Environmental Impact Assessment (Draft)

Project Number: 47070-002
April 2015

People's Republic of China: Hunan Dongjiang Lake Environmental Protection and Integrated Utilization Project

Prepared by the Zixing City Government for the Asian Development Bank.

CURRENCY EQUIVALENTS

(As of 14 October 2014)
Currency Unit – yuan (CNY)
CNY 1.00 = $ 0.1633
$ 1.00 = CNY 6.12

ABBREVIATIONS

ADB	Asian Development Bank
BOD_5	5-day biochemical oxygen demand
CNY	Chinese Yuan
COD	Chemical oxygen demand
DO	Dissolved oxygen
EA	Executing Agency
EIA	Environmental impact assessment
EIR	Environmental Impact Report
EIT	Environmental Impact Table
EMP	Environmental Management Plan
EMS	Environment monitoring station
EPB	Environmental Protection Bureau
FSR	Feasibility Study Report
FYP	Five Year Plan
GDP	Gross domestic product
GHG	Greenhouse gas
GRM	Grievance redress mechanism
HPG	Hunan Provincial Government
IA	Implementing Agency
MOE	Ministry of Environment
$PM_{2.5}$	Particulate matter with diameter<2.5 μ
PM_{10}	Particulate matter with diameter<10 μ
PMO	Project Management Office
PRC	People's Republic of China
RP	Resettlement Plan
SOE	State Owned Enterprise
SPS	Safeguard Policy Statement
TN	Total Nitrogen
TP	Total Phosphorus
TSP	Total Suspended Particulates
WHO	World Health Organization
WRB	Water Resources Bureau
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant
ZCG	Zixing City Government

WEIGHTS AND MEASURES

^oC	degree centigrade
dB	decibel
ha	hectare (10,000 m^2)
kg	kilogram
km	kilometer
km^2	square kilometer
kW	kilowatt
L	liter
m	meter
m^2	square meter
m^3	cubic meter
m^3/a	cubic meter per annum
m^3/d	cubic meter per day
mg/kg	milligram per kilogram
mg/l	milligram per liter
mg/m^3	milligram per cubic meter
mu	Chinese land unit (1 ha=15 mu)
MW	megawatt (1 million watts)
t	metric ton (1,000 kg)
t/a	ton per annum

NOTE

(i) In the report, "$" refers to US dollars.

Contents

I. EXECUTIVE SUMMARY

A. Introduction

1. The Zixing City Government (ZCG), People's Republic of China, has requested the Asian Development Bank (ADB) to provide investment and technical assistance support for the Hunan Dongjiang Lake Environmental Protection and Integrated Utilization Project (the project). The project will help the HPG maintain the relatively high water quality of Dongjiang Lake (in the context of gradually increasing human activity around the lake), improve water resource management at Dongjiang Lake as well as several nearby rivers and a smaller reservoir, and improve local management capacity for water resources. The project will be implemented within Zixing City, a county-level administration area which supports most of the Dongjiang Lake basin. The project is part of the ADB-PRC Country Operations Business Plan for 2013–2015 and is included in ADB's 2016 lending pipeline (2015 standby). Under the ADB Safeguard Policy (SPS, 2009) the project is classified Category A for environment, requiring preparation of an environmental impact assessment (EIA).

2. This EIA is based on information in five domestic EIAs and a Feasibility Study Report (FSR) prepared by national institutes, fieldwork conducted between September 2014 and March 2015 by a consultant team for the project preparatory technical assistance (PPTA), and sector studies by the PPTA team on water resources, wetlands, waste management, and climate change. PPTA fieldwork included river condition surveys and inspection of most planned construction sites for water transmission pipelines and water and wastewater treatment stations. The EIA includes an environmental management plan (EMP) (Attachment 1), which will be the guiding document for environmental-related issues in the construction and operational phases of the project.

B. The Project

3. The expected project impact is enhanced quality of life and sustainable economic development of Xiang River basin in Hunan Province. The expected project outcome is improved quality of water resource and environment of Dongjiang Lake. The project has five outputs: (i) improved pollution control; (ii) established urban–rural water supply system; (iii) river course rehabilitation; (iv) integrated ecosystem rehabilitation and management; and (v) strengthened environmental and project management capacity.

4. Output 1 will support: (i) domestic wastewater treatment – construction of six wastewater treatment plants (WWTPs) with a total capacity of 2,000 m^3/day, sewage collection pipes, and about 2,856 small wastewater treatment systems (WWTS) for rural villages and households; (ii) solid waste collection, compaction, and transfer facilities; and (iii) agricultural nonpoint source pollution management. Output 2 will support: (i) construction of two water supply plants with total water treatment capacity of 20,620 m^3/day for about 82,000 residents; (ii) water supply pipelines with total length of about 405 kilometers; and (iii) operation and maintenance equipment. Output 3 will support river course rehabilitation along sections of five rivers – dredging (14.612 km) and embankment (13.72 km). Output 4 will support: (i) aquatic facilities and management; (ii) wetland restoration and management facilities; (iii) soil erosion control, including reforestation and revegetation; and (iv) bamboo forest improvement for farmers. Output 5 will support: (i) establishment of an environmental monitoring center; (ii) establishment of deep water lake research center; (iii) public awareness, technical and vocational education and training in alternative livelihood activities for 30,000 rural residents; (iv) project implementation consulting services, training, workshops, and study visits; and (v) establishment of project monitoring and evaluation system. A summary of major construction works is in presented in Table ES-1.

Table ES-1: Summary of Project Construction Works

Component			Units	Pipeline (km)	Affected Land (mu)
Pollution Control	Domestic Wastewater Treatment	Town WWTP	6 (2,000 m^3/day)	38.1	4.72
		Rural WWTS	2,856	330.38	100
	MSW Transfer and Treatment	Waste Transfer Stations	7 (82 tons)	-	12.2
	Total				16.92
Urban-rural Water Supply	Urban-rural Water Supply	Yangdong	1 (20,000 m^3/day)	713.40	31.84
		Chukou	1 (620 m^3/day)	38.80	3
	Total				34.84
River course rehabilitation	Clearance of 14.7 km blockage and 13.7 km embankments km				102.2
Ecological Rehabilitation	Lake Ecosystem Rehabilitation	Stocking Platform	1 (parking lot 1 Platform		7.32
	Wetland Conservation and Rehabilitation	Constructed Wetland	3		123.94
	Total				131.26
Environmental Monitoring and Protection Capacity Building	Lake Monitoring and Research Capacity Building	Fish Monitoring Stations	6		1.2
				Total	**184.22**

WWTP = wastewater treatment plant, WWTS = wastewater treatment system.

5. **Project benefits.** The project is promoting a holistic approach to water resources management in the Dongjiang Lake basin, through implementing structural and non-structural measures to help address water pollution control, reduce flood risk, and increase management capacity and institutional arrangements across multiple agencies. Specific project benefits include: (i) securing the high water quality of the lake – maintaining it at Grade II or higher of the PRC Drinking Water Quality Standard; (ii) treating sewage to Class I standards; (iii) improving the rate of wastewater collection and treatment by over 80%; (iv) doubling the level of flood protection in selected rivers around the lake, from a 1 in 5 year to 1 in 10 year flood recurrence interval; (v) improved efficiency of water monitoring; and (vi) improved community forestry management and soil protection on hillsides. The project supports the *Dongjiang Lake Ecological Implementation Plan 2012-2015* to address water pollution, soil erosion, and water resource management. It is consistent with the PRC Third Plenum Resolutions for the Thirteenth Five-Year Plan (2016–2020), which promote environmentally friendly and resource-efficient development. The project is also consistent with ADB's Strategy 2020, which supports sustainable environmental management.

C. Baseline environment

6. The Dongjiang Lake basin comprises steeply sloping karst mountains with numerous small tributaries, around Dongjiang Lake, an artificial reservoir created in 1986. Most of the lower hillsides have been modified by human activity and support planted forests of bamboo, low secondary growth, settlements, and/or agricultural land. Since creation of the reservoir, much of the area has been designated as scenic or natural reserves and heavy industrial activity is prohibited. Baseline environmental sampling for air, noise, water, soil, and in-stream sediment quality was conducted at or near planned construction sites. Ambient quality of surface water, ground water, and noise met the specified PRC and international standards. Water quality is high at Dongjiang Lake and meets high standards (Class II or III, in different areas of the lake) of the PRC Drinking Water Quality Standard. For air quality, all sites met the specified standards except one (Daitou Village) which exceeded the standard for PM_{10}

emissions. This is probably due to burning of litter by residents, due to the lack of waste disposal systems (an issue the project is addressing). For soil and in-stream sediments, all samples along the five sampled rivers met the specified standard except for two heavy metals, arsenic and cadmium, while levels of a third, zinc, almost exceeded the standard. There has not been any large industrial activity in the project area, although small-scale quarrying occurs.[1] The rivers, including upstream areas, support relatively low human densities. The consistent pattern of sampling results for the five separate rivers and elsewhere in the project area indicates that high heavy metal levels are natural for the Dongjiang Lake area.

7. Biological baseline assessments were conducted to document vegetation communities, fauna, and habitats, supplemented by desktop review and local interviews. Due to the steep and remote mountains, protection status, and relatively low human densities, the Dongjiang Lake area supports a range of flora and fauna. Most are common and widespread species, but there are also records of species protected under national or provincial regulations. Most natural habitats around the lake have been modified by historical clearance and are secondary. Streams draining into Dongjiang Lake support small in-stream weirs but are otherwise relatively unimpeded and support habitats for breeding and seasonal dispersal by fish and aquatic invertebrates. Under the definitions of ADB's SPS, the upper and middle hill slopes (outside the project construction sites) retain some *natural habitat*, while most habitats around the lake support *modified habitat*. None of the project sites qualify as *critical habitat*.

8. Dongjiang Lake is located in two overlapping reserves, the 4A Dongjiang Lake Scenic Area and Dongjiang Lake Wetland Park, which also include the national Tiane Mountain Forestry Park. Project sites include locations in and outside these reserves. Three of the project wetland rehabilitation sites are in the national Dongjiang Lake Wetland Park. Part of the transmission pipelines for the Yangdong Water Supply sub-component is within the wetland park. There are no documented sites of physical cultural heritage in the project area.

D. Impacts and Mitigation Measures

9. **Construction.** Key construction-related risks relate to dredging and embankment along the sections of five rivers, six wastewater treatment stations, two water treatment plants, and water transmission pipelines. Potential impacts and measures to avoid, minimize, and mitigate these, are as follows. All proposed project activities are compatible with the zoning and regulations of the reserves and relevant provincial and local master plans and regulations for Dongjiang Lake (Section III). The project activities are intended to support the scenic, conservation, and socio-economic functions of the reserves. All relevant provincial and local agencies (including the environment, water resources, and forestry agencies) were involved in the development of the project activities.

10. ***Dredging and embankment.*** About 14.62 km of dredging and 13.72 km embankments will be implemented along the sections of five rivers. Some of these sections retain relatively natural habitats, steep-sided forested slopes and/or levels of heavy metals which exceed PRC standards. One of the rivers, Tianeshan, is located in a forest park. Construction risks include loss and damage of channel habitats, temporary elevated turbidity, and release of heavy metals. Mitigation measures include timing (dredging will only be conducted from September to February, the time of lowest water levels), site-specific sediment sampling prior to any works, closely controlled dredging and sediment removal (short, staged sections of river), on-site support by a wetland specialist, who will also design the embankment habitat features, and disposal of dredge material at sites within the river system with existing similar heavy metal levels (to avoid contaminating other regions). With these measures net impacts are anticipated to be minimal, with aquatic communities recolonizing the sections from intact

[1] Quarries are <2 ha and are for sand, gravel, limestone, and clay. There are no risks of heavy metal release associated with these quarries: sand and gravel are used for aggregate, limestone is used for concrete and building, and the clay for bricks.

sections upstream. No in-channel structures will be constructed which might impede the movement of fish or other aquatic fauna along he channels.

11. ***Construction of new facilities.*** Construction activities will involve noise, dust, vibration, vegetation removal, protection of water quality, and considerations for occupational and community health and safety and physical cultural values. These issues have been assessed and mitigation measures are in the EMP.

12. **Operations.** Key operation-related risks are: (i) cumulative nutrient loading in rivers and Dongjiang Lake from the treated effluent discharged by the six WWTPs; (ii) air and noise emissions from plant operation; and (iii) lack of maintenance of project facilities. For nutrient loading, modeling was conducted to assess the risk that the combined effluent loads from the six WWTPs might affect water quality and exceed the required standards. Results confirm that pollutants will be diluted to levels which are considerably lower than the required standard, within 100 m downstream of WWTPs, under conditions of low flow in the dry season. The four rivers are permanent (limiting the risk of stagnation and eutrophication) and none are used for drinking water supply. Risks to communities and aquatic ecology are concluded to be low. Air and noise emissions were also modeled, and confirmed to meet the required standards at the plant boundaries. For project operation and maintenance, to avoid the risk of new project structures and facilities being poorly operated or falling into disrepair: (i) the project includes capacity building for maintenance of all project facilities; and (ii) operational plans will be developed as part of the project for all facilities, which will include roles and responsibilities, schedules, and facility maintenance.

13. **Cumulative and indirect impacts.** The Dongjiang Lake basin is experiencing slow but steady population growth and incremental rising pressures to water quality. In addition to the current project, the ZCG is undertaking a range of other, domestically-funded programs to manage the lake resources and also promote development. The project will help achieve 100% of the targets in the *Dongjiang Lake Ecological Implementation Plan 2012-2015*. Dongjiang Lake is also a pilot lake under the PRC "One Lake, One Strategy" program. Under the program, the government will address remaining water pollution sources which are not being addressed under the current project (e.g. mining in upstream counties). These activities, combined with the project, aim to improve the water quality throughout the lake to Grade II or better of the PRC Surface Water Quality Standard (compared to current Grade III).

E. Climate Change

14. **Greenhouse gas emissions.** Project GHG emissions will be generated during construction (vehicles, machinery, workers) and operation (electricity use at the wastewater treatment and water treatment plants). Electricity will be supplied through the municipal grid. The total estimated annual GHG emission by the project is about 15,313 t CO_{2e} during construction and 1,583 t CO_{2e} during operation. The SPS requires that estimates of GHG emissions are made for projects which may emit >100,000 t CO2e per year. The estimated project emissions are small compared with this and the types of high-risk projects listed by the ADB Environment Safeguards Good Practices handbook (ADB 2012, pp.59–62). Further, the project will reduce net emissions through the reforestation component for karst vegetation and improved management of community bamboo forests.

15. **Adaptation to climate change.** A climate risk vulnerability assessment (CRVA) was conducted to identify the threat that climate change presents to the viability of the project, assuming a design life of 30-40 years. Modeling predicted that mean annual temperature will increase 1.0-1.1^{o}C from 2016-2035 and 1.5-2.6^{o}C by 2065, annual precipitation will remain the same or slightly decrease, and evapotranspiration will increase. Projected inflows to Dongjiang Lake for 2015-2030 remain similar to the baseline period of 1971-2000. Declining

seasonal flows could reduce the efficiency of the constructed water pipelines and treatment rates of the wastewater and water treatment plants, while altered storm intensity could threaten project facilities. Overall, these climate-related risks are assessed to be relatively low because: (i) large changes in precipitation are not predicted; (ii) the sub-tropical location of the project area is already subject to high rainfall (>1.3 m/year), which imparts a partial buffer to change; (iii) initial designs were for larger WTPs with higher capacity, which would have been at more risk from reduced water supply, but plant sizes were down-graded to sizes realistic to current and forecast demand; (iv) project structures have been designed for a 1 in 10 year capacity and reflects climate modeling; and (v) embankments have been designed to be porous for improved infiltration.

F. Public Consultation and Grievance Redress Mechanism

16. Two rounds of information dissemination and two rounds of public consultation were conducted for the project. Thirty-five government agencies and over 100 residents at Dongjiang Lake were consulted. Respondents generally thought that the project would improve livelihoods and the local environment. Concerns expressed included construction noise and dust, efficient waste collection, interruptions to water or power supply caused by accidental damage to easements, and odor from solid waste transfer. These concerns have been addressed in the project design and mitigation measures. Public consultation during project implementation is described in the EMP.

17. A grievance redress mechanism (GRM) has been developed in compliance with the SPS requirement to address environmental, health, safety, and social concerns associated with project construction, operation, and leasing arrangements. The GRM also facilitates a timely and effective response to any complaints from affected persons.

G. Environmental Management Plan

18. The EMP (Attachment 1) brings together all the mitigation measures for the identified impacts as well as pre-construction requirements, and construction and operational management prescriptions. The EMP also includes the GRM and an environmental monitoring program, to monitor and report on the environmental performance of construction and operations. The program forms part of a comprehensive set of environmental management documents. The EMP includes institutional responsibilities, training needs, reporting schedules and implementation costs. It will include the program for future public consultation.

H. Risks and Assurances

19. The project implementing agencies have no previous experience in ADB safeguard procedures. To support effective implementation of the project EMP: (i) full-time environment officers will be appointed in the project management and implementation offices; (ii) a loan implementation environmental consultant and wetland specialist will be recruited to support local agencies; (iii) pre-construction readiness procedures and defined roles and responsibilities of all relevant agencies have been included in the EMP; and (iv) staff will receive training in EMP implementation. Project-specific environmental assurances (Section X) have been agreed and are included in the project agreement between the ZCG and ADB.

I. Conclusion

20. It is concluded that full and effective implementation of the project EMP (Attachment 1), together with the training and project assurances, will minimize the environmental risks of the project and achieve compliance with the policy and regulatory standards applied in this EIA.

II. INTRODUCTION

21. Dongjiang Lake is located in Chenzhou Municipality, southeast Hunan Province, People's Republic of China (PRC) (Figure II-1). The lake, which is an artificial reservoir, is located within the Xiangjiang River Basin. Dongjiang Lake has a total capacity of 9.15 billion m^3. Water quality is high and ranges from Classes II to III in the PRC Environmental Quality Standard of Surface Water (GB3838-2002) standard and Level I standard of the Drinking Water Quality Standard (CJ3020-93). It is a valuable high-quality drinking water resource for Hunan Province. However, the lake is facing pollution challenges as water quality is gradually declining due to increasing human activity in the Dongjiang Lake area. The PRC Government has requested the Asian Development Bank (ADB) to provide financial support for the proposed Hunan Dongjiang Lake Environmental Protection and Integrated Utilization Project (the project).

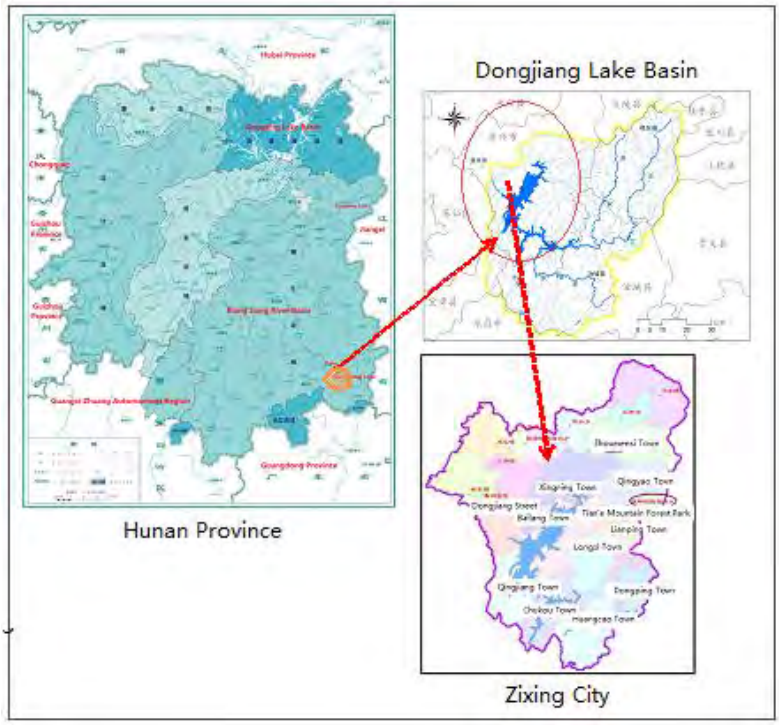


Figure II-1: Location of Zixing City and Dongjiang Lake in Hunan Province

22. The project is classified as 'Category A' by ADB. This project environmental impact assessment (EIA) and environment management plan (EMP) has been prepared in compliance with ADB's Safeguard Policy Statement (SPS, 2009). The EMP (Attachment 1), which will be the key guiding document for environmental-related issues in the construction and operational phases of the project. The EIA is based on: (i) information in the Feasibility Study Report (FSR) prepared by Hunan Agriculture and Forestry Investigation Design Institute and five domestic EIAs prepared by the Chenzhou Environmental Science Institute, Guangzhou Environment Protection Company and Zhongnan Engineering Corporation Limited; (ii) fieldwork conducted between September 2014 and March 2015 by a consultant team for the project preparatory technical assistance (PPTA). PPTA fieldwork included inspection of most proposed sites for major construction, river embankment and dredging, sections of proposed alignments and easements, and selected sites for a sample of waste treatment facilities; and (iii) other sector studies by the PPTA team, including water resources, wetlands, and climate change. The data presented in tables and figures in this EIA are from the FSR and domestic EIAs unless stated otherwise.

III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Policy Framework

23. In 2013, the Hunan Provincial Government (HPG) issued the *Scientific Development Plan for the Xiangjiang River Basin* (HPG 2013 [7]). The plan was one of the first scientific and comprehensive development plans for a river basin in the PRC. It emphasizes the concept of "Resources Conservation and Environmental Friendly" stewardship and requires the integrated management of the upper and lower portions of the basin. The plan defines five function zones: green belts, riverside towns, tourism areas, navigation routes and environmental friendly industrial areas. It aims at developing the Xiangjiang river basin for industry, culture, navigation, and ecosystems in an environmentally sound fashion.

24. The *Environmental Protection Ordinance of Dongjiang Lake in Hunan* is now under the 8th revision (2014). The ordinance applies to water resource and environmental protection of Dongjiang Lake and includes the Dongjiang and Xiaodongjiang reservoirs and all rivers that flow into them. Zixing, Rucheng, Guidong, and YiZhang counties are covered under the ordinance. Under the ordinance, the HPG will strengthen leadership for water resource and environmental protection of Dongjiang Lake through the enforcement of laws and regulations. Relevant agencies involved in the lake management include the provincial departments of environment, development and reform, finance, communication, land resources, housing and urban construction, transportation, agriculture, forestry, water conservancy, immigration, industry and commerce, and tourism. Each department is to take action in accordance with respective responsibilities to strengthen the Dongjiang Lake water resource and environmental protection.

