consultation were conducted, through questionnaire survey and public hearings with community representatives, local village committees, and local governmental divisions and organizations in April 2012 and September 2013. A total of 202 people and 16 agencies were consulted. Consulted persons supported the project and believed that it will benefit community health, drinking water safety, local economy, living standards, local environmental conditions, and effectively protect local water resources. Suggestions from stakeholders were received, including quality control of construction of WSPs and pipelines, good planning to avoid repeated excavation of underground pipelines, and no night-time construction to minimize noise impact to residents (Chapter VIII). A grievance redress mechanism (GRM) has been developed to receive, document, and resolve community concerns and to assist the project to maximize environmental and social benefits. The GRM was discussed during public consultations. Most consulted people believe that the project GRM is an improvement compared with current practices.

9. **Conclusions.** The project supports the PRC's Sustainable Urban and Rural Development Strategy and both the Shantou municipal and the Chaonan district development master plans. Potential environmental impacts during project construction and operation were analyzed; and mitigation measures were proposed in the domestic EIA and this IEE, including the EMP. This IEE concludes that the potential adverse environmental impacts and risks associated with the project can be prevented, eliminated, or minimized to meet the relevant national standards and the Guangdong provincial regulations if the project EMP is fully implemented, particularly (i) all mitigation measures and monitoring requirements are implemented; and (ii) the environmental management and institutional capacities of the PMO and implementing agencies (IAs) are strengthened through implementation of the project training and capacity building program.

II. INTRODUCTION

10. This IEE was prepared for the proposed Chaonan Water Resources Development and Protection Demonstration Project (the project) in Chaonan District of Shantou Municipality, Guangdong Province in the PRC. The IEE was prepared in accordance with the requirements ofADB's SPS (2009) on the basis of (i) the domestic EIA report provided by the Shantou Municipal Environmental Science Research Institute—the EIA Institute, (ii) the Chaonan Wastewater Pollution Control Plan (2013), (iii) the project FSR, (iv) social and economic assessments conducted under the PPTA, and (v) discussions between the ADB missions, the PPTA consultants, GPG, and CDG (footnote 1). The expected project outcome is improved and equitable water supply services to urban and rural residents in Chaonan District. The project has three outputs: (i) improved water resources protection, (ii) improved water supply infrastructure, and (iii) strengthened institutional and staff capacity. The project is classified by ADB as category B for environment, requiring the preparation of an IEE. Under the PRC's Management Guideline on EIA Classification of Construction Projects (2008), the project is classified as category A.[4] The domestic EIA was approved on 30 September 2013 by the Shantou municipal EPB.

11. Water source protection and supply of clean water are critical issues for Chaonan District. In 2010, over 429,600 residents did not have access to tap water; and over 400,000 residents were using unsafe or untreated drinking water. Groundwater in Chaonan contains high fluoride content (>8 mg/L compared with the national limit of 1.0 mg/L) which causes widespread dental fluorosis and skeletal fluorosis (footnote 3). Total water demand is expected to reach 288,800 m^3/d by 2020 and 331,423 m^3/d by 2025, but current water supply capacity is only 135,000 m^3/d. High rates (>50%) of NRW losses occur due to poor management and aging pipeline infrastructure, which has also resulted in energy loss, high water tariffs, and low service coverage. The current water supply capacity is far from meeting water demand.

12. The project will help protect water source protection areas, increase coverage for supply of safe water, and improve drinking water quality in Chaonan District (Section III). The project is consistent with the PRC's and Guangdong Province's Twelfth Five-Year Plan (2011–2015), which aim to promote equitable urbanization, balanced social economic growth, and coordinated urban–rural development. The project is also in line with ADB's strategic priorities which support urban and rural infrastructure and environmental improvement. It supports ADB's Water Operational Plan (2011–2020) for increasing coverage and improved services for water supply and sanitation, and promoting integrated water resources management;[5] and is in line with ADB's country partnership strategy (2011–2015) for the PRC, which supports the building of a harmonious society by (i) addressing the rising income inequality and the widening regional disparities; and (ii) promoting environmentally sustainable development.[6]

13. The environmental data described in this IEE is largely from information in the domestic EIA. Baseline sampling of air, noise, surface water, and soil quality was undertaken by the Shantou Municipal Environmental Monitoring Center.

III. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

14. **Overview.** The PRC has a wide range of laws, regulations, technical guidelines, and standards that govern the way in which environmental protection and EIA for construction projects must be implemented, including for pollution prevention and control on air, noise, water, ecology and solid waste; and technical guidelines on assessing atmospheric, noise or acoustic, and surface water environment and ecological impacts. The domestic EIA report upon which this IEE is based was prepared in accordance with the PRC's EIA Law (2003), the PRC Management Guideline on EIA Classification of Construction Projects (2008), and the technical guidelines on EIA. The release of the 2006 Interim Guideline on Public Consultation for EIA has also been a

[4] Government of the People's Republic of China, Ministry of Environmental Protection. 2008. *The PRC Management Guideline on EIA Classification of Construction Projects.* Beijing.
[5] ADB. 2011. *Water Operational Plan, 2011–2020*. Manila.
[6] ADB. 2012. *Country Partnership Strategy: People's Republic of China, 2011–2015.* Manila.

significant development that provides for opportunities to involve the public in the EIA process.

15. **Relevant laws, regulations, guidelines, and standards of the People's Republic of China.** The following national laws, regulations, guidelines, and standards are relevant to the project (Tables III.1–III.2):

Table III.1: National Laws and Regulations Relevant to this Project

Law	Year	Notes
Urban and Rural Planning Law	2008	Project supports district master plan
Water Pollution Prevention and Control Law	2008	
Solid Waste Pollution Prevention and Control Law	2005	Project involves solid waste disposal
Environmental Impact Assessment Law	2003	
Cleaner Production Promotion Law	2002	Project involves low carbon WSP issue
Water Law	2002	
Air Pollution Prevention and Control Law	2000	
Noise Pollution Prevention and Control Law	1999	
Land Administration Law	1999	
Forest Law	1998	Project includes reforestation
Water and Soil Conservation Law	1991	Project involves soil erosion control
Environmental Protection Law	1989	
Regulation		
National regulation for public disclosure of EIAs (NDRC)	2012	
Requirement for Social Risk Assessment of Large Investment Projects	2012	
National Biodiversity Strategy and Action Plan (2011–2030)	2010	
Requirements for the EIA Summary of Construction Project	2010	
Regulation on EIA of Plans and Programs	2009	
Classification Directory of Construction Project Environmental Protection Management (MEP, revised ed.)	2008	
National regulation for management of urban construction solid wastes (MHC)	2005	
Directive on Strengthening Wetland Protection and Management	2004	Project involves reservoirs
Environmental Protection Management for Construction Projects	2003	
Environmental Protection Supervision Rules for Construction Projects	1998	
Regulation on Protection of Wild Flora	1997	Reforestation involves wild flora
Pollution Control for Protection Zone of Drinking Water Source	1989	

EIA = environmental impact assessment, MEP = Ministry of Environmental Protection, MHC = Ministry of Health of China, NDRC = National Development and Reform Commission, WSP = water supply plant.
Source: Asian Development Bank.

Table III.2: Local Laws and Regulations

Laws and Regulations	Year
Drinking Water Source Protection Regulation of Shantou Municipality	2010
Environmental Protection Regulations of Guangdong Province (revised edition)	2010
Construction Project Management Regulation of Guangdong Province	2007
Regulation for Drinking Water Source Protection of Guangdong Province	2007
Regulation on Public Consultation for Constructions in Guangdong Province	2007
Urban Environmental Noise Functional Zoning in Guangdong Province	2007
Forest Regulations of Guangdong Province,	2003
Regulation on Environmental Protection and Management Regulations of Construction Projects in Guangdong Province	2002
Surface Water Function Zoning in Guangdong Province,	2001
Regulation on Prime Farmland Protection in Guangdong Province	2000

Laws and Regulations	Year
Regulations on Terrestrial Wild Animals Protection of Guangdong Province,	1997
Management Regulations on Scenic Areas in Guangdong Province,	1996
Provision on Protection and Management of Rare and Endangered Plants in Guangdong Province	1995
Regulations on Agricultural Environmental Protection in Guangdong Province	1995
Implementation of Measures of Water and Soil Conservation Law of the PRC in Guangdong Province	1994

PRC = People's Republic of China.
Source: Asian Development Bank.

16. Associated national guidelines applicable to the project are in Table III.3.

Table III.3: Applicable Environmental Guidelines

Guideline	Year/Code
Technical Guideline on EIA: Ecological Assessment	HJ 19-2011
Guideline on Jurisdictional Division of Review and Approval of EIAs for Construction Projects	2009
Technical Guideline on EIA: Acoustic Environment	HJ 2.4-2009
Guideline on EIA Classification of Construction Projects	2008
List of Construction Projects Subject to Environmental Protection Supervision	2008
Technical Guideline on EIA: Atmospheric Environment	HJ 2.2-2008
EIA Technical Guideline: Drinking Water Source Protection and Zoning	2007
Interim Guideline on Public Consultation for EIA	2006
Circular on Strengthening EIA Management to Prevent Environmental Risks	2005
Technical Guideline on Environmental Risk Assessment for Construction Project	HJ/T169-2004
Technical Guideline on EIA: Surface Water Environment	HJ/T 2.3-1993

EIA = environmental impact assessment.
Source: Asian Development Bank.

17. The environmental quality standard system that supports and evaluates the implementation of the environmental protection laws and regulations in the PRC is classified into two categories by function: pollutant emission and/or discharge standards, and ambient environmental standards. The standards applicable to this project are in Table III.4.

Table III.4: Applicable Environmental Standards

Standard	Code
Noise Limit of Industrial Enterprises	GB12348-2008
Noise Limit for Social Activities	GB22337-2008
Urban Ambient Acoustic Quality Standard	GB3096-2008
Domestic Drinking Water Quality Standard	GB5749-2006
Standard on Pollutant Discharges from Municipal Wastewater Treatment Plants	GB18918-2002
Surface Water Quality Standard	GB3838-2002
Ambient Air Quality Standard	GB3095-1996
Integrated Emission Standard of Air Pollutants	GB16297-1996
Integrated Wastewater Discharge Standard	GB8978-1996
Soil Quality Standard	GB15618-1995
Standard for Flood Control	GB50210-1994
Groundwater Quality Standard	GB/T14848-1993
Noise Limit for Construction Sites	GB12523-1990
Control Standards for Pollutants in Sludge for Agricultural Use	GB4284-1984

Source: Asian Development Bank.

18. Operation of the WSPs and quality of the treated water to be provided to residents will require compliance with the PRC's Domestic Drinking Water Quality Standard (GB5749-2006), in which 106 parameters must be met (Table III.5). Standard GB5749-2006 was promulgated in 2007, and some larger cities in the PRC (Beijing, Guangzhou, Shanghai, Shenzhen, and Tianjin) have applied the standard since then. It contains 106 parameters comprising 42 regular parameters and 64 nonregular parameters. The nonregular parameters include less common microbiological and toxicological compounds, particularly pesticides and synthetic organic compounds. Due to capacity limits in instruments, technologies, and personnel, most of the PRC's medium and small cities did not apply the standard until 1 July 2012, a date which MEP

had decreed all cities must monitor all 106 parameters.[7] CWSC is a county- and/or district-level water supply enterprise, and is required to directly monitor the 42 regular parameters; but does not presently have the capacity to monitor the 64 nonregular parameters: these are monitored by an external agency, the central laboratory of the Shantou Municipal Water Supply Company, through a contract of commission.

Table III.5: Drinking Water Quality Standards (GB5749-2006)

No.	Parameter	Limit
	Routine Parameter of Drinking Water Quality	
	Microbiological parameter	
1	Total coliform (MPN/100 ml or CFU/100 ml)	LD
2	Thermotoletant coliform (MPN/100 ml or CFU/100 ml)	LD
3	Escherichia Coli (MPN/100 ml or CFU/100 ml)	
4	Total plant count (CFU/ml)	100.00000
	Toxicological parameter	
5	Arsenic (As, mg/L)	0.01000
6	Cadmium (Cd, mg/L)	0.00500
7	Chromium Hexavalent (Cr^{6+}, mg/L)	0.05000
8	Lead (Pb, mg/L)	0.01000
9	Mercury (Hg, mg/L)	0.00100
10	Selenium (Se, mg/L)	0.01000
11	Cyanide (CN^-, mg/L)	0.05000
12	Fluoride (mg/L)	1.00000
13	Nitrate (mg/L)	10.00000
14	Trichloromethane (mg/L)	0.06000
15	Carbon tetrachloride (mg/L)	0.00200
16	Bromate (when O_3 is applied) (mg/L)	0.01000
17	Formaldehyde (when O_3 is applied) (mg/L)	0.90000
18	Chlorite (when ClO_2 is applied) (mg/L)	0.70000
19	Chlorate (when compound chlorine dioxide is applied) (mg/L)	0.70000
	Sensory Properties and General Chemical Parameter	
20	Chromaticity (Unit of platinum cobalt color)	15.00000
21	Turbidity (diffusing turbidity unit) NTU	1.00000
22	Odor and taste	No odor, no taste
23	Appearance	None
24	pH	6.50000 ≤ X < 8.50000
25	Aluminum (Al, mg/L)	0.20000
26	Iron (Fe, mg/L)	0.30000
27	Manganese (Mn, mg/L)	0.10000
28	Copper (Cu, mg/L)	1.00000
29	Zinc (Zn, mg/L)	1.00000
30	Chloride (Cl^-, mg/L)	250.00000
31	Sulfate (SO4-, mg/L)	250.00000
32	TDS (mg/L)	1,000.00000
33	Total hardness ($CaCO_3$) (mg/L)	450.00000
34	COD_{Mn} (mg/L)	3.00000
35	Volatile phenols (phenol) (mg/L)	0.00200
36	LAS (mg/L)	0.30000
	Radioactivity Parameter[8]	
37	Total α radioactivity (Bq/L)	0.50000
38	Total β radioactivity (Bq/L)	1.00000

[7] Available at: http://english.mep.gov.cn/News_service/media_news/201205/t20120514_227603.htm
[8] Radionuclide phase analysis is conducted if radioactivity value exceeds limits, to determine if the water is drinkable.

No.	Parameter	Limit
	Non-Routine Parameter	
	Microbial indicators	
39	Giardia cysts (count/10L)	<1.00000
40	Cryptosporidium oocysts (count/10L)	<1.00000
	Toxicological Parameter (mg/L)	
41	Antimonium (Sb, mg/L)	0.00500
42	Barium (Ba, mg/L	0.70000
43	Beryllium (Be, mg/L)	0.00200
44	Boron (B, mg/L)	0.50000
45	Molybdenum (Mo, mg/L)	0.07000
46	Nickel (Ni, mg/L)	0.02000
47	Silver (Ag, mg/L)	0.05000
48	Thallium (Ti, mg/L)	0.00010
49	Cyan chloride (CN^- mg/L)	0.07000
50	Chlorodibromomethane (mg/L)	0.10000
51	Bromodichloromethane (mg/L)	0.06000
52	Dichloroacetic acid (mg/L)	0.05000
53	1,2-dichloroethane (mg/L)	0.03000
54	Dichloromethane (mg/L)	0.02000
55	THMs	1.00000
56	1,1,1 - trichloroethane (mg/L)	2.00000
57	Trichloroacetic acid (mg/L)	0.10000
58	Trichloroaldehyde (mg/L)	0.01000
59	2,4,6 - trichlorophenol (mg/L)	0.20000
60	Bromoform (mg/L)	0.10000
61	Heptachlor (mg/L)	0.00040
62	Malathion (mg/L)	0.25000
63	PCP (mg/L)	0.00900
64	HCH (total amount, mg/L)	0.00500
65	Hexachlorobenzene (mg/L)	0.00100
66	Dimethoate (mg/L)	0.08000
67	Parathion (mg/L)	0.00300
68	Bentazone (mg/L)	0.30000
69	Parathion-methyl (mg/L)	0.02000
70	Chlorothalonil (mg/L)	0.01000
71	Carbofuran (mg/L)	0.00700
72	Lindane (mg/L)	0.00200
73	Chlopyrifos (mg/L)	0.03000
74	Glyphosate (mg/L)	0.70000
75	DDVP (mg/L)	0.00100
76	Arazine (mg/L)	0.00200
77	Deltamethrin (mg/L)	0.02000
78	2,4 - dichlorobenzene oxygen ethanoic acid (mg/L)	0.03000
79	Dichloro-diphenyl-dichlorothane (mg/L)	0.00100
80	Ethylbenzene (mg/L)	0.30000
81	Dimethylbenzene (mg/L)	0.50000
82	1,1- dichloroethylene (mg/L)	0.03000
83	1,2- dichloroethylene (mg/L)	0.05000
84	1,2- dichlorobenzene (mg/L)	1.00000
85	1,4- dichlorobenzene (mg/L)	0.30000
86	Trichloroethylene (mg/L)	0.07000
87	Trichlorobenzene (mg/L)	0.02000
88	Hexachlorobutadiene (mg/L)	0.00060
89	Acrylamide (mg/L)	0.00050

No.	Parameter	Limit
90	Tetrachloroethylene (mg/L)	0.04000
91	Toluene (mg/L)	0.70000
92	DEHP (mg/L)	0.00800
93	ECH (mg/L)	0.00040
94	Benzene (mg/L)	0.01000
95	Styrene (mg/L)	0.02000
96	Benzopyrene (mg/L)	0.00001
97	Chloroethylene (mg/L)	0.00500
98	Chlorobenzene (mg/L)	0.30000
99	Microcystin-LR (mg/L)	0.00100
	Physical Properties and General Chemical Parameters (mg/L)	
100	Ammonia nitrogen(NH_3-N, mg/L)	0.50000
101	Sulfide (S, mg/L)	0.02000
102	Sodium (Na, mg/L)	200.00000

General Parameters and Requirements for Drinking Water Disinfectant

	Disinfectant	Exposure Duration with Water	Limit in Water Supplied (mg/L)	Residue in Water Supplied (mg/L)	Residues in Network Peripheral (mg/L)
103	Chlorine and free chlorine (mg/L)	≥ 30 min	4.0	≥0.3	≥ 0.05000
104	Monochloramine (total chlorine, mg/L)	≥120 min	3.0	≥0.5	≥ 0.05000
105	Ozone (O_3, mg/L)	≥ 12 min	0.3	…	0.02000 / ≥ 0.05000 if chlorine is added
106	Chlorine dioxide (ClO_2, mg/L)	≥ 30 min	0.8	≥0.1	≥ 0.02000

CFU = colony forming unit, MPN = most probable number.
Source: Asian Development Bank.

19. Wastewater generated during construction, including machine wash-down, gravel cleaning, and muddied water generated during excavation, will not exceed standard Grade II of the PRC's Integrated Wastewater Discharge Standard (GB8978-1996, Table III.6).

Table III.6: Integrated Wastewater Discharge Standard (mg/L, except for pH)

Parameter	pH	COD_{Cr}	BOD_5	SS	NH_3-N	Oil
Grade II Standard	6–9	150	30	150	25	10

BOD_5 = 5-day biochemical oxygen demand, COD_{cr} = chemical oxygen demand, NH_3-N = ammonia nitrogen, SS = suspended solids.
Source: Asian Development Bank.

20. **Domestic framework for environmental impact assessment approval and environment management.** The PRC's Management Guideline of Environmental Protection Categories of Construction Projects (2008) identifies 23 general categories of EIAs and 198 subcategories based on the project's nature, scale, and environmental sensitivity. Under the guideline, the current project was classified into the categories of urban infrastructure, and water source protection and development. The institutional framework for the EIA approval process in Shantou Municipality involves the Shantou Municipality and Chaonan District EPBs. The Shantou EPB (i) organizes experts for the EIA evaluation, including compliance with appropriate laws, regulations, and standards; and (ii) is responsible for final EIA approval. The Chaonan District EPB is responsible for environmental management and supervision during project implementation, including mitigation measures and environmental monitoring.

21. The EIA report for all project components was prepared by the EIA Institute, holding national Grade B certificates in accordance with the PRC's Management Guideline on Qualification of EIA Institutes (MEP Ministerial Order No. 26, 2005).[9] The final domestic EIA was completed by mid-August 2013, and the EIA approval by end-September 2013. The PPTA consultants assisted in finalizing the domestic EIAs.

22. In the PRC, the enforcement of environmental laws and regulations rests with the environmental protection authorities within each level of government. At the national level, MEP is the regulatory, enforcement and supervision authority. Each province has an environmental protection department (EPD). The environmental management authorities at the municipal and/or subprovincial and county levels are the EPBs. These authorities are supported by the environmental monitoring stations (EMSs) and the environmental protection research institutes.

23. **International agreements.** The PRC is signatory to a number of international environmental agreements relevant to the project (Table III.7).

Table III-7: Applicable International Agreements

Agreement	Year	Purpose (Relevance to the Project)
Ramsar Convention on Wetlands of International Importance	1975	Prevent encroachment on and loss of wetlands for now and the future (project includes reservoirs)
Montreal Protocol on Substances That Deplete the Ozone Layer	1989	Protection of the ozone layer (same as above
Convention on Biological Diversity	1993	Conservation and sustainable use of biological diversity (project includes reforestation)
United Nations (UN) Framework Convention on Climate Change	1994	Achieve stabilization of atmospheric greenhouse gas concentrations (project involves low carbon water supply plants for energy saving and greenhouse gas emission reduction)
UN Convention to Combat Desertification	1996	Combat desertification and mitigate effects of drought (per capita water availability in Chaonan only 20% of national average; and, project involves soil erosion control).
Kyoto Protocol to UN Framework Convention on Climate Change	2005	Further reduction of greenhouse gas emissions (as above)

Source: Asian Development Bank.

24. **ADB policies and environmental, health, and safety guidelines of the World Bank.** ADB's SPS (2009) provides the basis for the project IEE. Projects funded by ADB must comply with the SPS requirements. The purpose of the SPS is to establish an environmental review process ensuring that projects funded under the ADB loans are environmentally sound; operate in line with applicable regulatory requirements; and are not likely to cause significant environment, health, or safety hazards. The SPS promotes good international practice as reflected in internationally recognized standards, such as the World Bank Group's Environmental, Health, and Safety (EHS) Guidelines.[10] The principles and standards of the EHS guidelines are adopted by the SPS. Some of the relevant EHS sector guidelines for this project include general guidelines (covering occupational EHS and community EHS), guidelines on waste management facilities, and on water and sanitation.[11] The water, air, and noise quality standards in the EHS guidelines provide a reference against project impacts.

25. **Justification on the use of the standards of the People's Republic of China for this project**. The domestic EIA Institute and the PPTA team compared the relevant PRC standards with provisions defined in the EHS guidelines; and concluded that with the exception of occupational health and safety, the application of the PRC standards was justified. This is based on (i) the PRC having strict and comprehensive regulatory standards for the water supply sector;

[9] Shantou Municipal Environmental Science Institute.
[10] World Bank. 2007. *Environmental, Health, and Safety Guidelines, 30 April 2007*. Washington DC. Available at: http://www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines.
[11] Section 1.1.1 (Drinking Water) includes water withdrawal, treatment, distribution, and water leakage control, etc.

and (ii) the PRC standards for occupational health and safety being relatively weak compared with the World Bank's EHS guidelines.

26. Compared with the PRC's EIA requirements, the SPS requires a number of additional considerations for the preparation of IEEs. These include (i) a project-specific GRM; (ii) definition of the project area of influence; (iii) assessment of direct, indirect, induced and cumulative impacts; (iv) due diligence of project-associated facilities; (v) protection of physical cultural resources; (vi) climate change mitigation and adaptation; (vii) occupational and community health and safety requirements (including emergency preparedness and response); (viii) impacts on livelihoods through environmental media; (ix) biodiversity conservation; and (x) ensuring that the EMP includes an implementation schedule and measurable performance indicators, of which these requirements are usually weak in the PRC EIAs. For filling in the gap, the domestic EIA has been updated three times in accordance with ADB's SPS by the EIA Institute with the assistance by the PPTA consultants. This project IEE complies with ADB's SPS requirements.

IV. DESCRIPTION OF THE PROJECT

A. Project Components

27. The expected project outcome is improved and equitable water supply services to urban and rural residents in Chaonan District. The project has three outputs: (i) improved water resources protection, (ii) improved water supply infrastructure, and (iii) strengthened institutional and staff capacity. Project locations are in Figures III.8–III.11.

28. Output 1 comprises (i) public awareness and learning on environment and sanitation, including development of education and training materials for schools, training of school teachers, establishment of exhibition hall, workshops, surveys, community educational promotion, and media campaign; (ii) water conservation reforestation of 1,628.4 ha in the catchments of three reservoirs, Jinxi, Longxi and Qiufeng; (iii) a study on pollution prevention and control measures in these reservoir areas, covering pollution source survey and control technology, nonpoint source pollution control, and wastewater collection and treatment technology; and (iv) solid waste collection and treatment for two villages, Chengpo and Qiufeng, at Qiufeng reservoir. The project reforestation target of 25,236 *mu* (1,682.4 ha) comprises 9,114 *mu* (607.6 ha), 14,208 *mu* (947.2 ha), and 1,914 *mu* (127.6 ha) in the catchment areas of Jinxi, Longxi, and Qiufeng reservoirs, respectively, accounting for 7.6%, 56.2%, and 36.1% of the total district reforestation targets for each reservoir. Research under Output 1(iii) for nonpoint source pollution control will include key contributing sources, volumes, and site-specific measures to address this issue, including a work plan with measurable actions, budget, and schedule.

29. Output 2 comprises (i) expansion of Qiufeng WSP from its current capacity of 70,000 m^3/d to 142,000 m^3/d and construction of a sludge treatment facility and water intake facility; (ii) rehabilitation of the Jinxi WSP by constructing a pump station and a sludge treatment facility; (iii) construction of a new WSP, Longxi, with capacity of 100,000 m^3/d, including all water treatment process structures and equipment, sludge treatment facility, and a pump station; (iv) installation of about 1,000 km of water delivery and distribution pipelines in the district (including replacement of 400-km old pipes); (v) establishment of a water quality monitoring center to service all three WSPs (the center will be housed within the Qiufeng WSP) to monitor water quality of the reservoirs and supply network; (vi) installation of about 37,770 household water meters; and (vii) provision of O&M equipment, including leakage detection and repair. Output 2(iv) will include the construction of a 21-km pipeline across the coastal plain to link the pipeline supply networks downstream from the three project reservoirs. Water flow will be regulated by a system of valves and a computerized system. This will strengthen the security of water supply in the district by enabling water sourced from one reservoir to be transferred between the WSPs, if necessary.

30. Output 3 comprises (i) provision of consulting services, training, and study tours for project implementation; (ii) support for the establishment of a water supply control center, comprising a remote monitoring and control system, a data transmission and dispatching center, and communication network, to operate the WSPs and water networks; (iii) support for the establishment of a water resources management and three-prevention (flood control, drought relief, typhoon prevention) management center; (iv) development of a water resources protection and development action plan to address issues concerning water safety, water allocation optimization, and water reuse and conservation; and (v) establishment of a project M&E system.

B. Project Rationale and Expected Benefits

31. **Special demonstration features.** The project is expected to significantly improve the water treatment and supply system for Chaonan District. It will also demonstrate the following innovations which can be replicated in other regions of Guangdong Province and the PRC: (i) an integrated approach to water resources management: the project will support structural and nonstructural measures for improved watershed management; (ii) inclusive water supply services and integration of urban and rural water supply system: the project will impact most of the district and provide improved water supply services to urban and rural residents. This model

is ADB's value addition of inclusive and balanced development. The project will improve responses to droughts and water supply reliability by integrating the three major water supply systems of the district to supplement each other when one system is facing water shortage; (iii) strengthened water utility operational performance: staff skills, operational performance, and improved monitoring will strengthen CWSC, the key agency and operator of the project water supply system; and (iv) water supply institutional and tariff reforms: streamlining of institutional arrangements will remove township and village levels, and make services equitable and affordable to the poor. Additional expected benefits are as follows:

32. **Protection of water sources.** The project will improve protection of three critical water source protection areas for the district—Jinxi, Longxi, Qiufeng reservoirs—by addressing soil protection, and point and nonpoint water pollution in the surrounding lands. Approximately 25,236 *mu* (1,682.4 ha) lands around the reservoirs are currently eroded and subject to soil erosion (Figures IV.1–IV.2), especially in the wet season. The project will undertake reforestation of eroded areas, using native plant species. This will contribute to improved soil stability, forest condition and habitats for biodiversity. Upon completion, the EIA estimates that the water storage capacity of the three reservoirs is expected to increase by 504,700 m^3 per year[12] and sediment deposited in the reservoirs will be reduced by 61,000 tons per year.[13] For point and nonpoint source pollution, two villages (Chengpo, Qiufeng) at Qiufeng reservoir are the key sources of water pollution (Figures IV.3–IV.4). Due to poor management and lack of rubbish collection and transfer facilities, much of the litter from these two villages is disposed alongside and/or within the reservoir. The project will implement an integrated urban and rural rubbish collection, transport and disposal system, with a particular focus on these two villages.

Figure IV.1: A bare area on the catchment area of Qiufeng Reservoir
(Picture taken on 6 December 2012)

Figure IV.2: The muddy river on upstream of the reservoir caused by soil erosion
(Picture taken on 6 December 2012)

33. **Supply of clean water.** The project will bring significant benefits to about 1.2635 million urban and rural residents in Chaonan District by improving and extending the tap water supply system, water source protection, and solid waste disposal. Of the total beneficiary population, approximately 85% are rural; 49.5% are women; and 6.73% are the poor living under the urban poverty line (less than CNY250 per capita per month and CNY210 per capita per month for the rural poor), and less than 1% is ethnic minority in the project area.

[12] Guangdong Provincial Forestry Department. 2005. *Guideline for Ecological Reforestation*. 'A 50,000 *mu* forest with canopy density of ≥0.6 has the potential capacity to water conservation and storage of 1 million m^3 water.'

[13] Liang Yin and Yang Xuan. 2008. *Soil Erosion Survey and Control Methods on South China's Red Soil Hill and Mountain Areas*. Nanjing Soil Research Institute of Chinese Academy of Sciences. Estimated by the EIA Institute based on soil erosion intensity in Guangdong's hilly areas.

Figure IV.3: Rubbish dumped on the reservoir bank (Qiufeng Village)

Figure IV.4: Littering directly into the reservoir (Chengpo Village)

Figure IV.5: A 6-year-old boy suffering from severe dental fluorosis

34. **Alleviation of water-related dental disease.** Chaonan District is a high priority site for endemic fluorosis in Guangdong Province. At present, there are almost 230,000 people (42 villages, 8 towns) drinking high fluoride content groundwater, in which the average fluoride concentration is around 8.0 mg/L, eight times higher than the domestic drinking water quality standard (GB5749-2006, Figure III.5). The project will reduce the endemic fluorosis by supplying tap water from the proposed WSPs to about 100,000 rural residents who currently drink high fluoride content groundwater. Improved water supply will be especially beneficial during drought and the dry season (Figures IV.6–IV.7).

Figure IV.6: Fire truck delivering water to residents in dry season

Figure IV.7: Residents taking water from a well

35. **Pollution control and environmental improvement.** Lian River suffers from severe wastewater pollution and cannot be used even for irrigation and landscaping. Solid waste in urban and rural areas is not well managed, with little proper collection, transfer, and disposal. At Qiufeng reservoir, due to poor management and lack of rubbish collection and transfer facilities, two villages, Chengpo and Qiufeng, are causing water pollution through rubbish dumping. The project will include urban and rural rubbish collection, transport, and disposal, focusing on these two villages to reduce reservoir pollution and eutrophication, and improve sanitation.

36. **Water and energy savings and climate change adaptation and mitigation.** Chaonan District is vulnerable to climate change (average annual rainfall may vary as much as 900–2,500 mm between a dry and wet year, respectively; Section III.C–III.D). More extreme droughts will require greater efficiency of water use. Due to previous low technical standards, aging pipeline networks, and current low efficiency of water supply dispatching, current NRW losses in Chaonan reach 50%, resulting in high water tariffs and excess energy use. NRW comprises two kinds of water loss: physical ('real') loss and apparent loss. The American Water Works Association (www.awwa.org) defines these as (i) real losses are the physical losses of water from the distribution system, including leakage and storage overflows; (ii) apparent losses are the paper losses that occur in utility operations due to customer meter inaccuracies, billing system data errors and unauthorized consumption. In other words, this is water that is consumed

but not properly measured, accounted, or paid for. Through the construction and upgrade of about 1,000-km water supply distribution pipelines, 37,767 water meters, procurement of water pipeline leakage detection and repairing equipment, the development of water supply monitoring centers, promotion of public awareness, and adoption of improved pump systems, the project will achieve significant water savings (an estimated 20% reduction in NRW loss) and energy savings; and reduce greenhouse gas (GHG) emissions (see below).

37. The water supply sector is at the forefront in dealing with climate change, because it consumes large amounts of energy in the water production and supply chain, from pumping raw water to WSPs, the treatment process, and distribution to consumers. The water supply industry is responsible for a number of carbon emissions. It uses a significant amount of energy: more than 80% of power supplied in the PRC is from coal-fired power generation plants; the waste gives off a variety of emissions. It also requires a lot of land for electricity generation. Energy use is primarily for pumping, although there are transport and other needs. In principle, this energy could be significantly decarbonized. The industry could, by careful management of supply and demand patterns, increase energy efficiency and reduce energy and water loss, and become a relatively low carbon industry. It is not a question of technical capability, but rather economic and regulatory incentives and constraints.

38. Energy is lost due to inefficient pump stations due to poor design, poor equipment, improper installation or maintenance, old pipes with high water-head loss, bottlenecks in the supply network, excessive supply pressure, and inefficient operation strategies of various supply facilities. Other causes for energy waste are excess supply due to pipeline leakage or poor management. NRW loss of 50% in Chaonan District means the same portion of energy is being lost. The project may achieve energy consumption savings of 40%–60% current consumption.

39. The average unit power consumption in the PRC's water supply sector is about 0.4 kilowatt-hours (kWh) for every cubic meter of water supplied. In the Philippines, the energy cost is 0.3–1.0 kWh/m^3 water supplied;[14] and in the United States, the energy cost for groundwater is 0.4–0.5 kWh/m^3.[15] In seven southeast Asian countries, the typical electricity expense for the water supply is 18% of final water cost.[16] Energy efficiency in the WSPs can be achieved by improving pump station design, water treatment process design, installation of variable speed drives (VSD) to pumps, and operating pumps efficiently by application of the supervisory control and data acquisition (SCADA) system. Pipeline leakage detection, repairing, and reduction would bring to significant saving in power consumption. Because the reservoirs of the proposed WSPs are located uphill of the WSPs, water can flow gravitationally to the WSPs without pumping. As a result, according to the FSR, the average unit power consumption for the water supply system is 0.117 kWh/m^3 which is less than 30% of the national average.

40. For the current project, GHG emission reduction benefits are derived primarily from the following interventions: (i) construction of low carbon water supply system, resulting annual power saving and GHG emission reduction by 17.767 million kWh electricity and 15,724 tons of carbon dioxide (CO_2) respectively;[17] (ii) reducing NRW from 50% to 30% will save 12.556 million m^3 clean water; (iii) reforestation of 25,230 *mu* (1,682 ha) in the catchments of three reservoirs; (iv) district water conservation planning and campaign through public awareness and institutional

[14] ADB Law and Policy Reform- Energy and Water Supply Service (Brief No.4 June 2010). Subic Bay Water Regulatory Board's e-mail to A. de Vera, an ADB water consultant.

[15] Center for Sustainable Systems. 2009. *U.S. Water Supply and Distribution Fact Sheet.* Pub No. CSS05-17. Ann Arbor: University of Michigan. Available at: http://css.snre.umich.edu/css_doc/CSS05-17.pdf

[16] ADB and Southeast Asian Water Utilities Network (SEAWUN). 2007. *Databook of Southeast Asian Water Utilities 2005*. Manila and Hanoi, ADB/SEAWUN. The energy cost for water supply is 23% of water operating expense. Final water cost is equal to 76% water operating expenses + 24% overhead costs. This makes electricity expense 18% of the final water cost.