25. Dongjiang Lake was the first artificial lake in the PRC to be protected by dedicated legislation. The *Dongjiang Lake Water Resources Protection Regulation* was issued on 30 November 2001 and came into effect 1 March 2002. Five water source protection zones were set under this regulation (Fig. III-1). Grade I and II water zones are the most protected. The following regulations are for each zone.

Grade I protection zone

- Prohibit constructing/expanding industrial projects except for hydropower and water supply facilities; prohibit water sports activities; no gasoline stations and water business; no cage culture; and prohibit forestry cutting.

Grade II protection zone:

- Prohibit constructing new or expanding mining facilities; prohibit using toxic fish medicine and pesticide with great residues;
- Domestic wastewater treatment facilities shall be provided in the urban area of townships; the municipal solid waste shall be collected, transported and disposal timely;
- Ship/vehicles loading oil or toxic cargo shall have overflow and anti-leakage measures;
- Passenger ships and tourism ships shall equipped with garbage, feces and oily wastewater treatment facilities; the terminal management agency shall have garbage, feces and oily wastewater collection and transportation facilities.

Secondary protection zone – the following activities are forbidden:

- Out of date mineral separation; national/provincial banned heavily polluting projects; industrial activities without effective pollution control measures;
- Dumping industrial waste, municipal garbage or other solid wastes to the river course;
- Directly or indirectly discharge into the water body that breach the emission standards;
- Using toxic materials or dynamite to catch fish;
- Other activities that will pollute the water.

26. The *Dongjiang Lake Ecological Implementation Plan 2012–2015*, was prepared by the PRC National Academy of Sciences, and although not a formal policy, provides guidance on research and environmental management priorities. The current (ADB-funded) project addresses the majority of these issues, which include water supply and treatment, soil erosion control, non-point source pollution, and wetland rehabilitation. Other issues are being addressed by domestically-funded programs.

Figure III-1: Water Source Protection Zones of Dongjiang Lake.

B. Legislative Framework for Environment Impact Assessment in the PRC

27. The five domestic environment impact assessments (DEIAs) upon which this project EIA is based has been prepared under the PRC EIA Law of 2003 and Management Guideline on EIA Categories of construction Projects (2008). The Interim Guideline on Public Participation in EIA (2006) also provides for opportunities to involve the public in the EIA process. This was strengthened by the Requirements on Preparation of Environmental Impact Report Summary (2012[51], MEP), which requires that the summary of DEIA reports are disclosed on local EPB websites. Key national laws and regulations that guide the DEIAs for the project are in Tables III-1 and III-2.

Table III-1: Applicable Environmental Laws

Title of the Law	Year
Environmental Protection Law	2014
Environmental Impact Assessment Law	2003
Water Law	2002
Water Pollution Prevention and Control Law	2008
Air Pollution Prevention and Control Law	2000
Noise Pollution Control Law	1997
Solid Waste Pollution Prevention and Control Law	2005
Water and Soil Conservation Law	2011

Forest Law	1998
Wild Fauna Protection Law	2004
Cleaner Production Promotion Law	2002
Urban and Rural Planning Law	2008
Land Administration Law	2004
Circular Economy Promotion Law	2009
Fishery Law	2000
Flood Control Law	1998
Protection of Cultural Relics Law	2013

Table III-2: Applicable Administrative Regulations

Regulation	**Year**
National	
Regulation on EIA of Plans and Programs	2009
Regulation on Environmental Protection Management for Construction Projects	1998
Directive on Wetland Protection and Management	2013
Environmental Protection Supervision Rules for Construction Projects	1998
Regulation on Culture Heritage Protection	2003
Regulation on River Course Management	1988
Requirements for the EIA Summary of Construction Project	2010
Classification of Construction Project Environmental Protection Management (MEP)	2009
National Biodiversity Strategy and Action Plan (2011-2030)	2010
Requirement for Social Risk Assessment of Large Investment Projects	2012
National Biodiversity Strategy and Action Plan (2011-2030)	2010
National regulation for public disclosure of EIAs (NDRC)	2012
Regulations on Scenic and Historic Areas	2006
Regulation on Hazardous Chemicals Safety Management	2011
Regulation on Wild Flora Protection	1996
Regulation on Wild Fauna Protection	1992
Regulation on Aquatic Wildlife Protection	1993
Regulation on Urban Water Supply	1994
Management of National Wetland Park (trial)	2010
Local	
Pollution Protection for Drinking Water Source Protection Zone	2010
Regulation on Environmental Protection in Hunan Province	2002
Regulation on Dongjiang Lake Water Protection in Hunan Province	2001
Regulation on Wetland Protection in Hunan Province	2005
Regulation on Scenic and Historic Areas in Hunan Province	2011

28. Implementation of the environmental laws and regulations is supported by a series of associated management and technical guidelines (Table III-3).

Table III-3: Applicable Environmental Impact Assessment Guidelines

Guideline	**Year/Code**
Jurisdictional Division of Review and Approval of EIAs for Construction Projects	2009
Guideline on EIA Categories of Construction Projects	2008
Interim Guideline on Public Consultation for EIA	2006
Technical Guideline on EIA: Outline	HJ2.1-2011
Technical Guideline on EIA Regarding Surface Water	HJ/T 2.3-1993
Technical Guideline on EIA Regarding Atmospheric Environment	HJ 2.2-2008
Technical Guideline on EIA Regarding Acoustic Environment	HJ 2.4-2009
Technical Guideline on EIA Regarding Ecological Impact	HJ 19-2011
Technical Specification on Water and Soil Conservation Plan	GB50433-2008
Technical Guideline on Environmental Risk Assessment for Construction Project	HJ/T 169-2004
Industrial Restructuring Directory (2011)	Revised in 2013

29. The PRC environmental quality standard system that supports the implementation of

the environmental laws and regulations is classified into two categories by function: pollutant emission/discharge standards; and, ambient environmental standards (Table III-4).

Table III-4: Applicable Environmental Standards

Standard	Code
Surface Water Quality Standard	GB 3838-2002
Urban Ambient Acoustic Quality Standard	GB 3096-2008
Ambient Air Quality Standard	GB 3095-1996/2012
Integrated Emission Standard of Air Pollutants	GB 16297-1996
Integrated Wastewater Discharge Standard	GB 8978-1996
Underground Water Quality Standard	GB/T 14848-93
Domestic Drinking Water Quality Standard	GB 5749-2006
Emission Standards of Environment Noise for Boundary of Site Noise	GB 12523-2011
Noise Limit of Industrial Enterprises	GB 12348-2008
Standard for pollution control on hazardous waste storage	GB 18597-2001
Pollution control for storage and disposal site for industrial solid wastes	GB18599-2001
Emission Standards for Odor Pollutants	GB 14554-93

C. International Agreements

30. The PRC is a signatory to international agreements relevant to environment protection. Those relevant to the project, along with the date of signing by the PRC, include:

- *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, 23 February 2005. To reduce greenhouse gas emissions by enhancing the national programs of developed countries aimed at this goal and by establishing percentage reduction targets for the developed countries;
- *Montreal Protocol on Substances That Deplete the Ozone Layer*, 1 January 1989. To protect the ozone layer by controlling emissions of substances that depletes it; and,
- *United Nations Framework Convention on Climate Change*, 21 March 1994. To stabilize greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system.

D. Applicable PRC and ADB Policies and Assessment Categories

31. The proposed project activities are classified as “Significant Impact” (requiring a full Environmental Impact Statement; EIS) or “Medium Impact” (requiring a Tabular EIA; TEIA). Based on the PRC Management Guideline on EIA Categories of construction Projects (MEP, 2008), four EIS studies and one TEIA are required (Table III-5). The five assessments will be approved by the Hunan Environment Protection Department.

Table III-5: Domestic EIA Institute for Each Component

Component	EIA institute	Report
Pollution Control	Guangdong Environmental Protection Engineering Design Institute	EIS
Urban-rural water supply	Zhongnan Engineering Corporation Limited	EIS
4.3km wetland access road (eco-system rehabilitation component)	Guangdong Environmental Protection Engineering Design Institute	EIS
Ecosystem rehabilitation	Chenzhou Municipal Environmental Protection Research Institute	TEIA
River course rehabilitation	Zhongnan Engineering Corporation Limited	EIS

32. ADB’s Safeguard Policy Statement (SPS 2009) provides the basis for this project EIA. All projects funded by ADB must comply with the SPS. The purpose of the SPS is to establish an environmental review process to ensure that projects funded under ADB loans are environmentally sound, comply with domestic laws, and are not likely to cause significant environment, health, or safety hazards. The project is classified as Category A by ADB, requiring the preparation of an EIA and EMP.

E. Assessment Standards

33. The environmental standard system that supports the implementation of the environmental protection laws and regulations in the PRC can be classified by function-ambient environmental quality standards, and by pollutant emission and/or discharge standards. ADB's SPS requires projects to apply pollution prevention and control technologies and practices consistent with international good practices such as the World Bank Group's Environmental, Health and Safety Guidelines (EHS).[2] For this assessment, where EHS standards exist for parameters and are relevant, they are used in parallel with PRC standards in this assessment.

1. Evaluation against Ambient Standards

34. The Chenzhou Municipal Environmental Protection Bureau has nominated the environmental quality classes for each component of the proposed Dongjiang Lake Environmental Protection and Integrated Utilization Project (Table III-6).

Table III-6: Environmental Quality Classes in the Project Area

Variable	Scope	Function Classes
Air	Dongjiang Lake Scenic Area and Wetland Park	Class I of GB3095-1996
	Qingyao River rehabilitation sites	Class I of GB3095-1996
	Tianeshan River rehabilitation sites	Class I of GB3095-1996
	Other project areas	Class II of GB3095-1996
Noise	Dongjiang Lake Scenic Area and Wetland Park	Class I of GB3096-2008
	Qingyao River rehabilitation sites	Class I of GB3096-2008
	Tianeshan River rehabilitation sites	Class I of GB3096-2008
	Residential areas within 35 m of trunk road (measured from the road mid-line)	4a of GB3096-2008
	Other project areas	Class II of GB3096-2008
Surface water	Dongjiang Lake	Grade I Zone: Class II of GB3838-2002 Grade II Zone: Class III of GB3838-2002
	Yongle River	Class III of GB3838-2002
	Xingning River	Class III of GB3838-2002
	Lianping River	Class III of GB3838-2002
	Guangqiao River	Class III of GB3838-2002
	Tianeshan River	Class III of GB3838-2002
	Qingyao River	Class III of GB3838-2002
	Yangdong Reservoir	Class III of GB3838-2002
	Changhuo River	Class III of GB3838-2002
Ground water	All project areas	Class III of GB/T 14848-93
Soil	All project areas	Class II of GB15618-1995

35. Air quality. The PRC ranks air quality into three classes according to *Ambient Air Quality Standard* (GB3095-1996; amended in 2000). Class I is the best air quality and Class III the worst. A new standard was issued in 2012 (GB 3095-2012), replacing GB3095-1996, and will become effective in all municipal level city in 2015 and nation-wide on 1 January 2016. The new standard combines Class II and Class III and introduces $PM_{2.5}$ standards. It also makes more stringent NO_2 standards. Currently, the applicable air quality standard is GB3095-1996. Class I is applicable for the project areas located in Dongjiang Lake Scenic Area. For the project areas out of the Dongjiang Lake Scenic Area, Class II is applicable.

36. The WHO has set up air quality guideline (AQG) standards for various air quality parameters for the protection of public health. Recognizing that progressive actions are needed to achieve these standards and the financial and technological limitations of some

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

countries or localities especially in developing countries, the WHO also established interim targets as intermediate milestones towards achieving the AQG. Table III-7 compares the PRC's GB 3095-1996 Class I and Class II standards with the GB 3085-2012 standards and the World Bank Group's EHS standards.

Table III-7: Comparison of PRC and WBG Ambient Air Quality Standards. n/a=not applicable

Variable	Averaging period	PRC Class I (μg/m^3)		PRC Class II (μg/m^3)		World Bank Group EHS[1] (μg/m^3)	
		GB3095-1996	GB3095-2012	GB3095-1996	GB3095-2012	Interim target	AQG
SO_2	1-year	20	20	60	60	n/a	n/a
	24-hour	50	50	150	150	50-125	20
	1-hour	150	150	500	500	n/a	n/a
NO_2	1-year	40	40	80	40	n/a	40
	24-hour	80	80	120	80	n/a	n/a
	1-hour	120	120	240	200	n/a	200
CO	24-hour	4,000	4,000	4,000	4,000	n/a	n/a
	1-hour	10,000	10,000	10,000	10,000	n/a	n/a
TSP	1-year	80	80	200	200	n/a	n/a
	24-hour	120	120	300	300	n/a	n/a
PM_{10}	1-year	40	40	100	70	30-70	20
	24-hour	50	50	150	150	75-150	50
$PM_{2.5}$	1-year		15	N/A	35	15-35	10
	24-hour		35	150	75	37.5-75	25

37. Acoustic quality. Noise environment for the project's settings will be evaluated against Class II standards of the Ambient Acoustic Quality Standard (GB3096-2008) (Table III-8). The PRC standards are more stringent than those of EHS.

Table III-8: Ambient Acoustic Quality Standards (unit: dB (A))

Applicable Class	Standard Value	
	Day-Time	Night-Time
Class I (residential, hospital, education, research, administrative area)	55	45
Class II (residential, commercial and industrial mixed area)	60	50
Class 4a (along roads – within 35 m measured from the mid-line)	70	55
World Bank EHS	70	70

38. Surface water quality. The ambient environmental standard applied in this EIA is Surface Water Ambient Quality Standard (GB3838－2002) Classes II and III (Table III-9). There is no EHS guideline or target for water quality in this context.

Table III-9: Surface Water Ambient Quality Standards (Unit: mg/L)

Standard	DO	BOD	COD	NH_3-N	Coliform/l
(GB3838-2002) – Class II	6	3	15	0.5	2000
(GB3838-2002) – Class III	≥5	≤4	≤20	≤1.0	10000

39. Groundwater quality. Groundwater quality will be assessed against Class III standards according to Quality Standards for Groundwater (GB/T14848-1993) (Table III-10). There are no equivalent EHS targets.

Table III-10: Quality Standards for Groundwater

Item	pH	Permanganate Index	Total	Nitrate Nitrogen	Fluoride	Total E.coli
Class III	6.5-8.5	≤3.0 mg/L	≤450 mg/L	≤20 mg/L	≤1.0 mg/L	≤3.0x10^3/L

40. Soil. Soil quality in the PRC is divided into three classes according to the Environmental Quality Standard for Soils (GB 15618-1995). Class I represents the best and Class III the worst. Class II is applicable for the proposed project area (Table III-11).

Table III-11: Environmental Quality Standard for Soils (Class II)

Parameter	Maximum Allowable Concentration (mg/kg dry weight)		
pH	<6.5	6.5-7.5	>7.5
Cadmium (Cd)	0.30	0.30	0.60
Mercury (Hg)	0.30	0.50	1.0
Arsenic (As) paddy / dry land	30 / 40	25 / 30	20 / 25
Copper (Cu) farmland / orchard	50 / 150	100 / 200	100 / 200
Lead (Pb)	250	300	350
Chromium (Cr) paddy / Dry land	250 / 150	300 / 200	350 / 250
Zinc (Zn)	200	250	300
Nickel (Ni)	40	50	60

2. Emission Standards for Construction and Operation Activities

41. Air quality. Fugitive emission of particulate matter (such as dust from construction sites) is regulated under PRC's Air Pollutant Integrated Emission Standard (GB 16297-1996), which sets 120 mg/m^3 as the maximum allowable emission concentration and ≤1.0 mg/m^3 as the concentration limit at the boundary of construction sites, with no specification on the particle diameter. Odor from the wastewater treatment stations and solid waste transfer stations should follow the Malodorous Pollutant Emission Standard (GB 14554-93). The maximum allowable concentrations at the boundary of the sites for NH_3, H_2S and odor are 1.5 mg/m^3, 0.06 mg/m^3, and "20" (dimensionless).

42. Wastewater. Discharge of wastewater from construction sites is regulated under PRC's Integrated Wastewater Discharge Standard (GB 8978-1996). Class I standards apply to discharges into Category III water bodies under GB 3838-2002. Class II standards apply to discharges into Categories IV and V water bodies. Class III standards apply to discharges into municipal sewers going to municipal WWTPs with secondary treatment. Wastewater generated during construction will be discharged into Category II water body. Class I of GB 8978-1996 applies for construction sites under this project (Table III-12).

Table III-12: Integrated Wastewater Discharge

Parameter	Class I	Class II	Class III
	For discharge into Category III water body	For discharge into Category IV and V waterbodies	For discharge into municipal sewer
pH	6–9	6–9	6–9
SS mg/L	70	150	400
BOD_5 mg/L	20	30	300
COD mg/L	100	150	500
TPH mg/L	5	10	20
Volatile phenol mg/L	0.5	0.5	2.0
NH_3-N mg/L	15	25	---
PO_4^{2-} (as P) mg/L	0.5	1.0	---
LAS (= anionic surfactant) mg/L	5.0	10	20

43. The proposed WWTPs in the urban areas of the townships are designed based on Class 1A/1B of Urban Sewage Treatment Plant Pollutant Discharge Standards (GB18918-2002) (Table III-13).

Table III-13: Discharge Standards for urban WWTP

Parameter	Unit	Class 1A	Class 1B
COD	mg/L	50	60
BOD_5	mg/L	10	20
SS	mg/L	10	20
Ammonia	mg/L	5(8)	8
TN	mg/L	15	20
TP	mg/L	0.5	1.0

44. Operation of the water treatment plant (WTP) and quality of the treated water to be supplied to residents must comply with the PRC Drinking Water Quality Standard (GB5749-2006), in which 106 parameters must be met (Tables III-14 and III-15).

Table III-14: Drinking Water Quality Standards (GB5749-2006)

No.	Parameter	Standard
	Routine Parameter of Drinking Water Quality	
	Microbiological parameter[3]	
1	Total coliform (MPN/100ml or CFU/100ml)	LD
2	Thermotoletant coliform (MPN/100ml or CFU/100ml)	LD
3	Escherichia Coli (MPN/100ml or CFU/100ml)	
4	Total plant count (CFU/ml)	100
	Toxicological parameter	
5	Arsenic (As, mg/L)	0.01
6	Cadmium (Cd, mg/L)	0.005
7	Chromium Hexavalent (Cr 6+, mg/L)	0.05
8	Lead (Pb, mg/L)	0.01
9	Mercury (Hg, mg/L)	0.001
10	Selenium (Se, mg/L)	0.01
11	Cyanide (CN-, mg/L)	0.05
12	Fluoride (mg/L)	1.0
13	Nitrate (mg/L)	10
14	Trichloromethane (mg/L)	0.06
15	Carbon tetrachloride (mg/L)	0.002
16	Bromate (when O3 is applied) (mg/L)	0.01
17	Formaldehyde (when O3 is applied) (mg/L)	0.9
18	Chlorite (when ClO2 is applied) (mg/L)	0.7
19	Chlorate (when compound chlorine dioxide is applied) (mg/L)	0.7
	Sensory Properties and General Chemical Parameter	
20	Chromaticity (Unit of platinum cobalt color)	15
21	Turbidity (diffusing turbidity unit) NTU	1
22	Odor and Taste	No odor, no taste
23	Appearance	None
24	pH	6.5≤X<8.5
25	Aluminum (Al, mg/L)	0.2
26	Iron (Fe, mg/L)	0.3
27	Manganese (Mn, mg/L)	0.1
28	Copper (Cu, mg/L)	1.0
29	Zinc (Zn, mg/L)	1.0
30	Chloride (Cl-, mg/L)	250
31	Sulfate (SO4-mg/L)	250
32	TDS (mg/L)	1000
33	Total Hardness (CaCO3) (mg/L)	450
34	CODMn (mg/L)	3
35	Volatile phenols (phenol) (mg/L)	0.002
36	LAS (mg/L)	0.3
	Radioactivity Parameter4	
37	Total α radioactivity (Bq/L)	0.5
38	Total β radioactivity (Bq/L)	1
	Non-routine parameter – microbial indicators	
39	Giardia cysts (count/10L)	<1
40	Cryptosporidium oocysts (count/10L)	<1
	Non-routine parameter – toxicological parameter (mg/L)	
41	Antimony (Sb, mg/L)	0.005

3 MPN= Most Probable Number; CFU: Colony forming unit.

4 Radionuclide phase analysis is conducted if radioactivity value exceeds limits, to determine if the water is drinkable.

No.	Parameter	Standard
42	Barium (Ba, mg/L	0.7
43	Beryllium (Be, mg/L)	0.002
44	Boron (B, mg/L)	0.5
45	Molybdenum (Mo, mg/L)	0.07
46	Nickel (Ni, mg/L)	0.02
47	Silver (Ag, mg/L)	0.05
48	Thallium (Ti, mg/L)	0.0001
49	Cyan chloride (CN- mg/L)	0.07
50	Chlorodibromomethane (mg/L)	0.1
51	Bromodichloromethane (mg/L)	0.06
52	Dichloroacetic acid (mg/L)	0.05
53	1,2-dichloroethane (mg/L)	0.03
54	Dichloromethane (mg/L)	0.02
55	THMs	1
56	1,1,1 - trichloroethane (mg/L)	2
57	Trichloroacetic acid (mg/L)	0.1
58	Trichloroaldehyde (mg/L)	0.01
59	2,4,6- trichlorophenol (mg/L)	0.2
60	Bromoform (mg/L)	0.1
61	Heptachlor (mg/L)	0.0004
62	Malathion (mg/L)	0.25
63	PCP (mg/L)	0.009
64	HCH (total amount, mg/L)	0.005
65	Hexachlorobenzene (mg/L)	0.001
66	Dimethoate (mg/L)	0.08
67	Parathion (mg/L)	0.003
68	Bentazone (mg/L)	0.3
69	Parathion-methyl (mg/L)	0.02
70	Chlorothalonil (mg/L)	0.01
71	Carbofuran (mg/L)	0.007
72	Lindane (mg/L)	0.002
73	Chlopyrifos (mg/L)	0.03
74	Glyphosate (mg/L)	0.7
75	DDVP (mg/L)	0.001
76	Arazine (mg/L)	0.002
77	Deltamethrin (mg/L)	0.02
78	2, 4 - dichlorobenzene oxygen ethanoic acid (mg/L)	0.03
79	Dichloro-diphenyl-dichlorothane (mg/L)	0.001
80	Ethylbenzene (mg/L)	0.3
81	Dimethylbenzene (mg/L)	0.5
82	1,1- dichloroethylene(mg/L)	0.03
83	1,2- dichloroethylene(mg/L)	0.05
84	1,2- dichlorobenzene(mg/L)	1
85	1,4- dichlorobenzene(mg/L)	0.3
86	Trichloroethylene(mg/L)	0.07
87	Trichlorobenzene(mg/L)	0.02
88	Hexachlorobutadiene(mg/L)	0.0006
89	Acrylamide (mg/L)	0.0005
90	Tetrachloroethylene (mg/L)	0.04
91	Toluene (mg/L)	0.7
92	DEHP (mg/L)	0.008
93	ECH (mg/L)	0.0004
94	Benzene (mg/L)	0.01

No.	Parameter	Standard
95	Styrene (mg/L)	0.02
96	Benzopyrene (mg/L)	0.00001
97	Chloroethylene(mg/L)	0.005
98	Chlorobenzene(mg/L)	0.3
99	Microcystin-LR(mg/L)	0.001
	Physical Properties and General Chemical parameters (mg/L)	
100	Ammonia Nitrogen(NH3-N, mg/L)	0.5
101	Sulfide (S, mg/L)	0.02
102	Sodium (Na, mg/L)	200

Table III-15: General Parameters and Requirements for Drinking Water Disinfectant

No.	Disinfectant	Exposure duration with Water	Limit in water supplied (mg/L)	Residue in water supplied (mg/L)	Residues in network end (mg/L)
103	Chlorine and free chlorine (mg/L)	≥30 min	4	≥0.3	≥0.05
104	Monochloramine (total chlorine, mg/L)	≥120 min	3	≥0.5	≥0.05
105	Ozone (O_3, mg/L)	≥12 min	0.3	-	0.02/ ≥0.05 if chlorine is added
106	Chlorine Dioxide (ClO_2, mg/L)	≥30 min	0.8	≥0.1	≥0.02

45. Sludge disposal. The quality of sludge going to landfill disposal should meet the Standard for Pollution Control on the Landfill Site of Municipal Solid Waste (GB 16889-2008). This requires the water content of sludge not to exceed 60%, and meet standards for reuse including as soil conditioner (GB15618-1995), afforestation in gardens and windbreak plantation (GB23468-2009), fertilizer for agricultural use (GB4284-84), land improvement (CJ/T 291-2008), brick building (CJ/T 289-2008) and other land applications

46. Noise. Construction noise will be assessed against the PRC Emission Standards of Ambient Noise for Boundary of Site Noise (GB 12523-2011) and Class II of Emission Standard for Industrial Enterprises Noise at Boundary (GB 12348-2008) (Table III-16).

Table III-16: Construction Site Noise Limits. Unit: Leq [dB (A)]

Period	Major Noise Source	Noise Limit	
		Day	Night
Construction	Bulldozer, excavators and loader; pile driving machines; concrete mixer, vibrator and electric saw; hoist and lifter	70	55
Operation	Pumps	60	50

47. Vibration. Construction activities will cause vibration impact, and should comply with the Standard for Urban Area Environmental Vibration (GB10070-88) (Table III-17).

Table III-17: Vertical Vibration Standard Value for Various Urban Areas (Unit: dB)

Scope of applicable area	Day	Night
Special residential area	65	65
Residential, cultural and educational area	70	67
Mixed area and commercial center	75	72
Industrial centralized area	75	72
Both sides of traffic trunk line	75	72
Both sides of railway main line	80	80

IV. DESCRIPTION OF THE PROJECT

A. Overview

48. The expected project impact is enhanced quality of life and sustainable economic development of Xiang River basin in Hunan Province. The expected project outcome is improved quality of water resource and environment of Dongjiang Lake. The project has five outputs: (i) improved pollution control; (ii) established urban–rural water supply system; (iii) river course rehabilitation; (iv) integrated ecosystem rehabilitation and management; and (v) strengthened environmental and project management capacity.

49. Output 1 will support: (i) domestic wastewater treatment – construction of six wastewater treatment plants (WWTPs) with a total capacity of 2,000 m^3/day, sewage collection pipes, and 2,856 small wastewater treatment facilities for rural villages; (ii) solid waste collection, compaction, and transfer facilities; and (iii) agricultural nonpoint source pollution management. Output 2 will support: (i) construction of two water supply plants with total water treatment capacity of 20,620 m^3/day for about 82,000 residents; (ii) water supply pipelines with total length of >730 km; and (iii) operation and maintenance equipment. Output 3 will support river course rehabilitation for five rivers.

50. Output 4 will support: (i) aquatic facilities and management; (ii) wetland restoration and management facilities; (iii) soil erosion control, including reforestation and revegetation; (iv) bamboo forest improvement for farmers; and (v) establishment of a pilot eco-compensation payment mechanism. The pilot scheme will compensate residents responsible for collection and treatment of solid waste and sewage with funds raised from fees on tourism entry, water use, and pollution discharge. The eco-compensation rate will be calculated according to the amount of solid waste and sewage collected and treated, the management efforts provided for environmental protection, and the prevention of accidents which may cause adverse environmental impacts. Output 5 will support: (i) establishment of an environmental monitoring center; (ii) establishment of deep water lake research center; (iii) public awareness, technical and vocational education and training in alternative livelihood activities for 30,000 rural residents; (iv) project implementation consulting services, training, workshops, and study visits; and (v) establishment of project monitoring and evaluation system. Major construction works are summarized in Table IV-1.

Table IV-1: Summary of Project Construction Works

Component			Units	Pipeline (km)	Affected Land (mu)
Pollution Control	Domestic Wastewater Treatment	Town WWTP	6 (2,000 m^3/day)	38.1	4.72
		Rural WWTP	2,856	330.38	100
	Solid waste collection and transfer	Waste Transfer Stations	7 (82 tons)	-	12.2
	Total				16.92
Urban-rural Water Supply	Urban-rural Water Supply	Yangdong	1 (20,000 m^3/day)	713.40	31.84
		Chukou	1 (620 m^3/day)	38.80	3
	Total				34.84
River course rehabilitation	Clearance of 14.7 km blockage and 13.7 km embankments km				102.2
Integrated Ecological Rehabilitation and Management	Lake Ecosystem Rehabilitation	Stocking Platform	1 (parking lot) 1 Platform		7.32
	Wetland Conservation and Rehabilitation	Constructed Wetland	3		123.94

	Total				131.26
Environmental Monitoring and Protection Capacity Building	Lake Environment Monitoring and Research Capacity Building	Fish Monitoring Stations	6		1.2
				Total	**184.22**

WWTP=wastewater treatment plant, WWTP=wastewater treatment system.

B. Project Design

1. Output 1. Improved Pollution Control

1.1 Domestic Wastewater Collection and Treatment

51. This subcomponent aims to minimize pollution to Dongjiang Lake from the surrounding towns and rural residents through activities that will collect the domestic wastewater and discharge after treating it to a satisfactory standard.

52. **Urban townships.** The town area domestic wastewater subcomponent will construct six new wastewater treatment plants (WWTPs; total treatment capacity 2,000 m^3/day) and associated sewage pipelines as well as other facilities to treat the wastewater from urban areas of selected townships surrounding Dongjiang Lake (Fig. IV-2; Table IV-2). Construction of the pipelines includes the tertiary connections to households as well as trunk lines.

Figure IV-2: Locations of Proposed WWTPs

Table IV-2: Development Proposal for Townships Wastewater Treatment Facilities

No.	Location	Capacity m^3/day	Sewer Network (m)			Check Well	Designed effluent Quality
			DN300HDPE	DN400HDPE	DN500HDPE		
1	Qingyao	600	8000		2900	100	Class 1B
2	Lianping	100	2100		2200	75	Class 1B
3	Qingjiang	300	5700	2800		285	Class 1A
4	Chukou	800	1300		4300	190	Class 1A

No.	Location	Capacity m^3/day	Sewer Network (m)			Check Well	Designed effluent Quality
			DN300HDPE	DN400HDPE	DN500HDPE		
5	Dongping	100	1800	1200		100	Class 1B
6	Longxi	100	2000	3800		130	Class 1B
Subtotal		2000	20900	10000	7200	880	Class 1B

53. Demand forecast. Due to land restraints in the mountainous areas, township populations are small and growth is minimal or slowly declining due to emigration to urban areas. Recent population sizes and water use (2013–2014) were regarded as the most appropriate to predict demands for the design, as follows.

- Qingyao Township – population of 4,000; water usage is 625 m^3/d.
- Lianping Township – population of 800; water usage is 100 m^3/d.
- Qingjiang Township (Daitou Village) – population of 1,872; water usage is 288 m^3/d.
- Chukou Township – 3,000 residents; water usage is 600 m^3/d.
- Dongping Township – 226 households (767 residents); water usage is 110 m^3/d.
- Longxi Township – population of 900; water usage is 113 m^3/d.

54. Wastewater is mainly from kitchen wastewater, rinse waste, sewage, and pig farm rinse water. With water to wastewater conversion rate of 80%, the wastewater volume and the treatment capacity of each WWTP is summarized in Table IV-3. The exception is the WWTP for Chukou Township, which will remain at its 800 m^3/d treatment capacity.

Table IV-3: Wastewater Volume Projection for Townships at Dongjiang Lake

Township	Population	Water consumption (m^3/d)	Conversion rate	Wastewater production (m^3/d)	Design Capacity (m^3/d)
Qingyao	4,800	625	0.8	500	600
Lianping	800	100	0.8	80	100
Qingjiang	1,872	288	0.8	230	300
Chukou	3,000	600	0.8	480	800
Dongping	987	110	0.8	88	100
Longxi	900	113	0.8	90	100

55. Treatment process. The WWTPs will adopt contact oxidation treatment process. For Chukou and Qingjiang townships, close to Dongjiang Lake, chemical phosphorus removal will also be used to meet Class 1A standard. Influent pollutant and treated effluent loads are estimated based on the per capita pollutant production referring to Outdoor Drainage Design Specification (GB 50014-2006, 2014 amendment).

Table IV-4: Designed Influent and Effluent water quality

Pollutant	Estimated Influent (mg/L)	Designed Effluent (mg/L) (Class 1A/Class 1B)	Removal rate (%) (Class 1A/Class 1B)
BOD_5	159	10/20	94.0/88.0
SS	227	10/20	96.0/92.0
COD_{cr}	250	50/60	82.0/78.4
TN	35	15/20	62.5/50.0
TP	4.5	0.5/1.0	90.0/80.0

56. Sludge disposal. All sludge will be temporarily stored and shipped out to fertilize the landscaping plantings. It is anticipated that sludge production using the contact oxidation process will be much less than other methods. All WWTPs will include a sludge processing facility which will treat sewage sludge. The sludge will be tested periodically to ensure that it is suitable of fertilizer. See also Section VII.

57. **Rural areas.** The rural wastewater treatment facilities comprise 2,856 small wastewater treatment systems (WWTP) including 2,450 separate 4-tank systems (4TS), 406 small collective systems (SCS), and 330.38 km collection pipes (Table IV-5).

Table IV-5: Development Proposal for Rural wastewater treatment facilities

No.	Items	Quantity	Remarks
1	4-tanks system	2450	<4 households
2	Size A SCS	173	4-15 households
	Size B SCS	119	15-30 households
	Size C SCS	52	30-45 households
	Size D SCS	47	45-60 households
	Size E SCS	15	60+ households
	Subtotal	406	
3	DN110	198.23 km	
	DN200	132.15 km	
	Subtotal	330.38 km	

58. Treatment process. The 4TS applicable for up to 4 households. For larger systems, Size C through Size E will be used. The 4TS combines an anaerobic biological process and a biological bed filter. It consists of four units including the collection tank, an anaerobic fermentation tank, a sedimentation tank and an artificial wetland (Figs. IV-3 and IV-4Figure IV-).

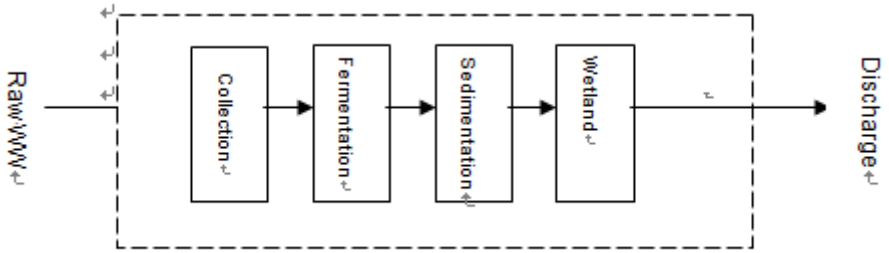


Figure IV-3: Process Fow Diagram of 4-tank System

Figure IV-4: Typical 4-tank System

59. For SCS, one of two (2) processes will be used depending on conditions. Option 1: for areas with ponds available, screens will be used to intercept large debris followed by standard designed septic tank and a polishing wetland. For the wetland, the hydraulic load will be between 0.25 and -0.5 m^3/m^2-day. As illustrated in Fig. IV-5, submerged flow will take place through porous fill. This porous fill will have four (4) layers with sizes (1^{st} layer) D20-50 mm, 0.2m thick; (2nd layer) D10-30 mm, 0.15 m thick; (3rd layer) D7-20 mm, 0.15m thick; and (4th layer) soil, 0.15 m thick.

60. Operation of WWTPs and WWTSs. Operation of the waste treatment facilities will comply with the ZCG *Management Methods for Operation and Maintenance of Village and Township Domestic Wastewater Treatment Facilities*. The manual was prepared in 2014 and the draft is currently being finalized. The manual describes roles and responsibilities of relevant agencies, operations and maintenance (O&M), recording, reporting, and fund management. The Zixing Housing, Urban and Rural Development Bureau will provide technical guidance, evaluation, random checks on O&M and effluent quality, training, and

financial management. The Zixing Finance Bureau will be responsible for fund raising, verification and disbursement for operation and maintenance. The township and village governments will be responsible for O&M of the WWTPs and WWTSs respectively. The manual will include standardized procedures for internal monitoring (of effluent quality etc) by each WWTP and WWTS: once approved, all stations will be legally required to implement these measures.

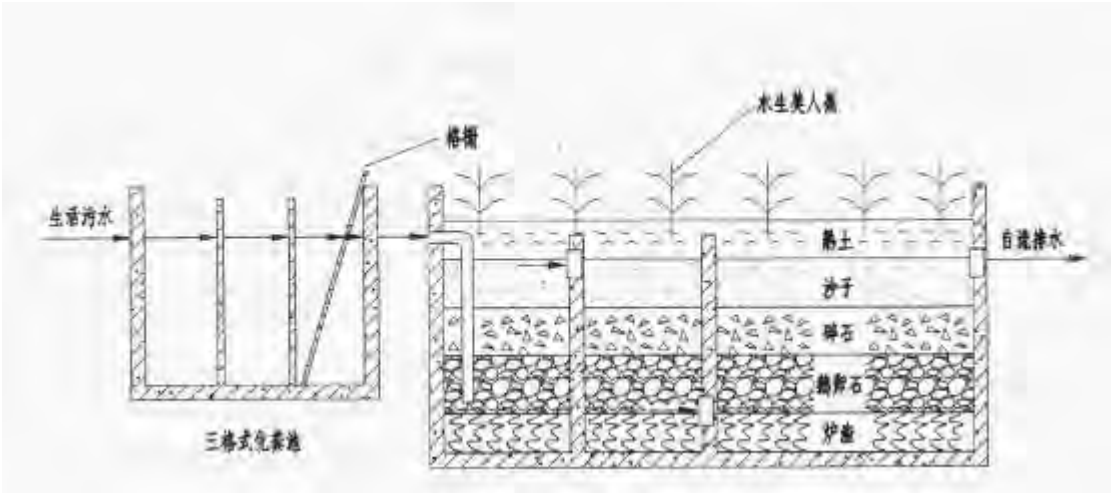


Figure IV-5: Example of Septic Tank with Wetland

61. Option 2: For those areas without ponds, the treatment will consist of: Screening + Septic tank + Oxidation Pond + Floating ecological bed (Fig. IV-6). The oxidation pond design will follow the Design Code for Oxidation Ponds (CJJ/T54-93) and will be capable of treating a biological oxygen demand (BOD) of 70-100 kg BOD/ha/day. The floating ecological bed will consist of 20% of the pond area will be ecological bed with plantings.

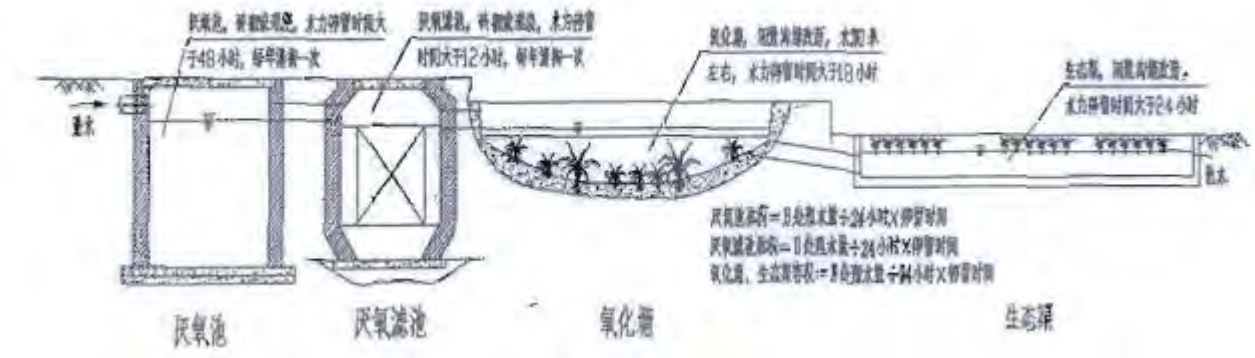


Figure IV-6: Example of Septic tank with Oxidation Pond

1.2 Solid Waste Collection, Transport and Treatment

62. Few villages have trash collection and public collection tanks are not emptied regularly. Excess garbage is often left exposed in small dump sites near roads and riverbanks. This is a health hazard as well as causing visual impacts. “Household classification, village collection, town transfer and county processing” is a process of garbage collection and transportation. Garbage is first collected by the villagers; then compressed and packed at town garbage transfer stations before being transported to a landfill (Fig. IV-7).

Figure IV-7: Solid waste collection and treatment flow diagram

63. Seven transfer stations are proposed (Table IV-6). Locations have been selected based on travel distances and times to disposal sites. The stations will be equipped with compressor, hauling vehicle, garbage grapple truck, and leachate suction trunk (Fig. IV-8). Garbage separation bins and awareness education brochures will be provided to the residents.

Table IV-6: Proposed Solid Transfer Stations

	Dongjiang	Qingjiang	Chukou	Dongping	Qingyao	Longxi	Zhoumensi
Village	Wenchang	Daitou	Jinxing	Zhoutang	Zhoutang	Xiadong	Xindong
Distance to Zixing Landfill	19.2 km	56.4 km	94.9 km	101.5 km	44.1 km	70.3 km	43.0 km
Served households	2,714	3,756	4,162	1,170	3,595	1,580	7,875
Served population	10,800	10,300	14,400	4,700	9,300	5,600	27,000
Capacity (ton)	10.8	10.3	14.4	4.7	9.3	5.6	27.0

Solid waste transfer station

Compressor

Leachate suction truck

Garbage trunk

Figure IV-8: Typical Solid Waste Transfer Station

64. Construction and equipment requirements for each station are presented in Table IV-7.

In addition, solid waste collection equipment includes 1,598 sealed dustbins, 88,438 classification buckets and 330 power sanitation vehicles. The public outreach program requires stainless steel bulletin boards, plastic bill boards and solid waste classification manuals.

Figure IV-9: Typical Layout of a Planed Solid Waste Transfer Station

Table IV-7: Major Works and Equipment Requirements for the Proposed Solid Waste Collection and Transfer Subcomponent

No.	Content	Unit	Construction scale											
			Total	Dongjiang	Qingjiang	Chukou	Dongping	Qingyao	Longxi	Zhoumensi	Xingning	Bailang	Huangcao	Lianping
I.	**Garbage transfer station**													
1.1	Main works	m^2	2960	360	480	335	350	465	480	490	n/a	n/a	n/a	n/a
1.2	Greening	m^2	2827	292	250	917	152	308	643	265	n/a	n/a	n/a	n/a
1.3	Unloading zone(astern ground)	m^2	1802	200	160	356	116	300	400	270	n/a	n/a	n/a	n/a
1.4	Access road	m	1380	500	200	400	0	200	0	80	n/a	n/a	n/a	n/a
1.5	Fencing	m	704	100	60	150	81	119	142	52	n/a	n/a	n/a	n/a
1.6	Transformer	Set	7	1	1	1	1	1	1	1	n/a	n/a	n/a	n/a
1.7	Foundation pit	set	10	1	2	1	1	1	2	2	n/a	n/a	n/a	n/a
1.8	Septic tank		7	1	1	1	1	1	1	1	n/a	n/a	n/a	n/a
1.9	Retaining wall	m^2	542	n/a	500	42	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1.1	Earthworks backfill	m^3	8300	n/a	6200	207	393	n/a	n/a	1500	n/a	n/a	n/a	n/a
1.11	Water, electricity installation	set	7	1	1	1	1	1	1	1	n/a	n/a	n/a	n/a
1.12	$PY_2ZII80E$ rollover vertical compressor	set	11	1	2	1	1	2	2	2	n/a	n/a	n/a	n/a
II.	**Garbage removal vehicles configuration**													
2.1	Sealed vehicle	set	10	1	1	1	n/a	2	2	3	n/a	n/a	n/a	n/a
2.2	Hook arm vehicle	set	180	13	17	18	6	18	9	34	26	21	15	3
2.3	Sewage suction vehicle	set	3	n/a	1	n/a	n/a	n/a	1	1	n/a	n/a	n/a	n/a

1.3 Agricultural Non-point Source Pollution Management

65. Agricultural pollution in the project area is a concern, due to poor farming practice, runoff from farmland carries fertilizer, pesticide and sediment. It is estimated that the annual loading of chemical oxygen demanding substances, ammonium, and total phosphorus into Dongjiang Lake are 15,548 tons, 3,021 tons and 604 tons respectively. The total use of pesticides in Dongjiang Lake area is estimated to be 236.47 ton. Typical household pesticide use is as high as 3.5 kg/mu of which 70% enters into the environmental threatening water quality. To meet this challenge, the project will promote formulated fertilization and environmental friendly pest control to reduce agricultural pollution.