[17] Calculated in comparison with the PRC national average power consumption in water supply sector and unit coal consumption for coal-fired power generation. Source: Northern China Municipal Engineering Design and Research Institute. 2009. *Detailed design document for Tianjin Cuijiamatou Water Treatment Plant*. Unpublished report.

strengthening; and (v) the reforestation will generate a carbon sink of 614,000 tons of CO_2 annually.[18]

Table IV.1: Energy and Water Savings and Greenhouse Gas Emission Reduction by the Project

Item	Unit	Amount
Increased water supply capacity by proposed WSPs	m^3/d	172,000.000
Annual water supply amount by proposed WSPs	m^3/a	62,780,000.000
Unit water supply power consumption of proposed WSPs based on the FSR	kWh/m^3	0.117
National average power consumption for unit water supply	kWh/m^3	0.400
Annual power consumption for proposed WSPs based on the FSR	kWh	7,345,260.000
Annual power consumption for equivalent water supplied based on national average	kWh	25,112,000.000
Annual power saving by proposed WSPs	kWh	17,766,740.000
Equivalent standard coal saving by the proposed WSP	tce	6,307.000
Annual CO_2 emission reduction by the proposed WSPs	t/a	15,724.000
Current annual water loss—estimated to be 50% NRW	m^3/a	31,390,000.000
Predicted annual water loss after project—estimated reduction of 20% NRW	m^3/a	18,834,000.000
Predicted annual water saving by reducing NRW from 50% to 30%	m^3/a	12,556,000.000

a = annum, d = day, CO_2 = carbon dioxide, EIA = environmental impact assessment, FSR = feasibility study report, kWh = kilowatt hour, m^3 = cubic meter, NRW = nonrevenue water, t = ton, tce = tons of standard coal equivalent, WSP = water supply plant.
Source: Estimation by the project preparatory technical assistance consultant and the EIA Institute.

41. The project conforms to the principles of the Bellagio Declaration on sustainable development and climate change, which recommends that adaptation strategies, at a minimum, include the following: (i) a long-term perspective (building climate resilient infrastructure); (ii) fixing and adapting what already exists (e.g., replacing aged water supply pipelines; building a high-efficiency pump station); and (iii) response to climate emergencies (preparedness, e.g., drought control), and reforestation to achieve local environmental and ecological improvement.[19]

42. **Disaster control.** Flood disaster prevention and control is limited in Chaonan District. The project's three-prevention (flood control, drought relief, typhoon prevention) management center will use information technology to establish disaster prevention and control planning.

43. **Increased institutional capacity.** The institutional development and capacity-building program of the project will strengthen the capacity of the PMO and IAs for project implementation, environmental protection and water supply system management. The project could also be a model for other similar counties and/or districts in Guangdong Province and elsewhere in the PRC.

44. **Poverty alleviation.** In 2010, the GDP per capita of Chaonan was 29% of the provincial average and 45% of the national average. The annual net income per rural resident was CNY5,076, half of the provincial average and 27% lower than the national average. The project will improve the local infrastructure, help attract outside investment, and promote social economy development, which will eventually result in more work opportunities; and effectively reduce the number of poor households.

[18] Estimation basis: 'Guideline for Calculation and Estimation of Forestry Carbon Sink', J. China Northwest Forestry University (2008); and 'Methods for Estimation of Forestry Carbon Sink'. Office of Carbon Sink in Beijing (2009).
[19] A flood warning system will be installed under the project component.

Figure IV.8: Locations of Reforestation in the Catchments of the Project Reservoirs

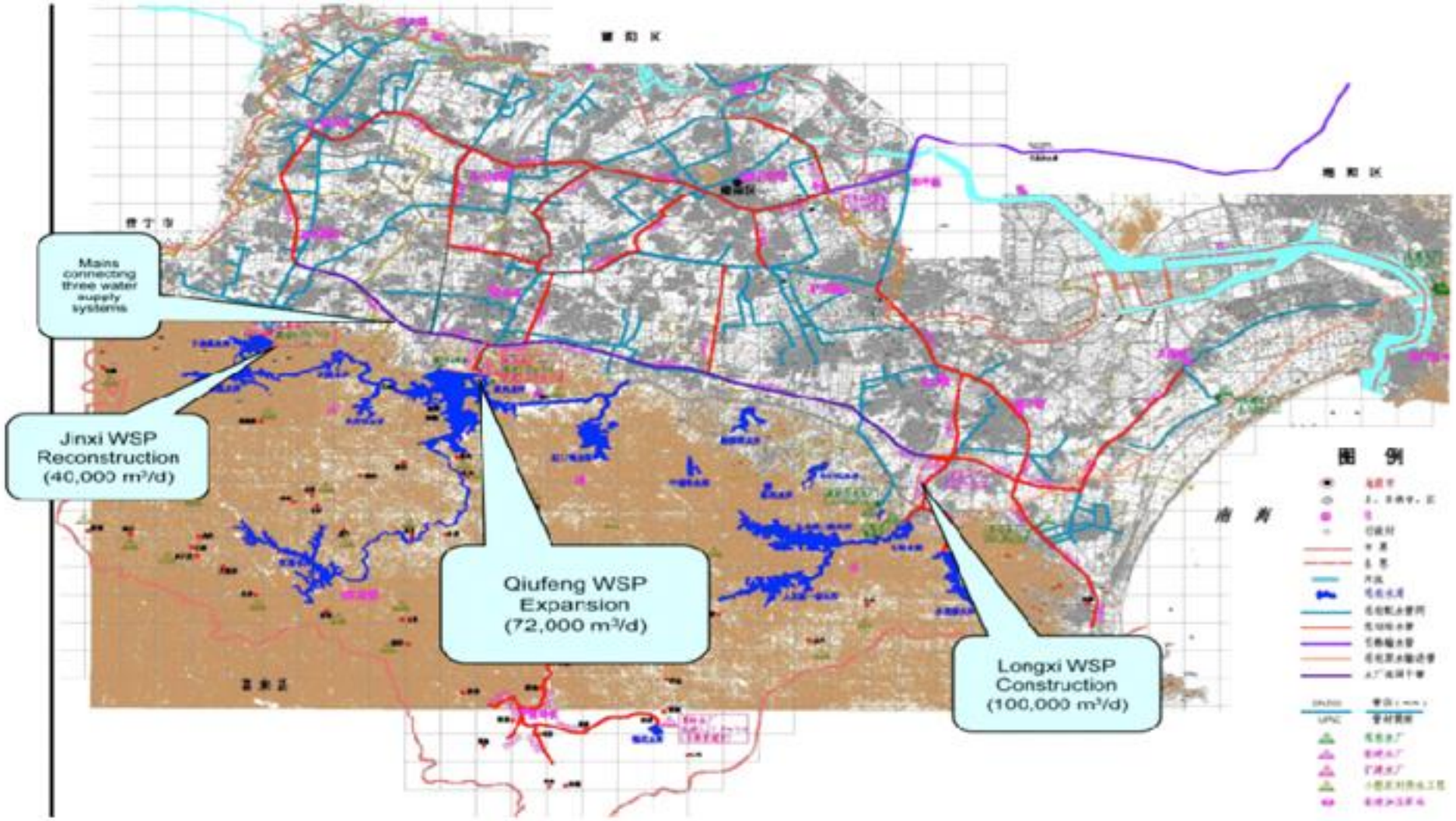


Figure IV.9: Locations of Reforestation in the Catchments of the Project Reservoirs

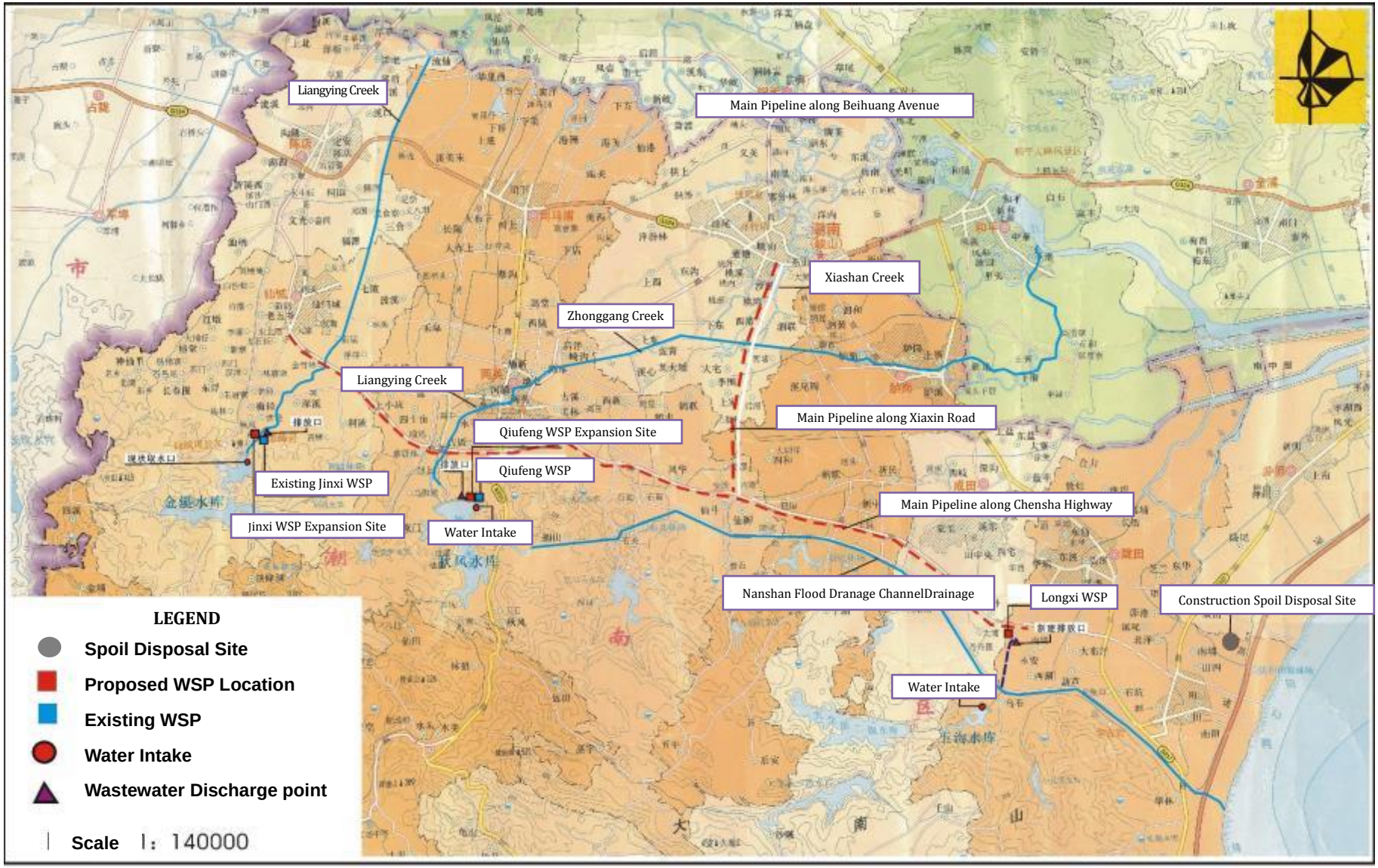


Figure IV.10: Location of Water Supply Plants, Main Pipelines, Wastewater Discharge Points and Spoil Disposal Site

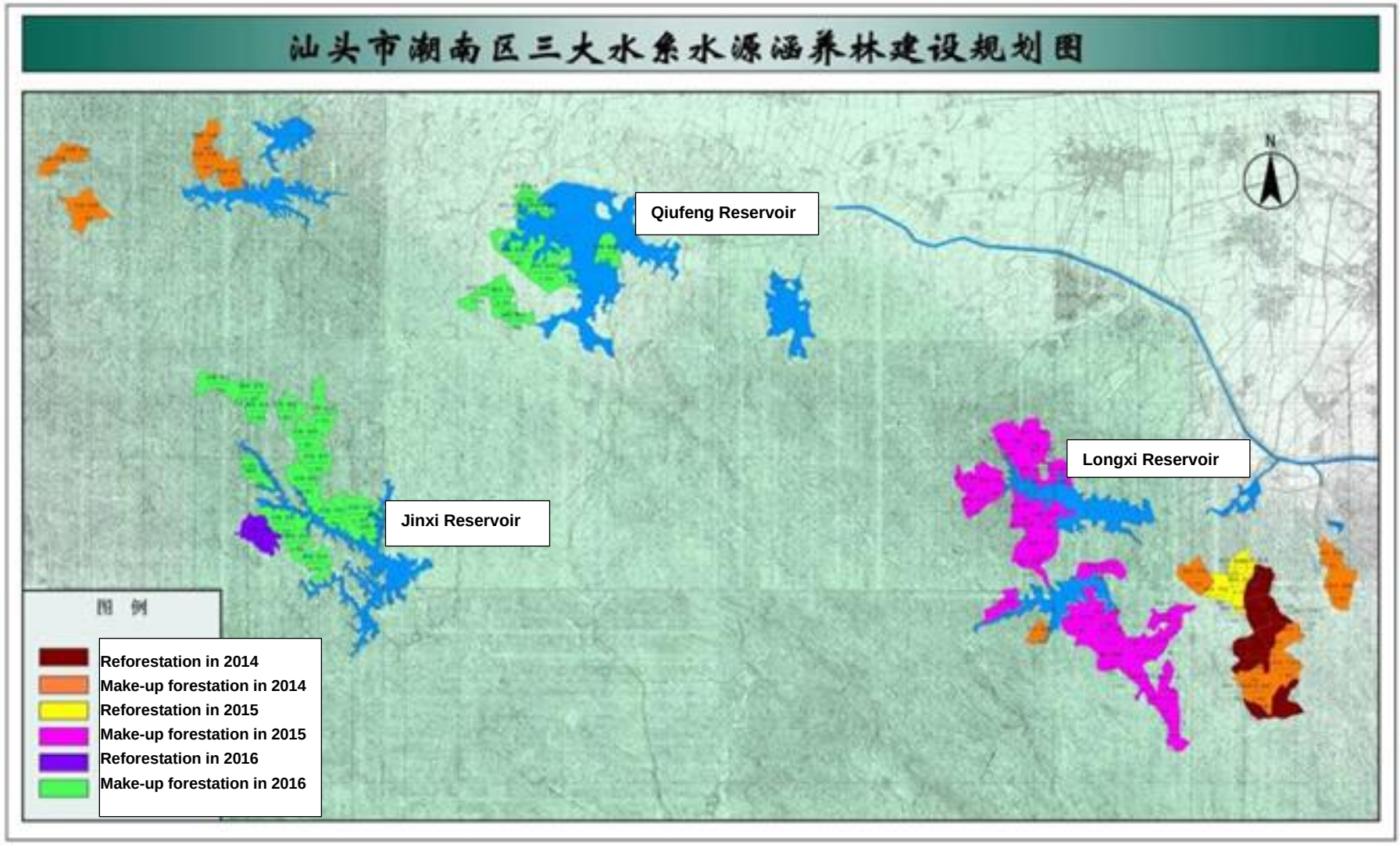


Figure IV.11: Locations of Reforestation in the Catchments of the Project Reservoirs

V. DESCRIPTION OF THE ENVIRONMENT (BASELINE)

A. Location and Setting

45. The project area is located in Chaonan District of Shantou Municipality, Guangdong Province in the PRC (Figures V.1–V.2). Shantou Municipality (N23°02'–23°38' E116°14'–117°19'; 2,064 square kilometers [km^2]) is located in the east of Guangdong Province, at the southern end of the Han River delta. It borders Chaozhou City in the north, Jieyang City in the west, and the South China Sea in the southeast. The municipality is 346 km from Hong Kong. In 2011, the total population was 5.29 million.

Figure V.1: Location of Chaonan District in Shantou Municipality

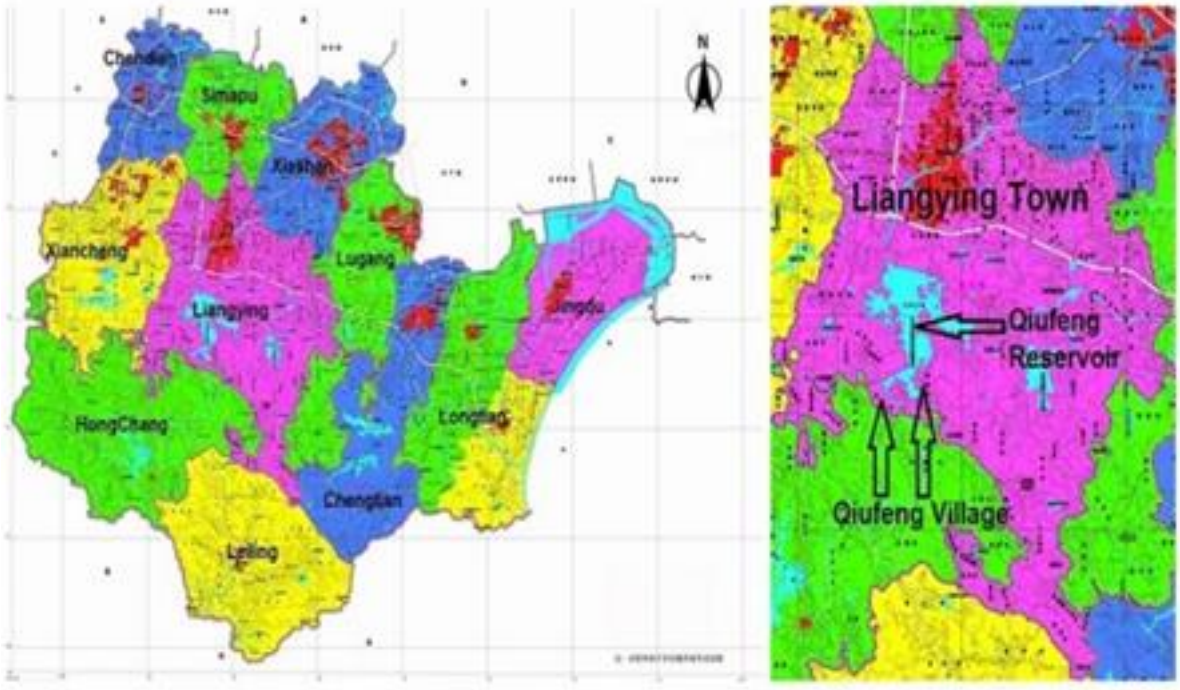


Figure V.2: Chaonan District

46. Most of Shantou Municipality (64%) is located on a coastal alluvial plain between Lianhua Mountain and the South China Sea. Remaining areas are mountainous or on plateaus. Topography slopes from northwest to southeast. Mountains include Lianhua (in the northeast), Sangpu (in the northwest) and Danan (in the southwest). The Han, Rong, and Lian Rivers flow through the municipality. Their entry to the sea forms the largest alluvial plain in east Guangdong. Shantou Municipality has been, for a long history, a transportation hub, import and export port, and commodity distribution center for the regions of east Guangdong, southern Jiangxi, and southwest Fujian. It is also a regional central city in terms of politics, economy and culture.

47. **Socioeconomic and/or human environment.** Chaonan District is a county level administrative division located in southwest Shantou Municipality. It has a total area of 600 km^2 (29% of Shantou Municipality) and 14.7 km coastline. By end-2011, Chaonan's population was 1.33 million, of which 85% were rural residents. The district capital is Xiashan Town, located 30 km from the Shantou city center. The urbanization rate is low (15%) and the population density is 2,227 persons/km^2, about 15.4 times the national average (145 person/km^2). The district administrates 11 towns and 232 villages, including the towns of Chendian, Hongchang, Leiling, Simapu, and Xiashan. Although Guangdong Province is one of the most developed provinces in the PRC, the income of residents in Chaonan District is far below the provincial and national averages. Of the seven districts and counties of Shantou Municipality, the economic condition of Chaonan District is the worst. In 2010, the per capita GDP was CNY13,500, 59.1% the municipal average (CNY22,800), 29% the provincial average (CNY47,000) and 45% the national average (CNY29,940). Rural residents have the lowest annual income. In 2011, the annual net income per rural resident was CNY5,076, 50% the provincial average and 27% lower than the national. Since 85% of Chaonan's population is rural, overall living standard of residents in the district is relatively low.

48. Project beneficiaries and potentially adversely affected groups may be broadly divided into 'upstream' and 'downstream' groups, reflecting the topography of the district, which comprises mountains to the west and a large coastal plain to the east. Ninety-five percent (1.26 million) of the district's population reside on this coastal plain; the remaining 5% reside in small towns and villages scattered throughout the mountainous western portion of the district. A series of reservoirs are located in the foothills at the western edge of the coastal plain, and these are the principal water supply for the entire plain population. 'Upstream' project activities focus on three of the largest reservoirs, Jinxi, Longxi, and Qiufeng (Sections V.A–V.B): the only 'upstream' project beneficiaries are the residents of two villages, Chengpo and Qiufeng (total population c. 4,000, Table V.3) located along the perimeter of Qiufeng reservoir. The other project beneficiaries comprise the 1.26 million 'downstream' urban and rural residents of Chaonan District. This population comprises 85% rural residents, 49.5% women, and 6.73% urban poor. Potentially adversely affected groups are all 'downstream' groups. They comprise (i) the residents of 11 villages (total population c. 95,000, Table V.3) and one school which may be impacted by construction activities, and (ii) residents which will experience economic displacement due to actual resettlement.

B. Geography, Topography, and Geology

49. The district comprises a mountainous inland region and a flat coastal plain (the Lian River plain), and slope declines from southwest to northeast. The Danan Mountain range extends from Pandai Village in Hongchang Town in the south to northeast. The highest mountain in the district is Leiling Mountain (elevation 521 meters [m]). The district is separated from Chaoyang District by the Lian River, which traverses the region from west to east. The coastline supports sandy beaches. The major soils in the project area are red soil, rocky soil and coastal sand, while the major rock formations are Triassic Period sand shale, Jurassic sandstone, volcanic rock, Late Quaternary delta sediments, and Late Yanshanian granite.

C. Climate

50. The district has a southern subtropical monsoon climate, warm and humid with abundant sunshine and precipitation. It has a long, mild summer and short winter, and a long frost-free period. Average annual precipitation is 1,700 mm, with most (82.2%) rainfall occurring from April to September. Average annual temperature is 21°C–22°C (maximum 36°C–40°C in July–early August; minimum 13°C–14°C in January–February). Within the general region of the three project reservoirs, Jinxi, Longxi, and Qiufeng, mean annual precipitation is 1,773–2,100 mm, mean annual depth of runoff is 831–1,186 mm, and the runoff coefficient (i.e., the percentage of precipitation that appears as runoff) is 0.5–0.6.

D. Hydrology and Water Resources

51. A water balance assessment was conducted for the project (Supplementary Appendix 8 of the PPTA Final Report: 'Detailed Water Resource Assessment in Chaonan District'). The assessment describes the existing water resources of the district (rainfall, runoff, groundwater), reservoir storage capacity, current demand and supply, allocation for drinking water, agriculture, industry, and environmental flows, existing capacity for water treatment and ability to meet current demand, projected demands up to 2025, and the potential impacts of climate change. The assessment concluded that the current supply capacity is insufficient to meet future water demands for the district, but that this supply–demand gap can be accommodated by the available district water resources until at least 2030. The assessment also noted that to achieve sustainable water supply, the district must implement water efficiency measures, including reduction in NRW loss, the timely implementation of at least two other domestic-funded projects, the 'Han River Diversion Project' and 'Irrigation Rehabilitation Project' (2021–2025), improved water use efficiency for agricultural irrigation and industry, and water conservation awareness raising for households and industries. After 2025, the potential impacts of climate change and/or consecutive 'dry' years may increase the risk of water shortage and need for seasonal rationing; agricultural water demand accounts for 50% annual district water use and the need to improve irrigation efficiency is a high priority.

52. The total annual average water resource in Chaonan District is 580 million m^3, of which surface water runoff is 548 million m^3 and groundwater is 32 million m^3. Leiling and Lian Rivers are the two largest rivers in the district. Leiling River originates from Leiling Mountain and has three branch streams joining together at Shuangxi Village in Leiling Town. It runs across Shenquan Port in Huilai County and enters into the South China Sea. The total average annual flow of the river is 11 million m^3. Its total length is 26 km and it has a catchment of 61 km^2. Lian River originates from Danan Mountain in Puning District and has two branch rivers. It enters the South China Sea through Haimen Port. It has a total length of 94.5 km and a catchment area of 838.5 km^2. The Lian River has abundant run-through water of about 1.04 billion m^3 in an average rainfall year (the maximum river flow is 1,324 m^3 per second).

53. The district has abundant groundwater resources, with an annual allowable exploitation of 32 million m^3. However due to high concentration of fluoride (8.0–8.5 mg/L compared with the domestic drinking water quality standard of 1.0 mg/L), more than 90% of the groundwater is undrinkable except springs in mountain areas.

54. There are 143 reservoirs and ponds in the district, with a combined catchment area of 221.61 km^2 and total storage capacity of 226 million m^3. Seven are medium-sized reservoirs with total catchment areas of 163.63 km^2 and total storage capacity of 188.02 million m^3. Sixty-five are small-sized reservoirs with a total catchment area of 50.27 km^2 and total storage capacity of 35.98 million m^3. The remaining 71 are ponds with a total catchment area of 8.87 km^2 and total storage capacity of 2.489 million m^3. Three reservoirs, Jinxi, Longxi, and Qiufeng, are the major drinking water sources in the district. They have a total storage capacity of 131.1 million m^3 and a total catchment area of 116.6 km^2. These are 'multi-year regulating reservoirs', meaning that

water inputs to the reservoir and total storage volume can be regulated. This design enables planning for flood and drought management. Annual inflow of water into these three reservoirs is 260 million m^3. The water quality in these reservoirs is generally good (Class II), but soil erosion occurs in some catchment areas and eutrophication risk is increasing due to nonpoint source pollution from agricultural activities.[2] At Qiufeng reservoir, water pollution is also occurring from domestic wastewater discharge and rubbish dumping at two villages (Chengpo and Qiufeng).

55. Management of the district's reservoirs and their catchments is under the jurisdiction of several district bureaus: the water resources bureau (WRB) and the district water supply company (for the actual water bodies), the EPB (for environmental management of the surrounding air and soil), and the forestry bureau (for the catchment forests). Under the Guangdong Water Source Quality Protection Regulation (2007) and the Shantou Municipal Water Source Protection Regulation, lands within 500 m of Jinxi, Longxi, and Qiufeng reservoirs are designated as a 'Grade I' prohibited zone. Public access in this zone is closely regulated within 100 m of the drinking water source.[20] At each of these reservoirs, the 500-m zone consists of degraded forest with bare soil patches and scattered graves. Management by the district bureaus comprises the regulation of visitor access, maintenance of the access roads, monitoring for threats to reservoir water quality and the catchment (e.g., forest fires), and reforestation. Future management will include maintenance of the new reforestation activities and solid waste program to be implemented by this project (Section II).

56. Water quality in the downstream region of Chaonan District (i.e., the coastal plain) is poor. The Lian River and its major tributaries are severely polluted, worse than Class V (GB3838-2002), and cannot be used even for irrigation and landscaping. Major pollutants are ammonium nitrate (NH_3-N), dissolved oxygen (DO), high chemical oxygen demand (COD_{cr}), and high biological oxygen demand (BOD_5).[21] Primary causes are untreated industrial effluent and domestic wastewater, which has resulted from rapid economic development and population growth in recent years. In 2011, total domestic wastewater discharge was 22.6 million m^3. Total industrial discharge was 19.2 million m^3, primarily from textile and dyeing factories in the district. In contrast, water quality in the project reservoirs (in the hills west of the coastal plain) is generally good (Class II); although soil erosion is present and eutrophication risk is increasing, especially in Qiufeng reservoir, due to nonpoint source pollution.[22]

57. Water sources protection and water supply safety are critical issues in the district. The average per capita water resource is 450 m^3, 20% the national average (2,200 m^3) and 26.5% the provincial average (1,700 m^3). There are estimated to be over 400,000 urban and rural people using unsafe or untreated drinking water, which has caused many health problems, especially dental fluorosis and skeletal fluorosis.[23] In 2010, about 296,700 residents in the district did not have adequate access to tap water. According to the Chaonan District Master Plan, the district's total population is expected to reach 1.56 million by 2020 and the total water

[20] Under the PRC's EIA Technical Guideline: Drinking Water Source Protection and Zoning (2007) and the Guangdong Provincial Regulation for Drinking Water Source Protection (2007, amended in 2010), reservoirs are encompassed by up to three water source protection zones. The 'prohibited zone' (Grade I) is the closest to the water source and receives the highest protection, and the following activities are prohibited: (i) new construction or expansion of any projects not relating to water supply facilities and water source protection; (ii) establishment of tourism facilities or boat yards; (iii) discharge of wastewater to water body; (iv) livestock raising or cage fishing; (v) actions which may cause pollution, e.g., tourism, swimming, washing; (vi) mooring of boats and/or ships or wood or bamboo rafts not related to water resource protection. The 'protection zone' (Grade II) adjoins the prohibited zone: no new buildings or construction projects which may drain pollutants to the water body are allowed, existing developments must reduce and manage their pollutant discharge, and no disposal of garbage, feces, oil, or hazardous substances is permitted. The 'buffer zone' (Grade III) is the outer-most zone: here, existing drainage and sewerage must be upgraded to ensure that water quality meets the relevant standards; and no disposal of garbage, feces, oil, or hazardous substances is permitted.

[21] The PRC's Surface Water Quality Standard (GB3838-2002).

[22] The PRC's national standard defines five water quality classes: Class I for headwaters and natural reserves; Class II for first class drinking water sources and habitats of rare species; Class III for second class drinking water sources, aquaculture, and swimming; Class IV for water sources for industrial use and recreations for indirect human contact; and Class V for water sources of agricultural use and landscaping.

[23] By the end of 2011, there were 230,000 people (42 villages, 8 towns) living in high-fluorosis area in the district.

demand is expected to reach 325,000 m^3/d. Current water supply capacity is 135,000 m^3/d, with high rates of NRW losses due to poor management, previously low technical standards and aged pipelines installed in the 1980s–1990s. Current NRW loss is as high as 50%, resulting in serious water and energy losses, high water tariffs and low service coverage. The current water supply capacity is far from meeting water demand. There are also many small basic rural water supply facilities operating with lower technical standards and poor management resulting in water safety problems.

58. Chaonan District supports two WSPs, Jinxi and Qiufeng. A third plant, Longxi WSP, previously operated; but operation was discontinued due to aging infrastructure. Jinxi and Qiufeng WSPs were constructed in the late 1980s and began operation in 1993 and the late 1990s, respectively (CWSC pers. comm.). Both WSPs are located on state-owned land. No domestic EIAs appear to be available for construction of either plant.

E. Ecological Environment

59. The project area is largely located on the Chaonan coastal plain and comprises a degraded urban–rural landscape of agricultural, residential and industrial lands. Forest habitats in the project area are restricted to the catchment zones of the three project reservoirs. These forests are part of the Danan Mountain range, which extend north, south and west of the project area. Preliminary inventories conducted by the Shantou municipal government indicate that the region supports at least 47 families and 125 species of plants (including pines, firs, Acacia, Banyan, camphor, bamboo) and 140 species of vertebrate fauna (an indication of species diversity is given in Table V.1). There are no records of threatened flora and fauna from the project area, although detailed ecological surveys for the project area have not been conducted.

Table V.1: Preliminary Inventory of Flora and Fauna in Chaonan District

No.	Flora	No.	Flora
1	*Lophatherum gracile*	24	*Melalauca leucadendra*
2	*Miscanthus sinensis*	25	*Eucalyptus tereticornis*
3	*Pinus massoniana*	26	*Eucalyptus citriodora*
4	*Cunninghamia lanceolata*	27	*Sterculia lanceolata*
5	*Gnetum parvifolium*	28	*Sapium discolor*
6	*Acacia confuse*	29	
7	*Castanopsis fissa*	30	*Ficus hispida*
8	*Fructus Gardeniae*	31	*Bischofia polycarpa*
9	*Embelia laeta*	32	*Ficus wightiana*
10	*Rubiaceae*	33	*Cinnamomum burmannii*
11	*Rhodomyrtus tomentosa*	34	*Ilex rotunda*
12	*Dicranopteris dichotoma*	35	*Pharbitis nil*
13	*Spora Lygodii*	36	*Microsorium fortune*
14	*Melia azedarach*	37	*Bidens pilosa*
15	*Ficus microcarpa*	38	*Conyza Canadensis*
16	*Ilex asprella*	39	*Phragmites communis*
17	*SmilaxchinaL.*	40	*Eleusine ingica*
18	*Rhaphiolepis indica Lindl*	41	*Solallum nigrum* L .var *Pauciflorum*
19	*Eurya chinensis*	42	*Youngiajaponica / Crepisjaponica*
20	*Spider brake*	43	*Euonymus fortune*
21	*Lantana camara*	44	*Juncellus serotinus*
22	*Cynodondactylon*	45	*Melia azedarach*
23	*Strophanthus divaricatus*	46	*Chukrasia tabularis*
No.	**Fauna**	**No.**	**Fauna**
1	*Bufo melanostictus* Common Toad	8	*Sus scrofa* Eurasian Wild Pig
2	*Hylarana guentheri* Guenther's Frog	9	*Manis* sp. Pangolin sp.

No.	Fauna	No.	Fauna
3	*Chinemys reevesii* Chinese Pond Turtle	10	*Passer montanus* Eurasian Tree Sparrow
4	*Natrix annularis* Ringed Water Snake	11	*Pica pica* Magpie
5	*Bungarus fasciatus* Banded Krait	12	*Phasianus colchicus* Ring-neck Pheasant
6	*Bungarus multicinctus* Many-banded Krait	13	Hirundinidae swallows and swifts
7	*Egretta garzetta* Little Egret		

Source: Domestic environmental impact assessment report.

60. Crops grown in the district include rice, sweet potato, wheat, potatoes, soybeans, peanuts, and sugar cane. Fruits include banana, orange, lychee, pineapple, plum, carambola, plums, canarium and pimela. Domestic livestock raised in the district include pig, cattle, sheep, rabbit, chicken, duck, geese and pigeon.

F. Environmental Quality (Baseline Sampling)

1. Project Zone of Influence, Evaluation Standards, and Sensitive Receptors

61. Baseline environmental data for the domestic EIA was collected by the Shantou EMS between December 2012 and January 2013. There is one EMS each in Shantou Municipality and Chaonan District, which are responsible for monitoring of ambient environmental quality and compliance monitoring of pollution sources in the municipality and the district respectively. Due to a weaker technical capacity and limited monitoring equipment at the Chaonan EMS, the Shantou EMS supports the Chaonan EMS with its environmental monitoring responsibilities.

62. The area of impact assessment (zone of project influence) for project construction and operation was defined by the EIA Institute, in accordance with the PRC's technical guidelines on EIA, and discussions with the PPTA team (Table V.2).

Table V.2: Impact Assessment Areas (Project Zone of Influence)

Item	Impact Area
Surface water	200-m, 300-m, and 400-m radius from WSP water intake points at Jinxi, Longxi, and Qiufeng reservoirs, respectively
Air	25 x 25-km area encompassing the project construction sites (WSPs and pipeline networks) and reforestation sites, to measure dust and vehicle and/or machinery emission
Noise	(i) WSP: at boundaries of project sites, and at sensitive points within 200 m from WSP boundary lines; (ii) pipeline: areas on both sides within 200 m from the pipeline corridors (main pipelines of Beihuan Avenue, Xiaxin Road and Chensha Highway); (iii) noise sensitive locations—residential areas, schools, hospitals[a]
Ecology	(i) the plain area: 200-m areas on both side of the pipeline corridors; (ii) Danan mountain area: 17 km^2 area encompassing the reforestation sites at Jinxi, Longxi, and Qiufeng reservoirs, including 500 m from the WSP boundary lines
Soil stability	Construction sites, stockpile areas, borrow pits and spoil disposal sites

km = kilometer, km^2 = square kilometer, m = meter, WSP = water supply plant.

[a] No hospitals are situated near the construction sites and none are in the 18 listed sensitive receptors. But the construction machineries and vehicles may travel near hospitals with noise impact according to the EIA Institute.