66. **Soil testing and formulated fertilizer.** Formulated fertilizer will be promoted in four townships and 17 villages surrounding Dongjiang Lake, including Horticultural Farm in Xingning Town, 4 villages in Bailang Country, 8 villages in Qingjiang Country and 4 villages in Dongjiang Street. Formulated fertilizer contains less nitrogen compared with commercial fertilizer and has been widely promoted in the PRC by the Ministry of Environment. A draft project plan for application of the formulated fertilizer has been prepared. The amount of formulated fertilizer to be applied will be tailored to individual sites within the project area and will be based on soil test results to be conducted during loan implementation. Preliminary soil test results and planning indicate: (1) formulated fertilizer may be applied at a rate of 60 kg/mu for an area of 1,803 ha (including 200 ha nursery and 1,603 ha orchard) over two years for a total of 3,246 tons; and (2) commercial organic fertilizer may be applied at a rate of 300 kg/mu for an area of 1,603 ha, for a total of 14,430 tons over a two year period (Table IV-8). The results of these tests will be analyzed with the results being presented to farmers as alternative to current farming methods.

Table IV-8: Proposed Soil testing and Areas for Formulated Fertilizer

Town	Village	Nursery		Orchards			Soil testing samples	Beneficiary households
		Area (ha)	Fertilizer (ton)	Area (ha)	Fertilizer (ton)	Commercial organic fertilizer (ton)		
Xingning	Horticultural Farm			20	18	90	6	47
	Subtotal			**20**	**18**	**90**	**6**	**47**
Bailang	Xiuliu			227	204	1020	68	310
	Bailang			160	144	720	48	300
	Jiangkou			260	234	1170	78	1100
	Taiqian			65	58.8	294	20	280
	Subtotal			**712**	**640.8**	**3204**	**214**	**1990**
Qingjiang	Fenglian			65	58.8	294	20	64
	Qingdong			87	78	390	26	234
	Huangqiao			173	156	780	52	199
	Jipin			112	100.8	504	34	268
	Qingcao			104	93.6	468	31	248
	Qingxi			100	90	450	30	190
	Shangli			120	108	540	36	182
	Dalong			110	99	495	33	300
	Subtotal			**871**	**784.2**	**3921**	**262**	**1685**
Dongjiang Street	Longquan	40	36					124
	Wenchang	60	54					186
	Renli	60	54					193
	Xinghong	40	36					118
	Subtotal							621
	Total	**200**	**180**	**1603**	**1443**	**7215**	**482**	**4343**

Note. Formulated fertilizer and commercial organic fertilizer will be promoted for 2 consecutive years; soil sample testing will be finished in 2016.

67. **Environmental friendly pest control**. This plan will cover 3 townships and 22 villages around Dongjiang Lake, including Hejiashan village in Xingning town, Pingshi village, 3 villages in Yuanyichang, Bailang village in Bailang township, Qingdong village in Qingdong township, Huangqiao village, Jipin village, Qingcao village, Qingxi village, Pizhu village, Jiaopin village, Shangli village and Dalong village. The project focuses on pest control for rice and fruits, in 13 villages in Xingning, Bailang and Qingjiang townships (town and community offices), for a total area of 1,603.0 ha. The project will also promote the use of insecticidal lamps, biological pesticides, and sticky traps (Table IV-9).

Table IV-9: Proposed works of environmental friendly pest control program

Township	Village	Orchard					Beneficiary households
		Area (ha)	SEVTIL (set)	Sticky traps (x10,000)	Biological pesticides (kg)	Frame type pesticide sprayer (set)	
Xingning	Horticultural Farm	20	8	2	47		
	Subtotal	20	8	2	47		
Bailang	Xiuliu	680	10	27.2	11.9	15	310
	Bailang	480	10	19.2	8.4	8	300
	Jiangkou	780	10	31.2	13.65	10	1100
	Taiqian	196	5	7.84	3.43	2	280
	Subtotal	2136	35	85.44	37.38	35	1990
Qingjiang	Fenglian	196	20	7.84	3.43	3	64
	Jiatian	200	20	8	3.5	3	81
	Shangbao	280	22	11.2	4.9	4	52
	Yahe	59	4	2.368	1.04	1	34
	Daitou	76	5	3.04	1.33	1	68
	Qingdong	320	20	12.8	5.6	4	420
	Shankou	260	20	10.4	4.55	4	234
	Huangqiao	300	20	12	5.25	4	136
	Jipin	520	40	20.8	9.1	6	199
	Taiyuan	336	60	13.44	5.88	5	268
	Qingcao	160	10	6.4	2.8	2	130
	Qingxi	312	12.48	5.46	4	248	
	Pizhu	300	45	12	5.25	4	190
	Jiaopin	500	100	20	8.75	8	286
	Shangli	140	8	5.6	2.45	2	160
	Dalong	360	25	14.4	6.3	3	182
	Subtotal	330	25	13.2	5.78	4	300
	Total	**6845**	**487**	**271.41**	**118.74**	**99**	**5,089**

SEVTIL=Solar Energy Frequency Vibration Type Insecticidal Lamp

2. Output 2. Urban-rural Water Supply System

68. This output comprises two subcomponents: (i) Yangdong water supply; and (ii) Chukou water supply (Table IV-10).

Table IV-10: Proposed Works for Water Supply Systems

Name	Work content	Location	Scale
Yangdong Water Supply	Water intake to WTP	Downstream of Yangdong Reservoir	2 water pipelines 13.7 km
	Water treatment plant	Longxing Mountain of Zhoumensi Town	20,000 m^3/d
	Pipelines	Along local roads	699.7 km (DN25-400)
	Pressure reducing station	Xindong, Hejiashan, Xingning	3 stations
Chukou Water Supply	Water intake to WTP	Chukou Nijia S-shaped area	water pipeline 7.8 km
	Water treatment plant	Hill behind town government	620 m^3/d
	Pipelines	Along local roads	27 km (DN25-100)

2.1 Yangdong Water Supply

69. The Yangdong water supply system is designed to enhance water supply for a total population of 82,000 living in five townships surrounding Dongjiang Lake. These townships are Zhoumensi Town, Lanshi County, Boshui County, Xingning Town and Bailang County. The system will have a capacity of 20,000 m^3/day. It is divided into four parts: freshwater intake, water transmission line, water treatment plant (WTP) and water distribution. From the intake pipes at the power station in the downstream of Yangdong Reservoir, water will be transferred by gravity through two DN400 pipelines, 13.8 km to the new WTP which will be located at Lengshuikeng on Longxing Mountain opposite to original Pengshi County Government, elevation of 700 m. The treated water will be distributed to Zhoumensi town in the south through the pipes that will be laid along S205 and S349 Roads and Xingning town (along S322 Road) and Bailang town (along X020 Road) in the south by gravity. The total length of transmission pipelines are 157.8 km (DN150-500) of ductile iron pipes. Main structures of the WTP include folded plate flocculation and incline tube sedimentation tank, V-type filter, backwash pumping room, clean water tank, dosing room, wastewater storage tank, gravity thickener, sludge dewatering room and ancillary buildings. Chlorine dioxide disinfection will be used. The clean water will be delivered to end users through 228 km of water branch (DN100) and 300 km household connection pipelines (DN25-DN100).

2.2 Chukou Water Supply

70. The existing water source for Chukou Township is mainly groundwater and surface water streams, which serve a population of 3,000. Existing sanitation is poor, especially in flood season, with water wells submerged and highly turbid water. The proposed Chukou water supply subcomponent will serve 3,000 residents in Chukou downtown with design capacity of 620 m^3/d. Raw water will be abstracted from the secondary tributaries of Chu River. The annual total runoff of Chu River is 1.24 million m^3. A masonry gravity dam will be built to store water, with a height of 1.6 m and crest of 10 m. The bottom of the dam will be 2.09 wide and the crest 0.5 m. A 0.4m (width)*0.4m (depth) intake is arranged at the left side of the dam then connected to 1.5m (length)*1.0m (width)*1.0m (depth) concrete sedimentation tank. The raw water will be delivered to the proposed Chukou Water Treatment Plant located in the hill behind Chukou township government through a 5.3 km PE pipe. Surface water is abundant (the project area receives 1.3 m rainfall a year), and reducing reliance on groundwater will help conserve and recharge local aquifers.

71. Chukou Water Treatment Plant and pipeline network. An automatically integrated water treatment system will be adopted for filtration and disinfection. The treated clean water will be distributed to the downtown of Chukou Town and two administrative villages through 4 km water main (DN100) and 23 km household connection pipes (DN 25-DN100).

3. Output 3. River Course Rehabilitation for Five Rivers

72. Five rivers will be rehabilitated, the Guangqiao, Lianping, Qingyao, Tianeshan, and Xingning Rivers (Fig. IV-10). All flow into Dongjiang Lake. Total catchment area is 710.1 km^2 and total combined length is 78.2 km. There are no flood control reservoirs in the catchments of the five rivers. A flood in 2006 caused damage to existing flood control structures. After completion of dredging and embankment, the river sections will be inspected monthly and after major flood events to assess channel condition.

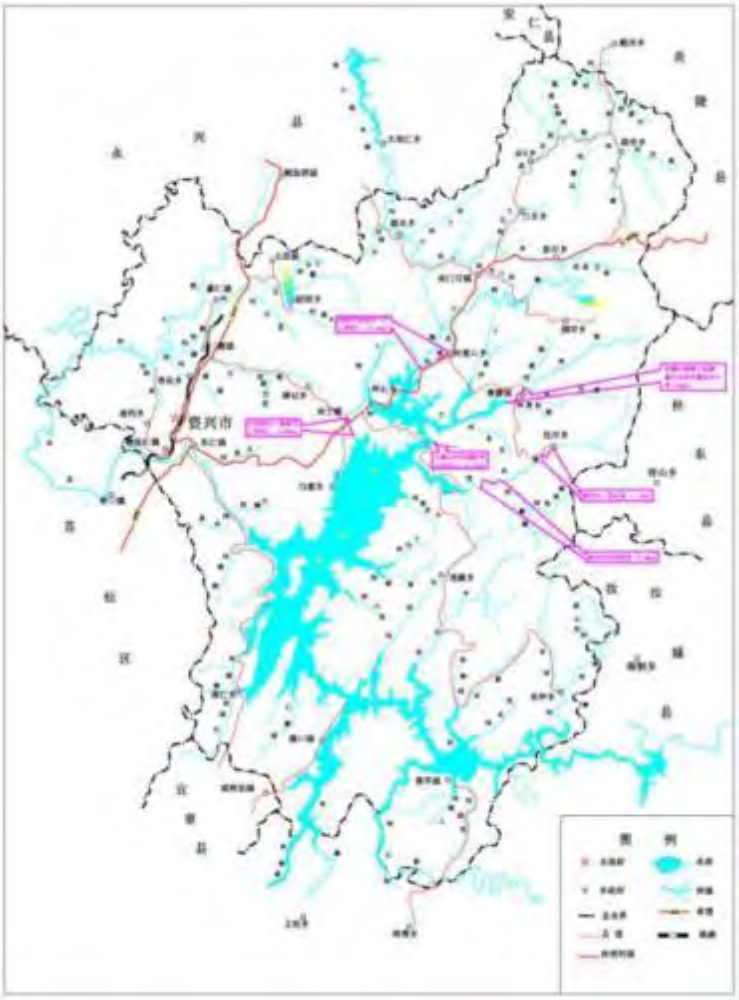
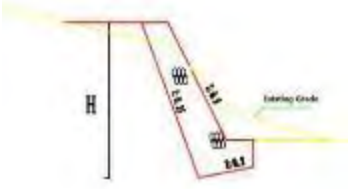


Figure IV-10: Location of Five Selected Rivers for Rehabilitation

73. Works comprise embankment with masonry retaining wall, Reno lining, grass planting bricks, dikes, blockage clearing, landscaping, stairs, and associated management facilities are proposed (Tables IV-11 and IV-12). These will provide protection for 1 in 10 year flood events.

Table IV-11: Proposed embankment type

Embankment Type	Remarks
	**Type 1: Masonry retain wall**
	**Type 2: Dike**

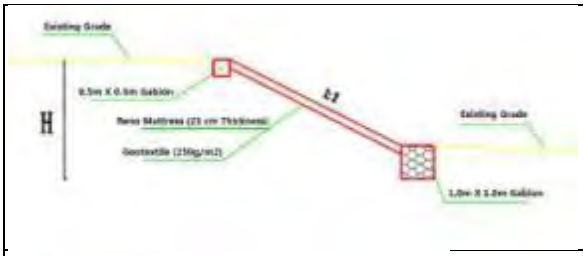
	**Type 3: Reno lining**
	**Type 4: Planting brick**

Table IV-12: Proposed Works for the River Rehabilitation Component

River	Masonry retain wall (m)	Reno (gabion) (m^2)	Planting bricks (m^2)	Dikes (m)	Dredging (m)	Landscaping (m)	Stairs	Mgmt Facilities (set)
Xingning	1315.2	454.9	392.29	594.2	2209	3400	18	1
Guangqiao	805.43	1000.55	1253.27	516.1	4263	6000	22	1
Lianping	294	512.5	100	990	849	5000	10	1
Qingyao	1254	1366	1159	663.4	4098	7000	20	1
Tianeshan	279.8	357.9	322.65	100	3193	3000	15	1
	3948.43	**3670.19**	**3227.21**	**2863.7**	**14612**	**24400**	**90**	**5**

4. Output 4. Integrated Ecosystem Rehabilitation and Management

4.1 Aquatic Facilities and Management

74. By 2009, there were 6,300 farmers using cage culture at Dongjiang Lake and annual catch was 12,000 tons. Since 2010, the ZCG has encouraged farmers to move cage culture facilities to land to protect the lake water quality. Over-fishing has decreased the lake fishery resources. The project will develop fish breeding facilities, artificial releasing platform (Fig. IV-11), release about 10 million summer fish fry, 41,000 kg winter fish fry and 36 million silverfish eggs into the lake every year for five years, and build six fish monitoring stations in Bailang, Xingning, Qingjiang, Huangcao, Chukou and Dongjiang (Table IV-13). Stocking numbers are based on the capture amount in 2013 (1,225 tons; Zixing Aquatic Animal Husbandry and Veterinary Bureau) and estimated fish production capacity in 2009 (518.1 kg/ha) and 2013 (6.6 kg/ha; Hunan Agriculture University and Hunan Provincial Fisheries Research Institute, assuming 18,000 mu available surface area of fish habitat). The 2013 capture. To maintain the stocked fish population, fishing will be prohibited from 1 April to 30 June. No fish feed will be used by the project; the stocked fish will rely only on existing food resources in the lake.

Figure IV-11: Proposed Artificial Fish Releasing Platform

Table IV-13: Proposed Works under Aquatic Facilities and Management Subcomponent

No.	**Proposed works**	**Unit**	**Number**	**Location**
1	Fish releasing platform			Bailang Bay
1.1	Temporary breeding farm	m^2	3000	
1.2	Supporting infrastructures			
(1)	Access road	km	0.72	
(2)	Parking lot	m^2	2000	
(3)	Water and power supply facilities	set	1	
1.3	Transportation and loading			
(1)	Boat	set	1	
(2)	Vehicle	set	2	
(3)	Automatic fish counting equipment	set	1	
2	Fish releasing			Dongjiang Lake
2.1	Summer fish fry	number	50 million	
2.2	Winter fish fry	kg	205,000	
2.3	Silverfish eggs	10,000	18,000	
3	Fish breeding base			Zhongdong Fish Farm
3.1	Breeding tanks rehabilitation			
(1)	Parent fish cultural tanks			
(2)	Fish fry cultural tanks			
(3)	Spawning tanks			
(4)	Training building			
(5)	Freezer and workshop			
(6)	Ancillary facilities			
3.2	Testing, loading, monitoring facilities	set	3	
4	Fish resources protection			
	Monitoring boat	set	1	
	Patrol boat	set	3	
	Monitoring car	set	2	
	Signboard		80	
	Fish releasing marker		40	
	Boundary marker		200	

4.2 Wetland Restoration and Management

75. The project will support restoration of three wetlands at lakeside as buffer zone to intercept pollutants and eroded soil, at Xingning River estuary, Huangcao lakeside wetland, and Hangxi River estuary wetland (Figure IV-12; Table IV-14).

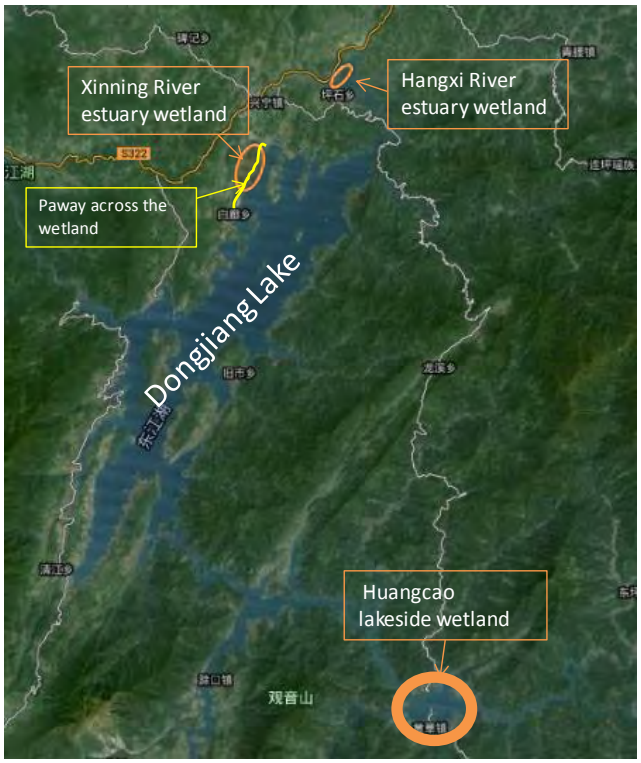


Figure IV-12: Location of Proposed Wetlands

Table IV-14: Proposed Works for Wetland Restoration Subcomponent

	Unit	No.	Scope of Construction
Xingning River estuary wetland			
Access road	km	4.5	7.5 m width; 87,600 m^3 of earthwork, 3.9 km of drainage and reinforcement, 0.45 km of special subgrade treatment, 33,200 m^2 of pavement, 25 culverts, 5 crossings
Wetland flora restoration	ha	26	6 ha greenery isolation zone, 4 ha of arbor grass protection zone, 6 ha shrub wetland zone restoration, 5 ha emerging plant zone restoration, 5 ha of floating-leaved and submerged plant zone restoration
Habitat creation	ha	14	7 ha bird habitat construction, 3.5 ha fish feeding farm, 3.5 ha macro-benthos bio-environment creation
Constructed wetland		1	29,200 m^2 of artificial wetland wastewater treatment tank, 21,411 m^3 of filling material, 290,000 wetland plants, 1 abutment, 1 supporting equipment, 2 km roads and fence wall, and landscaping
Education center and other works		1	800 m^2 wetland promotion area, 1.2 km wetland promotion hallway, 1.9 km pathway for ecology education, 800 m^2 footprint of technical exhibit room, 10 ecological floating islands, 5 waterside terraces, 3 scenic lookout pavilion, 1 bird observation pavilion, 1 interpretation system
Huangcao Lakeside Wetland	ha	26.7	3.15 ha Reno + ecological planting bag, 2.59 ha ecological embankment, 20.96 ha Vetiver double reinforced flexible embankment
Hangxi River Lake Estuarine Wetland Construction			
Wetland restoration	ha	85	20 ha marshland restoration, 65 ha lakeside transition zone plant restoration
Habitat environment	ha	15	7 ha bird habitat construction, 5 ha of fish feeding farm, 3 ha macro-benthos bio-environment creation.
Wetland infrastructure	km	5	Wetland patrol plank road, 10 pavilions

76. **Xining River Estuary subproject**. This will comprise an access road leading to the project area, engineered wetland, an estuary restoration zone, a habitat creating zone and an educational center. The access road connecting to Bailang Village will be designed as a Grade III road connecting Zhongdong Fish Farm to Bailang Village across the wetland. Total road length is 4.31 km. Current daily traffic volume is 456 domestic vehicles per day in 2014

and is forecast to increase to 1,679 per day in 2020 and 3,870 per day in 2035. Design speed is 30 km/h. The subgrade is 7.5 m, including 2x3.25 m traffic lane and 2x0.5 m road shoulders. The pavement type is asphalt. The design will use 0.62 km existing concrete road to save cost. The engineered wetland will be designed to treat water discharge from the Xingning River to Dongjiang Lake and effluent from Xingning WWTP (Fig. IV-13). The wetland area will be 3.33 ha. It will consist of emergent, floating leaf and submerged species in permeable substrate. Plants will comprise local species with high pollutant removal ability (Table IV-15). Designed influent and effluent loads are in Table IV-16.

Table IV-15: Engineering Wetland Planting

Type of plant	Major species used for planting	
	Scientific Name	Common Name
Emergent aquatic vegetation	*Phragmites australis*	Common Reed芦苇
	Typha angustifolia	Lesser Bulrush水烛
Floating-leaved vegetation	*Nymphaea tetragona*	Lotus睡莲
	Nymphoides peltatum	banana-plant荇菜
Submerged aquatic vegetation	*Ceratophyllum demersum*	Rigid Hornwort金鱼藻
	Vallisneria aquatica	Tape Grass苦草
	Hydrilla verticillata	Hydrilla 黑藻
	Potamogeton crispus	Curly-leaf Pondweed菹草

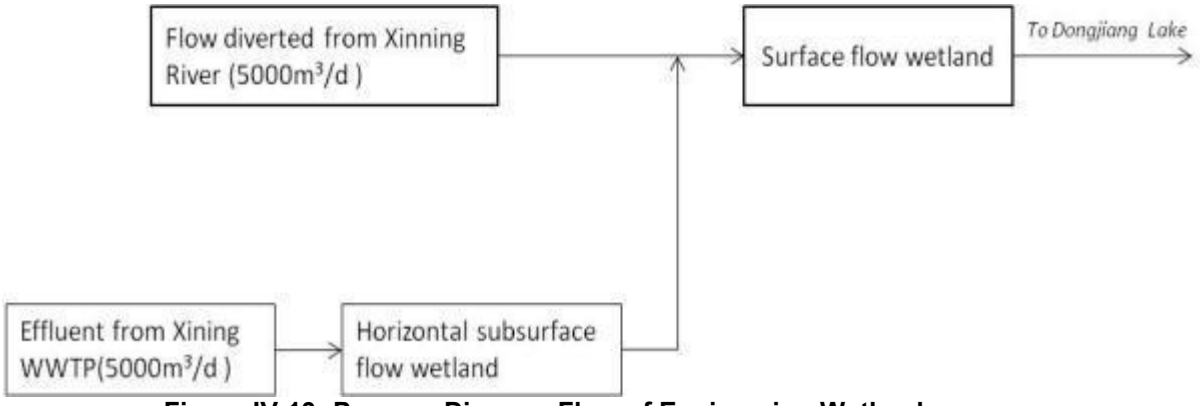


Figure IV-13: Process Diagram Flow of Engineering Wetland

Table IV-16: Incoming and Outgoing Water Quality for the Engineered Wetland

Item	COD_{cr}	NH_3-N	TN	TP
Influent (mg/L)	42.15	4.2035	10.276	0.64
Effluent (mg/L)	20	1	1	0.2

77. Two zones, estuary wetland restoration, and habitat creation, will be constructed. In the first zone, existing wetlands will be rehabilitated by planting emergent, floating leaf and submergent species along the shoreline (Table IV-17). In the second, habitats will be created for fish, birds and invertebrates (Table IV-18). Note that these habitats are not being designed to target particular species or communities, and the habitats are also intended for landscaping. A wetland education center and square will also be built to provide venue for education activities to tourist.

Table IV-17: Estuary Wetland Restoration Zone Planting

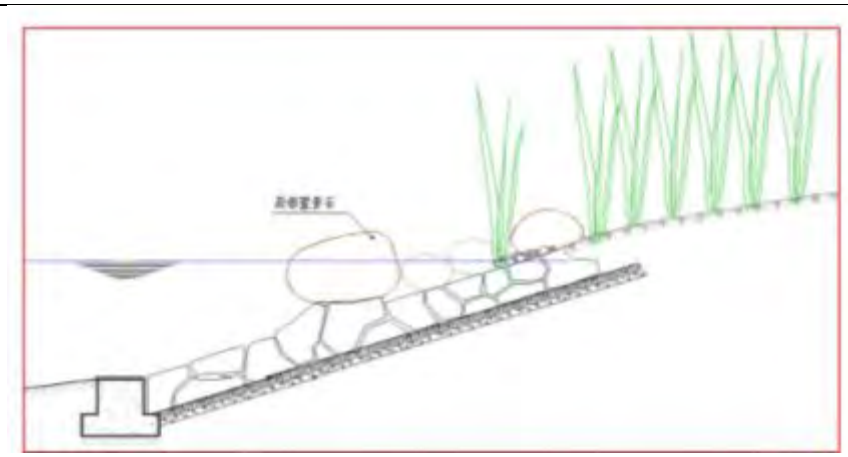
No.	Vegetation	Elevation (m)	Major Species
1	Greenery isolation zone	280-285	Trees: *Cinnamomum camphora, Sapium discolor, Elaeocarpaceae, Sassafras*
2	Trees+herbs protection zone	275-280	Trees: *Willow, Pterocarya stenoptera DC, Taxodium distichum;* Herbaceous plants: *Cypella herbertii, Houttuynia cordata*
3	Shrub+herbs zone	275~280	Shrubs: *Adina rubella, Hibiscus syriacus, etc;*

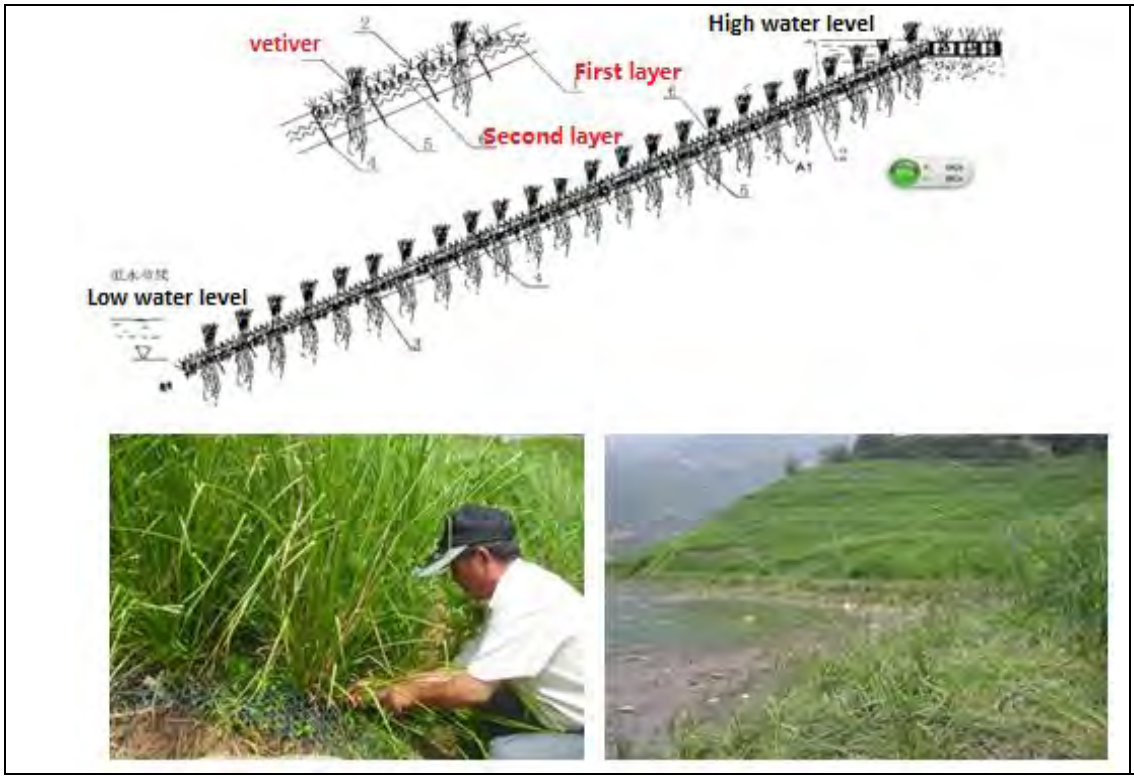
			Herbaceous plant*: FlagIris, Thalia dealbata, Canna indica, Scirpus tabernaemontani*
4	Emergent zone	273~275	*Phragmites australis, Zizania Caduciflora, Lythrum salicaria*
5	Floating-leaved and submergent zone	270~273	*Nymphaeaceae, Hydrocharis, Nymphoides peltatum, Potamogeton malaianus, Vallisneria spirals, Myriophyllum verticillatum*

Table IV-18: Habitat Creation Zone Method

Habitat	Approach
Bird habitat	Floating-leaved, emergent vegetation; depth 0.5-1 m; exposed banks with reed and shrub; shallow water habitats with lotus, water chestnuts, Euryale
Fish feeding grounds	Build fish feeding grounds in the water area near lakeside
Invertebrate habitat	Restoration the aquatic vegetation

78. **Huangcao lakeside wetland.** According to the water level monitoring at Dongjiang Hydropower Plant, the water level varies from 257.15 m to 285.12 m (2000-2013). There are 12 m water level differences from average water level (273.14 m) to normal water level (285 m). The lakeside wetland at Huangcao town will be restored to control soil erosion and intercept pollutant flow into Dongjiang Lake directly. Three embankment types will be utilized considering the geological and hydrological conditions (Fig. IV-14).

	**Riprap +Artificial Greenery Embankment**
	**Reno Mattress + Geotextile Bag**



Double-layer reinforced vetiver embankment

Figure IV-14: Embankment types for Huangcao lakeside wetland

79. Embankment types. (i) Riprap + Artificial Greenery Embankment. This design will be used for wetlands with bank slope <25°. Riprap is rock or other material used to armor shorelines and streambeds against scour and water erosion. It is made from a variety of rock types, commonly granite or limestone. Gravel wrapped with geotextile is usually placed underneath the riprap to form an impermeable layer to prevent erosion. (ii) Reno Mattress + Geotextile Bag. This will be used around Jinniu Island in Fenglin village, Huangcao town, where bank slope is >25°. These are gabion type manufactured from 60 x 80 mm double twist mesh with more planar area and relatively thin. Usually used to prevent flush from water waves. Geotextile bags are made from polypropylene or polyester fabric, are erosion resistant, non-degradable, and easy for plant growth. Usually used for river bank where has potential of landslide and collapse. (iv) Double-layer reinforced vetiver embankment. This will be used for the right bank of Jinniu Island, Garden Island, Ou river estuary, and Fenglin, Xinqiao, Tantou, and Jinla villages, with a total river bank length of 8.3 km and area of 20.96 ha where water levels drop significantly seasonally. This design uses mesh to form an integrated double layer 3-dimensional flexible mesh block structure, anchored by chaining plant stem with roots, and effectively prevent water erosion and scour.

80. **Hangxi River estuary wetland.** This will cover 105 ha, including 40 ha of vegetation restoration, 65 ha of lakeside buffer zone, 15 ha of habitat creation for fish, birds and benthic macro-invertebrate, 5 km plank road and 10 pavilions. Table IV-19 presents common local species that have been selected for planting in the Hangxi River estuary wetland.

Table IV-19: Hangxin River Estuary Wetland Planting

Function zone	Elevation (m)	Major species used for planting	
		Scientific Name	Common Name
Tree+shrub+herbs protection zone	275-285	*Salix chaenomeloides*	Giant Willow河柳
		Pterocarya stenoptera	Chinese Wingnut枫杨
		Taxodium distichum	Southern Cypress落羽杉
		Metasequoia glyptostroboides	Dawn Redwood水杉
		Taxodium ascendens.Brongn	池杉

		Adina rubella	细叶水团花
		Hibiscus syriacus Linn	Rose-of-Sharon木槿
		Iris wilsonii	黄花鸢尾
		Houttuynia cordata	鱼腥草
Emergent zone	274-275	*Phragmites australis*	Common Reed芦苇
		Typha angustifolia	Lesser Bulrush水烛
		Zizania caduuciflora	茭草
		Lythrum salicaria L.	千屈菜
		Acorus calamus	菖蒲
		Typha orientalis	香蒲
		Sagittaria trifolia	野慈菇
		Scirpus validus	水葱
		Arundo donax	Giant reed芦竹
Floating-leaved and submerged zone	270-273m	*Nymphaea tetragona*	Lotus睡莲
		Nymphoides peltatum	banana-plant荇菜
		Myriophyllum verticillatum	狐尾藻
		Vallisneria aquatica	Tape Grass苦草
		Euryale ferox	芡实
		Hydrocharis dubia	common水鳖
		Potamogeton malaianus	竹叶眼子菜

81. The constructed wetlands will be maintained and operated through operational plans which will define staff roles and responsibilities, and periodic inspection of wetland structures (subsurface inflow and drainage pipes, matting, gravel layers) and removal of localized sediment accumulation to sustain the designed hydraulics. Under the project, staff will be trained in management of the wetlands. At Xingning wetland, continual sharing of water quality data with Xingning WWTP will provide a process of quality assurance and control (QA/QC), to assess how the wetland is supporting the treatment of effluent from the WWTP. This is important to sustain robust vegetation biomass to sustain and naturally regenerate the wetland sediment and detrital layers where important removal processes of nitrogen, phosphorus and carbon assimilation and cycling are operating.

4.3 Soil Erosion Control (Reforestation and Revegetation)

82. Reforestation and revegetation are important for water conservation and sustainable development of Dongjiang Lake basin. The proposed works are listed in Tables IV-20 and IV-21. The rocky desertification areas that will be revegetated are illustrated in Fig. IV-15.

Table IV-20: Proposed Works for Soil Erosion Control Subcomponent

1 Protection of public forests				
1.1 Forest fire control				
1.1.1	Campus for fire protection team, material warehouse and observation tower	m^2	10198	1 municipal campus of fire protection team 2972 m^2, rehabilitation of 6600 m^2 outdoor training yard; 500 m^2 material warehouse; 126m^2/ observation tower.
1.1.2	Equipment			85 sets of office equipment; 56 sets of wind extinguishers; 56 sets of air pressure spray guns, 6 groups of relay pumps, 1 propaganda car of forest fire protection, 1 command car of forest fire protection, 3 troop carrier, 1 troopship and 32 patrol motorcycles; 24 sets of indoor training facilities.
1.1.3	Biological fire-proof forest belt	km	590	Expansion of biological fire-proof forest belt: expand the original 10 m of forest belt into 20 m wide; newly developed fire-proof forest belt: 20 m in width; mainly consists fire-proof tree species of *Schima superba*, waxberry and tea.
1.2	**Forest pest control**			

1.2.1	Pest census	ha	80,000	
1.2.2	Pest control equipment			13 sets sprayer/duster, 13 sets backpack smoke machine, 1 high range vehicle carrying sprayer, 1 pickup trunk, 2 pest forecasting toolkit, 26 protective clothing, 26 masks
1.2.3	Pesticides	ha	101.3	10 tons bassiana (a fungus), 14,030 bottles of omethoate (insecticide), 10,550 bags (200 gm per bag) of carbendazim (pesticide), and release of *Trichogramma* (a micro-wasp) to 1,447 mu of bamboo forest
2	**Ecological MIS–public forests**			
2.1	Public forest investigation and evaluation of ecological benefit	event	1	Monitoring Scheme for Ecological Benefit of Public Forests in Zixing City; conduct background investigation of 54,000 ha public forests, status investigation of annual changes and update resource data; conduct ecological benefit evaluation of public forests
2.2	MIS	event	1	Develop information management system of public forests, deploy hardware network equipment, develop database and software of public forests
3	**Karst reforestation**			
3.1	Afforestation	ha	1,000	Revegetation of eroded karst mountain slopes
3.2	Forest management	ha	13,666	Management of existing planted bamboo forest stands

MIS = management information system.

83. Four plant species combinations will be used for erosion control, based on site conditions. The planting density of Types 1, 2 and 3 is 4,500 individuals/ha. The density for Type 4 is 1,200 individuals/ha. The percentage of broadleaf species will be ≥30%.

- Type 1: coniferous tree (*Pinus massoniana (*pine*) and Cupressus funebris Endl (*cedarwood*) + broadlead species (Liquidambar formosana Hance (*maple*), Cornus wilsoniana, Koelreuteria paniculata, Schima superb, Zizyphus spinosus Hu (wild jujube));*
- Type 2: Coniferous species *(Pinus massoniana (*pine*) and Cupressus funebris Endl (*cedarwood*)* + precious broadleaf species *(Z.schneideriana (*beech*), Machilus nees, Cinnamomun camphcra (Camphor) and Taxus chinensis var mairei);*
- Type 3: mixed broadleaf species *(Z.schneideriana (beech), Liquidambar formosana Hance (*maple*), Schima superb, Cinnamomun camphcra (Camphor), Cornus wilsoniana, Rhizophora mangle (*Red mangrove *) , Zizyphus spinosus Hu (*wild jujube*))*
- Type 4: mixed broadleaf species *(zizyphus spinosus Hu (*wild jujube*), Cornus wilsoniana, Schima superb, Zizyphus spinosus Hu (*wild jujube*));* big nursery stock will be used. This type is suitable for roadside and waterside planting.

Table IV-21: Planting Approach for Reforestation in Karst Areas (unit: ha)

No.	Location	Subtotal	Afforestation					Forest stand management
			subtotal	Type 1	Type 2	Type 3	Type 4	
1	Xinning town	3780	380	103	98	154	25	3400
2	Bailang County	3232	299	49	120	80	50	2933
3	Dongjiang Street	2121	121	8	22	66	25	2000
4	Longxi County	133						133
5	Qingjiang County	2400	67	53	14			2333
6	Chukou Forest Farm	3000	133	87	46			2867
Total		14666	1000	300	300	300	100	13666

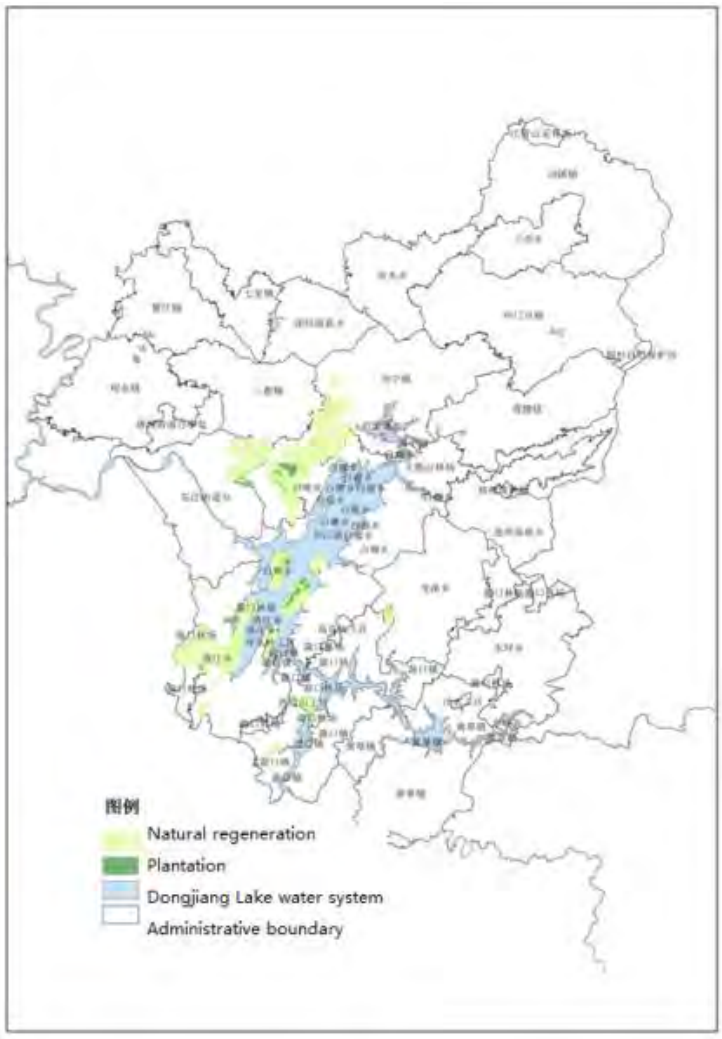


Figure IV-15: Location of Revegetation in Rocky Desertification Areas

4.4 Bamboo Forest Improvement for Farmers

84. Eight sites, Qingjiang township, Qingyao Town, Lianping Township, Bailang Town, Dongjiang Subdistrict, Xingning Town, Tiane Mountain Forest Farm and Chukou Forest Farm, will conduct a reforming project consisting of the planting of low-quality and low-benefit bamboo, and bamboo production base. The project will cover 2,595 ha (Table IV-22; Fig. IV-16).

Table IV-22: Areas of Improved Bamboo Forest

Location	Area (ha)
Xinning	134
Bailang	133
Dongjiang Street	200
Qingyao	665
Lianping	868
Qingjiang	165
Tiane Mountain Forest Farm	397
Chukou Forest Farm	33
Total	**2,595**

85. The process of forming low-benefit bamboos includes land selection (site control), structure control and genetic control. Site control facilitates root, bamboo shoot and bamboo

growth by improving conditions of water, heat, climate, temperature and fertilizers. Structure control structures forest appearance, plantation and age. This refers to adjustment of forest appearance to increase productivity and improve fertility and stability. Control of plantation structure refers to maintenance of plantation density, in order to increase leaf size, improve bamboo quality and output. Control of bamboo age refers to adjustment to age structure to improve fertility and output. Genetic control refers to planting and tending bamboo shoots to improve output and quality. Tending includes land clearing, weeding, ditching, fertilizing, shoot preservation, pruning, harvesting, and pest control. Under the project, farmers will be taught how to construct and maintain the bamboo forest, and to sell bamboo.

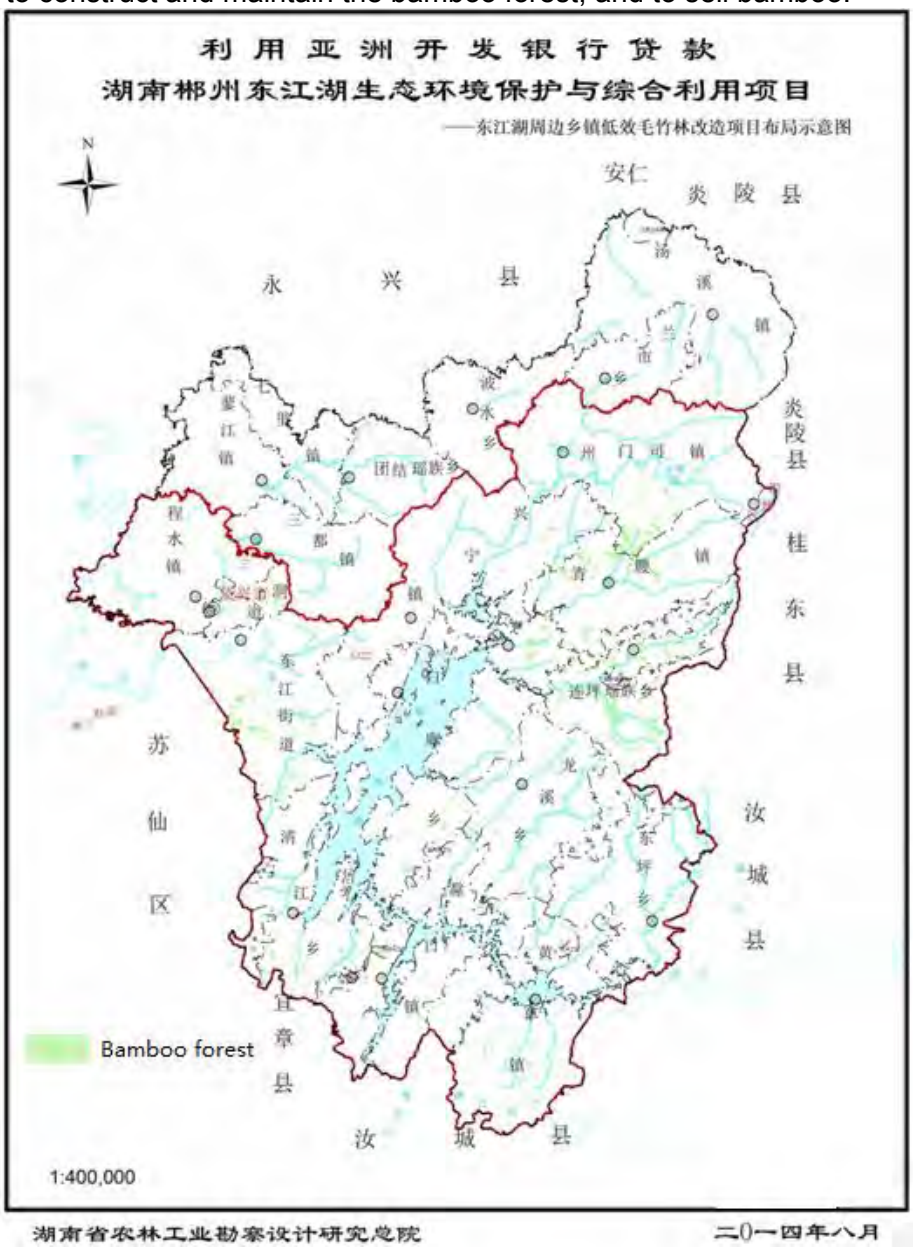


Figure IV-16: Location of bamboo forest improvement subcomponent

5. Output 5. Strengthened Environmental and Project Management Capacity

86. This output will comprise establishment of: (i) one environmental monitoring center; (ii) one deep water lake research center; (iii) public awareness, technical, and vocational education and training in alternative livelihood activities for 30,000 rural residents; (iv) project implementation consulting services, training, workshops, and study visits; and (v)

establishment of project monitoring and evaluation system. Project operation and maintenance arrangements are in Table IV-23.