Source: Domestic environmental impact assessment report.

63. Sensitive receptors to potential project construction and operational impacts were defined for this project as: villages, schools, reservoirs, and the Lian River. A total of 18 sensitive receptors were identified: 13 villages, one school, one river (Lian), and the three project reservoirs (Table V.3). These receptors formed the basis for selecting sites for baseline environmental sampling (Figure V.3).

Table V.3: Sensitive Receptors and Protection Objectives

No.	Sensitive Receptor	Scale	Location	Protection Objective/ Standard
1	Qiufeng Village	2,793 persons	35 m south of Qiufeng Reservoir	Ambient air quality standard/Grade I of GB3095-1996, and urban ambient acoustic quality standard/Grade I of GB3096-2008
2	Chengpo Village	1,294 persons	58 m west of Qiufeng Reservoir	
3	Xiandou Village	5,711 persons	10 m of main pipeline	Ambient air quality standard/Grade II of GB3095-1996, and urban ambient acoustic quality standard/Grade II of GB3096-2008
4	Xianxin Village	10,329 persons	245 m of main pipeline	
5	Dongxi Village	8,709 persons	150 m of main pipeline (Huanbei Avenue)	
6	Liannan Village	9,380 persons	1,000 m of main pipeline (Huanbei Avenue)	
7	Dapu Village	1,486 persons	66 m of main pipeline	
8	Sihe Village	7,888 persons	1,000 m of main pipeline (Xiaxin Rd)	
9	Xiweizhou Village	15,173 persons	500 m of main pipeline (Xiaxin Rd)	
10	Huaqiao Village	7,462 persons	100 m north of main pipeline (Huanbei Avenue)	
11	Yiying Village	1,1195 persons	150 m south of main pipeline (Huanbei Avenue)	
12	Yangchen Village	6,882 persons	400 m south of main pipeline (Huanbei Avenue)	
13	Silian Village	10,691 persons	80 m east of main pipeline (Xiaxin Rd)	
14	Shenxi Liumengling School	1,688 persons	2,000 m northeast of Jinxi WSP	Ambient air quality standard/Grade I of GB3095-1996, and urban ambient acoustic quality standard/Grade I of GB3096-2008
15	Lian River	Max. flow 1,324 m^3/s; average annual runoff 1.04 billion m^3	12 km south of the three WSPs	Surface water quality standard/Grade V of GB3838-2002
16	Qiufeng Reservoir	Capacity 69.03 million m^3	65 m south of Qiufeng WSP	Maintain the original ecological function
17	Longxi Reservoir	Capacity 14.00 million m^3	2,310 m south of Longxi WSP	
18	Jinxi Reservoir	Capacity 18.92 million m^3	167 m south of Jinxi WSP	

km = kilometer, m = meter, m^3 = cubic meter, s = second, WSP = water supply plant.
Source: Domestic environmental impact assessment report.

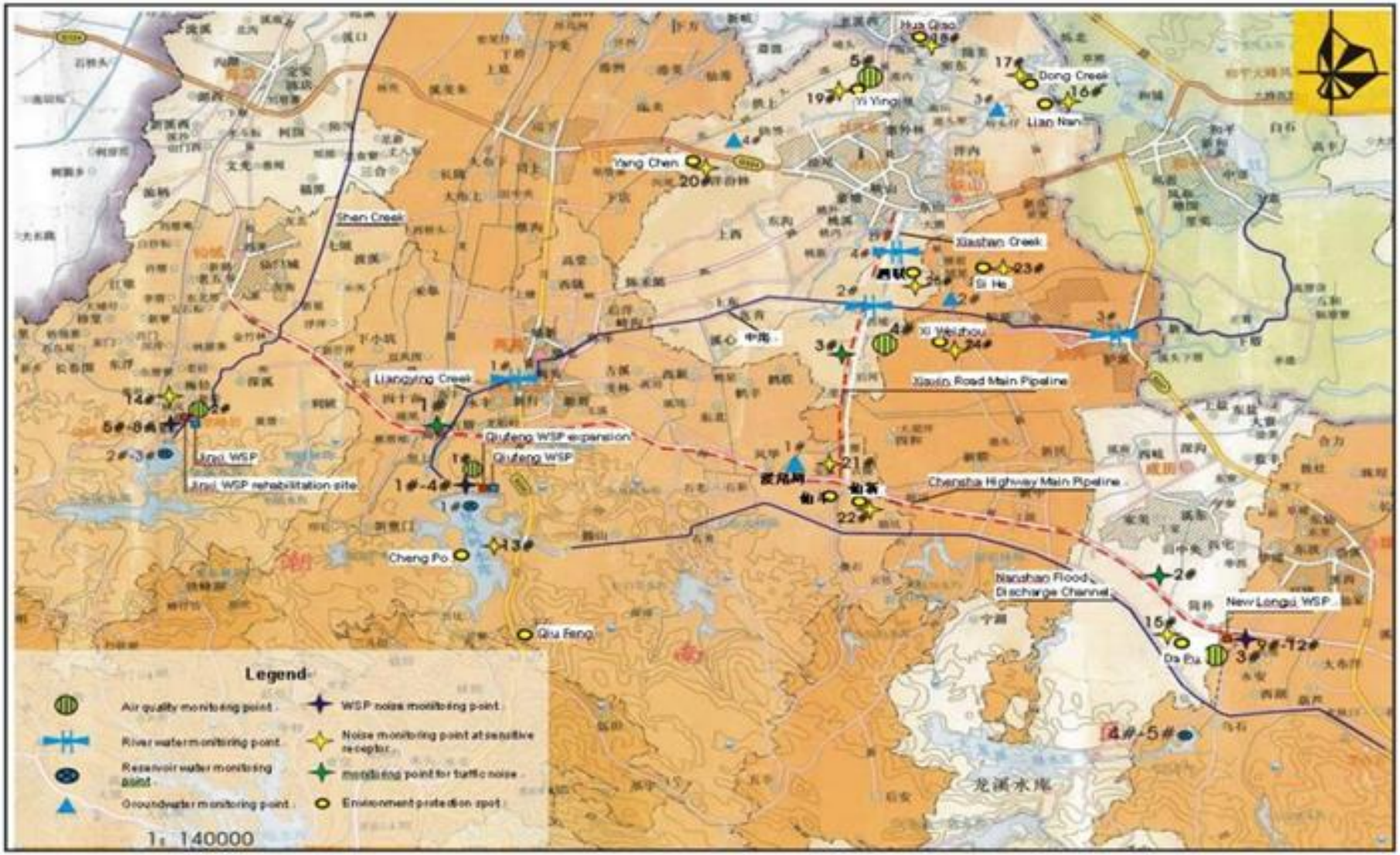


Figure V.3: Locations of Environmental Baseline Sampling and Environmental Protection Spots

2. Surface Water Quality

64. **Sampling methods and standards set for project.** Monitoring was conducted at creeks near construction sites and the three project reservoirs (Jinxi, Longxi, Qiufeng) once per day for two consecutive days (3–4 December 2012). Three monitoring points were sampled at Liangying Creek (#1–3) and one at Xiashan Creek (#4). For the three reservoirs, five monitoring points were selected in the middle of the reservoirs and at the intake points of the proposed Jinxi and Longxi WSPs. Twenty-six water quality parameters were sampled (Table V.4). The national standard adopted for the water quality assessment is the surface water quality standard (GB3838-2002): Grade V standard for the creeks and Grade II for the reservoirs (Table V.4).

Table V.4: Surface Water Quality Sampling Standards (mg/L except for pH)

Parameter	pH	COD_{Cr}	BOD_5	TN	DO	NH_3-N	TP	Volatile Phenol
Grade II	6-9	15	3	0.5	6	0.5	0.1	0.002
Grade IV	6-9	30	6	1.5	3	1.5	0.3	0.01
Grade V	6-9	40	10	2.0	2	2.0	0.4	0.1
Parameter	petroleum	S^-	Cr6+	As	Pb	Cd	Cu	Hg
Grade II	0.05	0.1	0.05	0.05	0.01	0.005	1.0	0.00005
Grade IV	0.5	0.5	0.05	0.1	0.05	0.005	1.0	0.001
Grade V	1.0	1.0	0.1	0.1	0.1	0.01	1.0	0.001
Parameter			**Sulfate**	**Chloride**	**NO_3-N**	**Dimethoate**	**Dichlorvos**	**Dipterex**
Surface water as drinking water source			250	250	10	0.08	0.05	0.05

As = arsenic, BOD_5 = 5-day biochemical oxygen demand, Cd = cadmium, COD_{cr} = chemical oxygen demand, Cr6+ = chromium VI, Cu = copper, DO = dissolved oxygen, Hg = mercury, mg/L = milligram per liter, NH_3-N = ammonia nitrogen, NO_3-N = nitrogen-nitrate, Pb = lead, pH = measure of acidity or basicity of an aqueous solution, S^- = sulfide, TN = total nitrogen, TP = total phosphorus.
Source: Asian Development Bank estimates.

65. **Results.** Sampling results (26 parameters) are summarized in Table V.5. Water quality of the three reservoirs meets Grade II standard (GB3838-2002) except total phosphorus (TP) and total nitrogen (TN), while the monitored parameters of pesticides (dimethoate, dichlorvos, dipterex), volatile phenol, sulfide (S), chromium VI (Cr6), arsenic (As), lead (Pb), cadmium (Cd), copper (Cu), and mercury (Hg) were lower than the detection limits (i.e., meet the Grade II standard). Therefore the water quality of the reservoirs is relatively good. The noncompliance of TP and TN is mainly due to discharge of domestic water into the reservoirs and (at Qiufeng reservoir) rubbish dumping from two nearby villages. For the river and creek sections, seven parameters—COD_{Cr}, BOD_5, TN, DO, TP, NH_3-N, S) do not meet Grade V standard and DO was much lower than the standard (Table V.5). The river sections are severely polluted, due to direct discharge of untreated domestic and industrial wastewater.

66. In addition to the water sampling undertaken for the domestic EIA, regular water quality monitoring is undertaken at Jinxi, Longxi, and Qiufeng reservoirs. Sampling conducted twice a year for the past 10 years indicates that the water qualities of the reservoirs meet the national standard Grade II of GB3080-2002 (Table V.6).

3. Groundwater Quality

67. **Sampling methods and standards set for project.** Four sites were sampled: one each at Liannan, Silian, Xiandou, and Yangchen villages, which the water supply pipelines will pass through. Sampling at Silian and Xiandou villages was conducted once per day for 2 days (3–4 December 2012). Sampling at Liannan and Yangchen villages was conducted on 4 January and 9 August 2013 respectively. Eight water quality parameters were monitored (Table V.7). The national standard adopted for this project is based on the Guangdong Provincial Groundwater Function Zoning, and is Grade III of the PRC's Surface Water Quality Standard (GB3838-2002).

68. **Results.** Most sampled parameters meet Grade III of the PRC's Surface Water Quality Standard (GB3838-2002, Table V.7). Two parameters (NH_3-N and COD_{Mn}) at Liannan Village exceed the standard, probably due to pollution from untreated domestic wastewaters.

4. Eutrophication in the Project Reservoirs

69. Most sampled parameters of surface water quality in the three project reservoirs met Grade II of the PRC's Surface Water Quality Standard (GB3838-2002), except TN and TP, indicating the risk of eutrophication. Sampling of chlorophyll-a content and primary Chlorophyll productivity was subsequently conducted in January 2013 (Table V.8). Results indicate the three reservoirs exhibit mild eutrophication, but retain good water transparency (1.7–1.8 m) (Table V.7). The eutrophication and non-compliance of TP and TN is mainly due to discharge of untreated wastewater into the reservoirs from nearby villages and rubbish dumping.

5. Ambient Air Quality

70. **Sampling methods and standards set for project.** Ambient air quality was monitored at five sites: (i) the three project WSPs: site of the proposed Longxi WSP and the existing Jinxi and Qiufeng WSPs (one sampling site per WSP), where Grade I of the PRC's Ambient Air Quality Standard (GB3095-1996) was applied; and (ii) two samples taken at Xiaxin Road and Beihuan Avenue (construction locations for the water supply pipeline network) where Grade II standard was applied. Sampling was conducted for seven consecutive days from 3 to 9 December 2012. Four parameters were sampled (Table V.9). The determining standards applied here are Grades I and II of the PRC's Ambient Air Quality Standard (GB3095-1996): Grade I is applicable for the WSPs and surrounding areas, and Grade II is for the pipeline works in the plain area. Standards under the World Bank's EHS guidelines[1] were also used in the assessment (Table V.9).

[1] World Bank Group. 2007. *Environmental, Health, and Safety Guidelines General EHS Guidelines*. Washington DC.

Table V.5: Surface Water Quality in at Sampling Sites (mg/L except pH and temperature)

Parameter	Liangying Creek (#1)	Liangying Creek (#2)	Liangying Creek (#3)	Xiashan Creek	Middle of Qiufeng Reservoir	Intake of Jinxi WSP	Middle of Jinxi Reservoir	Intake of Longxi WSP	Middle of Longxi Reservoir	Grade II Standard	Grade V Standard
Temperature	21.00000	20.85000	21.90000	20.50000	21.00000	21.10000	21.10000	21.25000	21.60000	…	…
pH	7.04500	7.16500	8.59500	7.25000	7.31500	7.09000	7.05500	7.09500	7.01500	6–9	6–9
Chlorophyll a	6.00500	26.40000	45.65000	38.05000	2.61500	2.96000	2.87500	2.17500	2.60000	…	…
Sulfate (SO_4)	92.90000	225.50000	585.50000	57.35000	2.27500	2.87000	2.09000	2.59500	2.75000	250.00000	…
Chloride (Cl)	52.50000	48.80000	59.45000	51.65000	5.02000	3.60500	2.83000	5.00500	4.75000	250.00000	…
Nitrate-N	4.60000	0.84300	1.83500	0.33700	0.28600	0.26800	0.52200	0.31550	0.28800	10.00000	…
Dimethoate	0.00010 (LD)	0.00010 (LD)	0.0001 (LD)	0.00010 (LD)	0.00010 (LD)	0.00010 (LD)	0.00010 (LD)	0.00010 (LD)	0.00010 (LD)	0.08000	…
Dichlorvos	0.00005 (LD)	0.00005 (LD)	0.00005 (LD)	0.00005 (LD)	0.00005 (LD)	0.00005 (LD)	0.00005 (LD)	0.00005 (LD)	0.00005 (LD)	0.05000	…
Dipterex	0.00025 (LD)	0.00025 (LD)	0.00025 (LD)	0.00025 (LD)	0.00025 (LD)	0.00025 (LD)	0.00025 (LD)	0.00025 (LD)	0.00025 (LD)	0.05000	…
Chemical oxygen demand (COD_{Cr})	220.00000	102.50000	213.00000	51.50000	5.00000 (L)	5.00000 (L)	15.00000	5.00000 (L)	5.00000 (L)	⩽15.00000	⩽ 40.00000
Biological oxygen demand (BOD_5)	49.95000	24.00000	50.45000	22.10000	0.75500	0.86500	1.58000	0.79500	0.82000	⩽3.00000	⩽ 10.00000
Total nitrogen (TN)	11.95000	8.46500	14.00000	13.50000	0.71800	0.69650	0.86800	0.76600	0.71300	⩽0.50000	⩽2.00000
Dissolved oxygen (DO)	0.25500	0.29000	0.33500	0.32500	7.83500	7.58000	5.90500	7.40000	7.58500	⩾6.00000	⩾2.00000
Ammonia nitrogen (NH_3-N)	3.81000	4.64500	7.52000	6.27500	0.01250	0.01250	0.21850	0.01250	0.01250	⩽0.50000	⩽2.00000
Total phosphorus (TP)	1.61000	1.17500	2.38500	1.08500	0.10250	0.08850	0.10900	0.10800	0.08950	⩽0.10000	⩽0.40000
Volatile phenol	0.00145	0.00165	0.00185	0.00140	0.00015	0.00015	0.00015	0.00015	0.00015	⩽0.00200	⩽0.10000
Suspended solid (SS)	66.00000	76.50000	221.50000	37.00000	14.50000	14.50000	13.00000	17.00000	15.50000	…	…
Petroleum	0.08500	0.11500	0.20500	0.08000	0.02500 (L)	0.02500 (L)	0.02500 (L)	0.02500 (L)	0.02500 (L)	⩽0.05000	⩽1.00000
Sulfide (S)	1.30000	1.40500	1.53500	0.95150	0.01000 (L)	0.01000 (L)	0.01000 (L)	0.01000 (L)	0.01000 (L)	⩽0.10000	⩽1.00000
Chromium (Cr_6)	0.00200 (L)	0.00200 (L)	0.00200 (L)	0.00200 (L)	0.00200 (L)	0.00200 (L)	0.00200 (L)	0.00200 (L)	0.00200 (L)	⩽0.05000	⩽0.10000
Chroma	25.00000	10.00000	200.00000	8.00000	2.00000	2.00000	2.00000	2.00000	2.00000	…	…
Arsenic (As)	0.00350 (L)	0.00950	0.01650	0.50350	0.00350	0.00350	0.00350	0.00350	0.00350	⩽0.05000	⩽0.10000
Lead (Pb)	0.00600	0.01400	0.00450	0.00300	0.00050 (L)	0.00100	0.00050 (L)	0.00050 (L)	0.00450	⩽0.01000	⩽0.10000
Cadmium (Cd)	0.00035 (L)	0.00255	0.00035 (L)	0.00035 (L)	0.00035 (L)	0.00035 (L)	0.00035 (L)	0.00035 (L)	0.00035 (L)	⩽0.00500	⩽

Parameter	Liangying Creek (#1)	Liangying Creek (#2)	Liangying Creek (#3)	Xiashan Creek	Middle of Qiufeng Reservoir	Intake of Jinxi WSP	Middle of Jinxi Reservoir	Intake of Longxi WSP	Middle of Longxi Reservoir	Grade II Standard	Grade V Standard
											0.010000
Copper (Cu)	0.00350	0.01350	0.02350	0.00450	0.00050 (L)	0.00050 (L)	0.00050 (L)	0.00050 (L)	0.0005 (L)	⩽1.00000	⩽1.00000
Mercury (Hg)	0.000025 (L)	0.000025 (L)	0.000124	0.000025 (L)	0.000025 (L)	0.000025 (L)	0.000025 (L)	0.000025 (L)	0.000025 (L)	⩽0.00005	⩽0.00100

LD = lower than detection limit. mg/L = milligram per liter, pH = measure of acidity or basicity of an aqueous solution, WSP = water supply plant.
Source: Domestic environmental impact assessment report.

Table V.6: Water Quality of the Three Reservoirs in 2012 (mg/L except pH, temperature, transparency, chlorophyll and coliform)

Monitored Parameter	Qiufeng Reservoir	Up Jinxi Reservoir	Down Jinxi Reservoir	Big Longxi Reservoir	Small Longxi Reservoir	Grade II Standard
Monitoring date	3 Jul 2012	28 Sep 2012	28 Sep 2012	28 Sep 2012	28 Sep 2012	
Temperature (℃)	30.100000	27.000000	27.400000	29.000000	29.600000	…
Transparency (cm)	190.000000	170.000000	168.000000	60.000000	150.000000	…
Chlorophyll a (mg/m^3)	4.180000	3.800000	4.260000	1.930000	0.890000	…
pH	8.180000	7.440000	7.520000	7.880000	7.590000	
Sulfate	3.240000	1.020000	1.210000	1.860000	1.770000	250.000000
Chloride	4.770000	2.570000	2.270000	5.760000	7.360000	250.000000
Nitrate nitrogen	0.422000	0.086000	0.172000	0.274000	0.563000	10.000000
Chemical oxygen demand (potassium permanganate index) COD_{Mn}	1.630000	3.190000	1.760000	1.130000	0.990000	4.000000
Chemical oxygen demand (COD)	10.00000L	11.300000	<10.000000	<10.000000	<10.000000	15.000000
Dissolved oxygen (DO)	7.480000	7.970000	7.670000	7.620000	7.580000	>6.000000
Biological oxygen demand (BOD_5)	1.620000	<2.000000	<2.000000	<2.000000	<2.000000	3.000000
Fluoride	0.240000	0.100000	0.110000	0.130000	0.120000	1.000000
Volatile Phenol	0.00030L	<0.002000	<0.002000	<0.002000	<0.002000	0.002000
Petroleum	0.05000L	<0.050000	<0.050000	<0.050000	<0.050000	0.050000
Ammonia nitrogen (NH3-N)	0.028000	0.116000	0.072000	0.483000	0.160000	0.500000
Mercury (Hg)	0.00005L	<0.000050	<0.000050	<0.000050	<0.000050	0.00005
Cyanide	0.00400L	<0.004000	<0.004000	<0.004000	<0.004000	0.050000
Fecal coliform	938.000000	800.000000	1,600.000000	1,200.000000	2,400.000000	2,000.000000
Iron (Fe)	0.044000	0.190000	0.050000	0.100000	<0.030000	0.300000

Monitored Parameter	Qiufeng Reservoir	Up Jinxi Reservoir	Down Jinxi Reservoir	Big Longxi Reservoir	Small Longxi Reservoir	Grade II Standard
Manganese (Mn)	0.006000	<0.010000	<0.010000	0.030000	0.020000	0.100000
Copper (Cu)	0.010000	<0.001000	0.002000	0.003000	0.007000	1.000000
Zinc (Zn)	0.030000	<0.050000	<0.050000	<0.050000	<0.050000	1.000000
LAS	0.02500L	<0.025000	<0.025000	<0.025000	<0.025000	0.200000
Selenium (Se)	0.00300L	<0.003000	<0.003000	<0.003000	<0.003000	0.010000
Arsenic (As)	0.00700L	<0.007000	<0.007000	<0.007000	<0.007000	0.050000
Cadmium (Cd)	0.00070L	0.000100	0.000100	<0.000100	<0.000100	0.005000
Chromium (Cr+6)	0.00400L	<0.004000	<0.004000	<0.004000	<0.004000	0.050000
Lead (Pb)	0.00100L	0.001000	0.002000	0.001000	0.001000	0.010000
Sulfide	0.02000L	<0.020000	<0.020000	<0.020000	<0.020000	0.100000

cm = centimeter, LAS = linear alkylbenzene sulfonate, LD = lower than detection limit, mg/m^3 = milligram per cubic meter, pH = measure of acidity or basicity of an aqueous solution,.
Source: Domestic environmental impact assessment report.

Table V.7: Groundwater Quality (mg/L except for pH and coliform)

Parameter	Xiandou Village		Silian Village		Liannan Village		Yangchen Village		Grade III Standard
Sampling date	3 Dec 2012	4 Dec 2012	3 Dec 2012	4 Dec 2012	4 Jan 2103	9 Aug 2013	4 Jan 2013	9 Aug 2013	
pH	6.3900	6.4100	6.5900	6.5500	7.6000	7.5400	7.6500	7.6100	6.50–8.50
NH_3-N	≤0.0250	≤0.0250	0.5790	0.6130	0.3700	0.3200	0.0390	0.0350	≤0.20
Chromium (Cr_6)	≤0.0040	≤0.0040	≤0.0040	≤0.0040	≤0.0040	≤0.0040	≤0.0040	≤0.0040	≤0.05
Total Hardness ($CaCO_3$)	12.4000	12.8000	8.0100	8.4100	10.0000	10.1000	9.1000	9.2000	≤450.00
Lead (Pb)	≤0.0010	≤0.0010	≤0.0010	≤0.0010	0.0020	0.0020	0.0010	0.0010	≤0.05
Cadmium (Cd)	≤0.0007	≤0.0007	≤0.0007	≤0.0007	≤0.0007	≤0.0007	≤0.0007	≤0.0007	≤0.010
Iron (Fe)	0.0380	0.0450	1.2500	1.1800	0.2200	0.2200	0.3000	0.3000	≤0.30
COD_{Mn}	≤0.5000	≤0.5000	≤0.5000	≤0.5000	4.0300	4.0000	0.5000	0.5000	≤3.00

COD_{Mn} = chemical oxygen demand (potassium permanganate index), mg/L = milligram per liter, NH_3-N = ammonia nitrogen, pH = measure of acidity or basicity of an aqueous solution,.
* December 2012 and January 2013.
Source: Domestic environmental impact assessment report.

Table V.8: Chlorophyll—A Content in the Project Reservoirs

Item	Qiufeng Reservoir		Longxi Reservoir	Jinxi Reservoir
Chlorophyll a content (mg/m^3)	2.615		2.600	2.880
Day-length (hours)	10.000		10.000	10.000
Euphotic depth (m)	1.800		1.800	1.700
Primary productivity (mg·c/m^2·d) [a]	94.140		93.600	97.920
Assessment result	Moderate eutrophication		Moderate eutrophication	Moderate eutrophication
Assessment standard (mg·c/m^2·d)	Oligotrophic	Moderate eutrophication	Eutrophication	High eutrophication
	＜50.000	50.000–100.000	100.000–150.000	＞150.000

m = meter, mg/m^3 = milligram per cubic meter, mg·c/m^2·d = milligram carbon per square meter per day.

[a] Primary productivity of a community is the rate at which biomass is produced per unit area by plants, expressed in dry organic matter. The unit is kilogram carbon per square meter per day [kg c/(m^2)(day)].

Source: Domestic environmental impact assessment report.

Table V.9: Ambient Air Quality Standard of GB3095-1996 (mg/m^3)

Pollutant	Time	Grade I Standard	Grade II Standard	EHS
SO_2	Annual average	0.02	0.06	n/a
	Daily average	0.05	0.15	0.125–0.050 (0.020 guideline)
	Hourly average	0.15	0.50	n/a
PM_{10}	Annual average	0.04	0.10	0.07–0.03 (0.02 guideline)
	Daily average	0.05	0.15	0.075–0.150 (0.050 guideline)
NO_2	Annual average	0.04	0.08	0.04 guideline
	Daily average	0.08	0.12	n/a
	Hourly average	0.12	0.24	0.20 guideline
CO	Daily average	4.00	4.00	n/a
	Hourly average	10.0	10.0	n/a

CO = carbon oxide, mg/m^3 = milligram per cubic meter, NO_2 = nitrogen dioxide, PM_{10} = particulate matter less than 10 μm, SO_2 = sulphur dioxide.

Source: Domestic environmental impact assessment report.

71. All sampled parameters met the respective standards (Table V.10).

Table V.10: Ambient Air Quality Sampling in Project Sites (mg/m^3)

Para-meter	Grade Applied (Location)	Monitoring Point	Hourly Average Concentration	Daily Average Concentration	Average Concentration in 7 Days	Standard	
						Hourly Average	Daily Average
SO_2	Grade I (Danan Mountain Area)	Site for Qiufeng WSP	0.012–0.037	0.014–0.023	0.019	0.15	0.05
		Site for Jinxi WSP	0.014–0.042	0.019–0.029	0.024		
		Site for Longxi WSP	0.011–0.029	0.015–0.020	0.018		
	Grade II (Plain area)	Xipo Village on Xiaxin Rd (pipeline construction)	0.024–0.083	0.038–0.053	0.042	0.50	0.15
		Gongshang Village on Beihuan Avenue (pipeline construction)	0.009–0.033	0.015–0.020	0.016		
NO_2	Grade I (Danan Mountain Area)	Site for Qiufeng WSP	0.009–0.031	0.016–0.022	0.020	0.12	0.08
		Site for Jinxi WSP	0.009–0.025	0.016–0.023	0.019		
		Site for Longxi WSP	0.009–0.014	0.010–0.013	0.011		
	Grade II (Plain area)	Xipo Village on Xiaxin Rd (pipeline construction)	0.014–0.021	0.017–0.020	0.018	0.24	0.12
		Gongshang Village on Beihuan Avenue (pipeline construction)	0.012–0.055	0.024–0.030	0.027		
PM_{10}	Grade I (Danan Mountain Area)	Site for Qiufeng WSP	…	0.023–0.035	0.027	…	0.05
		Site for Jinxi WSP	…	0.018–0.025	0.020		
		Site for Longxi WSP	…	0.013–0.021	0.017		
	Grade II (Plain area)	Xipo Village on Xiaxin Rd (pipeline construction)	…	0.031–0.041	0.035	…	0.15
		Gongshang Village on Beihuan Avenue (pipeline construction)	…	0.078–0.113	0.097		

EIA = environmental impact assessment, mg/m^3 = milligram per cubic meter, NO_2 = nitrogen dioxide, PM_{10} = particulate matter less than 10 µm, SO_2 = sulphur dioxide, WSP = water supply plant.
Source: Domestic EIA report.

6. Noise

72. **Sampling methods and standards set for project.** Noise monitoring was conducted at 29 points, comprising 12 at the boundaries of the WSPs (#1–12), three villages near the WSPs (#13–15), 10 points at nine villages and a school near the main pipeline routes along Beihuan Avenue, Xiaxin Road and Chensha Highway (#16–25), and four for monitoring baseline traffic noise along Beihuang Avenue, Chensha highway and Xiaxin Road (#26–29), respectively. Monitoring was conducted on three consecutive days from 5 to 7 December 2012. In accordance with the PRC's Urban Ambient Acoustic Quality Standard (GB3096-2008), assessment areas for construction of new pipelines along roads are classified as Class 4a or Class II. Sensitive areas such as schools, hospitals, residential communities and other sensitive spots are assessed based on the acoustic environment function zoning identified by the local EPB. The applicable environmental noise standard values and the applicable areas are in Table V.11.

Table V.11: Acoustic Quality Standards [dB(A)]

Standard	Applicable Area	PRC		EHS[a]	
		Day	Night	Day	Night
I	Areas within 200 m of WSP boundary lines and reservoir banks	55	45	n/a	n/a
II	Areas beyond 50 m on both sides of pipeline route in the plain	60	50	55	45
4a	Areas within 50 m on both sides of pipeline route in the plain	70	55	n/a	n/a

dB(A) = A-weighted decibel, m = meter, WSP = water supply plant.
[a] World Bank Group. 2007. *Environmental, Health, and Safety Guidelines*. Washington DC.
Source: The PRC's Urban Ambient Acoustic Quality Standard (GB3096-2008).

73. **Results.** Noise levels around the WSPs, nearby villages, and sensitive points along the main pipeline routes, all met Grade I of the PRC's Urban Ambient Acoustic Quality Standard (GB3096-2008) for daytime [55 dB(A)] and nighttime [45 dB(A)] (Table V.12). One site, Beicheng Avenue (#29), exceeded Grade 4a standard (70 dB(A) for daytime; 55 dB(A) for nighttime) due to heavy vehicle traffic. In general, according to the Shantou Municipal Environmental Quality Report (2012), the annual average environmental noise in the urban area of Chaonan District is 55.7dB(A), and which meets Grade II of the PRC's Urban Ambient Acoustic Quality Standard (GB3096-2008). This report also states that the annual average traffic noise within 50 m of roadsides was 68.8 dB(A), which meets the Grade 4a standard of GB3096-2008.

Table V.12: Environmental Noise Baseline in the Project Area [dB(A)]

No.	Monitoring Location	Result		Standard	
		Day	Night	Day	Night
(a) Monitoring points at the WSP boundaries					
1	Site of Qiufeng WSP (East)	48.2	44.0	55	45
2	Site of Qiufeng WSP (South)	50.9	43.2		
3	Site of Qiufeng WSP (West)	53.2	43.9		
4	Site of Qiufeng WSP (North)	47.2	43.8		
5	Site of Jinxi WSP (East)	52.9	44.0		
6	Site of Jinxi WSP (South)	53.8	43.4		
7	Site of Jinxi WSP (West)	53.4	43.2		
8	Site of Jinxi WSP (North)	50.9	44.4		
9	Site of Longxi WSP (East)	53.3	42.9		
10	Site of Longxi WSP (South)	50.8	44.1		
11	Site of Longxi WSP (West)	51.8	44.7		
12	Site of Longxi WSP (North)	53.1	42.3		
(b) Major acoustic environment sensitive points at the project area					
13	Qiufeng Village (near Qiufeng WSP)	51.5	44.1	55	45
14	Shenxi Liumengling School (near Jinxi WSP)	50.5	42.5		
15	Dapu Village (near Longxi WSP)	52.4	42.4		
16	Liannan Village (pipeline along Beihuang Avenue)	57.2	49.3	60	50
17	Dongxi Village (pipeline along Beihuang Avenue)	55.2	45.4		
18	Huaqiao Village (pipeline along Beihuang Avenue)	56.6	48.0		
19	Yiying Village (pipeline along Beihuang Avenue)	55.8	47.3		
20	Yangchen Village(pipeline along Beihuang Avenue)	57.1	46.6	60	50
21	Xiandou Village (pipeline along Chenshan Highway)	52.4	47.2		
22	Xianxin Village (pipeline along Chenshan Highway)	56.8	43.7		
23	Sihe Village(pipeline along Xiaxin Road)	57.3	47.2		
24	Xiwei Village (pipeline along Xiaxin Road)	57.4	41.3		
25	Silian Village (pipeline along Xiaxin Road)	55.6	44.9		
26	Longchuanling Village (on roadside of Chensha Highway	68.3	54.1	70	55
27	Southeast of Jianpu Village (on roadside of Chensha Highway	67.1	53.0		
28	Xipu Village (on roadside of Xiaxin Road	67.3	53.8		
29	On roadside of Beihuan Avenue	71.4	58.3		

dB(A) = A-weighted decibel, EIA = environmental impact assessment, WSP = water supply plant.
Source: Domestic EIA report.

7. Physical Cultural Resources

74. The Chaonan District Bureau of Cultural Relics reported no cultural relics or subsurface archaeological artifacts are known to exist in the project area. The nearest known physical cultural resource is Cuifeng Rock Scenic Spot (~660 years old), 13 km from the project area. Contemporary gravesites are scattered on the hillsides of Jinxi, Longxi, and Qiufeng reservoirs.

VI. ANTICIPATED IMPACTS AND MITIGATION MEASURES

A. Assessment of Potential Impacts

75. Potential project impacts, both positive and negative, were assessed during the domestic EIA and PPTA studies, through site visits, technical analysis and consultations with government agencies and local communities. Positive impacts include direct improvements to water quality and supply to a large majority of residents in Chaonan District, climate change adaptation and reduced water and energy losses, and pollution control (Section IV.B). Potential construction impacts include noise, air, and water pollution, fugitive dust, soil erosion and contamination, solid waste disposal, interference with traffic and municipal facilities, land acquisition and resettlement, and occupational and community health and safety. Potential operational impacts include noise and energy use of WSP pumps, occupational health and safety during WSP operation, and the need to maintain protection efforts at the three project reservoirs to minimize nonpoint source pollution from agriculture and rubbish dumping from local communities.

76. Potential adverse impacts have been grouped in three categories: impacts on physical, biological, and socioeconomic environment. Impacts during construction and operation are considered separately. Potential impacts from the project were considered under the following categories: (i) direct impacts—those directly due to the project itself; (ii) indirect impacts—those resulting from activities arising from the project, but not directly attributable to it; and (iii) cumulative impacts—impacts which in combination would exert a significant additive influence.

B. Detailed Design and Pre-Construction Phase: Measures to be Undertaken

77. The following measures will become permanently part of the infrastructure and will be included in the detailed design of facilities by the design institutes.

78. **Pipeline routes and water supply plant locations**. The proposed route for the pipeline network was selected to follow existing road easements as far as possible, to avoid environmental and social impacts. The proposed site for the new Longxi WSP was selected based on an evaluation of two potential sites and consideration of environmental, social and economic factors (Section VII). During the detailed design phase, these preliminary routes will need to be finalized and mapped. Any changes to the proposed routes or WSP location which may result in new environmental or social impacts will need to be evaluated.

79. **Reduced pipeline size.** The diameters of partial pipelines were reduced from 800–1,200 mm in the original FSR to 600–800 mm in the updated one. This will reduce the area of temporary and permanent land occupation, width of pipeline trench construction and surrounding land disturbance, and potential soil erosion.

80. **Low-carbon water supply system.** The WSPs will be designed to achieve the following aims: (i) high efficiency pumping, (ii) water leak detection and management, (iii) water supply system automation, and (iv) accurate metering and monitoring for water consumption.

81. **High efficiency pumping system.** The following design components are included in the FSR and will be designed in the detailed design phase: (i) design and install variable speed drives for pumping; (ii) match the pump to requirements—design or replace inefficient (and often over-sized) pumps with efficient, properly sized ones; and (iii) optimize the distribution piping and eliminate unnecessary valves. The following practices will be implemented during the operational phase: (i) control pump speed where appropriate; (ii) institutionalize improved O&M practices, including regular preventative inspection and maintenance, cleaning or replacing impellers, and checking lubrication of bearings; (iii) re-wind pump motors (when insufficient funds to replace them); and (iv) trim impellers where pumps too large for the application.

82. **Leak detection and management.** ‘Real’ water loss (Section III.B) will be reduced by (i) leak detection and repair (vehicles equipped with water leak detectors and repair tools will be

employed), (ii) design of an appropriate pressure management system within the water supply network, and (iii) design techniques and/or measures to minimize night flow to gauge leakiness of water supply system (Figures VI.1–VI.3).

Figure VI.1: Typical water leak due to aged pipe

Figures VI.2–VI.3: Acoustic loggers and digital ground microphone for leak detection

83. **Automation.** Automation in the water supply sector seeks to optimize efficiency by measuring system parameters such as pressure, water level, flow rates and water quality. The most common system used in some large and medium-sized cities in the PRC is the SCADA system. The basic SCADA system consists of one central computer (the master terminal unit [MTU]) that controls remote terminal units (RTUs) at key control points such as pumping and metering stations, plus the equipment to communicate between the MTU and RTUs. The RTU uses information from those sensors connected to it to control system components, such as pumps and valves; and. enables the user to access performance information on the site.

84. A properly designed SCADA system (Figure VI.4) for water pumping saves energy and water and improves service. Benefits include (i) complete information on pumping operation provided in real time; (ii) pump operation adjusted automatically as needed to ensure reliable water supply; (iii) the need for service personnel to visit sites for inspection, data collection, or adjustments greatly reduced; (iv) alarms sent to the central control location in case of emergency; (v) optimal pressure maintained in the water supply network, minimizing service interruptions, and eliminating water hammers; (vi) electricity consumption reduced and pump productivity increased; (vii) troubleshooting facilitated; (viii) equipment life increased; and (ix) reports generated automatically. Typical savings in the PRC and worldwide include: (i) water savings of about 10%; (ii) electricity savings of 12%–30%; (iii) reduced downtime of up to 30%; and (iv) reduced maintenance and personnel costs of 15%–30%.

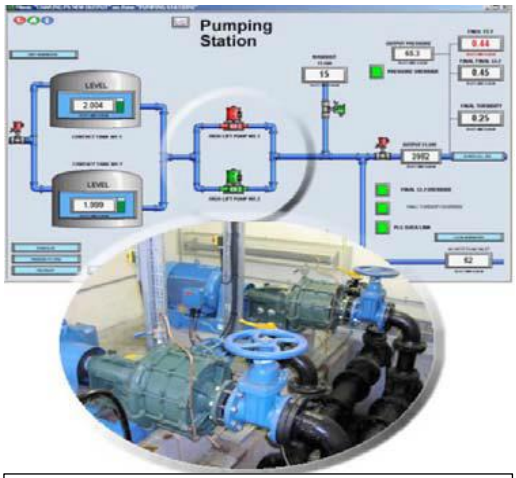


Figure VI.4: Typical SCADA System

85. The project will implement an inexpensive and basic SCADA system. The design of the SCADA system will be further developed in the preliminary and detailed design stages.

86. **Water supply metering.** The following principles are included in the FSR. They will be achieved through the detailed design phase for the water supply system: (i) create a system for water supply metering and monitoring if there is none; (ii) develop baselines and metrics for

regular monitoring and metering; (iii) create targets and gauge success towards achieving them against baselines and benchmarks; and (iv) design and install proper water meters, including magnetic card water meters, remote transmitting ones, etc. According to the FSR, about 37,767 new water meters will be installed under the project component.

87. **Water quality monitoring center of the Chaonan Water Supply Company.** Currently, there are two small water quality monitoring laboratories at the Qiufeng and Jinxi WSPs, with some glassware, chemicals and simple instruments. These laboratories are able to monitor 26 water quality parameters. As part of construction of the new Longxi WSP, a new water quality laboratory will be constructed. This will have the capacity to analyze 42 "regular" parameters (see para. 18). This new laboratory will be responsible for measuring water quality samples from the three WSPs (Jinxi, Longxi, and Qiufeng) and 47 rural water supply facilities in Chaonan District. The Domestic Drinking Water Quality Standard (GB5749-2006) lists a total of 106 water quality parameters, including 42 regular parameters and 64 non-regular parameters; although until July 2012 all 106 were generally only measured by laboratories in major cities in the PRC. The 42 parameters to be measured by the Longxi WSP, a county- or district-level water supply company, is satisfactory under the national standard for and Guangdong provincial regulation for internal monitoring of the quality of treated water to be produced by the project WSPs. Twice a year, water samples will be sent to the Shantou Water Supply Company for a complete analysis of the 106 parameters.

88. **Water quality monitoring.** The monitoring tasks after project completion will expand to (i) water sources of the three reservoirs, including different locations and depths; (ii) water intake points and outlets of the WSPs; (iii) water quality in the water supply network, particularly at the ends of pipelines; and (iv) 47 rural water supply facilities which service the rural region of Chaonan District, including their raw water and outlet water.

89. **Laboratory instruments.** Under the project, new laboratory equipment will be provided for the new water quality laboratory (Table VI.1).

Table VI.1: Laboratory Equipment to be provided under the Project

No.	Instrument	Amount
1	Gas Chromatograph (GC)	1
2	Graphite Furnace Atomic Absorption Spectrophotometer (AAS)	1
3	Ion Chromatograph	1
4	Ultra-violet and Visible Spectrophotometer	2
5	pH Meter	2
6	Turbidity Meter	3
7	Conductivity Meter	1
8	Residual Chlorine Detector	2
9	Microscope	2
10	Precision Electronic Balance	3
11	Ancillary Equipment and Facilities	Some
12	Sampling Vehicle (with water samplers and potable water quality detectors)	1

Source: Domestic environmental impact assessment report.

90. **Field sampling.** Because sampling locations for the district water quality monitoring are widely distributed, a mobile laboratory (monitoring vehicle) equipped with required portable instruments will be purchased for site monitoring at the reservoirs, the water supply networks and the rural WSP facilities. Moreover, the online automatic monitoring system will be also installed at the water intakes of the WSPs for early raw water quality detection. The mobile laboratory will measure the water quality parameters of pH, conductivity, turbidity, BOD_5, COD_{cr}, NH_3-N, NO_2-N, hardness, DO, TDS, toxicity, coliform and total bacteria, and leakage detection. The online automatic monitoring system can at least monitor the parameters of turbidity, NH_3-N

and COD_{cr} (Figure VI.5).

Figure VI.5: Typical Mobile Laboratory, and Portable and Online Water Quality Monitoring Instruments

91. **Training for the laboratory personnel.** Good monitoring quality needs qualified laboratory technicians. CWSC should, as soon as the project begins implementation, send promising laboratory technicians to the laboratory of the Shantou Municipal Water Supply Company, or the municipal EMS to learn operation of above instruments, including standard examination methods, quality assurance and/or quality control (QA/QC) procedure, and calibration and maintenance of the instruments.

92. **Reforestation component.** The following measures will be included in this component:

i) Native broad-leaved tree species, shrubs, and grasses will be used for reforestation.
ii) Target sites are eroded and bare hill slopes facing the reservoir water bodies.
iii) Only base fertilization will be applied, without top-dressing fertilizer or pesticide spraying, to avoid contaminated runoff into streams and the reservoirs.
iv) Planting will comprise a mixed mosaic of forests, shrubs, and grasses rather than mono-stands of a single or few species.
v) No foreign species will be used for reforestation.

93. **Spoil disposal site.** The construction spoil disposal site was identified by the PMO, IAs, design institute (DI), and EIA Institute in June 2013. It was approved by the Chaonan District Urban Management Bureau (UMB) in July 2013. Approval by the Shantou Municipal EPB is expected before end-September 2013. The PMO and IA (CWSC) reached an agreement with the site manager, the Chaonan (Shenzhen) Industrial Park, for spoil disposal on 10 July 2013. The site is state-owned construction land. No land acquisition or resettlement will be required, as

the land will be used temporarily under a voluntary negotiated agreement between CWSC and the industrial park. The land will later be used for industrial development, with the spoil serving for land leveling.

94. The site is located 700 m inland from the coast, between Jingtain Highway and Shenzhen–Shantou Expressway (23°9'13.72"N 116°32'27.88"E) (Figure III.10). The site is 7–25 km from the project construction sites. The total site area is 48.37 ha (725.6 mu). The site is a low-lying depression 1.2 m deeper than the surrounding landscape. It can support an estimated 0.56 million m^3 spoil, sufficient for containing the 0.37 million m^3 spoil to be generated by the project (Table VI.2). The site has many small pits. About 18 ha (37.2%) of the site supports vegetation: grass, shrubs, a fern *Diranopteris dichotoma* (a foreign species), and low trees *Casuarina* spp.[25] The site only supports Modified Habitat, not Natural Habitat (as defined by the SPS). There is planted tree windbreak (mainly *Casuarina*) between the beach and Shenzhen–Shantou Expressway. No national or provincial protected species or those in the International Union for Conservation of Nature (IUCN) Red-List of Threatened Species occur on the site. The nearest permanent freshwater body is the Lian River (6.7 km away). The spoil will comprise surplus soil from excavation of the water supply pipeline and WSP foundation work (96%) and small concrete blocks (4%). The spoil site will be filled until it reaches equal elevation level with the surrounding land.

95. Potential impacts comprise (i) soil erosion, especially during winds or rain; (ii) noise and fugitive dust generated during spoil uploading, transporting, and disposal; and (iii) the clearance of most existing vegetation. Mitigation measures for soil erosion control and site restoration are proposed in the domestic EIA and the project EMP (Attachment A; Table A.3). A comprehensive plan for the soil erosion control and site restoration, including re-vegetation, will be prepared during the detailed design stage. This will be included in all bidding documents and civil construction contracts. Under the supervision of Chaonan District EPB and UMB, internal inspection and monitoring for soil erosion and site restoration will be conducted by contractors and construction supervision companies (CSCs). Compliance inspection and monitoring will be conducted by the district EMS. The inspection and monitoring results will be submitted to the PMO, IAs, district EPB, WRB, and UMB, as the basis for project implementation progress reports and acceptance of construction.

96. **Environment management readiness.** The following measures will be implemented in the pre-construction phase to ensure the project's environment management readiness.

(i) Institutional strengthening, including (a) appointment of one qualified environmental officer within the PMO; (b) hiring of one loan implementation environment consultant (LIEC) within loan administration consultant services by the PMO; and (c) contracting of Chaonan District EMS by the PMO to conduct environmental impact monitoring.

(ii) **Updating the environmental management plan.** The mitigation measures defined in the project EMP (Attachment A) will be updated based on final detailed design. This will be the responsibility of the PMO, using a qualified DI.

(iii) **Land acquisition confirmation.** The resettlement plan will be updated with final inventory. This will be the responsibility of the PMO and the Chaonan Land Acquisition and Resettlement Office.

(iv) **Contract documents.** All tender documents will include the EMP obligations, including the environmental monitoring program. Approved spoil disposal sites, material haulage routes, borrow pit locations, and construction wastes disposal arrangements will be defined in the contracts as appropriate. This will be the DI's responsibility, with support of the PMO and the LIEC. All contractors and CSCs will be required to comply with the EMP.

[25] Source: EIA Institute.

(v) Following the award of contracts of construction and construction supervision, the contractor and the CSC will prepare a construction site EMP and an environmental supervision plan, respectively, including an emergency preparedness and response plan for construction emergencies and a site environment, health and safety plan, for approval by the PMO, the district EPB, and the IAs.

(vi) **Training in environmental management.** Environmental specialists and/or officials, including the LIEC and provincial and municipal EPBs, will be invited to provide training on implementation and supervision of environmental mitigation measures to the PMO, IAs, CSCs, and contractors.

C. Construction Phase: Impacts and Mitigation Measures

1. Environmental Management on Construction Sites

97. During construction, the assigned PMO environmental officer, together with environmental supervision engineers from the CSCs, will be responsible for enhancing site supervision, management and appraisal, and timely identification and resolution of any issues. Intermittent follow-up training (following the pre-construction measures; Section VI.B) will be conducted.

2. Impacts on Physical Resources

98. **Geology, topography, and soil.** Potential impacts on geology and topography may result from (i) pipeline excavation and backfill activities, which will occur along some existing roads, (ii) foundation works for WSP structures; and (iii) spoil disposal, which will cause topographical changes and visual problems unless properly controlled. The total estimated volume of earth to be excavated for construction of the WSPs and pipeline network is 1,619,624 m^3, and an estimated 1,584,197 m^3 will be required as in-fill (Table VI.3). Most of the excavated earth will be used as in-fill (including hauling in and out between different construction sites), creating a surplus spoil volume of 376,691 m^3 (Table VI.2).

99. Soil erosion may be caused by WSP construction, excavation of pipe trenches, and stockpiles and spoil from earthworks. Construction of the water intakes and pump stations at the three reservoirs could contribute to localized bank erosion. Moderate soil erosion (<500 tons/ha/year[26]) is expected during construction when surface vegetation and soil is disturbed. Soil erosion can also occur after completion of construction in areas, if site restoration is inadequate. The most vulnerable soil erosion areas in the construction sites of influence include foundation pits, pipeline trenches, spoil sites, temporary construction sites, and other areas where surface soil is disturbed. Soil contamination may result from the inappropriate transfer, storage, and disposal of polluted earth, petroleum products, chemicals, hazardous materials, liquids, and solid waste.

[26] Source: The Soil Erosion Protection Plan, 2013.

Table VI.2: Project Earthworks (m^3)

Project Components		Excavation (A)			Backfill (B)			Hauling in (C)		Hauling out (D)		Borrow from other sources (E)		Spoil (F)
		Earth	Rock	Subtotal	Earth	Rock	Subtotal	Vol.	Source	Vol.	To	Earth	Rock	Vol.
Qiufeng water treatment plant (WTP)	Plant area	46,772[27]	2,160	48,932	120,484		120,484	17,195 (gravel)	Pipeline excava-tion	2,160 (gravel)	Water intake	71,928		15,412
	Coffer-dam for water intake	187,369	43,183	230,552	187,369	43183	230,553	2,160 (gravel)	Qiufeng WSP			187,369	41,023	230,552
Longxi WTP		100,873		100,873	127,393		127,393	31,564	Pipeline excava-tion					5,044
Jinxi WTP		9,297		9,297	38,155		38,155	29,324	Pipeline excava-tion					465
Water supply pipeline		1,104,751	84,276	1,189,027	1,026,669		1,026,669			78,082	Three WTPs			84,276
Cofferdam at point of pipeline crossing creeks		40,541	402	40,943	40,541	402	40,943					40,541	402	40,943
Total		1,475,841	130,021	1,619,624	1,540,611	43,585	1,584,197	80,242		80,242		299,839	41,425	**376,691**
Key: F = Subtotals A – B + C – D + E														

Source: Domestic feasibility study report and environmental impact assessment with assistance of the project preparatory technical assistance consultants.

100. The following mitigation measures for soil erosion and contamination will be adopted.

(i) Prior to construction the contractor(s) will prepare and implement a site drainage and soil erosion management plan to prevent soil erosion, which will include the following.

(ii) Surplus spoil of 376,691 m^3 (Table VI.2) will be transported to the approved spoil disposal sites before completion of each component.

(iii) Stabilize all compacted pipe trenches, and other erosion-prone working areas while works are going on.

(iv) All earthwork disturbance areas must be stabilized within seven days of site completion.

(v) Minimize active open excavation areas during water supply pipeline trenching activities [28] and use appropriate compaction techniques for pipe trenches construction.

(vi) Provide temporary detention ponds or containment to control silt runoff.

(vii) Construct intercepting ditches and drains to prevent runoff entering construction sites, and divert runoff from sites to existing drainages.

(viii) Strip and stockpile topsoil, and cover or seed temporary soil stockpiles.

(ix) Limit construction and material handling during periods of rains and high winds.

(x) Properly re-vegetate disturbed surfaces, such as compacted pipeline trenches and WSPs after completion of constructions.

(xi) Locate temporary construction camps and storage areas to minimize land area required and impacts on soil erosion. Locate camps and storage sites at least 100 m from any streams or rivers.

[27] Including 13,762 m^3 of underwater excavation.
[28] Maximum length of a trench excavation is 300 m according to the domestic EIA report.

(xii) Properly store petroleum products, hazardous materials and wastes on impermeable surfaces in secured and covered areas.
(xiii) Remove all construction wastes from the site to the approved soil disposal sites.
(xiv) Establish emergency preparedness and response plan (spill management plan) and provide spill cleanup measures and equipment at each construction site. Require contractors to conduct training in emergency spill response procedures.
(xv) Implement the EMP soil monitoring program (Attachment A). Internal inspection and monitoring will be conducted by contractors and CSC while compliance inspection and monitoring shall be conducted by a licensed institute following the monitoring plan in the EMP. Monitoring results will be submitted to the IAs and the PMO, the Chaonan District EPB and WRB to serve as basis for project implementation progress reports and acceptance of construction.

101. **Impacts on hydrology and surface water quality.** The main impact on hydrology during construction focus on the water supply pipeline crossing the creeks in the district. There are seven points where the pipeline will cross four creeks: Shen, Liangying, Xiashan, and Zhonggang (Table VI.3 and Figures VI.6–VI.7). These creeks are severely polluted and have a water quality of Grade V of the PRC's Surface Water Quality Standard (GB3838-2002). The proposed construction method for the pipeline crossing in the FSR is on bridge abutment laying (Figure V.5), which is not expected to cause significant impacts on hydrology and water quality.

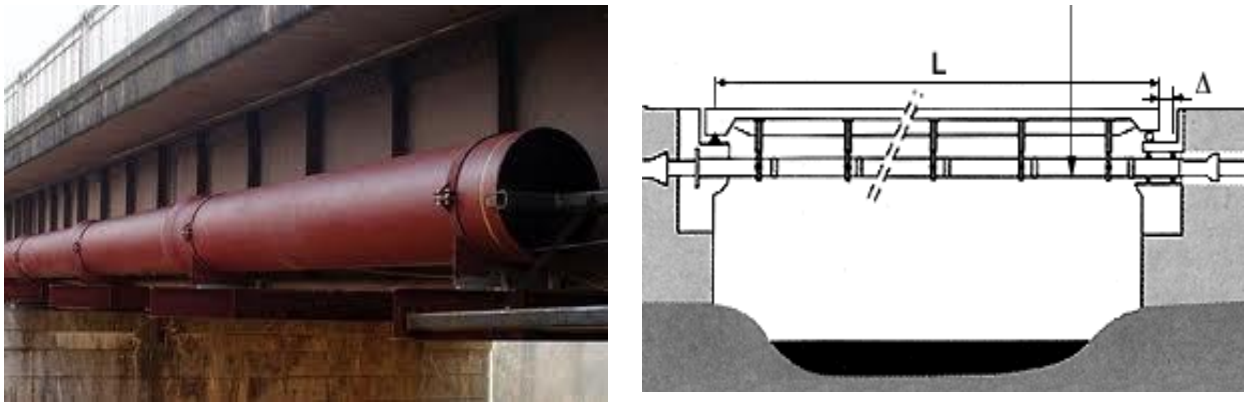


Figure VI.6: Laying Pipeline on Bridge Abutment

Table VI.3: Creeks to be Crossed by the Water Supply Pipeline

No.	Geographic coordinate of crossing point	Creek to be crossed	Width of creek
1#	23°13'22.88"(N), 116°18'57.88"(E)	Shen Creek	< 10 m
2#	23°14'23.39"(N), 116°19'27.72"(E)	Shen Creek	< 10 m
3#	23°16'32.19"(N), 116°20'5.17"(E)	Shen Creek	10 m
4#	23°12'13.76"(N), 116°20'45.80"(E)	Liangying Creek	15 m
5#	23°13'22.26"(N), 116°22'21.88"(E)	Liangying Creek	15 m
6#	23°13'36.27"(N), 116°25'17.61"(E)	Zhonggang Creek	20 m
7#	23°15'54.53"(N), 116°26'50.81"(E)	Xiashan Creek	25 m

Source: Domestic environmental impact assessment report.

102. **Other surface water to be impacted by the project.** The site of the proposed Jinxi WSP contains one pond (N23°12'20.71" E116°17'54.41") of about 1.66 mu (1,107 square meters [m^2]). The pond will be used for construction of a sludge thickening basin for the WSP. This will reduce the excavation earth work. The pond is highly polluted [Grade IV of the PRC's Surface Water Quality Standard (GB3838-2002)]. It is used for intermittent, local recreational fishing by residents of Shenxi Village; although it has never been contracted to individuals for fisheries, agricultural production, or any other business operations. The site (including the pond) will be acquired for the WSP. Compensation for loss of the land has been developed with Shenxi Village and is described in the project resettlement plan (RP). There are no other surface water bodies within 300 m from the construction sites of the proposed WSPs and pipeline routes according to the survey conducted by the EIA Institute in June 2013.

103. **Impact to surface water.** Construction activities have the potential to impact water quality of the project related reservoirs, creeks, and flood drainage channels. Construction of the WSPs, especially the water intake facilities and pump stations near the reservoirs, could impact surface water quality through runoff of disturbed soil. Contamination of reservoir water could potentially occur from inappropriate storage and handling of petroleum products and hazardous materials, accidental spills, disposal of domestic wastewater from construction camps, and wash-down water from construction equipment and vehicles during constructions of the WSPs, water intakes, and pump stations.

Figure VI.7: Water Supply Pipeline Crossing Creeks

104. **Construction wastewater.** Wastewater produced during construction will come from pipe ditch groundwater drainage, washing aggregates, pouring and curing concrete, and wastewater from maintenance and cleaning of mechanical equipment and vehicles. Based on the domestic EIA report, there will be four (average construction period) to five (peak period) construction sites simultaneously in the district. Each construction site will generate about 11 m^3/d construction wastewater according to the EIA. The work force during peak and average construction periods is estimated to be 1,100 and 800 workers respectively. The daily domestic wastewater discharge from each worker is 0.165 m^3 according to the EIA report. Estimates of construction and domestic wastewater generated during construction are in Table VI.4.

Table VI.4: Summary of Wastewater Generated during Construction

Item	Daily (peak)	Annual (peak)	Daily (average)	Annual (average)
Construction wastewater	55 m^3/d	15,950 m^3/a	44 m^3/d	12,760 m^3/a
Domestic wastewater	181.5 m^3/d	52,635 m^3/a	132 m^3/d	38,280 m^3/a

m^3/a = cubic meter per annum, m^3/d = cubic meter per day.
Note: The working days are estimated as 290 days per year.
Source: Domestic environmental impact assessment report.

105. The major pollutant in construction wastewater is suspended solid (SS, 500–2,000 mg/L), which will be used for water spaying dust control after sedimentation on construction site. The domestic wastewater generated from the WSP construction site will be discharged through the existing sewer drainage system of the WSPs. For the pipeline construction, according to the FSR, about half of the construction workers will live in rented apartments and the remainder (400–550)

will live in temporary camps, where eco-toilets and on-site wastewater pre-treatment systems will be installed.

106. The following mitigation measures for water protection will also be adopted:
   (i) **Water quality protection at the reservoirs.** All earthworks near the reservoirs will be accompanied by measures to minimize sediment runoff into the reservoirs. This will include the use of sediment traps to protect runoffs from construction activities;
   (ii) Discharge of construction wastewater to the reservoirs is prohibited;
   (iii) Fuel storage, maintenance shop, and vehicle cleaning areas will be stationed at least 500 m away from the reservoirs;
   (iv) Contractors' fuel suppliers must be properly licensed. They shall follow proper protocol for transferring fuel and the PRC standard of JT3145-88 (Transportation, Loading and Unloading of Dangerous or Harmful Goods); and
   (v) A water quality monitoring program for the project construction phase has been developed in the EMP and will be implemented to assess the impact of construction activities on the water qualities of the reservoirs compare with baseline conditions.

107. **Air quality.** Anticipated sources of air pollution from construction activities include (i) fugitive dust generated from earth excavation, filling, loading, hauling, and unloading; (ii) dust generated from disturbed and uncovered construction areas, particularly along pipeline trenches, especially on windy days; (iii) dust generated by the movement of vehicles and heavy machinery on unpaved access and haul roads; (iv) dust from aggregate preparation and concrete-mixing; (v) vehicle emission from construction vehicles (gaseous CH, CO, and NO_2) and heavy diesel machineries and equipment; and (vi) asphalt flue gas during road re-pavement after the pipeline work completion. All of the identified 14 sensitive receptors for this project (Table VI.3) will at some stage be impacted by dust and/or gaseous emissions from construction. Based on experience from similar constructions, the gaseous emission impact from pipeline construction is low, and fugitive dust impact is low to medium; although the impact from pipeline construction is short term and linear, the six receptors in Table VI.3 located nearest (10–100 m) to the pipeline construction sites should be especially protected.

108. The quantity of dust generated by the construction activities depends on the force of the wind, the humidity of the material and soil, the level of construction and the state of the site. It is estimated that under the general condition (with an average wind speed of 2.5 m/second) in the area of 150 m downwind from the emission sources, the dust becomes less apparent and disturbing. Based on findings in the domestic EIA, for dust generated by transporting earth and other construction materials, the impact will be very small once the transportation vehicles are covered in accordance with the EMP. The applicable standard for PM_{10} is 0.15 milligrams (mg)/m^3 in daily average concentration of the PRC's Ambient Air Quality Standard (GB3095-1996).

109. A particular emission from pipeline construction is asphalt flue gas due to road re-pavement after the pipelines have been buried. According to the FSR, about 500,000 m^2 of existing roads will be repaved. During the asphalt heating and mixing process, the fuel burning will produce smoke, and the asphalt will produce flue gaseous emissions. Currently, modern asphalt mixing equipment used in the PRC releases typical emission concentrations of asphalt flue gases of about 30 mg/m^3, which complies with asphalt flue gas discharge requirements of 80–150 mg/m^3 of the PRC's Integrated Emission Standard of Air Pollutants (GB16297-1996). It also complies with the PRC's Ambient Air Quality Standard (GB3095-1996), which limits the concentration of benzopyrene at 0.01µg/m^3 (at 100 m downwind from the asphalt mixer).

110. The following mitigation measures for air quality protection will be adopted:
   (i) Spraying water on construction sites and earth and/or material handling routes where fugitive dust is being generated;

(ii) Locating asphalt mixers as far away as possible (at least 500 m downwind) from the nearest villages, residential areas and other sensitive receptors;
(iii) Paying particular attention to dust suppression near sensitive receptors;
(iv) Storing petroleum or other harmful materials in appropriate places and covering to minimize fugitive dust and emission;
(v) Covering materials during truck transport, particularly the fine material, to avoid spillage or dust generation;
(vi) All asphalt mixing equipment used by the project will comply with flue gas discharge requirements of the PRC's Integrated Emission Standard of Air Pollutants (GB16297-1996) and the PRC's Ambient Air Quality Standard (GB3095-1996) (for benzopyrene emission);
(vii) Air quality monitoring will be conducted as part of the EMP environmental monitoring program to ensure that dust and asphalt mixing fumes, and other emissions from construction machinery and vehicles, do not exceed the set exceedance levels of the PRC standards of GB18352-2005, GB17691-2005, GB11340-2005, GB2847-2005, and GB18285-2005.

111. With the above mitigation measures, the impact of construction on air quality is anticipated to be acceptable according to the domestic EIA.

112. **Noise and vibration.** The project construction phase will result in increased noise levels and sudden and discontinuous vibration impacts. Construction will involve excavators, bulldozers, graders, stabilizers, dredgers, concrete-mixers, drills, stone-crushing and screening plants, rollers, and other heavy machinery. Noise during pipeline construction will be generated by trench excavators, rollers and other compaction machine (Table VI.5). Construction noise will be temporary and localized. Vibration impacts will occur from construction activities of foundation piling of WSP structures, pipeline trench compaction and stone crushing. Vibration impacts will be generated by pile drivers, land scrapers, loaders, and stone crushers, with the highest vibrations generated by pile drivers.

Table VI.5: Noise Emissions from Construction Machinery

No.	Machine Type	Average Sound Level at 10-m Distance from Machine [dB(A)]
1	Pile driver	105
2	Excavator	82
3	Bulldozer	76
4	Concrete mixer	84
5	Crane	82
6	Road roller	82
7	Truck	85
8	Electric saw	84

dB(A) = A-weighted decibel, EIA = environmental impact assessment, m = meter.
Source: Domestic EIA report.

113. Noise levels at different distances are gained after calculating the impact scope of equipment noise during construction (Table VI.6). The PRC's standard of Noise Limits for Construction Sites (GB12523–1990) specifies the noise limit Class II area as 70 dB(A) in the day and 55 dB(A) at night. Compliance limits for different machinery is in Table VI.7.

Table VI.6: Noise Levels of Construction Machinery at Varying Distances [dB(A)]

Machinery	Distance to Machinery									
	5 m	10 m	20 m	40 m	50 m	60 m	80 m	100 m	150 m	300 m
Excavator	84	78	72	66	64	63	60	58	55	47
Bulldozer	86	80	74	68	66	65	62	60	57	49
Land scraper	90	84	78	72	70	69	66	64	62	54
Loader	90	84	78	72	70	69	66	64	62	54

Machinery	Distance to Machinery									
	5 m	10 m	20 m	40 m	50 m	60 m	80 m	100 m	150 m	300 m
Roller	86	80	74	68	66	65	62	60	57	49
Concrete-mixer	87	81	75	69	67	66	63	61	58	50
Asphalt concrete paver	85	79	73	67	65	64	61	59	56	48

dB(A) = A-weighted decibel, EIA = environmental impact assessment, m = meter.
Source: Domestic EIA report.

Table VI.7: Construction Equipment Noise Impact Scope

Construction Stage	Construction Machinery	Limit Standard [dB(A)][a]		Impact Scope (m)	
		Day	Night	Day	Night
Earth and Stone Work	Excavator	75	55	15	150
	Bulldozer	75	55	18	180
	Land scraper	75	55	29	290
	Scraper loader	75	55	29	290
Piling	Pile driver	85	Prohibited	126	…
Structure	Road roller	70	55	32	180
	Truck	70	55	67	266
	Vibrator	70	55	53	224
	Dump truck	70	55	20	112
	Concrete Mixer	70	55	29	200
	Asphalt concrete paver	70	55	29	160

dB(A) = A-weighted decibel, EIA = environmental impact assessment, m = meter.
[a] The PRC's standard of Noise Limits for Construction Sites (GB12523-1990).
Source: domestic EIA report.

114. The noise impact distances during construction for compliance with the PRC's standard of Noise Limits for Construction Sites (GB12523-1990) are up to 130 m away from the source during the day and 300 m at night (Table VI.7). In addition, construction materials, surplus spoil, and construction wastes will be transported to and from the construction sites during the average 10-hour workday for the construction season of about 290 days per year in the project area for about 4–5 years. As a result, villages and urban residential areas through which haul roads pass and which are adjacent to construction sites will frequently experience noise levels at 70–80 dB in the audible scale. Without mitigation, these noise levels may impact residents and also cause injury to construction workers operating the equipment.

115. For project construction activities, construction will need to meet the PRC's standard of Noise Limits for Construction Site (GB12523-1990). During operation, the noise level of WSP operation will need to meet the Grade I Standard of the PRC's standard of Noise Limit of Industrial Enterprises (GB12348-2008, Table VI.8).

Table VI.8: Noise Limits for Construction Sites Standard [dB(A)]

Applicable Standard	Noise Limits	
	Daytime	Night
GB12523-1990	70	55
Grade I of GB12348-2008[a]	50	45

dB(A) = A-weighted decibel, EIA = environmental impact assessment.
[a] The PRC's standard of Noise Limit of Industrial Enterprises (GB12348-2008).
Source: Domestic EIA report.

116. The following mitigation measures for noise impacts will be implemented:

(i) Noise levels from equipment and machinery will conform to the PRC's standard of Noise Limit for Construction Sites (GB12523-1990), and vehicles and machinery will be properly maintained to minimize noise;

(ii) Quiet equipment (models with low sound levels) will be selected and exhaust muffling devices will be installed on combustion engines;

(iii) Noise reduction methods, including temporary noise barriers, will be applied within 300 m of villages and residential areas. (There are nine villages in Table V.3

within 300 m from construction sites);

(iv) During school examination days, heavy equipment (e.g., piling) will not be used;

(v) Sites for rock crushing, concrete-mixing, and similar activities will be located at least 1 km away from sensitive receptors. The gravel, sand, cement, and concrete will be purchased from adjacent Hulai County according to the FSR, where abundance construction materials are commercially available;

(vi) Between 22:00 and 07:00 hours,[29] all construction in urban areas and/or near sensitive receptors which exceeds night-time noise limits (Table V.8) will be halted, including movements of heavy vehicles, construction using heavy machinery, and/or piling (use of pile drivers);

(vii) Monitor noise at sensitive areas at regular intervals (Attachment A—EMP monitoring plan). If noise standards are exceeded, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation;

(viii) Prior to construction near sensitive receptors, the PMO will consult the affected communities and (a) ensure they are aware of the construction and so that activities with the greatest potential to generate noise and vibration are planned during periods of the day that will result in least disturbance; (b) with the communities, delineate construction hazard zones and identify structures which may be especially susceptible to vibration impacts; and (c) distribute ear protection against construction noise; and

(ix) During construction near sensitive receptors, the PMO will conduct monthly interviews with residents to seek feedback on noise impacts; and if necessary, adjust the working hours for construction activity.

117. **Solid waste.** Garbage will be generated from workers camps during construction. It is estimated that every worker in the camp will generate 0.5 kilograms per day (kg/d) of garbage (total 400 to 550 kg/d during average and peak construction periods, respectively). Construction workers will generate an estimated total 580 tons (estimated as average period) of garbage during the 5-year construction period, which will be transported to the Shantou Municipal Leidashi Landfill before the planned Chaonan District landfill begins operation.

118. There will be about 376,691 tons of construction wastes during the five-year construction, which will be transported to the approved construction spoil site for disposal (Table VI.2). The following measures will be implemented to manage solid waste:

(i) Covered garbage collection bins will be installed at each construction camp. It will be the responsibility of the contractors to provide sufficient garbage bins at proper locations; and ensure that they are protected from birds and vermin, and emptied regularly (using the local municipal solid waste collection systems by sighing contracts between the contractor and the local sanitation authority). The contractors' responsibility is included in the EMP and will be included in bidding documents and construction contracts; and

(ii) Construction waste that cannot be reused will be collected and regularly transported off-site by the contractor for disposal at the disposal site approved by the municipal EPB in compliance with the Law on the Prevention and Control of Environmental Pollution by Solid Waste of the PRC (issued 29 December 2004) and scrap material and demolition waste disposal standards promulgated by the PRC's Ministry of Housing and Urban–Rural Construction.

[29] The PRC guideline for noise control recommends a halt to construction noise from 20:00 to 07:00. The Shantou Municipality regulation for noise control is from 22:00 to 07:00, based on local conditions. This project follows the municipal regulation.