Table IV-23: Project Operation and Maintenance Arrangements in Zixing City

	Component / Sub-component	Activity	Implementing Unit	Operation and Maintenance Unit
A	**Improved pollution control**			
A.1	Domestic wastewater treatment	WWTP-urban area	HURB	Towns where facility is located
		WWTP-rural area	ZEPB	Villages
A.2	Solid waste collection, compaction, transfer, disposal	Collection, transfer	SD	Township government; sanitation department; and/or outsourced operation
		Landfill		
		Incineration		
A.3	Agricultural non-point source pollution management	Soil testing; fertilizer	AB	Farmers
		Crop pest control	AB	
		Training		
B	**Established urban-rural water supply system**			
B.1	Yangdong WTP and distribution project		WRB	Water Supply Company
B.2	Chukou water supply project		WRB	Chukou Town Government
C	**Integrated ecosystem rehabilitation and management**			
C.1	River modification	Xingning River	WRB	TWMS
		Guangqiao River	WRB	TWMS
		Qingyao River	WRB	TWMS
		Lianping River	WRB	TWMS
		Tian'e Mountain River	WRB	National Forestry Park
D	**Integrated ecosystem rehabilitation and management**			
D.1	Dongjiang Lake aquatic ecosystem rehabilitation	Fish release structures	DRMB	Aquatic Product Seeding Plant
		Fish release	DRMB	DRMB
		Breeding facility	DRMB	Zixing Aquatic Product Seeding Plant
		Fish monitoring station	DRMB	Fishery Administration Group
D.2	Wetland restoration and management facilities	Embankment	FB	FB
		Restoration	FB	FB
		Research	FB	FB
		Education	FB	
D.3	Karst area desertification rehabilitation project	Reforestation	FB	Will supervise; provide technical support; priority given to the forestry owner
		Regeneration	FB	
D.4	Ecological forest protection		FB	
D.5	Bamboo forest improvement		FB	
E	**Environmental Monitoring and Capacity Building for Ecological System Protection**			
E.1	Capacity building for environmental monitoring		ZEPB	EPB
E.2	Deep water research center		ZEPB	EPB
E.3	Training on livelihood skills		HRSS	HRSS
E.4	Project management and capacity building	Studies	PMO	
		Workshops		
		Training		
E.5	Project monitoring and evaluation system		PMO	

AB = agriculture bureau; DRMB = Dongjing Reservoir Management Bureau; EPB = environment protection bureau; FB = forestry bureau; HRSS = Human Resource and Social Security Bureau; HURB = Housing, Urban and Rural Development Bureau; PMO = project management office; SD = sanitation department; TWMS = Town Water Management Station; WRB = water resource bureau; WTP = water treatment plant; WWTP = wastewater treatment plant.

C. Associated Facilities

87. Xingning wetland to be constructed by the project will receive effluent from Xingning WWTP to make the treated effluent satisfy Class 1A standard. The design capacity of Xingning WWTP is 5,000 m^3/d with total investment of CNY31.59 million, serving Xingning Town. Submerged bio-film process is adopted. The WWTP is under construction (Fig. IV-17).

Figure IV-17: Construction Site of Xingning WWTP

V. DESCRIPTION OF THE ENVIRONMENT

A. Environmental Setting

88. Dongjiang Lake is situated in the Nanling Mountain Range. The landforms are mountains with foothills and plains (Fig. V-1). Topography is higher in the southeast, with mountains and steep ravines. Elevation of the lake surface is 285 m above sea level; hills and mountains range from 200 to 2,042 m (Bamian Hill). The underlying geology is igneous granite, metamorphic slate, and sedimentary limestone, sandstone and shale. Soils comprise red, yellow, red-yellow, and yellow-brown earths, mountain meadow, paddy, and karst soil.

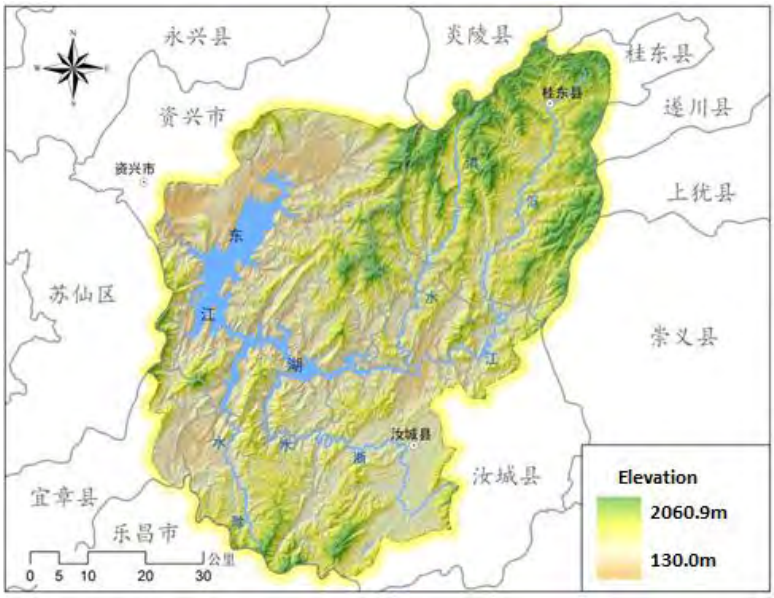


Figure V-1: Landform of Dongjiang Lake Basin

89. Climate. The Dongjiang Lake area has a humid subtropical climate, with four seasons (Table V-1). Spring is subject to heavy rainfall. Summers are long, hot, and humid. Average yearly rainfall at Dongjiang Lake is high (1,325 mm). The dry season is from September to February (Fig. V-2). Winter is brief, but cold snaps occur below freezing may occur.

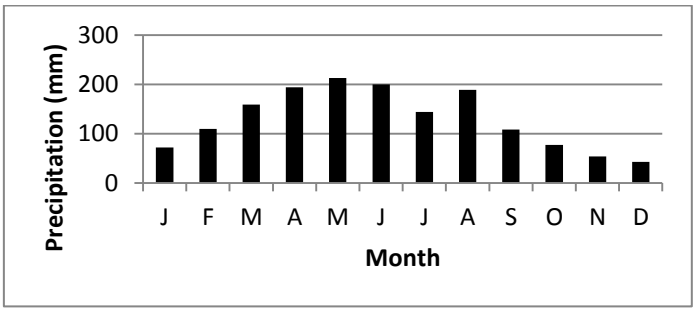


Figure V-2: Annual Rainfall Distribution for Dongjiang Lake (1971-2000)

Table V-1: Major Climatic Features of the Dongjiang Lake Area

Meteorological element	Unit	Value
Annual average temperature	^{0}C	16.9
Extreme maximum temperature	^{0}C	37.6
Extreme minimum temperature	^{0}C	-7.5
Annual rainfall	mm	1,325.0
Maximum rainfall	mm	1,857.0
Minimum rainfall	mm	1,315.0

Annual rainy days	days	182
Annual average relative humidity	%	81
Annual evaporation	mm	814.0
Maximum evaporation	mm	1,105.0
Minimum evaporation	mm	612.0
Annual sunshine hours	h	1,503.5
Annual frost-free period	days	280
Annual accumulated temperature above 0℃	^{0}C	5,648
Annual accumulated temperature above 10℃	^{0}C	3,125

90. Hydrology and water resources. Zixing City is located in the Xiangjiang River Basin (Fig. V-3). Dongjiang River is a tributary of Leishui River, which flows into the Xiang River. There are 436 rivers in Zixing City, including 67 rivers longer than 5 km. Total annual runoff is 2.28 billion m^3. The drainage area is 2,597.4 km^2. The project involves two reservoirs (Dongjiang Lake, Yangdong Reservoir) and 10 rivers. Dongjiang Lake was formed after construction of Dongjiang Dam in 1986 on the Leishui River. It has a capacity of 8.12 billion m^3 and is the second largest reservoir in middle-south PRC (the largest is Dongting Lake in northern Hunan Province). Dongjiang Lake has 160 km^2 water surface area, mean depth of 61 m and maximum depth of 141 m. It is in the top 10 largest freshwater lakes in the PRC by volume. Yangdong reservoir was built in 1967 with multi-function for irrigation, power generation and aquaculture. It is located in Yonglejiang River and has catchment area of 31.5 km^2 and total capacity of 15.1 million m^3 at normal water level of 824.43 m. The 10 project rivers belong to the Leishui river system, which originates from Guidong County and flows into Xiangjiang River from southeast to northwest. The Leishui River is 453 km long and has a catchment area of 11,783 km^2. The project will conduct dredging and embankment in five of the 10 rivers and abstract water and/or discharge treated water from the other five (Table V-2).

Figure V-3: Distribution of Project Related Water Systems

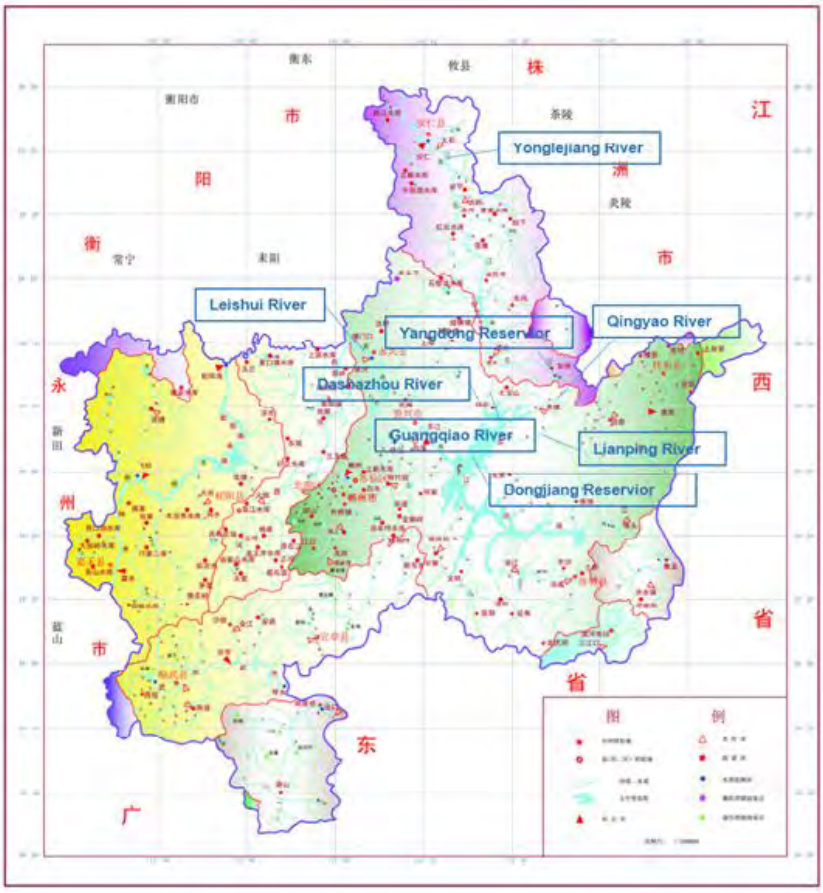


Table V-2: Hydrological Features of the Project Rivers

River	Catchment area (km^2)	Length (km)	Average gradient(‰)	Average Flow (m^3/s)	Project activity
Qingyao	144.2	22.5	21.74	14.62	Embankment, dredging
Guangqiao	41	12.6	24.34	1.6	Embankment, dredging
Xingning (=Dashazhou)	27.6	7.3	33.8	0.59	Embankment, dredging
Lianping	131.4	29.3	20.8	4.26	Embankment, dredging
Tianeshan	9.1	6.5	52.6	No info	Embankment, dredging
Zhoumensi	38.5	12.3	n/a	1.14	Pipeline of Yandong WTP will cross the river
Yongle	38.5	12.3	n/a	1.14	Excess water from Yangdong WTP will discharge into the river*
Dongping	123.1	29.1	n/a	3.0	Treated effluent from Dongping WWTP will discharge into the river
Changhuo	38.5	12.3	n/a	1.14	Treated effluent from Longxi WWTP will discharge into the river
Chu	515.6	51.8	n/a	6.74	Chukou water supply will abstract raw water from the river

Note. n/a = not available; WTP = water treatment plant; WWTP = wastewater treatment system. *The water purification process itself creates 'wastewater'; see Section V.

B. Physical Environment at the Project Sites

91. Surface water quality. Sampling and analysis were conducted according to *Technical Specifications Requirements for Monitoring of Surface Water and Waste Water* (HJ/T91-2002). Samples were taken at locations along six rivers, which are the locations for planned embankment, dredging, and/or discharge of tailings water from WTPs, from 20 to 22 September and 27 to 29 October 2014. For two sites, Dongping River and Dongjiang Lake, water quality data is cited from the *Quarterly Water Quality Bulletin of Dongjiang Lake Basin* (2014) developed by Chenzhou Municipal Environmental Monitoring Station (Table V-3). The results showed that the water quality of the water bodies monitored is superior to requirements of category III.

Table V-3: Baseline Surface Water Quality Monitoring

Sub-component	Water body	Date	Monitoring location	Parameters (mg/L except coliform bacteria No./L)								
				CODcr	BOD_5	pH	TP	NH_3-N	DO	TPH	SS	Coliform bacteria
Qingjiang WWTP	Dongjiang Lake	2014.2.24	Dalong	5.00L	3.51	6.96	0.01L	0.139	/	0.001L	/	1.9×10^2
		2014.7.2		5.42	1.26	7.01	0.01L	0.051	7.97	0.001L	/	7.9×10^2
Chukou WWTP	Dongjiang Lake	2014.2.24	Near Dongjiang port	5.00L	3	7.12	0.01L	0.148	/	0.001L	/	1.7×10^2
		2014.7.2		5.00L	1.3	7.16	0.01L	0.536	7.87	0.001L	/	7.0×10^2
Qingyao WWTP	Qingyao River	2014.9.20	500m upstream of the outlet	10.9	2	6.58	0.05	0.078	6.7	0.04L	21	1.6×10^3
		2014.9.21		10.3	1.9	6.65	0.06	0.086	6.7	0.04L	25	1.7×10^3
		2014.9.22		9.33	1.9	6.61	0.05	0.078	6.6	0.04L	24	1.7×10^3
		2014.9.20	Intersection of Xiaodong and Qingyao River	8.19	1.3	6.75	0.07	0.083	6.7	0.04 L	24	9.2×10^2
		2014.9.21		9.33	1.6	6.61	0.04	0.086	6.7	0.04 L	20	1.1×10^2
		2014.9.22		10	1.6	6.69	0.06	0.086	6.6	0.04 L	20	9.4×10^2
Lianping WWTP	Lianping River	2014.9.20	500m upstream of the outlet	8	0.6	6.93	0.05	0.044	6.4	0.04 L	14	4.7×10^2
		2014.9.21		8.16	0.9	6.95	0.05	0.05	6.4	0.04L	11	5.0×10^2
		2014.9.22		8.38	0.5	6.98	0.04	0.047	6.3	0.04 L	12	5.2×10^2
		2014.9.20	1500m downstream of the outlet	8.7	1.7	6.92	0.04	0.05	6.3	0.04 L	12	1.3×10^3
		2014.9.21		7.24	1.7	6.94	0.04	0.052	6.3	0.04 L	15	1.2×10^3
		2014.9.22		8.78	1.7	6.89	0.04	0.055	6.2	0.04 L	13	1.3×10^3
Longxi WWTP	Changhuo River	2014.9.20	500m upstream of the outlet	8.7	1.6	6.95	0.03	0.069	6.4	0.0003L	17	4.8×10^3
		2014.9.21		9.14	1.6	6.93	0.03	0.064	6.4	0.0003L	20	5.2×10^3
		2014.9.22		9.33	1.4	6.97	0.04	0.069	6.5	0.0003L	23	5.6×10^3
		2014.9.20	1500m downstream of the outlet	8.95	1	7.03	0.04	0.052	6.4	0.0003L	19	3.8×10^3
		2014.9.21		8.38	0.6	7.12	0.04	0.066	6.5	0.0003L	17	3.2×10^3
		2014.9.22		8	0.8	7.07	0.05	0.069	6.6	0.0003L	16	3.6×10^3
Dongping WWTP	Dongping River	Q1 2014	Along river	5.00L	3.05	7.07	0.01L	0.074	7.42	0.001L	/	125
		Q2 2014	Along river	5.00L	1.29	7.11	0.01L	0.049	7.66	0.001L	/	630
River rehabilitation	Qingyao River	2014/10/27-29	Downstream of the river sections will be rehabilitated	5L	/	6.62~7.43		0.121	6.5	/	4L	147
	Lianping River	2014/10/27-29		5L	/	7.10~7.81		0.038	6.4	/	4L	290
	Guangqiao River	2014/10/27-29		7.5	/	7.04~7.81		0.326	6	/	5	477
	Xingning Rive	2014/10/27-29		5L	/	7.15~7.57		0.041	5.8	/	4L	477
	Tianeshan River	2014/10/27-29		5L	/	7.15~7.57		0.041	5.8	/	4L	477
Yangdong Water Supply	Yongle River	2014/10/27	Downstream at Yangdong WTP	5L		7.04		0.092	6.2	/	/	27
		2014/10/28		5L		7.24		0.163	6.2	/	/	24
		2014/10/29		5L		7.58		0.073	6.4	/	/	18
Chukou Water Supply	Chu River		Data not yet received									
Category III				≤20	≤4	6-9	≤0.2	≤1.0	≥5	≤0.05		≤2000

L=refers to a consistent sampling result over several samples e.g. 5L = the value of 5 was obtained in repeated samples.

92. Groundwater quality. Groundwater was sampled near sites proposed for solid waste transfer stations. Quality of the samples complied with GB/T 14848-93 Category III standards (Table V-4). Low pH values at some sites are caused by naturally acid soils (there is no industry nearby).

Table V-4: Baseline Groundwater Quality Monitoring

Item	Unit	Qingyao SWTS	Lianping SWTS	Huangcao SWTS	Longxi SWTS	Dongping SWTS	Chukou SWTS	Category III Standard
pH		6.63	6.37	6.34	6.35	6.67	6.82	6.5~8.5
Total Hardness	(mg/L)	17.2	8.42	7.62	9.62	15.6	6.01	≤450
SO_4^-	(mg/L)	3.94	1.19	2.97	1.11	3.68	2.93	≤250
I_{Mn}	(mg/L)	1.2	0.27	0.89	0.23	2.28	1.35	≤3
NH_3-N	(mg/L)	0.081	0.025L	0.038	0.025L	0.069	0.025L	≤0.2
NO_3-N	(mg/L)	0.34	1.64	0.29	1.85	0.33	0.29	≤20
F-	(mg/L)	0.11	0.09	0.08	0.06	0.11	0.09	≤250
Volatile phenol	(mg/L)	0.0003L	0.0003L	0.0003L	0.0003L	0.0003L	0.0003L	≤0.002
Pb	(mg/L)	0.001L	0.001L	0.001L	0.001L	0.001L	0.001L	≤0.05
As	(mg/L)	3.7×10^{-3}	2×10^{-4}L	1.6×10^{-3}	2×10^{-4}L	2.9×10^{-3}	1.3×10^{-3}	≤0.05
Cr^{6+}	(mg/L)	0.005	0.006	0.008	0.007	0.007	0.004	≤0.05
Total coliform bacteria	(No./L)	<2	<2	<2	<2	<2	<2	≤3

SWTS = solid waste transfer station.

93. Noise. Typically, baseline noise monitoring for environmental impact assessment in the PRC consists of noise level measurements near sensitive receptors once in the day time and once in the night time each day for two consecutive days. Noise levels were monitored at: (i) the boundary of each planned wastewater treatment station (WWTP) site and solid waste transfer station (SWTS), on 17-18 September 2014; and (ii) residential areas and schools near the five rivers planned for dredging and embankment, on 31 October and 1 November 2014, by Zixing City Environmental Monitoring Station (Table V-5). Results show that the noise at the project sites during both daytime and nighttime meet the requirements of Class I of GB3096-2008, appropriate for residential areas and also meet EHS guidelines.