3. Impacts on Biological Resources, Ecology, and Biodiversity

119. There are no protected areas and no known records of rare, threatened, or endangered species within the project area. With the exception of the project component on reforestation of lands around Jinxi, Longxi, and Qiufeng reservoirs, project activities will be located in degraded and modified landscapes with low ecological values. Construction will involve limited removal of secondary vegetation along roadsides, channels, fish ponds, and rice fields, which may disturb nesting or foraging resources for common and widely distributed vertebrates and invertebrates which occur in these habitats. Such disturbance will be localized and temporary and occur within habitats which are extensive across the Chaonan coastal plain and hills. The project reforestation component may cause initial disturbance of shrubland on hillsides around Qiufeng; and the Jinxi, Longxi, and Qiufeng reservoirs during site access and preparation for tree planting. Such impacts will be localized and temporary and will not involve the construction of any permanent structures. No significant ecological impacts are anticipated. The following measures will be implemented to minimize impacts:

(i) Prior to construction, identify and demarcate existing vegetation (trees, shrubs) and habitats. As far as possible avoid the disturbance of demarcated sites;
(ii) Properly backfill, compact and re-vegetate pipeline trenches after completion;
(iii) Protect existing trees and grassland during WSP and pipeline construction. Where trees are to be removed or an area of grassland disturbed, replant trees and re-vegetate the area immediately after construction;
(iv) Remove trees or shrubs only as a last resort if they impinge directly on permanent works or approved necessary temporary works;
(v) In compliance with the PRC Forest Law, undertake compensatory planting of an equivalent or larger area of affected trees and vegetation; and
(vi) During construction activities (including reforestation), in the event that any nesting birds or animals are documented, demarcate the site and prohibit access by workers. As far as possible, plan construction to avoid the site until nesting is completed. Do not attempt to catch or relocate the nesting birds or animals.

4. Impacts on Physical Cultural Resources

120. No physical cultural resources were documented during fieldwork. Construction activities have the potential to disturb unknown subsurface cultural relics. In the event that any archaeological relics are uncovered, construction activities will be immediately suspended; and the PMO and the Chaonan Cultural Heritage Bureau will be promptly notified, in accordance with the PRC Cultural Heritage Protection Law. Construction at the site will only resume after thorough investigation and with the permission of the appropriate authorities. A clause for protection of unknown underground cultural relics will be included in construction contracts.

5. Impacts on Socioeconomic Resources

121. **Land acquisition and resettlement.** The project is classified as category B for involuntary resettlement. The project will require permanent land acquisition of 79.33 *mu* (5.3 ha) of village collective land for the construction of the three WSPs, including farmland, orchard land, construction land, wasteland, and water pond. All land is village-managed collective land currently not under use, except for a portion temporarily rented to two households in Dongbo village (Table VI.9). In addition, total temporary land occupation for laying the pipelines, access road, storing construction materials etc., will be about 2,721.16 *mu*, including 802.85 *mu* of state-owned land; and 1,468.33 *mu* of collective land. No house or building demolition will be triggered by the project. Additional 450.00 *mu* will be used for spoil disposal—storage of excavated earth not used for filling of pipeline trenches or other uses. The spoil disposal site is part of land earmarked for industrial park development, but currently not under use. The land is leased under a negotiated agreement between the industrial park company and CWSC.

122. Due diligence on these impacts has been conducted consistent with the PRC and ADB safeguard policy (SPS, 2009) requirements. Under the PRC law, prior to any land acquisition or resettlement, the IAs must obtain approval from the municipal and district land administration

bureaus to alienate farmland. The two households that will lose land will either be compensated by replacement with land of equivalent quality and quantity, or through a lump sum payment. The industrial park will use the spoil deposited to level the land after the project finishes disposal. An RP has been prepared which is consistent with the requirements set out in ADB's SPS (2009). The RP provides a socioeconomic profile of the affected persons (APs) and scope of impacts; and addresses issues related to compensation entitlement, legal framework, public consultations, grievance procedures, environmental protection, rehabilitation measures, and budget and implementation milestones. The budget for land acquisition is included in the project. When final design becomes available, the RP will be updated in consultation with the affected villages and submitted to ADB for approval. No land acquisition will be undertaken prior to the approval of the final RP by ADB.

Table VI.9: Permanent Land Acquisition for the Project

Component	**Land acquisition.** Unit: Chinese *mu* (ha)						Ownership	Affected Village/ People
	Farm-land	Orchard	Land for Construction	Waste-land	Pond	Total		
Expansion of Qiufeng WSP	0.000	20.390 (1.360)	0.000	4.610 (0.307)	0.000	**25.000 (1.670)**	Collective (village)	Gucuo Village / 9,811 people
Upgrade of Jinxi WSP	5.730 (0.382)	0.000	2.610 (0.174)	0.000	1.660 (0.111)	**10.000 (0.670)**	Collective (village)	Shenxi Village / 20,227 people
Construction of Longxi WSP	44.330 (2.955)	0.000	0.000	0.000	0.000	**44.330 (2.960)**	Collective (village)	Dongbo Village / 10,248 people
Total	**50.060 (3.337)**	**20.390 (1.360)**	**2.610 (0.170)**	**4.610 (0.310)**	**1.660 (0.110)**	**79.330 (5.290)**		**Three villages / 40,286 people**

ADB = Asian Development Bank, ha = hectare, WSP = water supply plant.
Source: ADB estimates.

Table VI.10: Temporary Land Occupation *(mu)*

Land Type	Civil Works	Material Storage Sites	Temporary Access Roads	Pipe Laying	Total	Ownership
Irrigated farmland	16.20	24.73	84.33	148.48	**274.40**	Collective
Non-irrigated farmland	21.60	32.97	112.44	197.97	**365.87**	Collective
Orchard land	10.80	16.48	56.22	98.99	**182.93**	Collective
Woodland	5.40	8.24	28.11	49.49	**91.47**	Collective
Green belt	0.00	0.00	0.00	1,755.18	**1,755.18**	State-owned
Total	**54.00**	**82.42**	**281.10**	**2,250.11**	**2,669.85**	

Source: ADB estimates.

123. The residents of Chengpo and Qiufeng villages (total population c.4,000, Table VI.3) at Qiufeng Reservoir are the only 'upstream' beneficiaries of the project. These villages will receive a solid waste collection program [project Output 1(iv)] and, through a project-specific assurance, the district government will also implement wastewater management systems at both villages by project completion. There are no project-related restrictions on livelihoods and neither village will be adversely affected by the project. Excluding construction-related impacts to 11 villages and one school and economic displacement, which are addressed in Sections VI.F (Table VI.3) and VI.5 (paras. 118–119) respectively, no other direct project impacts to livelihoods related to environmental media are anticipated.

124. **Employment.** The project will create job positions during construction (4–5 years) and operation. During the construction, labors, skilled and unskilled, will be needed to do civil works and equipment installation for the WSPs and water supply pipeline. During the project operation, laborers will be hired for operation, maintenance, and services of WSPs, pipeline and other facilities built by the project. In addition, the water resource protection component will hire labors for the reforestation in the area surrounding reservoirs. During the construction, a total of 656 job

positions will be created directly, including 66 positions of management and techniques, 138 positions of skilled laborers, and 452 positions of unskilled laborers. In addition, about 819 job positions will be created indirectly. During the project operation, according to scales of the new WSPs and current operation of CWSC and other public facilities, a total of 269 job positions will be created directly, including 134 positions of management and techniques, 118 positions of skilled labors, and 17 positions of unskilled labors.[30] The PMO and IAs will ensure that all PRC labor laws and core labor standards are respected.

125. **Gender.** During the PPTA, in addition to a specific focus group discussions (FGDs) for women, all the four FGDs conducted during the survey had women involved. According to the FGDs, women take more responsibilities for agricultural production and house work since many male laborers work far from home as migrants. The new water supply services can definitely reduce women's housework burden; and supply safe drinking water to 95% of the rural and urban residents will benefit the locals, particularly the women and children. The PMO has set employment targets for women which have been included in the social action plan and gender action plan and will be monitored and supervised.

6. Impacts on Health and Safety

126. **Community health and safety.** Some construction sites will be located close to villages, residential areas and schools, presenting a potential hazard to public health and safety. Construction may (i) increase the likelihood of road accidents, through increased vehicle activity and/or the use of heavy machinery; and (ii) cause unexpected interruptions in municipal services and utilities because of damage to pipelines for drainage, and gas supply, as well as to underground power cables and communication cables (including optical fiber cables). Traffic congestion, especially in urban areas, may worsen as pipeline construction and construction traffic increases, causing temporary inconvenience to traffic, villagers, residents, commercial operations, and institutions. The following project mitigation measures will be adopted by all project agencies and contractors:

(i) **Traffic management.** A traffic control and operation plan will be prepared by the contractor together with the local traffic management authority prior to construction. The plan will include provisions for diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at road crossings with an emphasis on public safety through clear signs, selecting transport routes to reduce disturbance to regular traffic, reinstating roads, and opening them to traffic as soon as the construction is completed;

(ii) **Underground facilities survey and protection.** Construction activities will be planned to minimize disturbances to utility services. Three-dimensional detection of underground facilities will be conducted before pipeline construction where appropriate;

(iii) **Information disclosure.** Villagers and residents will be informed in advance through media of the construction activities, and the dates and duration of expected disruption;

(iv) **Construction sites protection.** Public signs will be placed at construction sites in view of the public, warning people against potential dangers such as moving vehicles, hazardous materials, open-cut trenches and excavations, and raising awareness on safety issues. Heavy machinery will not be used after day light (to reduce night time construction noise) and all such equipment will be returned to its overnight storage area/position before night. All sites will be made secure, discouraging access by members of the public through appropriate fencing whenever appropriate; and

(v) **Community health.** Awareness raising and prevention methods against HIV, AIDS, and sexually transmitted infection diseases will be included for communities in the construction areas and will be conducted concurrently with training for workers (below).

[30] Source: PPTA social consultant's report.

127. **Occupational health and safety.** The construction industry is a hazardous industry with the potential for accidents. The civil works contractors will implement adequate precautions to protect the health and safety of construction workers. Contractors will manage occupational health and safety risks by applying the following measures:

(i) **Environmental, health, and safety officer.** An environmental, health, and safety officer will be appointed by each contractor to implement and supervise the environmental, health, and safety management plan;

(ii) **Environmental, health, and safety management plan.** Each contractor will prepare such a plan for the construction works on the basis of the EMP. The plan will include the following provisions:

(iii) **Construction site sanitation**

a) **Clean water.** Provide a clean and sufficient supply of fresh water for construction sites and for all workers' camps;

b) **Sewage and wastewater.** Provide an adequate number of latrines and other sanitary arrangements at construction sites and camps, and ensure that they are cleaned and maintained in a hygienic state;

c) **Solid waste.** Garbage cans at construction sites and camps will be set up, which will be periodically cleared to prevent outbreak of diseases;

d) **Effectively clean and disinfect project sites.** During site formation, spray with phenolated water for disinfection. Disinfect toilets and refuse piles and timely remove solid waste;

e) Ensure that no stagnant water collects on construction sites (e.g., in drains or open containers) to reduce the incidence of mosquitos or other disease vectors;

f) Exterminate rodents on site at least once every 3 months, and exterminate mosquitoes and flies at least twice each year;

g) Provide public toilets in accordance with the requirements of labor management and sanitation departments in the living areas on construction site, and appoint designated staff responsible for cleaning and disinfection; and

h) Provide awareness training to all construction workers to minimize disease risk (e.g., washing hands after using the toilet);

(iv) **Occupational safety**. Provide safety wear (hats, boots, helmets, goggles, ear plugs, respiratory masks, protective clothing), in accordance with relevant health and safety regulations, to all workers. Ensure they are used in all necessary construction activities;

(v) **Food safety.** Inspect and supervise food hygiene in cafeteria or canteen on site regularly. Cafeteria workers must have valid health permits. If food poisoning is discovered, implement effective control measures immediately to prevent it from spreading; and

(vi) **Disease prevention and safety awareness**

a) Provide all construction workers with physical examination before starting employment and implement semiannual health checks. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. From the 2nd year onwards, conduct physical examination on 20% of the workers every year;

b) Establish health clinic at location where workers are concentrated. This should be equipped with common medical supplies for simple treatment of accidents;

c) Specify (by the IA and contractors) the person responsible for health and epidemic prevention responsible for the education and propaganda on food and toilet hygiene and disease prevention to raise the awareness of workers;

d) **Emergency preparedness and response.** An emergency response plan will be prepared, including environmental, health, and safety emergencies associated with hazardous material spills and fire hazards, etc., and submitted to the district EPB for review and appraisal. Emergency phone link with hospitals will be established. A fully equipped first-aid base in each construction site and camp will be organized;

e) **Records management.** A records management system that will store and maintain easily retrievable records against loss or damage will be established. It will include documenting and reporting of occupational accidents, diseases, and incidents. The records will be reviewed during compliance monitoring and audits;

f) **Safety communication.** Ensure that occupational health and safety matters are given a high degree of publicity to all persons regularly or occasionally on each construction site. Posters will be displayed prominently in relevant areas of the site; and

g) **Training and awareness.** Requirements for HIV, AIDS, and sexually transmitted infection awareness training will be included in bidding documents and construction contracts, which will be monitored and supervised during the project implementation. All workers will be trained in basic sanitation, general health and safety matters, specific work hazards, and awareness and prevention of HIV/AIDS and other communicable diseases.

D. Operational Phase: Potential Impacts and their Mitigation

128. The main potential impacts during project operation relate to operation of the three WSPs (Jinxi, Longxi, and Qiufeng). Operation of the WSPs will generate noise and sludge, and involve the use of chemicals for water treatment. WSP staff will generate wastewater and refuse. A risk assessment was conducted for WSP operation (Table VI.11). Mitigation measures are described below and in the project EMP (Attachment A). It is concluded that the mitigation measures will reduce these risks to acceptable levels.

Table VI.11: Risks, Hazards, and Control Measures during Water Supply Plant Operation

Process	Risk	Mitigation Measure
Water intake (reservoirs)	Accidental chemical spill, resulting in contamination of water source	• Emergency response activity to switch to other WSP(s) through the main pipeline network and shut down the polluted WSP • Chaonan EPB implements the emergency response • CWSC will take effective measures to ensure the water supply safety
	Non-point pollution to the reservoirs including TN, TP, pesticides and pathogens.	• Strictly control non-point pollution by the district EPB • Strengthen water quality monitoring by CWSC, and the Chaonan EMS and WSPs • Enhance the water treatment process of coagulation-filtration-chlorination to control pathogens.
Pre-sediment-ation basin	Algal bloom in the pre-sedimentation basin, causing algal toxin, water treatment difficulty and taste and/or odor problems	• Water treatment process conducted and supervised by qualified staff of CWSC • Find reason for eutrophication; timely control of pollution source by comprehensive monitoring at reservoir
Coagulation and sedimentation	Mechanical or electrical failure of chemical dosing system, resulting in high turbidity and clogging of filter.	• Use backup coagulant dosing system • Installation and maintenance of automatic dosing pump with integrated alarm system in the event of failure
	Use of contaminated coagulant, resulting in contamination of water	• Coagulant must be purchased form approved supplier, demonstrating compliance with national product standard of GB1892-2009
Filtration	Failure of filtration system, with high turbidity and potential for pathogen	• Installation and regular calibration of online filtration turbidity monitoring instruments, with alarm system

Process	Risk	Mitigation Measure
	breakthrough	• Multiple separate filtration units in parallel • Keep good operation condition of filtration chamber by regular back flush and maintenance.
Chlorination	Insufficient or excessive chlorine dosing resulting in pathogen breakthrough or chlorine taste and odor	• Automate chlorine dosing and online residual chlorine monitoring to achieve chlorine content of 0.5 mg/L to 1.0 mg/L (30 minutes after chlorination).
Treated water storage	Accidental contamination of the treated water (e.g., rodents, groundwater ingress)	• Storage tanks for treated water will be roofed, vents, and overflows will be meshed • Storage tank walls will be lined with water proof material • Frequent inspections and maintenance of the tanks
Water supply pumping	Pump failure, power failure, loss of pressure, risk of re-contamination due to back-siphonage	• Backup pumps and dual power system must be installed and keep in good condition • Inspect the backup pumps and dual power system regularly
Distribution network	Pipe burst causing water re-contamination and interrupted service	• Proper pipe material selection • Procedures for operating system to avoid spikes and water hammering • Implementation of emergency response action plan, including quick repair of bursts and pipe cleaning and water quality monitoring for the network

CWSC = Chaonan Water Supply Company, EIA = environmental impact assessment, EMS = environmental monitoring station, EPB = environmental protection bureau, mg/L = milligram per liter, TN = total nitrogen, TP = total phosphorus, WSP = water supply plant.
Source: Domestic EIA report.

129. **Handling and disposal of hazardous materials at the water supply plants.** The WSPs will use chlorine dioxide (ClO_2) for water disinfection, and hydrochloric acid and sodium chlorite for chlorine dioxide generation. Chlorine dioxide is safer and produces less harmful organic trihalomethanes (TMHs) compared to liquid Cl_2 water disinfestation. The main constituents of chlorine dioxide in a ClO_2 generator, sodium chlorite solution, and hydrochloric acid, will be transported to and mixed in a reaction tank (batch reactor), in the WSPs' preparation rooms. The product, a gas-liquid mixture which consists of chlorine dioxide, is added to the water to achieve disinfection. Hazards exist in preparing, transporting, storing, and handling the hydrochloric acid and sodium chlorite used for chlorine dioxide generation. In the WSP chlorination rooms, there is a risk of hydrogen chloride and chlorine dioxide leakage. The following measures will be implemented to mitigate potential hazards to the health and safety of plant operators:

i) Chemicals will be transported and managed in compliance with the PRC regulations on hazardous chemical substance management;
ii) Transport vehicles and personnel will be qualified and trained with hazardous chemical substance handling and transportation;
iii) Storage of hazardous chemicals will be arranged with certificates procured from the police department and fire authorities;
iv) Chlorination rooms and chemical storage rooms in the WSPs will be equipped with automatic censors and alarms, which will be triggered by ClO_2 leakage;
v) Each plant will be equipped with gas masks, oxygen breathing apparatus, and other rescue materials to protect staff in the event of leakage of hydrogen chloride and ClO_2; and
vi) An emergency response plan will be prepared and implemented in each WSP. The plan will inform staff and visitors about the characteristics of ClO_2 and hydrochloric acid, potential hazards; and define accident prevention measures and evacuation plan.

130. **Operational noise.** Operational noise impacts may arise from equipment operation at the three WSPs, including pumps, fans, and sludge dewatering machines (spin-driers). In

general, operational noise of machines at a WSP is about 85–90 dB(A). Predictive sound modeling for WSP operation conducted for the project were as follows:

(i) Noise transmitting from a sound source to a receiver is attenuated by distance, adsorption in air, and deflection from obstacles. The predicted model[31] for noise assessment is

$$LA(r) = Aref\ (r0) - (Adiv + Abar + Aatm)$$

Where: LA(r) = sound level A at the distance of r0; LAref (r0) = sound level A at the reference distance of r0; Adiv = attenuation of the sound level A due to the geometrical radiation; Abar = attenuation of the sound level A due to the barrier; Aatm = attenuation of the sound level A due to air adsorption.

(ii) **Geometrical radiation.** Not considering the transmitting direction of sound source, the geometrical radiation equation is

$$L(r) = L\ (r0) - 20\lg(r/r0)$$

Where: L(r) = sound level at the distance of r; L (r0) = sound level at the distance of r0; 20lg(r/r0) = attenuation of geometrical radiation, that is A div.

(iii) **Attenuation of sound level A due to the obstacles.** The obstacles located between the sound source and predicted points, such as walls or buildings, are sound barrier. The existence of sound barrier does not make the sound wave arrive the predicted point directly so that it leads to much attenuation. The noise source from rooms contacts the surrounding structure closely so that the room plays an acoustic enclosure role in the sound transmission. The sound insulation coefficient for different material can be found in the related books, and then calculate it according to the theoretical equation. The sound insulation coefficient changes as the different conditions. In the domestic EIA report, it regards 25 dB(A) as the sound insulation of the surrounding structure.

(iv) **Attenuation of the air adsorption.** The sound attenuation due to the air adsorption is related to the sound wave frequency, the atmospheric pressure, temperature and humidity. The attenuation of the air adsorption can be calculated by the following equation:

$$Aatm = A(r-r0)/100$$

Where: r = distance from the sound source to predicted point; r0 = distance of the reference position, m; A = sound absorption coefficient of air per 100 meters.

(v) The noise predicted model of the assessment point is as follows.

$$L = 10\lg(10^{0.1L_b} + \sum_{i=1}^{n} 10^{0.1L_i})$$

Where: L = predictive noise value on assessment point, dB(A); Lb = background noise value on assessment point, dB(A); Li = influence value of sound source i on the assessment point, dB(A).

131. In the above model, only noise sources ≥85 dB(A) are measured. The WSP machinery and equipment will run in a steady state so that noise emission will be of a constant frequency. The ambient parameters are: temperature 10℃, humidity 50% and atmospheric pressure 1 atm. The predicted point is 1.5 m high to the floor. The background value of the predicted point is gained from the present measurements. The predicted results are the weighted value of different high sound sources at the predicted point (the background value has been added). The predicted values are shown in Table VI.12.

[31] Source: Domestic EIA report.

Table VI.12: Predicted Noise Levels in the Water Supply Plants [dB(A)]

WSP	Equipment	Noise at Source	Distance to WSP Boundary (m)	Predicted Noise at WSP Boundary	Standard Compliance	
					Day	Night
Qiufeng	Water intake pump	85	50	55	meet	exceed
	Back flush pump	85	12	55	meet	exceed
	Water supply pump	85	20	55	meet	exceed
	Sludge treatment	75	12	50	meet	exceed
Longxi	Water intake pump	85	60	55	meet	exceed
	Back flush pump	85	8	55	meet	exceed
	Water supply pump	85	15	55	meet	exceed
	Sludge treatment	75	12	45	meet	meet
Jinxi	Sludge treatment	75	12	50	meet	exceed

dB(A) = A-weighted decibel, EIA = environmental impact assessment, m = meter, WSP = water supply plant.
Source: Domestic EIA report.

132. All noise-emitting machinery and equipment will be installed in sound-proof housing within rooms in the WSPs. Based on the above calculations, the projected noise values at all boundaries of the WSPs during daytime meet the Grade I of the PRC's Urban Ambient Acoustic Quality Standard (GB3096-2008). During the nighttime, the predicted noise levels at some boundaries of the WSPs exceed the Grade I standard by about 5 dB(A) (Table VI.8). There are no villages or other sensitive receptors within 500 m of the boundaries of the three WSPs, and it is concluded there will be no significant impacts.

133. **Sludge in the water supply plants.** Each WSP will accumulate sludge in sedimentation tanks, due to sediment within the water drawn from the reservoirs. At the existing Jinxi and Qiufeng WSPs, sludge is currently disposed on barren land. This practice is not desirable: it occupies land, leads to soil erosion, causes fugitive dust in the dry season, and adds to soil loads entering waterways in the wet season. Beginning with this project, all sludge generated by the three WSPs will be reused for manufacturing bricks and other construction materials.

134. **Maintaining water supply safety in the water supply plants.** As discussed above, the proposed risk during the WSPs operation is generally low, through comprehensive training and capacity strengthening under this ADB project, and enhanced routine operation and management, the water quality of WSPs will meet related water quality requirements according to the updated FSR and the EIA. The reason why the FSR did not adopt high density sedimentation tank but horizontal sedimentation tank is that the latter needs simpler construction and equipment configuration, has convenient O&M, especially that the latter has long water retaining time, good anti-pulse loading capacity, such that it can guarantee the water quality of effluent when the turbidity of raw water is high. The other consideration is that the land for the WSP of the project is sufficient. Other management measures to ensure the environmentally sound running of the treatment plant are as follows:

i) equip the laboratory with monitoring instruments to examine 42 parameters of the PRC's Domestic Drinking Water Quality Standard (GB5749-2006);
ii) Build emergency warning system and equip with water source automatic monitoring systems in the reservoirs; and
iii) Ensure that WSPs' staff and/or workers are well trained on all steps of the treatment process, including emergency warning and response actions.

135. **Generation of wastewater and solid waste by water supply plant staff.** WSP staff will generate domestic wastewater and refuse. The three WSPs will employ 453 staff after project completion. The quantity of wastewater generated by staff is estimated to be 36.24 m^3/d or 13,046.4 m^3/year. This quantity is small and will be discharged to the wastewater treatment plant (WWTP) through the existing drainage networks. The volume of domestic refuse that will be generated by the staff is estimated to be 66.1 tons/year. This will be collected for disposal at the

planned Chaonan District landfill site, which will be constructed before the proposed WSPs begin operation.

Table VI.13: Summary of Rubbish Disposal and Wastewater Discharge from the Water Supply Plants

WSP	Capacity (m^3/d)	Staff No.	Rubbish	Wastewater		Pollutant Amount (t/a)			Discharge to
			(t/a)	(m^3/d)	(m^3/a)	COD_{cr}	BOD_5	NH3-N	
Qiufeng WSP	Existing 70,000 m^3/d	200	29.2	16.0	5,840.0	1.37	0.98	0.20	Liangyin Creek
	142,000 m^3/d after expansion	236	34.5	18.9	6,796.8	1.59	1.14	0.24	WWTP
Jinxi WSP	Existing 40,000 m^3/d	130	19.0	10.4	3,744.0	0.88	0.63	0.13	Shen Creek
	40,000 m^3/a after upgrade	137	20.0	11.0	3,945.6	0.92	0.66	0.14	WWTP
Longxi WSP	100,000 m^3/d after newly built	80	11.7	6.4	2,304.0	0.54	0.38	0.08	WWTP
Total	**382,000**	**453**	**66.1**	**36.24**	**13,046.4**	**3.05**	**2.18**	**0.46**	WWTP

BOD_5 = 5-day biochemical oxygen demand, COD_{cr} = chemical oxygen demand, d = day, kg = kilogram, m^3/a = cubic meter per annum, m^3/d = cubic meter per day, mg/L = milligram per liter, NH_3-N = ammonia nitrogen, t/a = ton per annum, WSP = water supply plant, WWTP = wastewater treatment plant.
Note: Pollutant concentrations of BOD_5, COD_{cr}, and NH_3-N are 167 mg/L, 234 mg/L, and 35 mg/L, respectively; the garbage and domestic garbage are estimated as 0.4 kg/shift and 80.0 L/shift per staff.
Source: Domestic environmental impact assessment report.

136. **Greenhouse gas emissions.** The current total water supply capacity in the district is 110,000 m^3/d with a power consumption of 0.15 kWh/m^3 water supplied in 2012. The total annual power consumption is 6.022 million kWh, equivalent to 2,018 tons of standard coal and 5,030 tons of CO_2 emission (Table VI.14). After project completion, the total water supply capacity will be 282,000 m^3/d, the power consumption for unit water supplied will be 0.117 kWh/m^3 according to the FSR because high energy efficiency technologies will be adopted, based on which the estimated annual electricity and standard coal consumptions and GHG emission are 12.04 million kWh, 4,034 tons of coal equivalent (tce), and 10,058 tons of CO_2 (tCO_2), respectively (Table VI.14).

Table VI.14: Summary of Power Consumption and Greenhouse Gas Emission for the Water Supply Plants

No.	Item	Amount
1	Water supply capacity of existing WSPs in 2012 (m^3/d)	110,000.000
2	Unit power consumption of existing WSPs (kWh/m^3)	0.150
3	Annual power consumption for existing WSPs (kWh/a)	6,022,500.000
4	Equivalent standard coal consumption for existing WSPs (tce/a)	2,018.000
5	Equivalent GHG (CO_2) emission from existing WSPs (t/a)	5,030.000
6	Water supply capacity of the WSPs after the project completion	282,000.000
7	Power consumption for unit water supply after proposed WSPs completion (kWh/m^3)	0.117
8	Annual power consumption for water supply after proposed WSPs completion (kWh/a)	12,042,810.000
9	Equivalent standard coal consumption for water supply after proposed WSPs completion (tce/a)	4,034.000
10	Equivalent GHG (CO_2) emission after water supply after proposed WSPs completion (t/a)	10,058.000
11	Standard coal consumption for PRC unit power generation (kg tce/kWh)	0.335[a]
12	CO_2 emission factor from standard coal consumption (tCO_2/tce)	2.493[b]

a = annum, CO_2 = carbon dioxide, d = day, GHG = greenhouse gas, kg = kilogram, kWh = kilowatt hour, m^3 = cubic meter, PRC = People's Republic of China, t = ton, tce = ton of coal equivalent, tCO_2 = ton of carbon dioxide, WSP = water supply plant.
[a] Standard average data issued by the China Power Enterprises Association in 2010.
[b] Estimation factor published by the PRC National Energy Administration in 2008.
Source: Consultant's estimation based on the environmental impact assessment and the feasibility study report.

137. **Socioeconomic impacts.** Project operation is not anticipated to cause direct impacts to livelihoods through environmental media. The project will not cause any change in the amount of land available for agriculture or district water allocations for agriculture, industry or other sectors.

E. Reforestation Component and Reservoir Maintenance

138. Critical to the success of the reforestation component will be survival rate of the planted trees, shrubs, and grasses. To maximize planting success, this project component includes (i) regular inspection of planted individuals; (ii) basal application of fertilizer, but no top dressing, to avoid contamination of water bodies; and (iii) at sites subject to pest damage, avoid use of pesticide and as far as possible, use other forms of control (e.g., manual removal for large insects).

139. For at least one reservoir, Qiufeng, rubbish dumping is a key issue for reservoir water quality, due to the presence of two villages, Chengpo and Qiufeng, along the reservoir banks. This project includes components to improve education, awareness, and litter collection systems at the three reservoirs. Should these efforts be unsuccessful, it is possible that illegal landfill and dumping will continue occurring near the reservoirs. This progress of these project components will be regularly monitored during project implementation.

F. Cumulative, Indirect, and Induced Impacts

140. **Cumulative impacts.** Cumulative impacts are defined as the combination of multiple impacts from existing projects, the proposed project, and anticipated future projects that may result in significant adverse and/or beneficial impacts that would not be expected in case of a stand-alone project. Short-term cumulative impacts of the project will comprise the combined effects of project construction together with any nearby construction projects, which will collectively increase the pressures of traffic on the existing road network, civil works, air-borne dust, waste generation and community disturbance. These will be mitigated to acceptable levels by (i) coordination between project components and other projects, including construction schedules and shared access roads and borrow and/or disposal sites; (ii) planning of vehicle transport routes and schedules by contractors with road management authorities and communities; (iii) mitigation measures to minimize dust, noise, and waste; (iv) education of construction workers to minimize social disturbance and cultural conflict; (vi) access for local traffic; and (vii) maintenance of access roads and timely restoration and/or strengthening upon completion. The project GRM will enable any APs to report excessive disturbances during construction.

141. **Environment-related livelihood impacts.** Similar to many regions in the PRC, CDG aims to reduce agricultural water demand by improving irrigation efficiency. These water savings, while positive, might result in changes to land use or production efficiency, which could affect the livelihood of farmers dependent on water-hungry crops (e.g., rice). The current project is not involved in agricultural water use, but its large scope for domestic water use may influence district water planning for other sectors, and this issue is mentioned here for completeness. CDG aims to reduce annual water consumption for irrigation from 64.4 million m^3 in 2011–2012 to 51.5 million m^3 (by 2020) to 49.1 million m^3 (by 2025). Compared with 2013, mean annual water consumption for agricultural irrigation by 2025 is expected to be reduced by 30% in the Jinxi and Longxi irrigation zones and 20% in the Qiufeng irrigation zone.[32] These savings will be achieved through (i) improved irrigation efficiency developed under two government initiatives: the *Program of Irrigation Districts Reconstruction and Upgrading* (under the *Medium-Sized Irrigation Districts Water Conservation and Continuing Construction Planning in Guangdong Province* 2011–2015) and the *Program of Demonstration Pilots on Construction of Water Conservation Society in Chaonan*; (ii) the allocation of some water from the *Nanshan Flood Diversion Project* (to be completed in 2019) to the Longxi irrigation zone; and (iii) the current district water allocations for pump irrigation from the Leiling and/or Lian rivers will maintained beyond 2020.[37] Quantitative targets have been established to track incremental progress toward overall district irrigation water targets. CDG has also stated that until at least 2030, no irrigated land will be reduced, crop structure will remain the same as current mix, and that agricultural needs must

[32] PPTA Final Report (2013). Supplementary Appendix 8. Detailed Water Resource Assessment in Chaonan District.

continue to be met. Further, the three project reservoirs (Jinxi, Longxi, and Qiufeng) are used for domestic (not agricultural) water supply, and no changes in reservoir water allocations will be made by the project. On this basis, the risk of livelihood impacts due to improved irrigation water efficiency is considered to be low. No project-related impacts are anticipated.

142. **Indirect and induced impacts—increased wastewater production.** Indirect impacts are adverse and/or beneficial environmental impacts which cannot be immediately traced to a project activity but can be causally linked. Induced impacts are adverse and/or beneficial impacts on areas and communities from unintended but predictable developments caused by a project which may occur later or at a different location. The project will cause one known induced impact: increased pressure on WWTPs. The WSPs will result in an increase of 172,000 m^3/d water supply. This will result in the production of an estimated 137,600 m^3/d of wastewater, which will require treatment. Under the Chaonan District Integrated Wastewater Treatment Plan (2013), three new WWTPs to treat the area of influence of the new WSPs will be constructed by 2020. This will increase the total treatment capacity to 155,000 m^3/d by 2015 and 305,000 m^3/d by 2020. This capacity will ensure that no untreated wastewater is discharged into the Lian River. A project-specific assurance has been received from CDG that these three WWTPs and their associated pipeline connections will be operational before completion of the WSPs.

VII. ALTERNATIVE ANALYSIS

143. Alternative analysis was conducted during the domestic feasibility studies and by the PPTA consultants. Alternatives for project components were identified and compared against technical, economic, social, and environmental criteria. For the environment, the primary objective was to identify and adopt options with the least adverse environmental impacts and maximum environmental benefits. Four types of alternatives were assessed: (i) 'no project' scenario, (ii) alternative sites for expansion of Qiufeng WSP, (iii) alternative site for the water intake pumping house of Qiufeng WSP, (iv) alternative sites for the new Longxi WSP, and (v) alternatives for some of the construction materials to be used.

144. **No-project scenario.** Under the no-project scenario are as follows:

i) **Water resource protection.** Water quality of the reservoirs would continue to decrease due to increasing levels of pollutants from point and nonpoint pollution, and soil erosion from surrounding hillsides. Eutrophication and frequency of algae blooms would probably increase. This could eventually jeopardize the local environment and the health of the 1.2635 million urban and rural district residents;

ii) **Integrated urban and rural water supply system.** Without the proposed water supply component, about 400,000 urban and rural residents will continue to drink unsafe or untreated water, which has caused health problem for decades. About 100,000 residents in 42 villages will continue to drink high fluoride content groundwater and continue to suffer from endemic fluorosis;

iii) **New pipelines.** Without laying new pipelines to replace the aged ones and installation of 37,767 new water meters, current NRW losses will continue to remain as high as 50%, resulting in huge losses of water and energy. The project will reduce NRW from 50% to 30% by new pipeline installation, timely water leak detection and repairing, installation of water meters, and public awareness for water conservation; and

iv) **Solid waste management.** Without this component, the unsanitary conditions in urban and rural areas, including littering and illegal rubbish dumping on reservoir banks and roadsides, will continue. This will cause public health problems and pollution to the reservoirs. This project component provides facilities and equipment for collection, transport and disposal of domestic solid wastes, important for improving the sanitary condition of urban and rural residents and also the environmental conditions of reservoirs.

145. **Alternative sites for expansion of the Qiufeng water supply plant.** Field surveys indicated an unoccupied site 1.2 km from the existing Qiufeng WSP could house the expanded WSP. An existing access road (2-km long) connects this site with the existing WSP. Nearby lands are not suitable, either being within the protected reservoir zone, hilly, supporting tombstones, or under the existing 220 kilovolt (kV) high-voltage power line towers. This site has the following advantages compared with other options: (i) rational layout; (ii) close to Qiufeng reservoir and the existing WSP and short distance (1.1 km) to the existing water supply distribution network, resulting in lower investment and operation cost; (iii) no farmland occupation or buildings; (iv) good geological condition, resulting in low cost for structural foundation works; (v) close to the existing power transformer station, easy for power connection. The FSR recommends this site for the WSP expansion.

146. **Alternative sites for water intake pump house for the Qiufeng water supply plant.** There are currently two existing water intake pump stations, with a total capacity of 70,000 m^3/d. This cannot meet the designed capacity of 142,000 m^3/d, therefore a new pumping house is necessary for the WSP. According to the terrain and characteristics of the water level variation of Qiufeng reservoir, two locations are compared for construction of the new pumping house: one is located west of the existing WSP, about 370 m from the existing pump station. Its ground elevation is 19.8–20.5 m. The second is located 90 m east of the existing water intake culvert,

and has ground elevation of 17.4–18.5 m (Figure VII.1). Comparison of the two options is in Table VII.1. Option 1 is selected because of less head loss and less impacts on the reservoir dam.