Table V-5: Baseline Noise Monitoring

Monitoring location		**Monitored**				**Applicable emission standard**	
		Day 1		**Day 2**			
		Day	**Night**	**Day**	**Night**	**Day**	**Night**
Qingyao WWTP	1m east of the site boundary	47.6	40.3	47.4	40.1	60	50
	1m south of the site boundary	47.2	39.1	47.2	39.6	60	50
	1m west of the site boundary	46.8	39.9	47.3	39.0	60	50
	1m north of the site boundary	47.9	40.3	47.0	39.1	60	50
Qingyao SWTS	Central of the sites	45.9	39.2	46.0	39.1	60	50
Lianping WWTP	1m east of the site boundary	46.7	38.1	46.4	37.5	60	50
	1m south of the site boundary	47.3	38.4	45.7	38.3	60	50
	1m west of the site boundary	46.6	39.0	46.4	38.6	60	50
	1m north of the site boundary	46.8	39.1	46.9	38.0	60	50
Lianping SWTS	1m east of the site boundary	46.4	39.4	48.5	38.2	60	50
	1m south of the site boundary	46.9	38.5	46.0	37.8	60	50
	1m west of the site boundary	46.7	38.2	45.8	38.2	60	50
	1m north of the site boundary	47.1	37.3	46.3	37.7	60	50
Huangcao WWTP	1m east of the site boundary	47.0	38.2	47.4	37.5	60	50
	1m south of the site boundary	47.9	38.6	46.6	36.5	60	50
	1m west of the site boundary	47.1	38.3	47.0	37.0	60	50

	1m north of the site boundary	47.9	37.4	46.9	37.2	60	50
Longxi WWTP	1m east of the site boundary	46.5	36.7	46.2	36.9	60	50
	1m south of the site boundary	46.2	37.3	46.4	37.3	60	50
	1m west of the site boundary	46.9	37.8	45.7	36.9	60	50
	1m north of the site boundary	46.1	37.3	46.6	36.8	60	50
Longxi SWTS	Near X019	45.2	36.8	45.5	36.5	60	50
Dongping WWTPs	1m east of the site boundary	46.3	36.6	46.9	37.0	60	50
	1m south of the site boundary	45.0	37.4	46.5	36.7	60	50
	1m west of the site boundary	47.8	37.2	47.3	36.9	60	50
	1m north of the site boundary	46.0	37.6	46.7	37.2	60	50
Dongping SWTS	Central of the sites	46.0	37.0	46.4	36.4	60	50
Chukou WWTP	1m east of the site boundary	47.6	40.3	46.6	40.7	60	50
	1m south of the site boundary	47.8	40.0	47.7	39.8	60	50
	1m west of the site boundary	46.6	39.9	47.8	40.5	60	50
	1m north of the site boundary	47.2	39.7	47.3	40.3	60	50
Chukou SWTS	Central of the sites	46.9	39.6	46.6	40.7	60	50
Bailang SWTS	1m east of the site boundary	48.0	39.8	46.7	40.3	60	50
	1m south of the site boundary	48	40.1	47.2	40.2	60	50
	1m west of the site boundary	47.7	40.7	46.8	39.9	60	50
	1m north of the site boundary	47.6	40.1	47.2	40.4	60	50
Yangdong WTP	Yangdong WTP site	46.1	39.3	46.0	38.0	60	50
Qingyao River	Residential areas near the river	53	37.3	52.8	37.9	55	45
Lianping River	Residential areas near the river	47.1	39.3	45.7	39	60	50
Guangqiao River	Residential areas near the river	45.3	40.4	47	40	60	50
Xingning River	Residential areas near the river	52.8	42.8	52	40.9	60	50
Tianeshan River	Residential areas near the river	47.3	41	46.1	39.2	55	45
Zhongdong Fish farm	Zhongdong Fish Farm	47.3	44.0	/	/	60	50
Xingning wetland	Jiangkou of Bailang	45.8	38.6	/	/	60	50
Fish releasing platform	Bailang	46.3	40.6	/	/	60	50
Huangcao wetland	Huangcao Town	46.9	43.7	/	/	60	50

94. Air quality. Sampling of atmospheric environmental quality was conducted by the Zixing Monitoring Station. There is no large industry development in any of the project sites which might cause significant emissions of pollutants. Sampling was conducted at seven sites (Table V-6). Results show that in the project area, the daily average concentration of NO_2, SO_2, PM_{10} and TSP sampled meet the requirements of Category II of *Ambient Air Quality Standards* (GB 3095-2012), and that the ambient levels of NH_3 and H_2S meet the allowable concentration standards in residential areas in *Design Sanitary Standard of Industrial Enterprises* (TJ 36-79). Daitou Village of Qingjiang Town is located in the Dongjiang Scenic Area so the applicable standard is Category I. The PM_{10} monitored at Daitou Village does not meet the requirements of Category I.

Table V-6: Results of Air Quality Sampling

Sub-component	No.	Date	Location	Parameter						Standard
				SO_2	NO_2	H_2S	NH_3	PM_{10}	TSP	GB3095 - 2012
				24-hour average (mg/m^3)						
1.1-Qingyao WWTP; 1.2-Qingyao SWTS; 3.1 Qingyao River Rehabilitation	G1	2014.9.15-2014.9.21	Chenji	0.007 -0.011	0.004 -0.008	0.002 -0.003	0.02-0.03	0.073 -0.097	-	II
1.1-Qingjiang WWTP; 1.2 Qingjiang SWTS	G2	2014.9.15-2014.9.21	Daitou Village	0.007 -0.009	0.004 -0.007	0.002	0.02-0.03	0.072 -0.094	-	I
1.1-Longxi WWTP; 1.2 Longxi SWTS	G3	2014.9.15-2014.9.21	Longxi Middle School	0.007 -0.012	0.005 -0.007	0.002 -0.003	0.02-0.03	0.078 -0.094	-	II
1.1-Dongping WWTP; 1.2 Dongping SWTS	G4	2014.9.15-2014.9.21	Zhoutang Village	0.007 -0.011	0.005 -0.007	0.002 -0.003	0.02-0.03	0.078 -0.09	-	II
1.1-Chukou WWTP; 1.2	G5	2014.9.15-	Jinxing	0.005	0.005	0.002	0.02-	0.08	-	II

Sub-component	No.	Date	Location	Parameter						Standard
				SO_2	NO_2	H_2S	NH_3	PM_{10}	TSP	GB3095 -
Chukou SWTS; 2.2 Chukou Water Supply		2014.9.21	Village	-0.012	-0.009	-0.003	0.03	-0.095		
2.1-Yangdong WS	G6	2014.10.27-2014.11.2	Pengshi County	-	0.007 -0.024	-	-	-	0.112 - 0.126	II
4.1 Xingning Wetland	G7	2014.9.15-2014.9.21	Taiqian Village	0.005 -0.009	0.005 -0.008	0.002 -0.003	0.02-0.03	0.087 -0.096	-	II
GB 3095-2012	*Class I*			*0.05*	*0.08*			*0.035*	*0.12*	
	Class II			*0.15*	*0.08*			*0.15*	*0.3*	
TJ 36-79[5]						*0.01*	*0.2*			

SWTS=solid waste transfer station, WWTP=wastewater treatment plant.

95. Soil. Guangdian Metering and Testing (Hunan) Limited Company was contracted to sample the soil quality for the proposed sites of WWTPs and SWTSs. Samples were taken in October 2014. Results show that the cadmium content at Qingyao, Dongping and Chukou, and arsenic contents at Huangcao and Chukou, exceed Class II of Environmental Quality Standard for Soils (GB 15168-1995) (Table V-7). There is no industry development in the project area. Chenzhou Municipality is rich in metal resources and high background metal content is natural.

Table V-7: Results of Soil Quality Monitoring (Unit: Mg/Kg, Ph: Dimensionless)

Monitoring location	Distance to planned sites	Parameters monitored							
		pH	Cu	Zn	Cd	As	Cr	Hg	Pb
Chenjia of Qingyao Town	600 m	5.24	24.1	127	0.342	15.9	67.7	0.186	49.7
Shanglian Vill., Lianping Town	1000 m	5.5	26.5	103	0.236	16.2	87.7	0.127	38.1
Daitou Vill., Qingjiang Town	50 m	5.8	41.6	146	0.248	38.3	125	0.279	48.2
Huangcao Town Gov. building	200 m	6.15	41.6	183	0.140	58.3	117	0.118	54.9
Huangcao Hospital	300 m	5.74	19.9	118	0.122	20.7	88.1	0.134	50.5
Qiaotou of Longxi Town	100 m	6.65	40.6	157	0.284	17.8	95.2	0.196	31.5
Longxi Middle School	50 m	7.35	25.3	95.5	0.208	18.9	73.5	0.131	29.0
Zhoutang Vill., Dongping Town	400 m	7.46	32.3	133	0.322	9.03	101	0.28	36.0
Chukou Town Gov. Building	<1000 m	7.11	29.8	113	0.708	21.9	28.6	0.083	98.2
Jinxing Village, Chukou	<1000 m	6.75	17.4	64.1	0.184	47.4	49.0	0.178	41.2
Taiqian Village, Bailang Town	<1000 m	7.07	19.9	83.7	0.191	21.5	167	0.134	25.2
Bailang port	<1000 m	7.35	40.6	54.3	0.050	13.2	116	0.072	34.5
Class II of GB15618-1995 (≤)		6.5	100	200	0.30	40	250	0.30	250

96. Sediment. The PRC does not have a standard for sediment in waterways such as streams, rivers, lakes, reservoirs and the sea. It is common practice in the PRC to use Environmental Quality Standard for Soils (GB 15168-1995) to assess sediment quality since most sediment would be disposed on land and mostly likely for future agricultural or planting uses. In-channel sediment samples were taken by Zixing City Environmental Monitoring Station in October 2014 for the five rivers which will be dredged and embanked. Results show that the contents of cadmium and arsenic exceed Class II standards (Table V-8). Except for Xingning River, which flows through the built-up area of Xingning town, the other four rivers are in rural locations and one (Tianeshan) is located in a reserve, Tianeshan National Forestry Park. High background levels of cadmium and arsenic are natural in the area, and which is also reflected in the results of the soil sampling.

Table V-8: Sediment Monitoring Results

River	Monitored items	Monitoring results	Class II (PH6.5-7.5)	Class II (PH>7.5)
Qingyao River	pH	7.59		7.59
	Cu	26.5	100	100
	Zn	214	250	300

[5] Design sanitary standard of Industrial Enterprises

	Cd	**2.57**	**0.3**	**0.6**
	As	**44.6**	**25**	**20**
	Cr	48.1	300	350
	Hg	0.156	0.5	1
	Pb	81.4	300	350
	Ni	36.1	50	60
	BHC	0.49×10^{-4}	0.5	0.5
	DDT	6.07×10^{-2}	0.5	0.5
Lianping River	pH	7.63		
	Cu	34.6	100	100
	Zn	239	250	300
	Cd	**0.99**	**0.3**	**0.6**
	As	**130**	**25**	**20**
	Cr	64.1	300	350
	Hg	0.038	0.5	1
	Pb	65	300	350
	Ni	47.7	50	60
	BHC	0.49×10^{-4}	0.5	0.5
	DDT	2.76×10^{-2}	0.5	0.5
Guangqiao River	pH	7.48		
	Cu	16.5	100	100
	Zn	136	250	300
	Cd	**0.32**	**0.3**	**0.6**
	As	20.5	25	20
	Cr	18	300	350
	Hg	0.073	0.5	1
	Pb	59.6	300	350
	Ni	31.8	50	60
	BHC	0.49×10^{-4}	0.5	0.5
	DDT	3.15×10^{-2}	0.5	0.5
Xingning River	pH	7.81		
	Cu	83.4	100	100
	Zn	166	250	300
	Cd	**0.87**	**0.3**	**0.6**
	As	**50.4**	**25**	**20**
	Cr	78.1	300	350
	Hg	0.526	0.5	1
	Pb	106.9	300	350
	Ni	44.8	50	60
	BHC	0.49×10^{-4}	0.5	0.5
	DDT	7.15×10^{-2}	0.5	0.5
Tianeshan River	pH	7.35		
	Cu	33.8	100	100
	Zn	177	250	300
	Cd	**0.75**	**0.3**	**0.6**
	As	**99.8**	**25**	**20**
	Cr	66.2	300	350
	Hg	0.056	0.5	1
	Pb	56.2	300	350
	Ni	47.3	50	60
	BHC	0.49×10^{-4}	0.5	0.5
	DDT	0.17×10^{-3}	0.5	0.5

C. Ecological Resources

1. Overview

97. Dongjiang Lake basin supports a range of species, as well as rare, threatened, and/or protected flora and fauna species.

98. **Vegetation and flora.** The original vegetation in the Dongjiang Lake basin was subtropical evergreen broad-leaved forest, although little intact forest remains. Forest coverage is 72%, which comprises: (i) cultivated vegetation – bamboo forest, economic forest, cultivated crops, fruit forest, Chinese fir and shrubs, in valleys and low hills; (ii) secondary coniferous, mixed broadleaved, and planted forests, between 500-800 m; (iii) natural coniferous, mixed broadleaved, and planted forest, from 800-1000 m; (iv) natural evergreen and deciduous broad-leaved mixed forest, from 1,000-1,600m and pine forest formed by aerial seeding in 1970s; and (v) meadow located at high mountains, above 1,600m (Fig. V-4). The largest remaining intact natural vegetation are scattered patches on steep hill slopes.

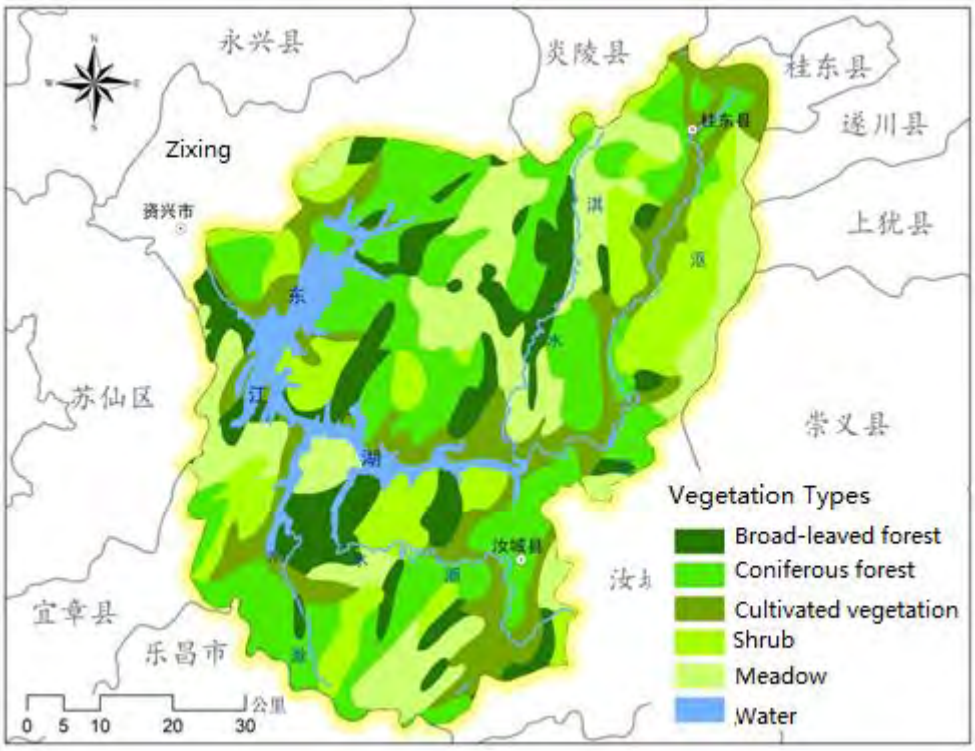


Figure V-4: Vegetation Distribution in Dongjiang Lake Basin

99. There are 1,246 seed plant species recorded in the Dongjiang Lake area, belonging to 541 genera of 146 families, including 1,057 terrestrial species and 189 wetland species. At least 17 national protected flora species occur: five Grade I species (*Cathaya argyrophylla, Metasquoia glyptostroboides, Ginkgo biloba, Taxus wallichiana var. mairei and Bretschneidera sinensis*) and 12 Grade II species (*Cephalotaxus oliveri, Eurycorymbus cavaleriei, Emmenoptery henryi, Magnolia officinalis, M. officinalis subsp. Biloba, Glycine soja, Cinnamomum camphora, Ormosia henryi, Fagopyrum dibotrys, Zelkova schneideriana, amptotheca acuminate and Cibotium barometz*). In addition, there are 21 orchid species protected by convention on International Trade in Endangered Spices of Wild Fauna and Flora (CITES), such as *Anoectochilus roxburghii, Dendrobium falconeri, Cymbidium ensifolium*.[6] The full list is given in Table V-9.

Table V-9: Protected Wild Flora Species in Dongjiang Lake Basin

No.	Chinese Name	Scientific Name	Status
1	银杏	*Ginkgo biloba L.*	CP.I
2	银杉	*Cathaya argyrophylla* Chun et Kuang	CP.I

[6] Liu Keming *etal*., Dongjiang Lake Wetland Flora Investigation Report (2005)

3	水杉	*Metasequoia glyptostroboides* Hu et Cheng	CP.I
4	南方红豆杉	*Taxus wallichiana* Zucc. var. *mairei*	CP.I
5	伯乐树	*Bretschneidera sinensis* Hemsl.	CP.I
6	樟树	*Cinnamomum camphora* (L.) Presl.	CP.Ⅱ
7	喜树	*Camptotheca acuminate* Decne	CP.Ⅱ
8	金荞麦	*Fagopyrum dibotrys* (D.Don) Hara	CP.Ⅱ
9	野大豆	Glycine soja Sieb. et Zucc.	CP.Ⅱ
10	篦子三尖杉	*Cephalotaxus oliveri* Mast.	CP.Ⅱ
11	伞花木	*Eurycorymbus cavaleriei* Rehd. et H.-M.	CP.Ⅱ
12	香果树	*Emmenoptery henryi* Oliv.	CP.Ⅱ
13	厚朴	*Magnolia officinalis* Rehd. et Wils.	CP.Ⅱ
14	凹叶厚朴	*M. officinalis*.ssp. *Biloba*(Rehd. et Wils.) Law	CP.Ⅱ
15	花榈木	*Ormosia henryi* Prain Prain	CP.Ⅱ
16	榉树	*Zelkova schneideriana* H.-M.	CP.Ⅱ
17	金毛狗	*Cibotium barometz*(L.)J. Sm.	CP.Ⅱ
18	花叶开唇兰	*Anoectochilus roxburghii* (Wall.) Lindl	CITES II
19	白芨	*Bletilla striata* (Thunb. Ex A. Murray) Rchb. f.	CITES II
20	剑叶虾脊兰	*Calanthe davidii* Franch.	CITES II
21	反瓣虾脊兰	*C.reflexa* (Kuntze) Maxim	CITES II
22	长距虾脊兰	*Calanthe* sylvatica (Thou.) Lindl.	CITES II
23	杜鹃兰	*Cremastra appendiculata* (D. Don) Makino	CITES II
24	建兰	*Cymbidium ensifolium* (L.) Sw.	CITES II
25	蕙兰	*C.faberi Rolfe*	CITES II
26	多花兰	*C.floribundum* Lindl.	CITES II
27	春兰	*C.goeringii* （Rchb. f.）Rchb. f.	CITES II
28	寒兰	*C.kanran Makino*	CITES II
29	扇脉杓兰	*Cypripedium japonicum* Thunb.	CITES II
30	串珠石斛	*Dendrobium falconeri* Hook	CITES II
31	细茎石斛	*D.moniliforme* (L.) Sw	CITES II
32	斑叶兰	*Goodyera schlechtendaliana* Rchb. f.	CITES II
33	鹅毛玉凤花	*Habenaria dentata* (Sw.) Schltr.	CITES II
34	见血清	*Liparis nervosa* (Thunb.) Lindl.	CITES II
35	斑叶鹤顶兰	*Phaius flavus* (Bl.) Lindl.	CITES II
36	细叶石仙桃	*Pholidota cantonensis* Rolfe	CITES II
37	独蒜兰	*Pleione bulbocodioides* (Franch.) Rolfe	CITES II
38	绶草	*Spiranthes sinensis* (Pers.) Ames	CITES II

Note: CP-PRC national protected; CITES: Convention on International Trade in Endangered Spices of Wild Fauna and Flora. Source: Liu Keming *etal*., Dongjiang Lake Wetland Flora Investigation Report (2005)

100. **Fish, amphibians, reptiles, birds and mammals.** According to a fauna survey by the Chinese Academy of Science in 1984 and Hunan Normal University during 1990-1991, 2005, the following have been recorded in the Dongjiang Lake area: 74 fish species (15 families), 26 reptiles (8 families), 17 amphibians (7 families), 87 birds (29 families) and 20 terrestrial mammals (13 families). A total of 220 vertebrates have been recorded in Dongjiang Lake Basin, including 11 Grade II national protected wild fauna species (1 amphibian, 1 mammal, 9 bird species), 101 “valuable” (high economic/scientific values) species, 14 CITES-listed species (1 amphibian, 3 mammals, 10 birds), and four endangered species (Tables V-10 to V-14).[7]

[7] Deng Jianguo etal. Wild fauna investigation report for Dongjiang Lake Basin.

Table V-10: Fish Species Recorded in Dongjiang Lake

No.	Species Name	Status
	鲤形目 CYPRINIFORMES	
1	宽鳍鱲 *Zacco platypus*	
2	马口鱼 *Opsariichthys bidens*	
3	青鱼 *Mylopharyngodon piceus**	
4	草鱼 *Ctenopharyngodon idellus**	
5	赤眼鳟 *Squaliobarbus curriculus*	
6	粲条 *Hemiculter leucisculus*	
7	鳊鱼 *Parabramis pekinensis*	
8	红鳍鲌 *Cuiter erythropterus*	
9	南方拟粲 *Pseudohemiculter dispar*	
10	鲂 *Megalobrama terminalis**	
11	华鳊 *Sinibrama wui*	
12	翘嘴红鲌 *Erythroculter ilishaeformis*	
13	蒙古红鲌 *Erythroculter mongolicus*	
14	细鳞斜颌鲴 *Plagiognathops microlepis*	
15	黄尾鲴 *Xenocypris davidi**	
15	银鲴 *Xenocypris argentea**	
16	圆吻鲴 *Distoechodon tumirostris*	
17	中华鳑鲏 *Rhodeus sinensis*	
18	大鳍刺鳑鲏 *Acanthorhodeus macropterus*	
19	高体鳑鲏 *Rhodeus ocellatus*	
20	彩石鲋 *Pseudoperilampus lighti*	
21	刺鲃 *Spinibarbus caldwelli*	
22	中华倒刺鲃 *Spinibarbus sinensis*	HBES
23	侧条厚唇鱼 *Acrossocheilus parallens*	
24	半刺厚唇鱼 *Acrossocheilus hemispinus*	
25	白甲鱼 *Varicorhinus simus*	HBES
26	稀有白甲鱼 *Varicorhinus*	HBES
27	小口白甲鱼 *Varicorhinus lini*	
28	粗须铲颌鱼 *Varicorhinus barbatus*	
29	瓣结鱼 *Tor(Folifer)brevifilis*	HBES
30	麦穗鱼 *Pseudorasbora parva*	
31	黑鳍鲹 *Sarcocheilichthys nigripinnis*	
32	棒花鱼 *Abbottina rivularis*	
33	光唇蛇鮈 *Saurogobio gymnocheilus*	
34	花鲭 *Hemibarbus maculatus*	
35	重唇鲭 *Hemibarbus labeo*	
36	似鮈 *Psendogobio vaillanti*	
37	鲤鱼 *Cyprinus carpio**	
38	鲫鱼 *Carassius auratus*	
39	鳙鱼 *Aristichthys nobilis**	
40	鲢鱼 *Hypophthalmichthys molitrix**	
41	鳅科 *Cobitidae*	
42	花鳅 *Cobitis taenia*	
43	泥鳅 *Misgurnus anguillicaudatus*	
44	大鳞泥鳅 *Misgurnus mizolepis*	
45	短体条鳅 *Nemachilus potanini*	
46	花斑沙鳅 *Botia fasciata*	
47	平鳍鳅科 *Homalopteridae*	
48	毛缘犁头鳅 *Lepturichthis fimbriata*	
49	平舟前台口鳅 *Pareformosania pingchowensis*	
	鲿形目 SILURIFORMES	
50	鲿鱼 *Silurus asotus*	
51	胡子鲿 *Clarias batrachus*	HBES
52	鲿科 *Bagridae*	
53	黄颡鱼 *Pelteobagrus fulvidraco*	
54	鳠 *Hemibagrus macropterus*	
55	切尾似鲿 *Pseudobagrus truncates*	
56	长吻鮠 *Leiocassis longirostris*	
57	鱼妖科	
58	拟缘鱼央 *Leiobagrus marginatoides*	
	鳉形目 CYPRINODONTIFORMES	
59	胎鳉科 *Poeciliidae* 青鳉 *Oryzias latipes*	
	合鳃鱼目 SYMBRANCHIFORMES	
60	黄鳝 *Monopterus albus*	
	鲈形目 PERCIFORMES	
61	暗鳜 *Siniperca obscura*	HBES
62	大眼鳜 *Siniperca kneri*	
63	鳜 *Siniperca chuatsi*	
64	斑鳜 *Siniperca scherzeri*	
65	长身鳜 *Coreasiniperca roulei*	HBES
66	黄鲇鱼 *Hypseleotris*	
67	吻虾虎 *Rhinogobius giurinus*	
68	克氏虾虎 *Rhinogobius cliffordpopei*	
69	叉尾斗鱼 *Macropodus opercularis*	HBES
70	乌鳢 *Ophiocephalus argus*	
71	斑鳢 *Ophiocephalus maculates*	
72	月鳢 *Channa asiatica*	HBES
73	刺鳅 *Mastacembelus aculeatus*	
74	大刺鳅 *Mastacembelus armatus*	

'Status' = protection status. * = species to be stocked in the lake by the project. See footnote for Table V-14 for key to other codes.