Table VII.1: Comparison of Water Intake Location Alternatives

Option	Advantage	Disadvantage
Option 1 (370 m west of existing WSP)	• Close (365 m) to WSP expansion site; short water distribution pipelines; less water head loss; close to No. 235 Highway	• Higher elevation causing high excavation volume
Option 2 (90 m east of existing water intake culvert)	• Less excavation earth work	• Longer water distribution pipe; high water head loss; difficult for layout of water distribution pipeline; needs land acquisition; construction vehicles must pass on the reservoir dam

m = meter, WSP = water supply plant.
Source: Environmental impact assessment report.

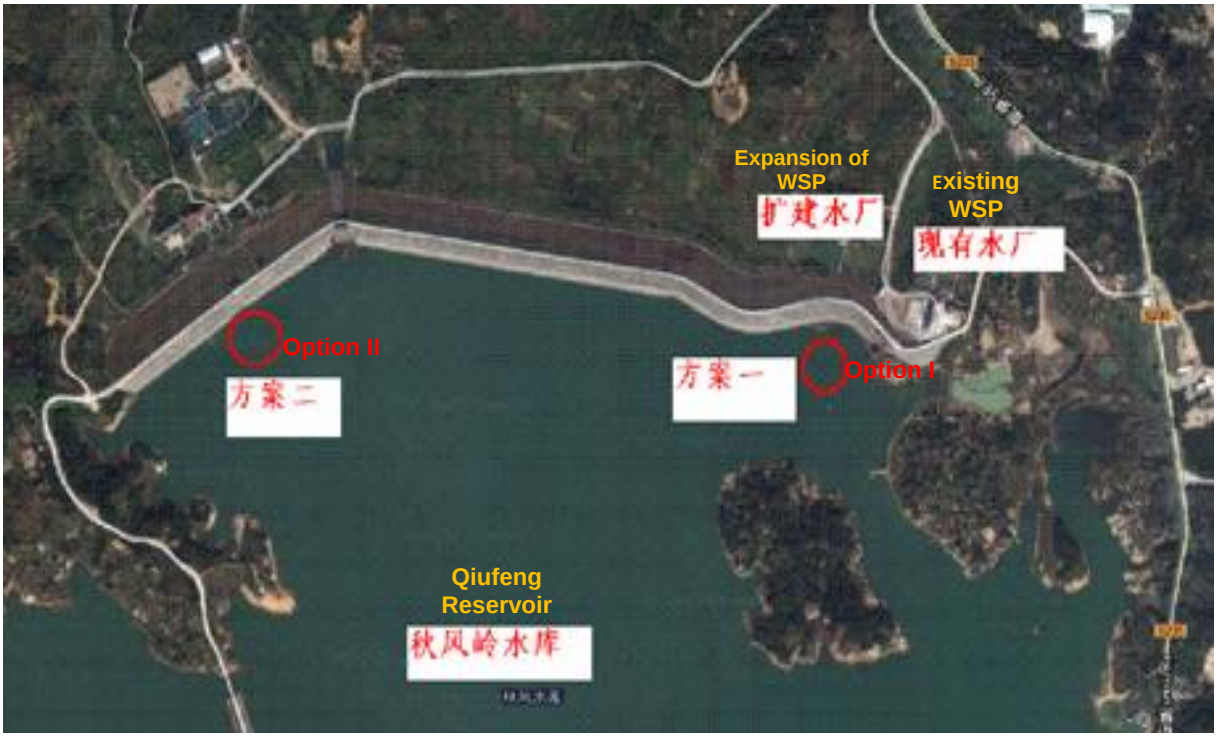


Figure VII.1: Location of Water Intake Pumping Station at the Qiufeng Reservoir

147. **Alternative sites for the Longxi water supply plant.** The WSP will be constructed as part of the project and will have a capacity of 100,000 m^3/d. Higher elevation land around Longxi reservoir cannot be used for the WSP because the land is reserved for forestation and agriculture. Two sites were compared (Figure VI.2). Option 1 is Chensha roadside of Dongbo village. This site is near the access road to the reservoir, and is construction land 180–200 m long x 180 m wide. Total land area is 44.33 *mu* (2.96 ha), sufficient for the WSP. A water pipe from the reservoir to the plant would need to be 3.1 km long, and would be laid along road from the reservoir to the site. Option 2 is Tianxiner Village, located south of the Nanshan flood drainage channel and close to Tianxin Middle School. It is construction land 285 m long x 65–112 m wide. Total land area is 42 *mu* (2.8 ha). The land is currently planted with fruit trees. The raw water pipe would need to be 4.8 km long, and lie along the road along the Nanshan drainage channel. But there is a high-voltage line across northern part of the land (Table VII.2; Figures VII.2–VII.4). After comparison, Option 1 was selected because of low costs for construction and operation, and transport convenience.

148. **Other alternatives.** Other alternatives were analyzed in the FSR, including (i) pipe materials; (ii) treatment process; and (iii) alternatives of sedimentation tank, filtration tank, and dewatering equipment. Alternatives were based upon cost effectiveness and technical

considerations and did not have differential environmental effects. Selection of water treatment processes must comply with the PRC's Domestic Drinking Water Quality Standard (GB5749-2006). The most common and frequently used process of flocculation, sedimentation, filtration, and disinfection is adopted in water purification.

Table VII.2: Comparison of Site Alternatives for Longxi Water Supply Plant

Item	Option 1: Dongbo Village	Option 2: Tianxier Village
Advantage	• Site between water source and water supply service area; construction land, no land acquisition required • close to Chensha road, convenient, easy connection with main pipeline under road	• No land acquisition required; easy drainage due to nearby Nanshan drainage channel; good geological condition and low foundation costs; close to He-Hui road, for transport
Disadvantage	• Higher cost due to installation drainage pipe to Nanshan drainage channel	• Far from the water source and water supply service area; high-voltage (110 kV) power line across site
Construction cost	CNY87.440 million	CNY145.940 million
Resettlement cost	CNY7.304 million	CNY8.504 million
Operation cost	CNY3.770 million/year	CNY4.177 million/year

kV = kilovolt.
Source: Environmental impact assessment report.

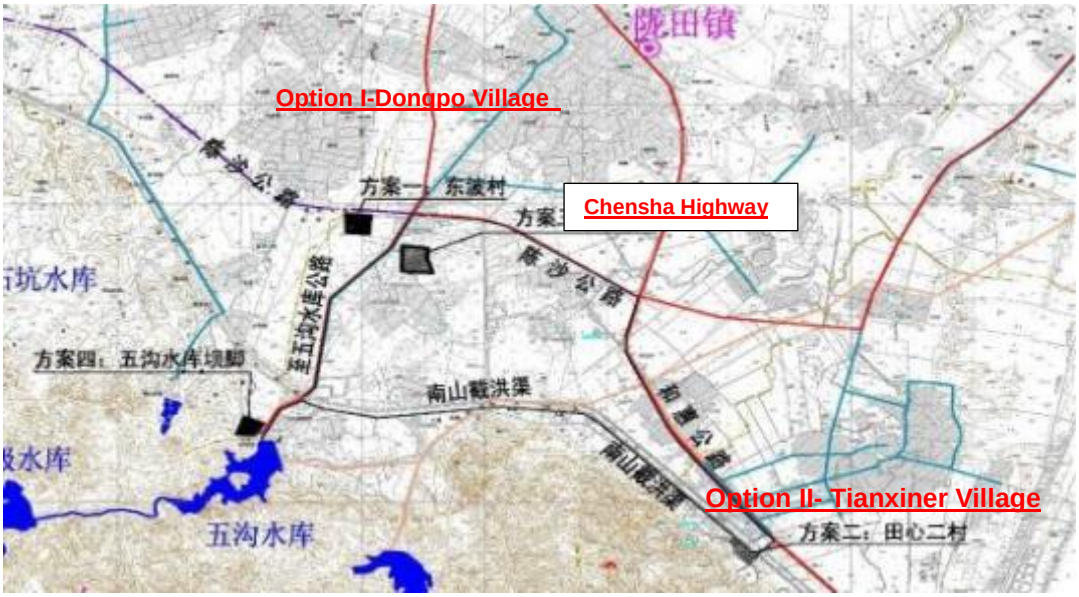


Figure VII.2: Alternative Locations of Longxi Water Supply Plant

Figure VII.3: Current Site Situation (Option 1)

Figure VII.4: Current Site Situation (Option 2)

VIII. DUE DILIGENCE FOR ASSOCIATED FACILITIES

149. A due diligence for the associated facilities of the project was conducted by the PPTA consultants and the EIA Institute based on ADB's SPS requirements. The following are classified as facilities associated to this project: (i) the operational capacity of the existing WWTPs; and (ii) the district integrated wastewater treatment plan, including WWTPs and the sewer networks to be completed in the near future (before the proposed WSPs become operational).

150. **Existing wastewater treatment plants and sewer collection networks.** There are two existing WWTPs, Liangying and Xiashan, in Chaonan District. They have a total treatment capacity of 50,000 m^3/d. This will be expanded to 60,000 m^3/d by 2015 and 120,000 m^3/d by 2020, according to the Chaonan District Wastewater Treatment Plan (2013–2020).[33] Xiashan WWTP has a floor space of 4.67 ha and utilizes the treatment process of modified oxidation ditch + fine bubble aeration. It complies with Class II of the PRC's WWTP effluent quality standard (GB18918-2002, Table VIII.1). Due to limited sewer collection network (only 5,282 m by end of 2012), the current treatment volume is 22,000 m^3/d, only 73.3% of the designed treatment capacity of 30,000 m^3/d. The service area and population in 2012 are 42 km^2 and 210,000, respectively.

Table VIII.1: Water Quality and Quantity of the Existing Wastewater Treatment Plants in 2012[a]

Parameter	Xiashan WWTP		Liangying WWTP		Class II Standard[b]
	Influent	Effluent	Influent	Effluent	
Chemical oxygen demand (COD_{cr}), mg/L	190.00	30	276.00	31.00	100 mg/L
Biological oxygen demand (BOD_5), mg/L	69.10	4.1	93.70	5.00	30 mg/L
Suspended solid (SS), mg/L	102.20	15.8	102.00	14.00	30 mg/L
Total nitrogen (TN), mg/L	16.00	3.9	…	…	…
Ammonia nitrogen (NH_3-N), mg/L	12.65	1.34	11.39	2.39	30 mg/L
Total phosphorus (TP), mg/L	2.93	1.98	…	…	3 mg/L
pH	8.31	7.52	8.77	7.57	6–9
Wastewater volume (million m^3/a)	8.79	8.53	8.01	7.93	…
Length of sewer collection pipeline (m)	5,476.00		10,595.00		…

(…) = data not available, EIA = environmental impact assessment, pH = measure of acidity or basicity of an aqueous solution, PMO = project management office.

[a] Annual average in 2012 from 12 monthly monitored data.

[b] The PRC's Standard on Pollutant Discharges from Municipal Wastewater Treatment Plants (GB18918-2002).

Sources: EIA Institute and the PMO.

151. Liangying WWTP has a floor space of 7.4 ha. It utilizes the treatment process of hydrolysis acidification+A/O. It complies with Class II of the PRC's WWTP effluent quality standard (GB18918-2002, Table VIII.1). Due to limited sewer collection network (only about 4,000 m), the current treatment volume is 12,000 m^3/d, only 60% of the designed treatment capacity of 20,000 m^3/d. The service population and area in 2012 are 135,000 and 16.7 km^2 respectively.

152. **Three planned wastewater treatment plants.** Three new WWTPs, Chendian, Longtian, and Simapo, will be constructed, with a total capacity of 95,000 m^3/d, and will be operational before end of 2015. Their total capacity will be expanded to 185,000 m^3/d before end of 2020 according to the Chaonan District Wastewater Treatment Plan (2013–2020).

[33] The plan was prepared in March 2013; and according to the PMO, was approved in July 2013.

Table VIII.2: Summary of Wastewater Treatment in Chaonan District

Status	WWTP	Service Area (km^2)/Town	Planned Population		Wastewater Quantity (m^3/d)		Treatment Capacity of WWTP (m^3/d)			Effluent Quality by 2020	Discharge Destination
			2015	2020	2015	2020	2011	2015	2020		
Existing	Xiashan	45.9/ Xiaoshan	189,900	210,700	56,900	65,200	30,000	30,000	60,000	Class I-B	Lian River
	Liangying	19.0/ Liangying	143,300	154,400	47,900	55,400	20,000	30,000	60,000	Class I-B	Liangying Creek
Planned	Chendian	17.2/ Chendian	86,700	93,400	31,000	36,400	0	30,000	60,000	Class I-B	Lian River
	Simapo	17.7/ Simapo	109,000	117,400	35,700	41,000	0	30,000	60,000	Class I-B	Lian River
	Longtian	53.7/ Longtian, Shenzhen Longgang Industrial Zone	102,400	110,300	46,800	57,500	0	35,000	65,000	Class I-B	Tianxin Bay
Total		**153.5**	**631,300**	**686,200**	**218,300**	**255,500**	**50,000**	**155,000**	**305,000**		

km^2 = square kilometer, m^3/d = cubic meter per day, WWTP = wastewater treatment plan.
Source: Chaonan District Wastewater Treatment Plan (2013–2020).

153. After completion of the proposed WSPs, the tap water supply capacity of the district will increase to 172,000 m^3/d, and the corresponding wastewater will increase to 138,000 m^3/d.[34] According to the Chaonan District Wastewater Treatment Plan (2013–2020) by then the total wastewater treatment capacity in the district will increase by 255,000 m^3/d (to 305,000 m^3/d) (Table VIII.2). According to the Chaonan District Wastewater Treatment Plan (2013–2020), as well as the due diligence, the existing and planned WWTPs in the district will have enough surplus treatment capacity to treat the wastewater generated by the proposed WSPs. The effluent from the WWTPs will meet the PRC standard (GB18918-2002). Overall, the impact of the proposed WSPs on the surface water quality is anticipated to be low if the WWTPs operate, and are constructed as planned. Regular compliance monitoring by the local EMS during operation will assess possible unanticipated impacts of the project on surface water quality, particularly the Lian River; and additional mitigation measures and corrective actions will be defined, if necessary.

154. **Municipal landfill.** There is currently no existing landfill site in Chaonan District. CDG has identified a district landfill site, in the Xiandou–Liangou Mountain area, 17 km from Xiashan Town (the main urban center of Chaonan District). The planned volume of the landfill site is 2.75 million m^3, and it will have a service life of 15 years. An FSR for the landfill site is being prepared. There is no clear completion date for this site yet. For the current project, all domestic solid waste will be disposed at the existing Shantou Municipal Leidashi landfill site, 63 km from the district's urban area. This began operation in 2003 (phase I) and was expanded in 2006 (phase II). The site has a total capacity of 10.50 million m^3 and a total area of 187 *mu* (12.5 ha). The daily municipal rubbish disposal capacity is 1,462 m^3. In 2013, Shantou Municipality initiated a pilot recycling program at two communities, where rubbish is sorted into four disposal bins prior to municipal collection (recyclable, nonrecyclable, hazardous, kitchen wastes). Most rubbish in the municipality is still disposed as mixed landfill.

[34] According to the PRC's design criteria, the wastewater value is calculated as 80% of the water supply value.

IX. INFORMATION DISCLOSURE, CONSULTATION, AND PARTICIPATION

155. **Legislative framework.** Meaningful public and stakeholder participation and consultation during project planning, feasibility study, design, and implementation are an important EIA requirement; and can directly reflect the public's perceptions on environmental quality in the project's area of influence. Relevant provisions in the Environmental Protection Law of the PRC and the Regulations on the Administration of Construction Project Environmental Protection (Order of the State Council, No. 253) require that an EIA report prepared by a certified EIA Institute shall be in accordance with relevant laws to solicit the opinions of organizations concerned and residents within and nearby the project sites. In August 2012, the PRC National Development and Reform Commission (NDRC) issued a new requirement for "Social Risk Assessment of Large Investment Projects" which emphasizes the importance of public consultations in an effective manner; and requires that the results of public consultation are clearly summarized in the EIA report, including the dates of consultations, number of stakeholders, who the stakeholders are, and the comments received. It is also important to show how the concerns and comments from the stakeholders and APs have been addressed by the updated FSR, the project design, the EIA, and EMP. ADB's SPS also requires meaningful public participation, consultation, and information disclosure.

156. **Information disclosure and public consultation.** Information disclosure and public consultation were conducted during preparation of the FSR, domestic EIA, and this IEE. This included internet disclosure, questionnaire survey, and meetings with the stakeholders. Interviewees were villagers, village committees, urban residents, a school, potential project-related APs, and other concerned stakeholders. Two rounds of information disclosure were conducted by the EIA Institute (Table IX.1; Figures IX.1–IX.2). The first round (11 September 2012) was carried out during early EIA preparation. The content was a detailed description of project scope; contact details of the Chaonan PMO, IAs, the EIA Institute, and local EPB; major procedures and scope of the EIA; and main aspects for public consultation. This was posted on the CDG website (http://www.chaonan.gov.cn/). The second round (16 September 2013) was undertaken after preparation of the updated FSR and EIA report; and confirmation of the construction spoil disposal site to solicit public comments on the EIA findings, including potential impacts, mitigation, and management of construction and operation. This was posted on the website of the Shantou Municipal Environmental Science Association (http://www.stesa.cn/) (Figures IX.1–IX.2).

157. **First round of public consultation.** Consultations were held with residents, villagers, local water management authorities, and experts about the project, including construction disturbance, possible impacts on water source protection, and drinking water safety. One hundred and fifteen (115) questionnaires were distributed in the public meeting by the EIA Institute: 15 to local organizations and/or units and 100 to APs of different age groups, gender, educational backgrounds, and occupations (Table IX.1). All (100%) of the consulted APs and organizations supported the project and believed that it will improve local social and economic development and living conditions (Table IX.2). Issues raised by the respondents included (i) wastewater treatment for the current wastewater situation; (ii) noise, dust, solid waste and soil erosion impacts of construction and their mitigation; (iii) quality control of WSP construction and pipelines; and (iv) existing rubbish collection and disposal for improving the local sanitation condition. Suggestions provided by the respondents included (i) ensuring correct discharge of wastewater and exhaust gas from machinery and vehicles during construction (especially pipeline construction in residential areas); (ii) timely collection and disposal of construction spoil; (iii) no night-time construction to minimize noise impact to residents and noise monitoring near schools; (iv) planning to avoid repeated excavation of underground pipelines; (v) undertaking water spraying to minimize fugitive dust on construction sites; and (vi) protecting existing ecological resources during construction and improving vegetation in the WSPs and after the pipeline construction. All considerations have been included as mitigation and management measures in the updated FSR, EIA, and this IEE, including the project EMP (Attachment A).

Figure IX.1: First public disclosure

Figure IX.2: Second public disclosure

Table IX.1: Respondents of First Round of Questionnaire Survey

Basic Information of the Consulted Affected Persons			No. of Respondents	%
100 affected persons consulted	Gender	Male	95	95
		Female	5	5
	Age	20–45	42	42
		46–60	50	60
		≥60	8	8
	Occupation	Civil servant and cadre	2	2
		Worker	19	19
		Farmer	59	59
		Servicemen	5	5
		Self-employed individuals	15	15
15 organizations consulted	1) Yangfenchen Villagers' Committee, 2) Yiying Community Residential Committee, 3) Huaqiao Villagers' Committee, 4) Liannan Villagers' Committee, 5) Dongxi Villagers' Committee, 6) Silian Community Residential Committee, 7) Linzhao Villagers' Committee, 8) Xiandou Villagers' Committee, 9) Chengpo Villagers' Committee, 10) Qiufeng Villagers' Committee, 11) Xianxi Villagers' Committee, 12) Shenxi Elementary School in Xiancheng Town, 13) Xiweizhou Villagers' Committee, 14) Sihe Villagers' Committee, and 15) Jianpu Villagers' Committee.			

Source: Environmental impact assessment report.

Table IX.2: Results of First Round of Questionnaire Survey

Question	Option	No. of Replies from 100 affected persons Surveyed	%	No. of Replies from 15 Organizations Surveyed	%
What is the area you think needs to be specially protected?	Villages around the project area	76	76	14	93.3
	Qiufeng, Longxi and Jinxi reservoirs	83	83	15	100.0
	Liangying and Xiashan creeks	17	17	0	0.0
What do you think about the current local environmental quality?	Good	5	5	1	6.7
	Fair	85	85	14	93.3
	Poor	10	10	0	0.0
What do you think is the main environmental problem in the project	Air pollution	6	6	0	0.0
	Solid waste littering	87	87	14	93.3

Question	Option	No. of Replies from 100 affected persons Surveyed	%	No. of Replies from 15 Organizations Surveyed	%
area?	Wastewater pollution	68	68	13	86.7
	Noise impact	0	0	1	6.7
	Soil erosion	29	29	2	13.3
	No impact	7	7	0	0.0
What are the negative impacts causing by the project construction?	Air pollution	5	5	0	0.0
	Wastewater discharge	7	7	0	0.0
	Noise impact	11	11	0	0.0
	Solid waste	21	21	0	0.0
	Soil erosion	3	3	0	0.0
	No impact	72	72	15	100.0
Do you think the project will benefit the local residents and environment?	Yes	85	85	15	100.0
	No	1	1	0	0.0
	Do not know	14	14	0	0.0
What do you think the overall environmental impact of the project?	Positive	47	47	8	53.3
	Negative	0	0	0	0.0
	Do not know	53	53	7	46.7
What do you think the significance of the environmental impact of the project?	Significant impact	0	0	0	0.0
	Moderate impact	2	2	0	0.0
	Limited impact	98	98	15	100.0
Do you agree to implement the project with the proposed mitigation measures?	Agree	100	100	15	100.0
	Not Agree	0	0	0	0.0

Source: Environmental impact assessment report.

Table IX.3: Respondents of Second Round of Questionnaire Survey

Basic Information of the Consulted Affected Persons			No. of Respondents	%
102 affected persons consulted	Gender	Male	56	55
		Female	46	45
	Age	20–45	44	43
		46–60	55	54
		≥60	3	3
	Occupation	Civil servant and cadre	7	7
		Worker	2	2
		Farmer	79	77
		Servicemen	3	3
		Self-employed individuals	11	11
	Education	Primary school	25	25
		Middle school	68	67
		Vocational school	9	9
		University and college	0	0
	Location	Within project impact areas	102	100
		Out of project impact areas	0	0
16 organizations consulted	1) Yangfenchen Villagers' Committee, 2) Yiying Community Residential Committee, 3) Huaqiao Villagers' Committee, 4) Liannan Villagers' Committee, 5) Dongxi Villagers' Committee, 6) Silian Community Residential Committee, 7) Linzhao Villagers' Committee, 8) Xiandou Villagers' Committee, 9) Chengpo Villagers' Committee, 10) Qiufeng Villagers' Committee, 11) Xiweizhou Villagers' Committee, 12) Sihe Villagers' Committee, 13) Jianpu Villagers' Committee, 14) Chaonan District Education Bureau, 15) Chaonan District Water Resources Bureau; and 16) Chaonan District Forestry Bureau			

Source: Environmental impact assessment report.

158. **Second round of public consultation.** The second round of public consultation comprised a meeting, during which general discussions and a questionnaire survey were held. The meeting was held at the CWSC (conference room) on 16 September 2013; and was organized by the EIA Institute, the PMO, and the IAs. The aim was to present the findings from

the domestic FSR and EIA, and issues identified by the PPTA consultants and ADB missions; and to receive public feedback (Table IX.4). The meeting was also used to present the main anticipated impacts and the proposed mitigation measures as defined in the FSR and the EIA, including the newly identified spoil disposal site. Participants comprised residents, villagers, government agencies related with the project, including construction disturbance, water source protection, drinking water safety, and restoration of the spoil disposal site. One hundred and eighteen (118) questionnaires were distributed at the meeting: 16 to local organizations and/or units and 102 to APs of different age groups, gender, educational backgrounds, and occupations (Table IX.3). All (100%) questionnaires were completed.

Table IX.4: Results of Second Round of Questionnaire Survey

Question	Option	No. of Replies from 16 Units Surveyed	%	No. of Replies from 102 Affected Persons Surveyed	%
What is the area you think needs to be specially protected?	Villages around the project area	13	81	98	96
	Qiufeng, Longxi and Jinxi reservoirs	11	69	65	64
	Liangying and Xiashan creeks	9	56	54	53
	Construction spoil disposal site in the industrial park	0	0	0	0
What do you think about the current local environmental quality?	Good	1	6	0	0
	Fair	15	94	99	97
	Poor	0	0	3	3
What do you think is the main environmental problem in the project area?	Air pollution	5	31	10	10
	Solid waste littering	10	63	15	15
	Wastewater pollution	12	75	90	88
	Noise impact	4	25	5	5
	Soil erosion	8	50	42	41
	No impact	0	0	0	0
What are the negative impacts causing by the project construction?	Air pollution	0	0	2	2
	Wastewater discharge	0	0	0	0
	Noise impact	0	0	0	0
	Solid waste	0	0	0	0
	Soil erosion	0	0	1	1
	No impact	16	100	99	97
Do you think the project will benefit the local residents and environment?	Yes	16	100	79	77
	No	0	0	0	0
	Do not know	0	0	33	32
What do you think the overall environmental impact of the project?	Positive	16	100	102	100
	Negative	0	0	0	0
	Do not know	0	0	0	0
What do you think the significance of the environmental impact of the project?	Significant impact	16	100	102	100
	Moderate impact	0	0	0	0
	Limited impact	o	0	0	0
Do you agree to the spoil disposal site and with the proposed environment protection measures?	Agree	16	100	102	100
	Not Agree	0	0	0	0

Source: Environmental impact assessment report.

159. **Results of the second round of public consultation.** All (100%) of the consulted APs and stakeholders supported the project (Table IX.4). They believe the project will improve the local social, economic, and ecological environment; and improve drinking water safety and living conditions for residents. For the spoil disposal site, all (100%) surveyed APs and units agreed to the proposed site location. And with more detailed information on the project compared with the

first round of public consultation, the APs, and stakeholders were able to comment on other specific issues. These are listed below.

(i) Some APs expressed their concern about reservoir pollution caused by the activities of re-forestation. They requested that spraying pesticides be strictly prohibited;
(ii) Some APs are concerned about the land acquisition and resettlement (LAR) plan and compensation rates, and hoped the plan be made available to the public and that compensation rates are transparent;
(iii) Most APs who will benefit from water supply improvement were concerned about the tariff for tap water supply after project completion. They hope the tariff will remain affordable;
(iv) Most APs who will be affected by the pipeline laying expressed concern about impacts from construction noise, dust, and solid waste. They hoped their daily lifestyle would be guaranteed. [Note: Mitigation measures for noise, air, water, and safety and health of residents and workers is addressed in the project EMP and domestic EIA.];
(v) Most APs and stakeholders suggested the pipelines should be constructed with road construction under proper planning and coordination between government agencies; and
(vi) Some APs and stakeholders hoped the spoil disposal should be properly coordinated with the industrial park's planning and construction.

160. During the meeting, most participants indicated that if all the mitigation measures proposed in the EIA and EMP are strictly carried out and supervised by the district EPB and UMB during construction and operation, then they would be satisfied.

161. After the meeting, all feedback was summarized and provided to the DI and EIA Institute. The concerns and suggestions, and corresponding mitigation measures have been fully taken into account and incorporated in the latest FSR, the EIA, and this project IEE. Note that public concern for wastewater pollution was high (see response to the question "What do you think is the main environmental problem in the project area?" in Table IX.4). Except for wastewater issues to be caused by project construction and operation, the broader issue of wastewater management is outside the scope of this project. A project-specific assurance has been developed with CDG to ensure that three planned WWTPs and their associated pipeline connections will be operational before completion of the project WSPs (see Project Assurances in Section XI).

162. **Future consultation.** Dialogue will be maintained with the APs and stakeholders throughout project implementation. This will ensure that public concerns are understood and addressed in a timely manner. A consultation and participation plan during construction and operation has been developed and is part of the project EMP (Attachment A). Future consultation will be undertaken via (i) questionnaire surveys, household visits, workshops, and public hearing (consultation meeting); (ii) involvement of the APs and stakeholders during inspection and monitoring of EMP implementation; and (iii) consultation with the public after the project completion. These consultations will help evaluate public opinion on project success.

163. The project's environmental information will be further disclosed by the Chaonan District EPB, the Shantou Municipal EPB, and ADB as follows:

(i) The approved domestic EIA report (in Chinese) will be available in the CDG website;
(ii) Copies of the domestic EIA (in Chinese) will be available on request from the Shantou Municipal EPB and Chaonan District EPB;
(iii) This project IEE will be available at www.adb.org before ADB Board consideration for the loan; and
(iv) Environment performance and monitoring reports during the project implementation will be developed on a semiannual basis and will be disclosed on ADB's website of www.adb.org.

X. GRIEVANCE REDRESS MECHANISM

164. **Background.** In the PRC, under Decree No. 431 Regulation on Petition Letters and Petitioner (State Council, January 2005), a complaint acceptance mechanism is required at all levels of government, and which also protects complainants from retaliation. Under the PRC Decree No. 15 Environmental Complaint Hotline Management (MEP, 15 December 2010), agencies are required to implement a hotline number to receive complaints and/or queries of project activities. The Shantou Municipal EPB and the Chaonan District EPB both operate hotlines (telephone numbers 0754-12369 and 0754-87921635 respectively).

165. Under current general practices in Chaonan District, as in other parts of the PRC, persons affected by construction generally first report to the contractors and IAs directly, or through their community committees. If the issue is not dealt with satisfactorily, the Chaonan District EPB, which takes the leading role in addressing public concerns for the environment, then consults with the project owner or contractor to address the issue. This process is usually time-consuming. The major weakness of this system is (i) the lack of a project-specific unit to address grievances, and (ii) no specific timeframe for addressing grievances.

166. **Project-specific grievance redress.** A project GRM was developed by the Chaonan PMO, the IAs, domestic EIA institute, and PPTA team. The GRM is a joint mechanism for the social and environmental aspects of the project. The GRM addresses ADB's SPS requirement to provide a platform for addressing any community concerns. It is designed to enable open channels for effective communication, identify, avoid, and mitigate any adverse impacts on potential APs caused by project implementation and operations, and establish trust and respect between the PMO, the IAs, and contractors with the local communities. The GRM will be accessible to all members of the community, including the poor and vulnerable, women, children, and ethnic minority groups. Multiple points of entry, including face-to-face meetings, written complaints, telephone conversations, or e-mail, are included in the GRM. Opportunities for confidentiality and privacy for complainants will be honored where this is requested; and in other cases, if regarded as important. The project GRM comprises the following (Figure IX.1):

(i) The PMO environmental and social officers will be responsible for implementation of the GRM. These staff will instruct the contractors and CSCs on how to proceed with any public concerns received. They will coordinate with the district EPB and other government divisions, if necessary; and will be supported by theLIEC;
(ii) The Shantou Municipal EPB and Chaonan District EPB hotline telephone numbers, 0754-12369 and 0754-87921635 respectively, will both form part of the GRM;
(iii) Prior to construction, key contact points for the GRM will be identified. These will include the project IAs, contractor foremen (or contractor-nominated environmental and safety personnel), the Chaonan EPB, and village committee heads. These personnel will be informed of the GRM and will ensure that their respective staff will be aware of their responsibility to receive and forward any complaints received. Contact details (phone numbers, addresses, e-mail) will be publicly disseminated on information boards at construction sites and in the Chaonan EPB website;
(iv) Each contractor will assign an environment, health, and safety (EHS) officer; and
(v) A series of clear steps to identify how any complaints are received, forwarded to the appropriate persons, addressed within stated timelines, and documented.

167. **Grievances which may be received.** Public grievances addressed by the GRM will most likely relate to environmental issues during construction, as consultations with communities (Section VIII) confirmed basic support for the project. Grievances may include (i) damage to public roads due to water supply pipeline laying, and heavy vehicle operation and transportation of heavy equipment and materials; (ii) disturbance of traffic and increased traffic congestion; (iii) dust emissions; (iv) construction noise and vibration; (v) soil erosion; (vi) inappropriate disposal of construction spoils; (vii) loss of income; (viii) damage to private homes; (ix) safety measures

for the protection of the general public and construction workers; and (x) reservoir water quality deterioration during WSPs and water intake constructions.

168. **Grievance redress mechanism procedure.** The GRM procedure is as follows (Figure IX.1). Any and all costs associated with addressing and solving public grievances shall be covered by the project. The GRM will remain open until project completion. Under the GRM, three entry points have been established—i.e., these are the agencies which any affected person may contact: the PMO, the IAs (including the Chaonan District Education Bureau, Forestry Bureau, UMB, WRB, and CWSC), the Chaonan EPB, the village committees of Chengpo, Dapo, Dongxi, Huaqiao, Liannan, Qiufeng, Sihe, Silian, Xiandou, Xianxi, Xiweizhou, Yangchen, and Yiying; the Xiandou, Xianxi villages (including any of the individual members of the committees), the Shenxi Liumengling School, the construction contractors, and the CSCs.

(i) **Stage 1.** The AP submits a written or oral complaint to any of the established entry points for the project GRM. The GRM agency which receives the complaint will immediately report it to the PMO environmental and/or social officer, who will prepare a written record of the complaint. Unless the complaint was received anonymously or has already been resolved (e.g., by the contractor), the PMO environmental and/or social officer will immediately facilitate a meeting among the GRM agencies to (i) identify a course of action; (ii) inform the other GRM agencies, if necessary; (iii) emphasize discretion and respect for the AP, and anonymity if this is requested by the AP and/or the PMO decides this will benefit the AP; and (iv) identify which GRM agency will lead resolution of the issue with the AP.

Initiating resolution with the AP will occur within 7 working days of the complaint being received by the GRM entry approached by the AP. As far as possible, the issue will also be resolved within this 7-day period, to the satisfaction of the AP and the PMO. The PMO environmental and/or social officer will closely oversee this process, and ensure a written record is kept of the process. Complaints which are clearly not project-related and/or are outside the mandate of the GRM (e.g., fraud, corruption), and for which other procedures are more appropriate, will be passed to relevant authorities. The LIEC will assist the PMO officers in replying to the AP. Records of complaints will be included in the semiannual environmental reports to ADB.

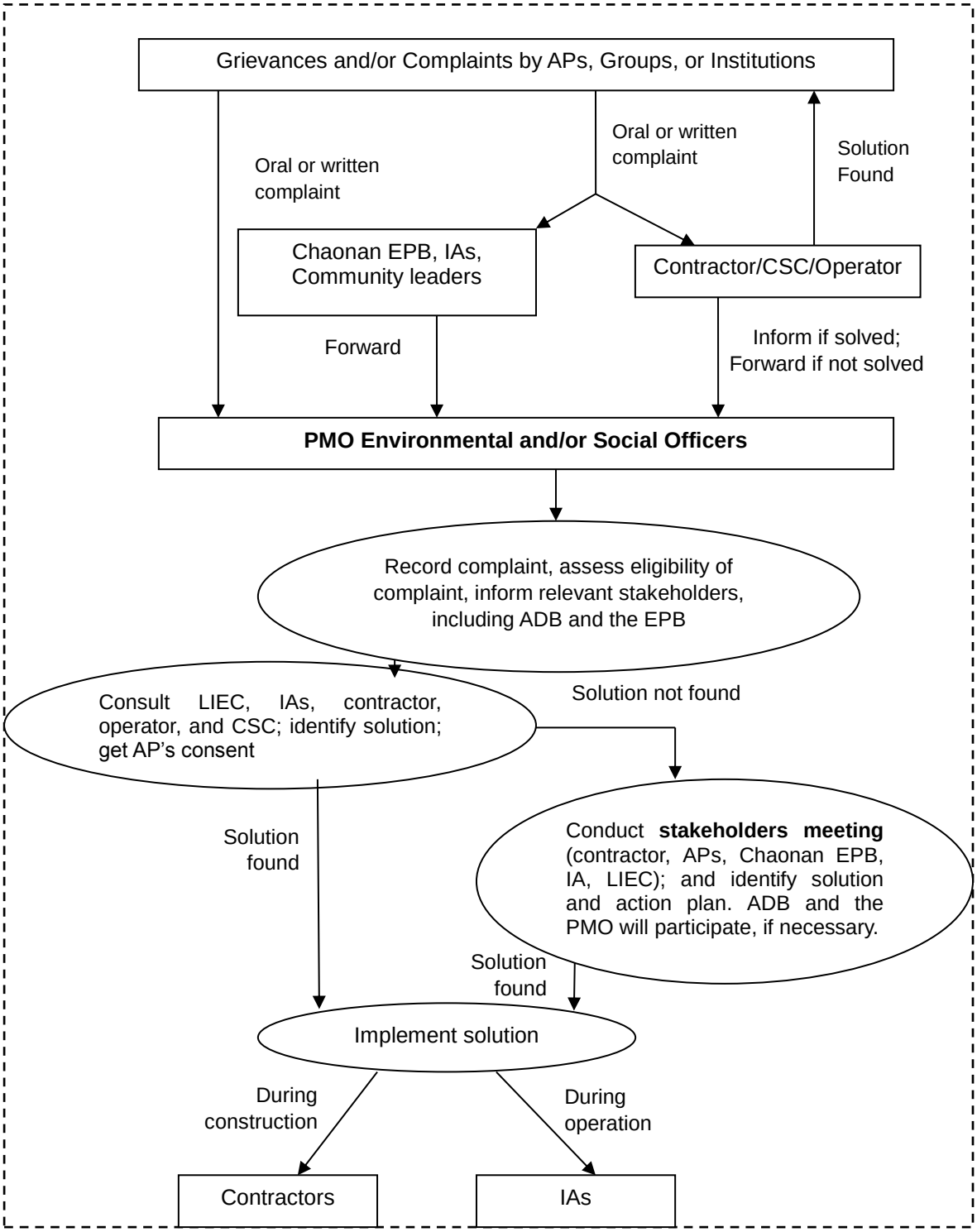
(ii) **Stage 2.** If no solution can be identified by the PMO environmental and/or social officer and the AP, or the AP is not satisfied with the proposed solution, the PMO will organize, within 2 weeks, a multi-stakeholder meeting with the AP, contractor, the IA, and the Chaonan EPB. The hearing shall identify a solution and formulate an action plan. The contractors during construction and the IAs during operation will implement the agreed-upon redress solution and report the outcome to the PMO within the agreed upon timeframe.

169. At any time, an AP may contact ADB (East Asia Department) directly, including the ADB Resident Mission in the PRC.

170. If the above steps are unsuccessful, people who are, or may in the future be, adversely affected by the project may submit complaints to ADB's Accountability Mechanism. The Accountability Mechanism provides an independent forum and process whereby people adversely affected by ADB-assisted projects can voice, and seek a resolution of their problems, as well as report alleged violations of ADB's operational policies and procedures. Before submitting a complaint to the Accountability Mechanism, affected people should make a good faith effort to solve their problems by working with the concerned ADB operations department. Only after doing that, and if they are still dissatisfied, should they approach the Accountability Mechanism.[35]

[35] Available at: http://compliance.adb.org/

Figure X.1: The Project Grievance Redress Mechanism



AP = affected person, CSC = construction supervision company, EPB = environmental protection bureau, IA = implementing agency, LIEC = loan implementation environmental consultant, PMO = project management office.
Source: Asian Development Bank.

XI. CONCLUSIONS

A. Project Benefits

171. The project will bring significant benefits to about 1.23 million urban and rural residents in Chaonan District by improving water supply system, water source protection, water conservation reforestation, and solid wastes disposal. Of the total beneficiary populations, approximately 85% are rural, 49.5% are women, and 6.73% are the poor living under the poverty line in the project area.

172. The expected energy saving and GHG emission reduction from the project are derived primarily from (i) construction of low carbon water supply system, resulting in an annual power saving and GHG emission reduction of 17.767 million kWh electricity and 15,724 tons of CO_2, respectively (against a baseline of the PRC's nation-wide average unit power consumption and CO_2 emissions in the water supply sector); (ii) reduction in NRW loss from 50% to 30%, which will save 12.556 million m^3 clean water per year; (iii) reforestation of 25,230 *mu* (1,682 ha) degraded lands in the catchments of the three project reservoirs, which will generate a carbon sink of 614,000 tons CO_2 annually; and (iv) the district-wide water conservation planning and campaign through public awareness promotion and institutional strengthening.

173. The project will mitigate point and nonpoint water pollution to the three reservoirs, by solid waste disposal, the identification of methods for wastewater discharge pollution control, watershed management, and improved water quality monitoring. The proposed solid waste disposal component will also clean up the urban and rural areas; and close down existing unsanitary landfills and garbage dumps, which will also reduce the amount of wind-blown dust, plastic bags, and other debris that not only affects the residents' health, but impact to the farmland, surface water, and local sanitation condition.

174. The project will provide Chaonan District with an opportunity to establish and strengthen its institutional capacity for project implementation, environmental protection, and water supply system management. The project could also be a model for similar developments in other cities and/or towns in Guangdong Province and in the PRC.

B. Environmental Impacts and Mitigation Measures

175. During construction, potential impacts include soil erosion, noise and vibration, fugitive dust, solid wastes, and community and occupational health and safety. Overall, construction-related impacts will be localized, short term, and can be effectively mitigated through the application of good construction practices and implementation of community and occupational health and safety plan.

176. During operation, the most important issues are drinking water safety and water source protection. Management measures related to operation of the WSPs includes strict maintenance of national water quality treatment processing measures and safety standards following the PRC's Domestic Drinking Water Quality Standard (GB5749-2006), technical capacity of the water supply company to analyze about 70 water quality parameters as required by national law to verify water quality, preparation of an emergency warning system against water contamination, and ensure that WSP staff are trained in water treatment and the emergency response system. For adequately addressing the issues, a risk assessment was conducted, which identified a number of hazards and risks; and concluded that the control measures proposed in the FSR and the EIA report would reduce the risks to acceptable levels.

C. Project Assurances

177. CDG has committed to the standard ADB project assurances (applicable to all ADB projects) concerning effective implementation of the EMP, including mitigation measures, reporting, the GRM, and budget. In addition, the following project-specific assurances shall also apply:

(i) CDG shall ensure that (a) by 2015, up to 3 additional waste water collection and treatment plants, Chendian, Longtian, and Simapu, each with a capacity of 30,000 m^3/d shall be constructed and shall become fully operational according to the Chaonan District Waste Water Treatment Plan (2013–2020); and the residents of their respective service areas shall be connected to the sanitation and sewage networks of these waste water collection and treatment plants; (b) by 31 December 2020, the three new wastewater collection and treatment plants and the two existing wastewater collection and treatment plants in Liangying and Xiashan towns shall be expanded to capacities as follows: Chendian, 50,000 m^3/d; Liangying, 60,000 m^3/d; Longtian, 70,000 m^3/d; Simapu, 50,000 m^3/d; and Xiashan, 70,000 m^3/d, respectively; and the residents of their respective service areas shall be connected to the sanitation and sewage networks of these wastewater collection and treatment plants; and (c) by 2020, wastewater management facilities in Chengpo and Qiufeng villages shall be in place and shall become fully functional;

(ii) CDG shall ensure that all planting activities under the project, including water conservation reforestation, rehabilitation of construction sites and post construction landscaping around Jinxi, Longxi, and Qiufeng reservoirs shall only use plant species which are native to the Danan mountain ranges of the Chaonan District and are sourced from local stock within the Chaonan District or neighboring counties. In the event that non-native seedlings are required for rapid stabilization of exposed soils and sites, CDG shall ensure that only sterile seedlings are used to prevent weed spread;

(iii) To avoid pollution of the reservoir waters, CDG shall ensure that no pesticides and no top dressing fertilizers shall be used for any activities under the project, including water conservation reforestation, rehabilitation of construction sites, and post-construction landscaping around Jinxi, Longxi, and Qiufeng reservoirs; and

(iv) CDG shall ensure that emergency preparedness and response mechanisms for drinking water source protection and water supply safety are developed for the project in compliance with relevant PRC regulations and ADB's SPS.

D. Overall Conclusion

178. The project will support the PRC's sustainable urban and rural development policy, and the Chaonan District Socioeconomic Development Master Plan. Public consultation indicated that all surveyed persons support the project and believe that it will benefit the local social-economy, improve drinking water safety, raise living standards, and effectively protect the local environment, particularly the reservoirs. The findings of the domestic EIA and this IEE are that some negative impacts on air, water, acoustic environment, and point and nonpoint pollution are expected. Most impacts are anticipated to be temporary and localized. Overall, the project's potential environmental impacts are expected to be acceptable if all the mitigation measures and monitoring requirements defined in the EMP are strictly implemented; and the environmental management and institutional capacity of the PMO, the IAs, the CSCs, and contractors are strengthened through implementation of the training program in the EMP.

ENVIRONMENTAL MANAGEMENT PLAN FOR THE GUANGDONG CHAONAN WATER RESOURCES DEVELOPMENT AND PROTECTION DEMONSTRATION PROJECT

People's Republic of China

October 2013

Prepared by the Chaonan District Government with the assistance of the Asian Development Bank

A. Introduction

1. An environmental management plan (EMP) has been prepared for the Guangdong Chaonan Water Resources Protection and Conservation Demonstration Project. Preparation drew on the domestic environmental impact assessment (EIA) report prepared by the Shantou Municipal Environmental Science Research Institute (the EIA Institute); discussions with the Chaonan project management office (PMO) and implementing agencies (IAs); and consultations with the Shantou Municipal environmental protection bureau (EPB), and the Chaonan District's EPB, education bureau (EB), forestry bureau (FoB), and water resources bureau (WRB), as well as the Chaonan Water Supply Company (CWSC), and local communities. The EMP covers all phases of project implementation: detailed design and pre-construction, construction, and operation. It identifies anticipated impacts and mitigation measures, and the institutional responsibilities to monitor and ensure compliance with the environmental laws, standards, and regulations of the People's Republic of China (PRC) and the Asian Development Bank's (ADB) Safeguard Policy Statement (SPS, 2009). The EMP specifies (i) the objectives of environmental management; (ii) mitigation measures and estimated budget; (iii) implementing organization and responsibilities; (iv) an environmental monitoring program; (iv) inspection, monitoring, and reporting arrangements; and (v) a feedback and adjustment mechanism. Monitoring results will be used to evaluate (i) extent and severity of actual environmental impacts against the predicted impacts, (ii) the performance of the environmental protection measures and compliance with relevant laws and regulations, (iii) trends of impacts, and (iv) overall effectiveness of the project EMP.

2. This EMP is based on proposed project feasibility study report (FSR) as of August 2013. Detailed engineering designs are yet to be finalized and may require subsequent impact assessment and/or revisions to this EMP. The finalized EMP will be disclosed on the ADB public website (www.adb.org) and included in the project administration manual (PAM). The final EMP will also be included as a separate annex in all bidding and contract documents. The contractors will be informed of their obligations to implement the EMP, and to provide for EMP implementation costs in their bids for project works.

B. Institutional Arrangements and Responsibilities for Environmental Management Plan Implementation

3. **Executing agency and project leading group.** The Chaonan district government (CDG) is the executing agency (EA) for the project (Fig. A.1). The EA is responsible for communication with ADB, loan onlending and repayment, as well as supervision and guidance of the PMO and IAs during project implementation. CDG has established a leading group headed by the director of the CDG, which includes the director or deputy director of the district Development and Reform Commission (DRC), the urban management bureau (UMB), EB, EPB, FoB, and WRB. The project leading group is responsible for directing the project and providing policy guidance during project implementation.

4. **Project management office and implementing agencies.** A PMO has been established, headed by the executive deputy administrator of CDG, comprising 16 full-time staff from district DRC, EB, EBP, FoB, UMB, finance, housing and construction, and water affairs bureaus; and CWSC. The PMO currently has four departments of contract management, finance, engineering and technology, and administration. An environmental and social management unit was established under the engineering and technology department. The PMO will be responsible for overall guidance, supervision, coordination, and management of project preparation and implementation. The PMO will conduct the daily operations for project preparation and implementation. There are four IAs, each responsible for project subcomponents (Table A.1).

Table A.1: Project Implementing Agencies and Subcomponents

Component	Description	IA
Component I	**Water Sources Protection**	EB/ UMB
I-1	Raising public awareness on environmental protection and sanitation	
I-2	Study on water sources protection within the reservoirs	
I-3	Solid waste disposal within Class I protection zone of Qiufeng reservoir	
I-4	Reforestation in the catchment areas of the three reservoirs	FoB
Component II	**Integrated Urban and Rural Water Supply System**	WSC
II-1	Expansion of Qiufeng WSP	
II-2	Upgrade of Jinxi WSP	
II-3	Construction of New Longxi WSP	
II-4	Water Supply Distribution Pipelines	
II-5	Water Quality Monitoring Center	
Component III	**Institutional Strengthening and Capacity Building**	
III-1	Technical Assistance for Project Implementation	WSC
III-2	Water Resources Protection and Utilization Action Plan	WRB
III-3	Water Supply Dispatch Center	WSC
III-4	Water Resources Management and Three-Prevention Dispatch Center	WRB

CWSC = Chaonan Water Supply Company, EB = Chaonan education bureau, FoB = Chaonan forestry bureau, PPTA = project preparatory technical assistance, UMB = Chaonan urban management bureau; WRB = Chaonan water resources bureau, WSP = water supply plant.
Source: Final PPTA consultant's report.

5. **Tasks of the project management office.** The PMO's major tasks include (i) directing project preparation and implementation activities; (ii) drawing up the annual work program and budget; (iii) coordinating procurement activities; (iv) coordinating financial management of the IAs and consolidating project accounts and financial statements; (v) preparing and submitting withdrawal applications through the Chaonan District finance bureau (FB) via the Shantou Municipality finance bureau to the Guangdong Provincial Finance Department for approval and submission to ADB; (vi) establishing baseline data to monitor project impacts, including regular monitoring of physical and financial progress; (vii) submitting reports to ADB, CDG, and relevant government departments of Shantou Municipality and Guangdong Province; (viii) supervising and reporting safeguards implementation and compliance; and (ix) liaising with ADB and other agencies.

6. **Tasks of the implementing agencies.** The IAs will include (i) CWSC, who will be responsible for the implementation of all activities under improved water supply infrastructure output and activities of the water supply control center under strengthened institutional and staff capacity output; (ii) Chaonan water affairs bureau (WAB, through its water conservancy construction and management center), who will be responsible for the implementation of the water resources management and three-prevention (flood control, drought relief, typhoon prevention) management system/center, and the water resources protection and development action plan under strengthened institutional capacity output; (iii) Chaonan FoB will be responsible for water conservation reforestation subproject under the improved water resources protection output; (iv) Chaonan EB will be responsible for public environment and sanitary awareness activities under improvement water resources protection output; (v) Chaonan EPB will be responsible for water resources pollution control and prevention research in the water source protection area under the improved water resources protection output; and (vi) Chaonan UMB will be responsible for the implementation of solid waste collection and treatment subproject under improved water resources protection output. Consulting services, training and study tours, and project monitoring and evaluation under the strengthened institutional and staff capacity output will be implemented by CWSC in coordination with relevant bureaus under the coordination and guidance of the PMO.

7. The PMO and IAs will also be responsible for implementing the EMP, consisting of inspection, monitoring, reporting, and initiating corrective actions or mitigation measures.

8. **Project management office environment officer.** The PMO environmental officer will be responsible for implementation of the EMP. The officer will take charge of (i) overall coordination of the EMP; (ii) supervising the implementation of mitigation measures during

project construction and operation; (iii) supervising contractors and construction supervision companies (CSCs) internal monitoring, and coordinating the external and compliance monitoring; (iv) ensuring that environmental management, monitoring, and mitigation measures are incorporated into bidding documents, construction contracts, and operation management manuals; (v) reporting the EMP performance to the EA and ADB; (vi) coordinating the grievance redress mechanism (GRM, together with the PMO social officer); and (vii) responding to any unforeseen adverse impact beyond those mentioned in the domestic EIA, the project initial environmental examination (IEE) and this EMP. The PMO environmental officer will be technically supported by the loan environmental implementation consultant (LIEC) and supervised by the municipal and district EPBs.

9. At the stage of detailed engineering design, the PMO will pass the EMP to the design institute to have mitigation measures incorporated into the detailed design. The EMP will be updated at the end of the detailed design phase and finally incorporated in bidding document and construction contracts. To ensure that the contractors comply with the EMP's provisions, the PMO environmental officer, with the support of the LIEC, will prepare and provide the following clauses, to be incorporated into the bidding procedures: (i) a list of environmental management requirements to be budgeted by the bidders in their tender documents; (ii) environmental clauses for contractual terms and conditions; and (iii) major items in the domestic EIA, IEE, and EMP.

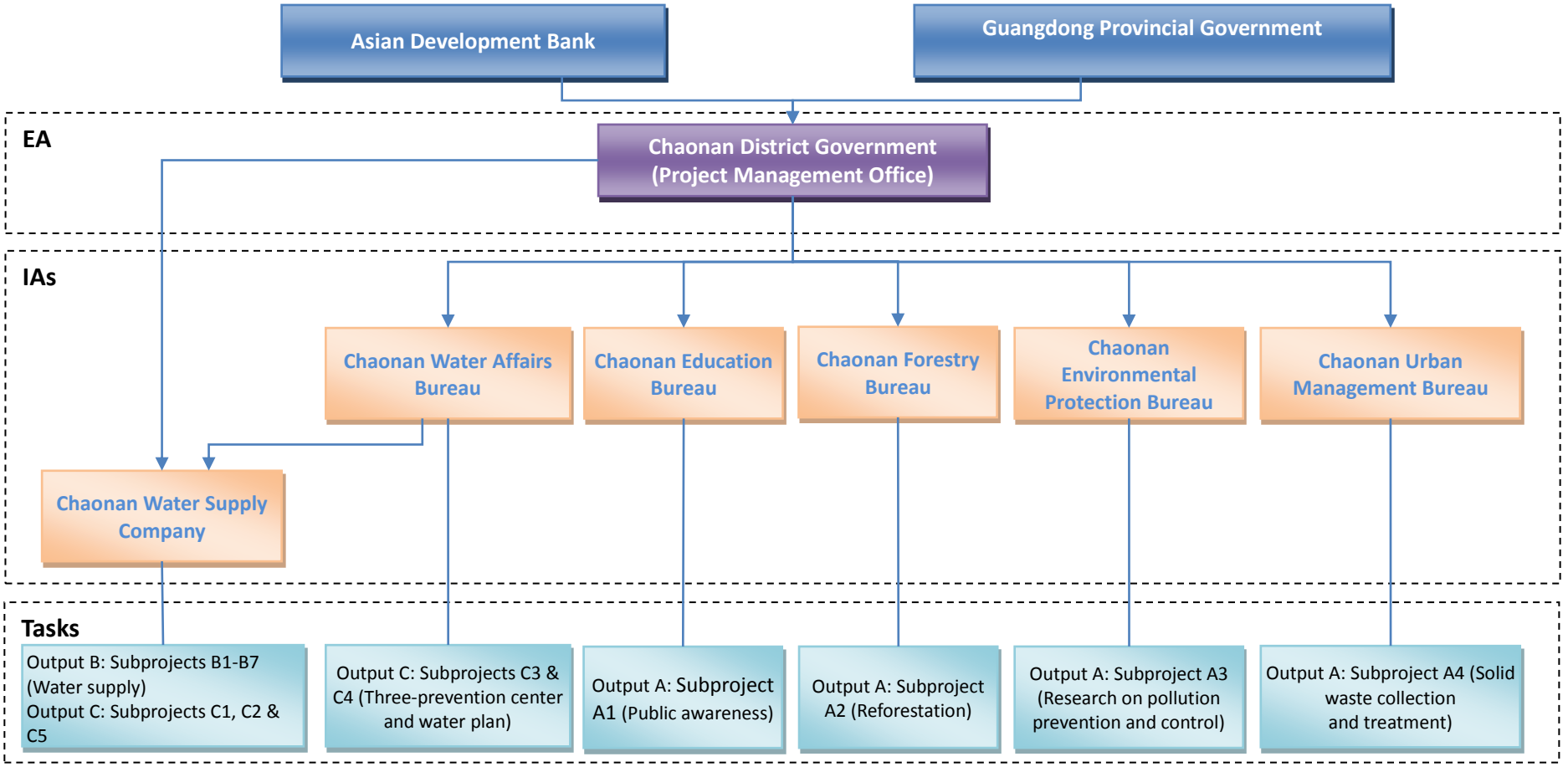
10. **Loan implementation environmental consultant.** An LIEC will be hired under subcomponent III.1 (Table A.1). The LIEC will advise the PMO and IAs, CSCs, and contractors on all aspects of environmental management and monitoring for the project. The LIEC will (i) assist the PMO and IAs in updating the EMP, including the environmental monitoring program; (ii) verify implementation of the EMP mitigation measures; (iii) review internal and compliance monitoring reports and the semiannual external environment performance and/or monitoring reports; (iv) provide training to the PMO, IAs, CSCs, and contractors on the environmental laws, regulations, and policies of the PRC, ADB's SPS, EMP implementation, and GRM; (v) identify any environment-related implementation issues, propose necessary corrective actions, and reflect these in a corrective action program; (vi) help the PMO and IAs prepare semiannual environmental monitoring and progress reports to ADB; and (vii) undertake regular site visits.

11. **Construction contractors.** Construction contractors will be responsible for implementing relevant mitigation measures and internal monitoring during construction with the help of CSCs and under the supervision of the district EPB.

12. **Construction supervision companies.** CSCs will be selected through the PRC bidding procedure, which will be coordinated by the PMO and/or IAs. The CSCs will oversee construction progress and quality and EMP implementation. Each CSC shall have at least one environmental engineer on their respective construction site to (i) supervise the contractor's EMP implementation performance; (ii) conduct internal environmental inspection and monitoring; (iii) fill out weekly environmental performance forms to be submitted to the PMO and IAs; and (iv) prepare the contractor's environmental management performance section in the monthly project progress reports submitted to the PMO.

13. **Chaonan District environmental monitoring station.** The Chaonan District environmental monitoring station (EMS) will ensure compliance with PRC environmental standards and regulations through implementation of the project environmental monitoring program (Table A.5) and regular and random environmental compliance monitoring during construction and operation. The EMS will conduct the compliance monitoring on behalf of the Chaonan EPB.

Figure A.1: Project Organizational Structure



C1. Provision of project implementation consulting services, training and study tours
C2. Establishment of a water supply control center
C3. Establishment of a water resources management and three-prevention (flood control, drought relief, typhoon prevention) management center
C4. Development of a water resources protection and development action plan
C5. Establishment of a project monitoring and evaluation system

Source: Asian Development Bank.

C. Potential Impacts and Mitigation Measures

14. Potential project environmental impacts and their mitigation measures are summarized in Tables A.3–A.4. Mitigation measures will be incorporated into detailed design, bidding documents, construction contracts and operational management manuals, which will be implemented by the design institutes, contractors, CSCs, the PMO, and IAs, with technical support from the LIEC and under the supervision of the municipal and district EPBs. The effectiveness of these measures will be evaluated based on environmental inspections and monitoring to determine whether they should be continued, improved or adjusted. The mitigation measures aim to (i) mitigate environmental impacts; (ii) achieve compliance with PRC environmental laws, regulations, and standards and ADB's SPS; and (iii) protect environmental resources and ecosystems, and maximize social-economic and environmental benefits.

D. Environmental Monitoring, Inspection, and Reporting

15. The project environmental monitoring program (Table A.5) focuses on the project's area of influence. The program describes the scope of monitoring, parameters, time and frequency, implementing and supervising agencies, internal and external monitoring, and estimated costs. A detailed cost breakdown will be provided by the Chaonan EMS when the detailed environmental monitoring programs are prepared at the start of each subcomponent implementation. Sampling of individual parameters shall comply with the methods provided in the relevant national environmental monitoring standards for air, water, noise, soil, pollutant discharge, and the PRC's Domestic Drinking Water Quality Standard (GB5749-2006). These standards are comparable with the World Bank's Environmental, Health, and Safety (EHS) Guidelines. The EMP will be implemented until project completion, except for the monitoring of potential operational-phase impacts, which will start upon the physical completion of each project component and be implemented until 12 months after the date of physical completion of the final project component. This is to ensure that all potential operational impacts are monitored for at least 12 months. Because construction activities are phased, components completed before year 5 of construction will receive more than 1 year of operational-phase monitoring.

16. **Internal monitoring.** This will comprise monitoring and inspection by the PMO, the Jinxi and Qiufeng water supply plants (WSPs), the CSCs, and contractors. The PMO environmental officer, supported by the LIEC, will be responsible for internal inspection and overall compliance with the EMP throughout the project, until project completion. The PMO environmental officer, the LIEC, and the Chaonan EPB will advise and supervise the contractors, the CSCs, and IAs to ensure that the environmental mitigation measures defined in the EMP are properly implemented. Each contractor and CSC will recruit at least one environmental staff for its internal environmental inspection and supervision during construction. At the start of the project implementation, detailed internal environmental monitoring plans will be prepared by the CSCs, based on the project EMP, and reviewed and approved by the PMO and LIEC.

17. **External monitoring.** This will comprise monitoring by the Chaonan EMS and LIECs. The Chaonan EMS will be responsible for the environmental monitoring program (i.e., water, air, noise, and soil monitoring). The frequency and scope of the monitoring is described in Table A.5. Semiannual monitoring reports will be prepared by the Chaonan EMS and then submitted to the IAs, municipal and district EPBs and the PMO for review. The LIECs will verify the EMP implementation and environmental monitoring information prepared by the PMO and IAs. In verifying, external experts may conduct their own investigation by visiting the project sites, taking samples, and/or conducting site inspections. The external experts will discuss the verification results with the PMO and the IAs, suggest corrective actions, and reflect findings in their EMP implementation and environmental monitoring verification reports. To ensure accuracy of the monitoring, the quality assurance (QA) and/or quality control (QC) procedures will be conducted in accordance with the following regulations:

(i) Regulations of QA/QC Management for Environmental Monitoring issued by the Ministry of Environmental Protection (MEP) in July 2006;

(ii) QA/QC Manual for Environmental Water Monitoring (Second edition), published by the State Environmental Monitoring Center in 2001; and
(iii) QA/QC Manual for Environmental Air Monitoring published by the State Environmental Monitoring Centre in 2001.

18. The results of environmental monitoring will be used to assess (i) extent and severity of actual environmental impacts against predicted impacts; (ii) effectiveness of the mitigation measures and compliance with environmental standards and regulations; (iii) trends in impacts; (iv) overall effectiveness of EMP implementation; and (v) the need for additional mitigation measures and corrective actions if noncompliance is observed.

19. **Monthly internal reports.** During project construction, monthly environmental progress reports will be prepared by the CSCs and submitted to the PMO and IAs (Table A.2). These will summarize the monthly monitoring and inspection data collected by the CSCs. These reports will present: (i) project implementation status; (ii) mitigation measures implemented; (iii) results of monitoring and inspections, including monitoring data of air, noise, and surface water, particularly outlet water qualities from the proposed WSPs; (iv) analysis of monitoring data against relevant standards; v) violations of environmental regulations and standards (vi) any additional mitigation measures required; (vii) any environmental training received; (viii) occupational health and safety (e.g., any accidents); and (ix) any issues and follow-up actions e.g., complaints. Note that the data for points (iii) and (iv) will be provided by the Chaonan EMS.

20. **Semiannual environmental monitoring and progress reports.** The PMO will, on behalf of the EA, submit to ADB semiannual environmental progress reports based on the internal and compliance monitoring and external inspections. The reports will include (i) progress and effectiveness of EMP implementation; (ii) environmental monitoring and compliance; (iii) institutional strengthening and training; (iv) public consultation (including GRM); and (v) any problems encountered during construction and operation, and corrective actions undertaken. Information on progress of the associated facilities which are relevant as part of the environmental assurances under the project, will also be included, including expansion of the two existing wastewater treatment plants (WWTPs) and construction of the three new WWTPs, and wastewater treatment and solid waste collection in Chengpo and Qiufeng villages at Qiufeng reservoir. The LIEC will help the PMO prepare these semiannual reports. The LIEC will also submit a verification report to ADB, which will confirm project compliance with the EMP and the PRC laws, regulation, and standards; and identify any implementation issues and corrective actions.

21. **Report of environmental acceptance monitoring and audit.** No later than 1 month after completion of construction work, the IAs will collect data and/or reports from contractors and the CSCs, and submit construction completion reports to the PMO and the district EPB. The report will indicate the timing, extent, and effectiveness of the completed mitigation and maintenance activities, and point out the need for further mitigation measures and monitoring during operations. Within 2 months after physical completion of a project component, environmental acceptance monitoring, and audit reports will be (i) prepared by the EMS in accordance with the PRC Regulation on Environmental Check-and-Acceptance of Project Completion (State Environmental Protection Agency, 2001), (ii) reviewed for approval by Shantou Municipal EPBs, and (iii) finally reported to ADB by the PMO and the LIEC.

22. **ADB safeguard review mission.** At least once a year, an ADB safeguard mission will visit the project sites to review project compliance with the EMP, including review of monitoring data, status of EMP implementation, and performance of the GRM. Contractor compliance with the EMP will be discussed with the PMO and considered in the next bid evaluations.

Table A.2: Environmental Reporting Plan

Phase	From	To	Reporting
Construction			
Internal monitoring report	CSCs	IAs	Monthly
Compliance monitoring report	District EMS	PMO, IAs, district EPB	Semiannual
Semiannual progress report	PMO, LIEC	ADB	Semiannual
EMP completion report	CSCs, Contractors	PMO, IAs, LIEC	1 month after project completion
Environmental acceptance report	Local EMS	Municipal and district EPBs, PMO, IAs, EA, ADB	2 months after project completion
Operation (monitoring for at least 12 months after the date of physical completion)			
Internal monitoring report	IAs	District EPB, PMO,	Quarterly
Compliance monitoring report	District EMS, LIEC	PMO, IAs, Municipal and District EPBs, EA, ADB	Semiannual

ADB = Asian Development Bank, CSC = construction supervision company, EA = executing agency, EMP = environmental management plan, EMS = environmental monitoring station, EPB = environmental protection bureau, IA = implementing agency, LIEC = loan implementation environmental consultant, PMO = project management office.
Source: ADB.

E. Institutional Strengthening

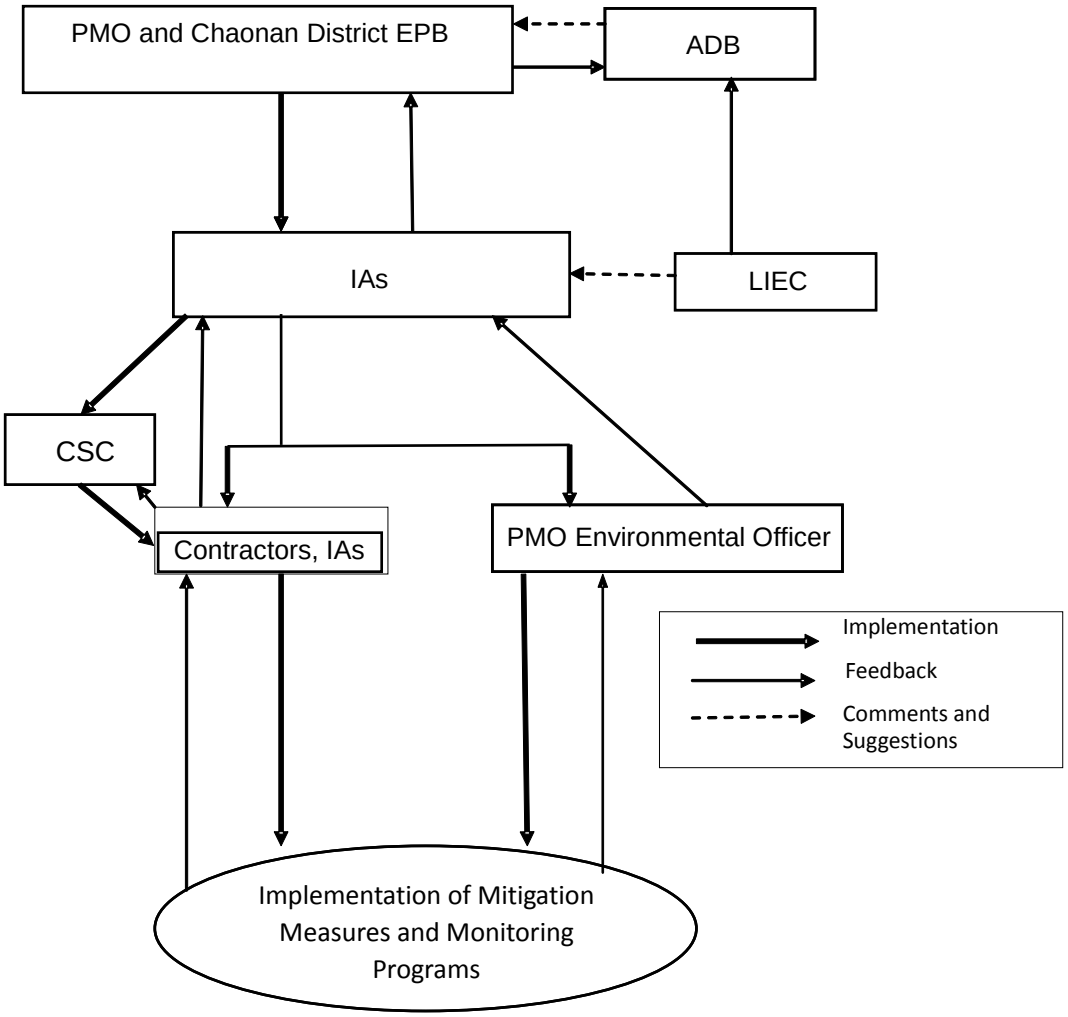
23. Assessment during the project preparatory technical assistance (PPTA) showed that the PMO and IAs lack technical capacity for environmental management. To ensure effective EMP implementation, the capacity of the PMO, IAs, operators of project facilities (OPFs).[1] The CSCs and contractors will be strengthened by training. Training in how to implement the EMP will be given by the LIEC and experts from the provincial and municipal EPBs. Training in the importance of best-practice construction methods for this project, including the need for extra care at reservoirs and sensitive receptors, construction site rehabilitation, and reduction of nonrevenue water (NRW) loss, will be given (Table A.6).

F. Mechanism for Feedback and Adjustment

24. Upon completion, this project EMP will be translated into Chinese and inserted into the domestic EIA report. This will ensure the EMP is integrated within the PRC legal framework for the project. The EMP will be updated as needed by the Chaonan District EPB with assistance from the PMO, LIECs, and IAs, when there are design changes, changes in construction methods and program, poor environmental monitoring results, and/or if mitigation measures prove to be ineffective or inadequate. Based on environmental monitoring and reporting systems in place, the Chaonan District EPB and the PMO (with the support of the LIEC) shall assess whether further mitigation measures or improvement in environmental management practices are required as corrective actions. If necessary, public consultations will be held. The PMO will inform ADB promptly of any changes to the project and needed adjustments to the EMP. The updated EMP will be submitted by the PMO to ADB for review and approval, and will be disclosed on the project website. The feedback and adjustment mechanisms are presented in Figure A.2.

[1] The OPF of the reforestation component will be 29 villages under the supervision of the FB; OPF of the WSPs and pipeline will be CWSC; the OPF of three-prevention dispatch center will be the WRB; and the OPF of solid wastes disposal component will be the UMB.

Figure A.2: Mechanism for Feedback and Adjustment of the Environmental Management Plan



Source: Asian Development Bank.

Table A.3: Potential Impacts and Mitigation Measures for Project Construction

Item	Potential Impact	Mitigation Measure	Responsibility		Budget (xCNY10,000)
			Implement	Supervise	
Preconstruction Phase					
Detailed design stage	Process and equipment of WSPs	• Design low-carbon water supply system, including (i) high efficiency pumping with variable speed drivers; (ii) water leak detection, repairing, and management (equipment and mechanism); (iii) water supply system automation for energy saving (SCADA); (iv) accurate metering and monitoring • Design water quality monitoring lab in the CWSC to monitor about 42 of 106 parameters listed in the PRC's Domestic Drinking Water Quality Standard (GB5749-2006) • Design online automatic monitoring system at the water intakes of the WSPs • Design a water quality monitoring vehicle with portable instruments for monitoring of the water supply network and rural water supply facilities • All WSP sites and pipeline routes in the detailed designs shall be carefully selected to avoid or minimize potential adverse impacts on the environment and surrounding communities	DI	PMO CWSC, WRB	Included in design contract
	Design of reforestation component	• Select native trees for the reforestation with good water conservation function • Prohibit planting of foreign species • Focus on degraded hillsides around Jinxi, Longxi, and Qiufeng reservoirs • Random planting with mixed trees, shrubs, and grasses	DI	PMO WSP, FoB, WRB	Included in design contract
	Spoil disposal sites	• During detailed design, develop a comprehensive management and restoration plan according to requirements defined in approved EIA report. The plan will be prepared by a qualified design institute which includes environmental management. Submit the plan to Chaonan EPB and UMB for approval. The mitigation measures in the plan will be included in all civil bidding document and construction contracts.	DI, IAs	PMO, EPB, CWSC	Included in design contract
Construction preparation					
	Designate Environmental Officer	• Designate a well-trained environment officer in the PMO	PMO	EA, EPB, ADB	
	Update EMP	• Update mitigation measures defined in this EMP based on final detailed design, submit to district EPB for approval	EIA Institute, IAs, PMO	Municipal and district EPBs, ADB	Included in EIA contract
	LARP	• Incorporate updated LARP in detailed design	DI, IAs, PMO	BCA, BLM	Included in resettlement budget
	External and compliance environmental monitoring	• Prior to construction, engage the Chaonan District EMS for compliance monitoring • Prepare a detailed work plan, based on the environmental monitoring program (Table A.5)	PMO, IAs	Municipal and district EPBs, ADB	Included in specific budget for monitoring
	Technical assistance	• Include environment provisions in the TOR for selecting the LIEC	PMO, IAs	ADB	Included in loan

Item	Potential Impact	Mitigation Measure	Responsibility		Budget (xCNY10,000)
			Implement	Supervise	
	Bidding and contract documents	• Include environment requirements in the bidding documents for selection of DI, contractors, and loan implementation TA consultants • Include environmental mitigation and monitoring clauses defined in the EMP in the contracts with DI, contractors, and loan implementation TA consultants	PMO, IAs	Municipal and district EPBs, ADB	Contractor contracts
	EMP training	• LIEC, and/or invited environment specialists and/or officials from provincial and municipal EPB, provide training on construction environmental management and implementation and supervision of environmental mitigation measures to contractors and CSCs	PMO, LIEC, IAs	Municipal and district EPBs, ADB	Included in loan
	EMP and supervision manual	• Prepare environmental operation and supervision plans/manuals for all construction activities. These plans will need to fulfill the requirements of this EMP	Contractors, CSCs	PMO, IAs, EPB, LIEC	Included in construction contract
	Internal environmental monitoring and supervision plan	• Prepare an internal environmental monitoring plan to meet the requirements defined in the EIA, the IEE, and the EMP. These plans will need to fulfill the requirements of this EMP	Contractors, CSCs	PMO, IAs, Municipal and district EPBs, LIEC	Included in construction contract
	Establish GRM	• Establish a PPCU in the PMO • Provide training for PPCU members and GRM access points • Disclose the PPCU's phone number, fax, address, and email to the public on the district EPB's website and on information boards at each construction site	PMO, IAs	Municipal and district EPBs, LIEC, ADB	Included in PMO budget
	Onsite EHS officer	• After contract award and prior to start of construction, assign an onsite EHS officer for each contractor	Contractors	PMO, IAs, CSCs, LB	Included in construction contract
	Resettlement, economic displacement	• Establish a resettlement office of local officials to manage land acquisition and resettlement • Conduct information dissemination and community consultation programs • Ensure resettlement activities are reasonably completed before construction starts • Ensure implementation of the project social development action plan	IAs, LARO,	PMO, EA, LB, BCA	Included in LARP budget
Construction Phase					
Soil and geology	Soil erosion	• Stabilize compacted pipe trenches, and other erosion-prone working areas • Earthwork disturbance areas must be stabilized within 7 days after earthwork completion • Minimize active open excavation areas during water supply pipeline trenching activities (Maximum trench length will be 300 m in accordance with the domestic EIA report); use appropriate compaction techniques for pipe trench construction • Provide temporary detention ponds or containment to control silt runoff • Construct intercepting ditches and drains to prevent runoff entering construction sites, and divert runoff from sites to existing drainages • Strip and stockpile topsoil, and cover or seed temporary soil stockpiles • Limit construction and material handling during periods of rains and high winds • Properly re-vegetate disturbed surfaces, such as compacted pipeline trenches and the WSPs after completion of constructions • Appropriately locate construction camps and storage areas to minimize land area required and impact on soil	Contractors, CSCs	PMO, IAs, EPB, LIEC	500.0 (included in construction contracts)

Item	Potential Impact	Mitigation Measure	Responsibility		Budget (xCNY10,000)
			Implement	Supervise	
		erosion • Implement soil erosion inspection and monitoring program. Internal inspection will be conducted by contractors and CSCs. Compliance inspection by a licensed institute (Table A.5). Monitoring results will be submitted to the PMO and IAs, and district EPB and WRB. These will serve as basis for project implementation progress reports and acceptance of construction			
	Soil Contamination	• Properly store petroleum products, hazardous materials and wastes on impermeable surfaces in secured and covered areas • Remove construction wastes from the site to approved waste disposal sites • Establish emergency preparedness and response plan (spill management plan) • Provide spill cleanup measures and equipment at each construction site. Require contractors to conduct training in emergency spill response procedures			
	Spoil disposal site management and rehabilitation	• Prior to operation, construct intercepting ditches and drains, retaining walls (on upstream area of the site) and sedimentation basins (on downstream area of the site) to mitigate soil erosion • Top soil (with some grass) on the spoil site will be stripped, moved, and stored temporarily on nearby open areas for site rehabilitation. Temporary sandbag retaining walls will be used to control top soil loss • Existing small pits and depressions in the site will be filled with spoil first • Avoid clearance of trees and bushes as much as possible. Where these have to be removed, (a) re-plant the individuals on-site within a week; and/or, (ii) conduct on-site compensatory planting of an equivalent or larger area of the affected trees and vegetation (as per the PRC Forest Law) • Conduct site restoration (compacting, re-vegetation) within a week after disposal of every 50,000 m^3 spoil (or every 4 hectares). Replace the original top soil and vegetation, or plant native trees and grass in case the original trees or bushes have been damaged • Only use coastal plant species native to Chaonan District for all planting activities • On windy or rainy days, cover loose and bare spoil • Trucks carrying the spoil will be covered to avoid spillage or dust generation. Give special attention to dust suppression near sensitive receptors e.g., schools, hospitals, villages, and residential areas along spoil hauling roads • Prohibit spoil transport vehicles working along urban and village roads between 22:00 and 07:00 hours, as per the PRC and Guangdong provincial regulations • Identify, demarcate, and protect small animals, reptiles, and birds[a] living on the spoil site • Disposal of any hazardous solid waste is strictly prohibited • Conduct project completion audit to confirm the site is restored in accordance with the approved EIA and the PRC laws and regulations.[b] Hold contractors liable in case of noncompliance	Contractors, CSCs	PMO, IAs EPB, LIEC	100.0 (included in construction contracts)
Reservoir water quality	Water quality and hydrology	• Earthworks near the reservoirs will be accompanied by measures to minimize sediment runoff into the reservoirs, including sediment traps • The discharge of construction wastewater to the reservoirs will be prohibited • Fuel storage, maintenance shop, and vehicle cleaning areas will be stationed at least 500 m away from the reservoirs • A water monitoring program has been developed and will be implemented to assess construction impacts (see	Contractors, CSCs	PMO, IAs, LIEC, CWSC, EPB, WRB,	48.0 (included in construction contracts)

Item	Potential Impact	Mitigation Measure	Responsibility		Budget (xCNY10,000)
			Implement	Supervise	
		Table A.5)			
Ambient Air	Dust and emission generated by construction activities	• Spray water on construction sites and earth and/or material handling routes where fugitive dust is being generated • Locate asphalt mixers at least 500 m downwind from the nearest villages, residential areas, and other sensitive receptors • Pay particular attention to dust suppression near sensitive receptors • Store petroleum or other harmful materials in appropriate places and covering to minimize fugitive dust and emission • Cover materials during truck transport, particularly the fine material, to avoid spillage or dust generation • Ensure emissions from vehicle and construction machinery comply with the PRC standards (GB18352-2005, GB17691-2005, GB11340-2005, GB2847-2005, and GB18285-2005)	Contractors, CSCs	PMO, IAs LIEC, EPB	35.0 (included in construction contracts)
Noise	Noise generated from construction activities	• Ensure noise levels from equipment and machinery conform to the PRC standard of noise limit for construction sites (GB12523-1990); and properly maintain construction vehicles and machineries to minimize noise • Apply noise reduction devices or methods where piling equipment is operating within 300 m of villages, schools, hospitals and residential areas • Locate sites for rock crushing, concrete-mixing, and similar activities at least 1 km away from sensitive areas • To reduce noise at night, restrict operation of machinery generating high levels of noise (e.g. piling) and movement of heavy vehicles along urban and village roads between 22:00 and 07:00 hours in accordance with municipal regulations • Take special caution at construction sites close to sensitive sites. When construction activities are unavoidable during school seasons, the use of heavy equipment will be restricted to weekends and non-class hours • For construction sites near sensitive receptors, place temporary hoardings or noise barriers around noise sources • Monitor noise at sensitive receptors (see Table A.5). If noise standards are exceeded, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation • Distribute ear protection plugs to residents prior to start of construction activity • Conduct monthly interviews with residents adjacent to construction sites to identify community complaints about noise and seek suggestions to adjust work hours of noise-generating machinery	Contractors, CSCs	PMO, IAs, LIEC, EPB	40.0 (included in construction contracts)
Vibration	Vibration generated by piling	• In consultation with local residents and/or other property/landowners, identify structures which may be most vulnerable to vibration impacts • Cleary demarcate such structures to avoid hazards to human safety • Coordinate with residents on the timing of heavy machinery work close to these structures • Prohibit piling and compaction operations at night	Contractors, CSCs	PMO, IAs, LIEC, EPB	5.0 (included in construction contracts)
Solid Waste	Solid waste generated by construction activities and from workers'	• Provide appropriate waste collection and storage containers at locations away from the reservoirs or sensitive receivers • Reach agreement with municipal waste collection services for regular collection of domestic waste prior to construction • Hold contractors responsible for proper removal and disposal of any significant residual materials, wastes and	Contractors, CSCs	PMO, IAs, LIEC, EPB	18.0 (included in construction contracts)

Item	Potential Impact	Mitigation Measure	Responsibility		Budget (xCNY10,000)
			Implement	Supervise	
	camps	contaminated soils that remain on the ground timely during and after construction • Any planned paving or vegetating shall be done as soon as the materials are removed to protect and stabilize the soil • Burning of waste is strictly prohibited • Provide sufficient garbage bins at strategic locations and ensure that they are protected from birds and vermin, and emptied regularly (using the municipal solid waste collection systems)			
Flora and Fauna	Protection of vegetation	• Protect existing vegetation nearby construction sites • Properly backfill, compact and re-vegetate pipeline trenches after construction • Protect existing trees and grassland during WSP and pipeline construction. Where vegetation must be disturbed, re-vegetate immediately after construction • Remove trees or shrubs only as a last resort if they impinge directly on permanent works or approved necessary temporary works • In compliance with the PRC's forest law, undertake compensatory planting of an equivalent or larger area of affected trees and vegetation • Identify, demarcate, and protect sites where small animals, reptiles, and birds of common species live such as vegetated roadside areas, trees, and reservoir beaches • Only use native plant species of local provenance for replanting in the WSPs and along the roads if the pipeline construction damaged existing vegetation	Contractors, CSCs	PMO, IAs FoB, EPB, LIEC,	120.0 (included in construction contracts)
	Fauna	• Identify, demarcate, and protect sites where small animals, reptiles, and birds of common species live such as vegetated roadside areas, trees, inner areas of bridges and river beaches • If any nesting birds or animals are found, demarcate the site, prohibit access by workers, and as far as possible, plan construction around but not in the site until nesting is completed. Do not attempt to catch or relocate the nesting birds or animals • In the event that any animals are found in pipeline trenches, contact EPB and ensure that the animal is released nearby, and unharmed	Contractors, CSCs	PMO, FoB, IAs, LIEC, EPB,	4.6 (included in construction contracts)
Socio-economy	Physical cultural resources	• Establish chance-find procedures for physical cultural resources. If an artifact is unearthed during construction, work will be stopped immediately. The BCR, IAs, and the PMO will be promptly notified. Construction will only resume after permission of the appropriate authority	Contractors CSCs	IAs, PMO, LIEC, BCR	…
Health and safety	Community health and safety	• Traffic management. A traffic control and operation plan will be prepared, to be approved by the TMB before construction. The plan will include provisions for diverting or scheduling construction traffic to avoid morning and afternoon peak traffic hours, regulating traffic at road crossings, selecting transport routes to reduce disturbance to regular traffic, reinstating roads, and opening them to traffic as soon as the construction is completed • Underground facilities survey and protection. Construction activities are planned to minimize disturbances to utility services. Three-dimensional detection of underground facilities will be conducted before construction where appropriate • Information disclosure. Residents and businesses will be informed at least 2 weeks in advance, through media of the construction activities, given the dates and duration of expected disruption • Public signs will be placed at construction sites, warning people of potential dangers such as moving vehicles,	Contractors CSCs	IAs, PMO, LIEC, TMB	30.0 (included in construction contracts)

Item	Potential Impact	Mitigation Measure	Responsibility		Budget (xCNY10,000)
			Implement	Supervise	
		hazardous materials, excavations, and raising awareness on safety issues. All sites will be secured, through fencing if appropriate			
	Occupational health and safety	• An EHS officer will be appointed by each contractor to implement and supervise the EHS management plan. • Each contractor will prepare an EHS management plan for construction works, based on this EMP. The EHS management plan will include the following: ○ provide clean and sufficient supply of fresh water, for construction sites, camps, offices, workshops ○ provide adequate number of latrines and other sanitary arrangements at construction sites and work camps, and ensure they are maintained in a hygienic state ○ install and regularly empty garbage receptacles at construction sites and camps ○ provide personal protection equipment, e.g., safety boots, helmets, gloves, protective clothing, goggles, ear protection, in accordance with relevant health and safety regulations for workers • Prepare emergency response plan to address accidents and emergencies, including environmental and public health emergencies associated with hazardous material spills and similar events. Submit to EPB for review and appraisal. Emergency phone link with hospitals in the district will be established. A fully equipped first-aid base in each construction camp will be organized • Maintain a record management system, to document occupational accidents, diseases, and incidents. Records will be reviewed during compliance monitoring and audits • Ensure occupational health and safety matters are accorded a high priority to all persons accessing construction sites. Posters will be displayed prominently in relevant areas of the site • Train all construction workers in basic sanitation, general health and safety matters, and specific hazards of their work. Implement SITs/HIV/AIDS and other communicable diseases awareness and prevention program to target the local community and construction workers	Contractors, CSCs	PMO, IAs, LB, EPB, LIEC,	50.0 (included in construction contracts)
Total Budget					**CNY9.506 million**

ADB = Asian Development Bank; BCA = Chaonan Bureau of Civil Affairs; BCR = Chaonan Bureau of Cultural Relics; BLM = Chaonan Bureau of Land Management; CSC = construction supervision company; CWSC = Chaonan Water Supply Company; DI = design institute; EA = project executing agency; EIA = environmental impact assessment; EHS = environment, health, and safety; EMP = environmental management plan, EMS = Chaonan District environmental monitoring station; EPB = environmental protection bureau; FoB = Chaonan forestry bureau; FSR = feasibility study report; GRM = grievance redress mechanism; IA = project implementing agency; IEE = initial environmental examination; km = kilometer, LARP = land acquisition and resettlement plan; LARO = District Land Acquisition and Resettlement Office; LB = Chaonan labor bureau; LIEC = loan implementation environmental consultant; m = meter, m^3 = cubic meter, PMO = project management office; PPCU = project pubic complaints unit; PPTA = project preparatory technical assistance; PRC = People's Republic of China, TA = project technical assistance; TMB = Chaonan traffic management bureau; UMB = Chaonan urban management bureau; WRB = Chaonan water resources bureau; WSP = water supply plant.

[a] The fauna on the spoil site include small snakes and rodents according to the domestic EIA report.

[b] Solid Waste Pollution Prevention and Control Law (2005); National Regulation for Management of Construction Solid Wastes (2005; PRC Ministry of Housing and Construction).

Sources: Domestic EIA and FSR, PPTA Consultant's Report, and consultations with the EIA Institute, the PMO, CWSC, EPB, FB, WRB, and other government divisions.

Table A.4: Potential Impacts and Mitigation Measures for Project Operation

Item	Potential Impact	Mitigation Measure	Responsibility		Budget ($xCNY10^4$)	Source of Funds
			Implement	Supervise		
Integrated Urban and Rural Water Supply Component						
Water source protection	Accidental chemical spill, resulting in contamination of water source	• Emergency response to switch to other WSPs through the distribution network for the safe water supply and shut down the polluted WSP • Implement the emergency response mechanism	CWSC, EPB	WRB, Shantou Municipal EPB	10.0/year	Included in the CWSC operation cost
	Point and nonpoint pollution to the reservoirs	• Measures to identify and control pollution sources to be identified under project component 1.3. • Under project component 2.5 (water quality monitoring center), strengthen water quality monitoring at reservoirs, especially for TN, TP, chlorophyll. and pathogens • Enhance the water treatment process of coagulation—filtration—chlorination to control pathogens	CWSC, EMS[a]	WRB, EPB		
Water treatment process	Algal bloom in the pre-sedimentation basin, causing algal toxins, water treatment difficulty and taste and/or odor problems	• Water treatment process will be conducted and supervised by qualified staff of the CWSC • Locate source of eutrophication. Timely control the pollution source by comprehensive monitoring all over the reservoir	CWSC	WRB, EMS, EPB	150.0/year	
	Mechanical or electrical failure of chemical dosing system, resulting in high turbidity and clogging of filters	• Use backup coagulant dosing system • Install and maintain automatic dosing pump with integrated alarm system in the event of failure				
	Use of contaminated coagulant, resulting in contamination of water	• Coagulant must be purchased form approved supplier, demonstrating compliance with national product standard of GB1892-2009				
	Failure of filtration system, with high turbidity and potential for pathogen breakthrough	• Install and regularly calibrate online filtration turbidity monitoring instrument, with alarm system • Multiple separate filtration units in parallel • Maintain operational condition of filtration chamber by regular back flush and maintenance				
	Insufficient or excessive chlorine dosing resulting in pathogen breakthrough or chlorine taste and odor	• Automated chlorine dosing and online residual chlorine monitoring to achieve chlorine content of 0.5 mg/L to 1.0 mg/L (30 minutes after chlorination)				
	Treated water storage: Accidental recontamination of water (through rodents, birds, etc. and groundwater ingress)	• Clean water storage tank will be roofed. Vents and overflows will be meshed • Storage tank walls will be lined with water proof material • Frequent inspections and maintenance of the tank				
	Water supply pumping failure, power failure, with loss of pressure and risk of recontamination due to back-siphonage	• Backup pumps and dual power system will be installed and maintained in good condition • Inspect backup pumps and dual power system regularly				

Item	Potential Impact	Mitigation Measure	Responsibility		Budget (xCNY10[4])	Source of Funds
			Implement	Supervise		
	Pipe burst causing water recontamination and interrupted service	• Proper pipe material selection • Identify and implement procedures for operating system to avoid spikes and water hammering • Implement emergency response action plan, including quick repair of bursts and pipe cleaning and water quality monitoring for the network				
Water supply safety	Training and monitoring	• Equip monitoring instruments in the CWSC laboratory to analyze a minimum of 42 parameters of the PRC's Domestic Drinking Water Quality Standard (GB5749-2006), but target a monitoring capacity of 70 parameters within 2 years of WSP operation • Build emergency warning system and equip with water source automatic monitoring systems in the reservoirs • Ensure WSP staff will be well trained on all steps of treatment process, including emergency warning and response actions				
Solid Wastes Collection and Disposal Component						
Solid waste	Solid waste from adjacent villages and residential communities	• All rubbish from Chengpo and Qiufeng villages at Qiufeng reservoir will be regularly collected then disposed at the interim waste collection station to be developed by the project The waste will then be disposed at the Shantou Municipal landfill station	UMB	EPB	200.0/year	Included in the UMB operation cost
	Rubbish collection and transport equipment	• Properly maintain rubbish collection and transport equipment				
Water Conservation Reforestation Component						
Flora	Reforestation	• Properly maintain natural and planted trees, and other vegetation on the catchment areas of the reservoirs • Conduct biological pest control on the basis of no pesticides and top dressing fertilizer • Conduct routine inspection and maintenance of ecosystem of the reservoirs, and the water conservation reforestation	FoB	EPB	30.0/year	Included in the WCB operation cost
				Total:	**CNY3.9million ($629,000)/a**	

CWSC = Chaonan Water Supply Company; EIA = environmental impact assessment, EHS = environment, health, and safety; EMS = Chaonan environmental monitoring station; EPB = Chaonan District environmental protection bureau; FoB = Chaonan District forestry bureau; FSR = feasibility study report, GRM = grievance redress mechanism; mg/L = milligram per liter, PMO = project management office; PPTA = project preparatory technical assistance; TN = total nitrogen, TP = total phosphorus, UMB = Chaonan District urban management bureau; WRB = Chaonan water resources bureau; WSP = water supply plant.

[a] The district EMS.

Sources: Domestic EIA and FSR, PPTA Consultant's Report, and consultations with the EIA Institute, CWSC, the PMO, EPB, FoB, WRB, and other government divisions.

Table A.5: Environmental Monitoring Program

Subject	Parameter	Location	Frequency	Implement	Supervise	Applicable Standard	Baseline Compliance	Pollutant Exceeded Standard	Action if Exceeded Standard	Budget ($xCNY10^4$)
Construction Phase										
Reservoir water quality	pH, SS, NH_3-N, oil, COD_{cr}, BOD_5, TP, total coliforms	Center of Jinxi, Longxi, and Qiufeng reservoirs; and the water intake points of the three WSPs	Once a month	EMS	CWSC, EPB	Grade II of the Surface Water Quality Standard (GB3838-2002)	24 monitored parameters met the standard	2 parameters of TN and TP exceeded standard	(i) immediately monitor the water quality to identify pollution source; (ii) take enforcement action to stop pollution and investigate responsibility	20.0
Water quality of wastewater drainage creeks	pH, SS, NH_3-N, oil, COD_{cr}, BOD_5, TP, total coliforms	At discharge points of the wastewater drainage creeks of Liangying, Nanshan, and Shenxi	External monitoring: once per day for 3 consecutive days, twice per year	EMS	CWSC, EPB	Grade V of the Surface Water Quality Standard (GB3838-2002)	19 monitored parameters met the standard	7 monitored parameters of COD_{Cr}, BOD_5, TN, DO, TP, NH_3-N, and sulfide exceeded the standard	(i) speed up the planned WWTP construction; (ii) properly operate the existing WWTPs; (iii) prohibit wastewater directly discharge	20.0
Air	Inspect dust mitigation measures (Table A.3) and maintenance of vehicles and construction equipment	Visual inspection at all construction sites	Internal monitoring: at least once a month External monitoring: at least twice per year	CSC LIEC, EMS	IAs IAs, PMO, EPB					Included in construction supervision contract Included in loan implementation TA contract
	TSP, NOx	All construction sites (at least one point 100 m upwind, two points 100 m downwind), the spoil disposal site, and sensitive receivers nearby (see Section IV of IEE-sensitive receivers within project	External monitoring: twice per day for 3 consecutive days, twice per year	EMS	IAs, PMO, EPB	Grade I of the Ambient Air Quality Standard (GB3095-1996) for the WSP sites, and Grade II of GB3095-1996 for other pipeline construction sites	All monitored parameters met the standard		(i) immediately monitor to identify the reason for exceeded standard; (ii) ensure contractor to take effective mitigation measures; and	15.0

Subject	Parameter	Location	Frequency	Implement	Supervise	Applicable Standard	Baseline Compliance	Pollutant Exceeded Standard	Action if Exceeded Standard	Budget (xCNY10[4])
		area of influence)							(iii) ensure CSC to strengthen supervision	
Noise	LAeq	Boundaries of all WSPs, and sensitive receivers near the pipeline construction sites (see Section IV of the IEE-sensitive receivers within project area of influence)	External monitoring: twice per day (once in day time and once at night time) for 2 consecutive days, once per month	EMS	PMO, IAs, EPB	Grade I of the Urban Ambient Acoustic Quality Standard (GB3096-2008) for the WSP sites, Grade II standard for the pipeline sites within the plain area, and Grade 4a standard for pipeline sites within 50 m on both sides of roads	All monitored sites met the standards except the point at Beicheng Avenue	1.4 dB(A) in daytime and 3.8 at nighttime exceeded 4a standard (70 dB(A) for daytime and 55 dB(A) for nighttime) at the point of Beicheng Avenue	(i) Endure contractor to take effective measures to control noise source; and (ii) ensure CSC to strengthen supervision; (iii) stop noisy construction machineries operation during nighttime.	8.0
Solid Waste	Garbage from work-camps and construction waste at construction sites	Visual inspection at all construction sites and work-camps	Internal monitoring: Monthly External monitoring: Twice per year	CSCs LIEC, EMS	IAs, PMO PMO, IAs, EPB	(i) Standard for pollution control on the landfill site for domestic waste (GB16889-1997), and (ii) the PRC's Solid Waste Pollution Prevention and Control Law			(i) Send written warning to contractor; (ii) take enforcement action and clean the site	Included in the construction supervision contract Included in loan implementation TA contract
Soil erosion, vegetation	Quantity of soil erosion and ecologic restoration	Visual inspection at borrow pit and spoil sites	Internal monitoring: Radom check after rainstorm (rainfall＞ 50mm)	CSCs	IAs, PMO	(i) Technical Specification of Water and Soil Erosion Control for Civil Construction (GB50433-2008) (ii) Acceptance Standard of Soil Erosion control for Civil Construction (GB/T22490-2008) (iii) Soil Erosion Control Standard	Soil erosion intensity ＜ 500 t/km^2.a		(i) immediately inspect the soil erosion situation and identify the reason (ii) take enforcement action to stop soil erosion	Included in the construction supervision contract

Subject	Parameter	Location	Frequency	Implement	Supervise	Applicable Standard	Baseline Compliance	Pollutant Exceeded Standard	Action if Exceeded Standard	Budget (xCNY10^4)
			External monitoring: twice per year, and once after completion of construction	LSMI, LIEC	PMO, EPB	for Civil Construction (GB/T50434-2008)				Included in loan implementation TA contract
	Compensatory plantings and re-vegetation of spoil disposal sites and construction sites	Visual inspection at all disposal sites and temporary occupied lands	Internal monitoring: At least four times per year	CSCs	IAs, PMO					Included in the construction supervision contract
			External monitoring: Twice per year, and once after completion of construction	LIEC	IAs, PMO, EPBs					Included in loan implementation TA contract
Occupational health and safety	Work camp hygiene and safety, availability of clean water and emergency response plans	Inspection at all construction sites and work-camps	Internal monitoring: Monthly	CSC	IAs,	Guideline of occupational health and safety management system (GB/T28002-2002)				Included in the construction supervision contract
			External monitoring: Twice per year	LIEC	City/county health bureau					Included in loan implementation TA contract
Subtotal										**CNY63xCNY10,000 ($103,280) for 5 years**
Operational Phase										
Water quality of the reservoirs	Temperature, pH, SS, NH_3-N, oil, COD_{cr}, BOD_5, TN, TP, total coliforms, Chlorophyll-a, chloride, sulfate, NO_3-N, DO, SS, sulfide, Cr_6+, dimethoate, dichlorphos, dipterex	Center of the three reservoirs, and the water intake points of the three WSPs	Once a month	EMS	WSC, EPB	Grade II of Surface Water Quality Standard (GB3838-2002)	24 monitored parameters met the standard (see IEE results)	2 parameters (TN, TP) exceeded the standard	(i) immediately investigate the pollution source; (ii) take enforcement action to stop pollution and investigate responsibility	12.0/year

Subject	Parameter	Location	Frequency	Implement	Supervise	Applicable Standard	Baseline Compliance	Pollutant Exceeded Standard	Action if Exceeded Standard	Budget (xCNY10^4)
Water quality of the treated water by the 3 project WSPs	42 regular parameters[a]	WSP treated water	Once a month	CWSC laboratory	EPB, health bureau	The PRC's Domestic Drinking Water Quality Standard (GB5749-2006)			Identify causes; review water treatment process and water source protection; initiate corrective action	Include in the CWSC operational budget
Noise	LAeq	The boundaries of all WSPs, and sensitive receivers nearby the WSPs and pumping station	External monitoring: Twice per day (once in day time and once at night time) for 2 consecutive days, semiannually	EMS	PMO, IAs, EPB	Grade I of the PRC's Urban Ambient Acoustic Quality Standard (GB3096-2008)			WSPs to take effective measures to control noise source	5.0/year
Vegetation	Trees and vegetation survival and coverage rate	Reforestation areas and spoil disposal sites	Internal monitoring: Spot check, twice per year	FoB, IAs	EPB, FoB				Review causes for dieback or seedling failure; re-vegetate	Included in FB's operation budget
Soil erosion	Soil erosion situation, turbidity increase in the reservoirs during rainy season	On the catchment areas of the reservoirs, in particular the reforestation areas, and the three reservoirs	Internal monitoring: once a year	WRB	Municipal WRB, EPB					Included in the WRB's operation budget
			External monitoring: once a year	LSMI	Municipal WRB, EPB				Identify sites of severe erosion; implement sediment traps/other measures until reforestation complete	
Associated facilities	CODcr, NH_3-N, BOD_5, SS	Effluent discharge points of WWTPs associated with the project	External monitoring: according to PRC regulations	EMS	EPB	Standard on Pollutant Discharges from Municipal Wastewater Treatment Plants (GB18918-2002)	All the monitored parameters of effluent from the existing WWTPs met the standard		Identify causes; take treatment measures to improve the effluent quality until standard is met	Included in WWTPs' operation budgets
Leakage of water pipelines	NRW loss rate	All water transmission and distribution pipelines	Daily patrol; respond to alerts from general public	CWSC water leakage detection	CWSC, WRB				Timely repair of the leak and/or replace aged pipe	Included in the CWSC's operation budget

Subject	Parameter	Location	Frequency	Implement	Supervise	Applicable Standard	Baseline Compliance	Pollutant Exceeded Standard	Action if Exceeded Standard	Budget (xCNY10^4)
				and repairing staff						
Subtotal										**CNY170,000 ($27,420)/year**
TOTAL:				**Construction phase:** **Operation phase:**		**CNY63.00 x CNY10,000.00 ($103,280.00) for 5 years** **CNY17.00 x CNY10,000.00 ($27,420.00) per year**				

BOD_5 = 5-day biochemical oxygen demand, COD_{cr} = chemical oxygen demand, CSC = construction supervision company, CWSC = Chaonan Water Supply Company, EMS = Chaonan environmental monitoring station, EPB = Chaonan environmental protection bureau, IA = project implementing agency, LA_{eq} = equivalent continuous A-weighted sound pressure level, LIEC = loan implementation environmental consultant, LSMI = licensed soil erosion institute, NH_3-N = ammonia nitrogen, NOx = nitrogen oxide, NRW = nonrevenue water loss, PM_{10} = particles measuring 10μm or less, PMO = project management office, SS = suspended solid, TSP = total suspended particle, WRB = Chaonan water resources bureau, WWTP = wastewater treatment plant.

[a] These 42 parameters are as follow: Total coliform, Thermotolerant coliform, Escherichia coliform, Total plate count, As, Cd, Cr^{+6}, Pb, Hg, Se, Cyanide, NO_3-N, Chloroform, Tetrachloromethane (CCl4), Fluoride, Bromate, Formaldehyde, NH_3-N, Chlorite, Chlorate, Chromaticity, Turbidity, odor, taste, appearance, pH, Al, Fe, Mn, Cu, Zn, Chloride, Sulfate, TDS, Total hardness, COD_{mn}, Volatile phenol, LAS, Total α-radioactivity, Total β-radioactivity, ClO_2, and Residual Cl_2.

Source: Asian Development Bank estimates.

Table A.6: Institutional Strengthening and Training Program

Training	Trainer	Attendees	Contents	Time	Days	People	Budget (x CNY 10^4)
ADB's SPS (2009); PRC environmental laws, regulations, and policies	LIEC	Contractors, CSCs, IAs, EPB, EMS, FoB, PMO, OPs	• ADB's SPS (2009) • Relevant PRC environmental laws, policies, standards, regulations for construction, surface water pollution, drinking water protection • Best practice environmental management for civil works—WSP, pipeline	2	1.5	30	2.0
GRM	LIEC	IAs, contractors, PPCU, Ops, EPB, EMS, community representatives from villages near WSPs and construction areas	• GRM structure, responsibilities, timeframe • Types of grievances, eligibility • Gender responsive GRM • Recording and reporting procedures	2	1.0	30	2.0
EMP implementation	LIEC	Contractors, CSCs, IAs, EPB, EMS, PMO, Ops	• Responsibilities under EMP and how to implement specific tasks • Environmental protection contents during construction and WSPs operation. • Environmental forms and reporting (daily and monthly) • EMP improvement and corrective actions	2	1.5	25	2.2
Reservoir management	Tbd	WRB, CWSC, PMO, IAs, Ops	• Basic principles of surface water management • Point and nonpoint pollution control • Nonpoint pollution control, eutrophication	2	1.0	30	2.0
Low carbon water supply	Tbd	CWSC, WRB, Ops	• Energy-saving and GHG emission reduction in water supply sector • NRW, reduction strategy and methods.	2	1.5	30	3.0
Reservoir protection and sustainable agriculture	Tbd	Local villagers nearby the reservoirs, IAs, FoB, EPB, EMS	• Sustainable water management and water saving irrigation practices • Fertilizer and pesticide use and impacts on surface water ecosystem	2	1.0	30	2.0
Emergency preparedness and response	Tbd	Contractors, CSCs, IAs, EPB, EMS, LIEC, CWSC, Ops	• Environmental accidents and mitigation • Emergency response team, procedure and actions • Flood emergency planning • Flood early warning system	2	1.0	20	1.5
Soil erosion protection	LIEC	Contractors, CSCs, city/county IAs, EPB, EMS, FoB, WRB, Ops	• Risks for soil erosion and other hazards • Mitigation measures	2	1.0	30	2.0
Environmental monitoring, inspection, and reporting	LIEC	Contractors, CSCs, EPB, EMS	• Monitoring and inspection methods, data collection and processing, interpretation of data, reporting system • QA/QC control during environmental monitoring	1	1.0	20	1.5
Total		**CNY182,000 ($29,355)**		**17**	**10.5**	**245**	**18.2**

ADB = Asian Development Bank, CSC = construction supervision company, EMP = environmental management plan, EPB = Chaonan environmental protection bureau, EMS = environmental monitoring station, FoB = Chaonan District forestry bureau, GRM = grievance redress mechanism, IA = implementing agency, LIEC = loan implementation environmental consultant, NRW = nonrevenue water, Ops = operators, PMO = Chaonan project management office, PRC = People's Republic of China, PPCU = project public complaints unit, QA/QC = quality assurance/quality control, SPS = Safeguard Policy Statement, Tbd = to be decided, WRB = Chaonan water resources bureau, WSP = water supply plant.

Note: The institutional and training program will be paid from the consultant services package of the loan.

Source: ADB.