Table V-11: Amphibians Recorded in Dongjiang Lake Basin

Species Name	Status
有尾目 CAUDATA	
蝾螈科 *Salamandridae*	
无斑肥螈 *Pachytriton labiatus*	HBES
无尾目 ANURA	
锄足蟾科 *Pelobatidae*	

小角蟾 *Megophrys minor*	HBES
蟾蜍科 *Bufonidae*	
中华蟾蜍 *Bufo gargarizans*	HBES
黑眶蟾蜍 *Bufo melanostictus*	HBES
雨蛙科 *Hylidae*	
三港雨蛙 *Hyla sanchiangnensis*	HBES
蛙科 *Ranidae*	
日本林蛙 *Rana japonica*	
黑斑蛙 *Rana nigromaculata*	HBES
沼蛙 *Rana guentheri*	HBES
泽蛙 *Rana limnocharis*	HBES
虎纹蛙 *Rana rugulosa*	CPII, CITE II, EN
花臭蛙 *Rana schmackeri*	HBES
棘胸蛙 *Rana spinosa*	HBES
华南湍蛙 *Amolops ricketti*	HBES
树蛙科 *Rhacophridae*	
斑腿树蛙 *Rhacophorus megacephalus*	HBES
大树蛙 *Rhacophorus dennysi*	HBES
姬蛙科 *Microhylidae*	
小弧斑姬蛙 *Microhyla heymonsi*	HBES
饰纹姬蛙 *Microhyla ornata*	HBES

Table V-12: Reptiles Recorded in Dongjiang Lake Basin

Species Name	**Status**
龟鳖目 TESTUDINATA	
鳖科 *Trionychidae*	
中华鳖 *Pelodiscus sinensis*	HBES
龟科 *Emydida*	
乌龟 *Chinemys reevesii*	HBES
有鳞目 SQUAMATA	
壁虎科 *GEKKONIDAE*	
多疣壁虎 *Gekko japonicus*	HBES
蜥蜴科 *Lacertidae*	
北草蜥 *Takydromus septentrionalis*	HBES
石龙子科 *Scincidae*	
中国石龙子 *Eumeces chinensis*	HBES
蓝尾石龙子 *Eumeces elegans*	NBES
蝾蜓 *Sphenomorphus indicus*	HBES
游蛇科 *Colubridae*	
钝尾两头蛇 *Calamaria septentrionalis*	HBES
翠青蛇 *Cyclophiops major*	HBES
赤链蛇 *Dinodon rufozonatum*	HBES
王锦蛇 *Elaphe carinata*	HBES
红点锦蛇 *Elaphe rufodorsata*	HBES
黑眉锦蛇 *Elaphe taeniura*	HBES
中国水蛇 *Enhydris chinensis*	HBES
黑背白环蛇 *Lycodon* ruhstrati	HBES
山溪后棱蛇 *Opisthotropis latouchii*	HBES
灰鼠蛇 *Ptyas korros*	HBES
虎斑游蛇 *Natrix tigrina*	HBES
环纹华游蛇 *Sinonatrix aequifasciata*	HBES
华游蛇 *Sinonatrix percarinata*	HBES

乌梢蛇 *Zaocys dhumnades*	HBES
眼镜蛇科 Elapidae	
银环蛇 *Bungarus multicinctus*	HBES
蝰科 *Viperidae*	
蝮蛇 *Gloydius brevicaudus*	HBES
尖吻蝮 *Deinagkistrodon acutus*	HBES
烙铁头 *Protobothrops mucrosquamatus*	HBES
竹叶青蛇 *Trimeresurus stejnegeri*	HBES

Table V-13: Birds Recorded in Dongjiang Lake Basin

Species	Status
鸊鹈目 PODICIPEDIFORMES	
鸊鹈科 *Podicipedidae*	
小鸊鹈 *Tachybaptus ruficollis*	HBES
鹳形目 CICONIIFORMES	
鹭科 *Ardeidae*	
苍鹭 *Ardea cinerea*	HBES
绿鹭 *Butorides striatus*	HBES,JBES
池鹭 *Ardeola bacchus*	HBES
白鹭 *Egretta garzetta*	CITEIII, NBES
夜鹭 *Nycticorax nycticorax*	HBES,JBES
雁形目 ANSERIFORMES	
鸭科 *Anatidae*	
绿翅鸭 *Anas crecca*	CITE III, NBES,JBES
花脸鸭 *Anas Formosa*	CITE II, NBES,JBES
鸳鸯 *Aix galericulata*	CPⅡ,EN
隼形目 FALCONIFORMES	
鹰科 *Accipitridae*	
赤腹鹰 *Accipiter soloensis*	CPⅡ,CITE III
雀鹰 *Accipiter nisus*	CPⅡ,CITE II
松雀鹰 *Accipiter virgatus*	CPⅡ,CITE II
普通鵟 *Buteo buteo*	CPⅡ,CITE II
蛇雕 *Spilornis cheela*	CPⅡ,CITE II,EN
隼科 *Falconidae*	
红隼 *Falco tinnunculus*	CPⅡ
鸡形目 GALLIFORMES	
雉科 *Phasianidae*	
灰胸竹鸡 *Bambusicola thoracica*	HBES
白鹇指名亚种 *Lophura nycthemera*	CPⅡ
勺鸡 *Pucrasia macrolopha*	CPⅡ
环颈雉 *Phasianus colchicus*	Hunan province
鹤形目 GRUIFORMES	
秧鸡科 *Rallidae*	
白胸秧鸡 Amaurornis phoenicurus	HBES
董鸡 *Gallicrex cinerea*	HBES,JBES
黑水鸡 *Gallimula chlropus*	HBES,JBES
鸻形目 CHARADRIIFORMES	
鸻科 *Charadriidae*	
凤头麦鸡 *Vanellus vanellus*	HBES,JBES
鹬科 *Scolopacidae*	
青脚鹬 *Tringa nebularia*	NBES
白腰草鹬 *Tringa ochropus*	HBES,JBES
林鹬 *Tringa glareola*	JBES,JBES,ABES
矶鹬 *Tringa hypoleucos*	HBES,JBES,ABES
扇尾沙锥 *Gallinago gallinago*	HBES,JBES
丘鹬 *Scolopax rusticola*	HBES,JBES
鸽形目 COLUMBIFORMES	
鸠鸽科 *Columbidae*	
山斑鸠 *Streptopelia orientalis*	HBES
珠颈斑鸠 *Streptopelia chinensis*	HBES
鹃形目 CUCULIFORMES	
杜鹃科 *Cuculidae*	
鹰鹃 *Cuculus sparverioides*	HBES
四声杜鹃 *Cuculus micriopterus*	HBES
大杜鹃 *Cuculus canorus*	HBES,JBES
鸮形目 RTRIGIFORMES	
草鸮科 *Tytonidae*	
草鸮 *Tyto capensis*	
鸱鸮科 *Strigidae*	
红角鸮 *Otus scops*	
斑头鸺鹠 *Glaucidium cuculoides*	
夜鹰目 CAPRIMULGIFORMES	
夜鹰科 *Caprimulgidae*	
普通夜鹰 *Caprimulgus indicus*	HBES,JBES
佛法僧目 CORACIIFORMES	
翠鸟科 *Alcedinidae*	
冠鱼狗 *Ceryle lugubris*	
普通翠鸟 *Alcedo atthis*	HBES
蓝翡翠 *Halcyon pileata*	HBES
鴷形目 PICIFORMES	
啄木鸟科 *Picidae*	
斑姬啄木鸟 *picumnus innominatus*	HBES
绿啄木鸟 *Picus canus*	HBES
大斑啄木鸟 *Picoides major*	HBES
雀形目 PASSERIFORMES	
百灵科 *Alaudidae*	
小云雀 *Alauda gulgula*	NBES
燕科 *Hirundinidae*	
家燕 *Hirundo rustica*	HBES,JBES,ABES
金腰燕 *Hirundo daurica*	HBES,JBES
鹡鸰科 *Motacillidae*	
灰鹡鸰 *Motacilla cinerea*	ABES
白鹡鸰 *Motacilla alba*	JBES,ABES
树鹨 *Anthus hodgsoni*	JBES
鸭科 *Pycnonotidae*	
领雀嘴鹎 *Spizixos semitorques*	HBES
白头鹎 *Pycnonotus sinensis*	HBES
伯劳科 *Laniidae*	

棕背伯劳 *Lanius schach*	HBES
椋鸟科 *Sturnidae*	
灰椋鸟 *Sturnus cineraceus*	NBES
八哥 *Acridotheres cristatellus*	HBES
鸦科 *Corvidae*	
松鸦 *Garrulus glandarius*	Hunan Provincially
红嘴蓝鹊 *Urocissa erythrorhyncha*	HBES
河乌科 *Cincldae*	
褐河乌 *cinclus pallasii*	
鹪科 *Muscicapidae*	
鹊鸲 *Copsychus saularis*	HBES,JBES
北红尾鸲 *Phoenicurus auroreus*	JBES
红尾水鸲 *Rhyacornis fuliginosus*	
灰背燕尾 *Enicurus schistaceus*	Hunan Provincially
乌鶇 *Turdus merula*	Hunan Provincially
斑鶇 *Turdus naumanni*	HBES,JBES
画眉亚科 *Timaliinae*	
棕颈钩嘴鹛 *Pomatorhinus ruficllis*	Hunan Provincially
红头穗鹛 *Stachyris ruficeps*	
黑领噪鹛 *Garrulax pectoralis*	HBES
画眉 *Garrulax canorus*	CITE II,NBES
白颊噪鹛 *Garrulax sannio*	NBES
红嘴相思 *Leiothrix lutea*	CITE II,NBES

灰眶雀鹛 *Alcippe morrisonia*	
棕头鸦雀 *Paradoxornis webbianus*	
黄眉柳莺 *Phylloscopus inornatus*	JBES
黄腰柳莺 *Phylloscopus proregulus*	HBES,JBES
强脚树莺 *Cettia fortipes*	
褐头鷦莺 *Prinia subflava*	
乌鹟 *Muscicapa sibirica*	JBES
山雀科 *Paridae*	
大山雀 *Parus major commixtus*	HBES
黄腹山雀 *parus venustulus*	HBES
红头长尾山雀 Aegithalos concinnus	HBES
绣眼科 *Zosteropidae*	
暗绿绣眼 *Zosterops japonica*	HBES
文鸟科 *Ploceidae*	
树麻雀 *Passer montanus*	HBES
白腰文鸟 *Lonchura striata*	
雀科 *Fringillidae*	
金翅 *Carduelis sinica*	HBES
黑尾蜡嘴 *Eophona migratoria*	HBES,JBES
三道眉草鹀 *Emberiza cioides*	HBES,JBES

Table V-14: Mammals Recorded in Dongjiang Lake Basin

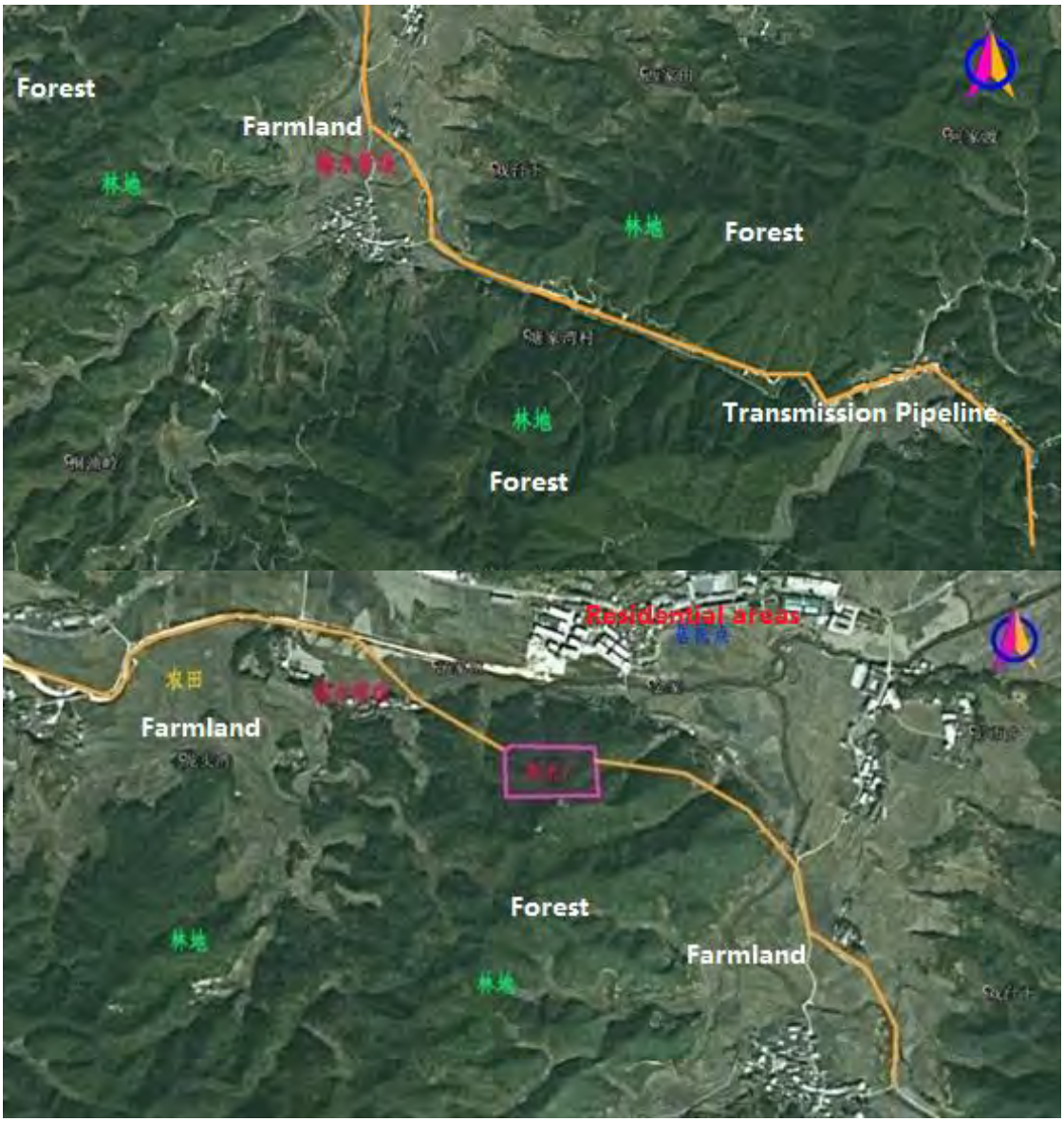
Species	Status
食虫目 INSECTIVORA	
猬科 *Erinaceidae*	
普通刺猬 *Erinaceus europaeus*	HBES
鼩鼱科 *Soricidae*	
臭鼩 *Suncus murinus*	
鼹科 *Talpidae*	
缺齿鼹 *Mogera robusta*	
翼手目 CHIROPTERA	
菊头蝠科 *Rhinolophidae*	
马铁菊头蝠 *Rhinolophus ferrumequinum*	Hunan Provincially
菊头蝠 *Rhinolophus pearsonii*	Hunan Provincially
蝙蝠科 *Vespertilionidae*	
普通伏翼 *Pipistrellus* abramus	Hunan Provincially
兔形目 LAGOMORPHA	
兔科 *Leporidae*	
华南兔 *Lepus sinensis sinensis*	Hunan Provincially
啮齿目 RODENTIA	
松鼠科 *Sciuridae*	
红腹松鼠 *Callosciurus erythraeus*	Hunan Provincially
隐纹花松鼠 *Tamiops swinhoei*	Hunan Provincially
鼠科 *Muridae*	
黑家鼠 *Rattus rattus*	
黄胸鼠 *Rattus flavipectus*	
褐家鼠 *Rattus norvegicus*	
小家鼠 *Mus musculus*	
食肉目 CARNIVORA	

鼬科 *Mustelidae*	
黄鼬 *Mustela sibirica*	CITE III,NBES, EN, IUCN
鼬獾 *Melogale moschata*	HBES
灵猫科 *Viverridae*	
花面狸 *Paguma larvata*	CITE III,NBES, EN
猫科 *Felidae*	
豹猫 *Felis bengalensis*	CITE II, NBES, EN
偶蹄目 ARTIODACTYLA	
猪科 *Suidae*	
野猪 *Sus scrofa*	HBES
鹿科 *Cervidae*	
小麂 *Muntiacus reevesi*	HBES
水鹿 *Cervus unicolor*	CP Ⅱ

Note: HBES: Hunan provincially protected wild fauna species with beneficial, economic and scientific research value; NBES: nationally protected wild fauna species with beneficial, economic and scientific research value; ABES: Australia protected BES; JBES: Japanese protected BES; EN=endangered in China Red Data Animal List; IUCN: International Union for Conservation Nature; CP: PRC national protected; CITE: convention on International Trade in Endangered Spices of Wild Fauna and Flora; CITE II: species are species that are not necessarily threatened with extinction, but may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with the survival of the species in the wild; CITE III: species that are listed after one member country has asked other CITES Parties for assistance in controlling trade in a species.

2. Rural–Urban Water Supply Component

101. Based on a field survey conducted by the EIA institute in December 2014, desktop review, and interviews with residents and forestry bureau staff, the water supply component will extend over forest, grassland, agriculture, wetland, and towns (Fig. V-4).




Farmland
居民点
输水管线
居民点
居民点
Residential areas
居民点


Forest
林地
农田
Farmland
Forest
林地

Figure V-4a: Biological environmental of Yangdong Water Supply subcomponent

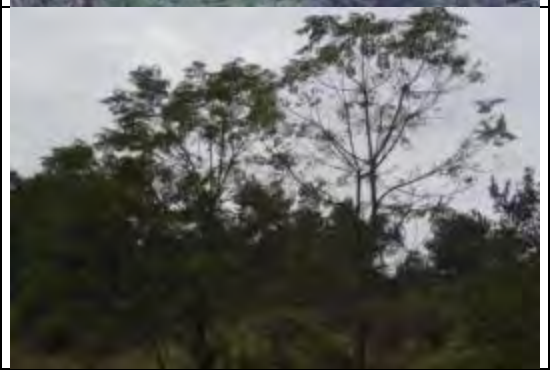
Figure V-5b: Biological environmental of Chukou Water Supply subcomponent

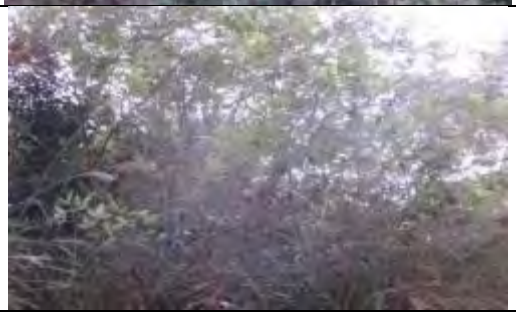
102. Vegetation and flora. Little if any primary or mature secondary vegetation remains in the project sites, especially around Dongjiang Lake. Existing vegetation is mainly planted fir forest, bamboo forest, pine, shrubs and cultivated plants. The main crops in the project area are rice, corn, sweet potatoes and soybean (Table V-15). The main fruit specie is citrus. The field survey did not record any protected species. One old sweet gum tree ("Liquid amber") was found. It is 15 m away from the proposed Xingning-Hejiashan water pipeline.

Name: "Liquid amber"
Age: unknown; estimated 220 years
Height: 30m
Diameter: 80cm
Location: S322 road (E113°26′08″, N25°58′45″, elevation: 293m)

Figure V-6: *Liquidambar* found in the assessment area

Table V-15: Major Terrestrial Vegetation Types in the Assessment Area of Water Supply Component

Vegetation Type	Dominate species	Distribution	Site photos
Coniferous forest	Pine *Pinus massoniana*	Xingning water distribution station, along transmission pipeline from Zhoumensi town to Yangdong WTP	
	Chinese fir *Cunninghamia lanceolata*	Widely distributed	
Broadleaf forest	Neem *Melia azedarach*	Roadside or scattered near villages	

Vegetation Type	Dominate species	Distribution	Site photos
Planted bamboo forest	Bamboo *Phyllostachys pubescens*	Widely distributed	
	Chinese cane *Indocalamus tessellatus*	Along transmission pipelines to Boshui country	
Shrub	Firethorn *Rhus chinensis*	WTP and along transmission pipelines	
	Vitex *Vitex negundo*	WTPs, Chukou transmission pipeline and roadside	

Vegetation Type	Dominate species	Distribution	Site photos
	Paper mulberry *Broussonetia papyrifera*	Scattered on river bank and roadside	
Grassland	Fern *Dicranopteris linearis*	Widely distributed	
	Sword grass *Miscanthus floridulus*	Widely distributed	

Vegetation Type	Dominate species	Distribution	Site photos
	Imperata grass *Imperata cylindrical*	Widely distributed	
	Foxtail *Setaria viridis*	Widely distributed on roadside, river bank and wetland	
Economic forest	Chinese fir, camphor, paulownia, bamboo, poplar, eucalyptus, etc	Scattered along transmission pipeline	

Vegetation Type	Dominate species	Distribution	Site photos
Economic and fruit forest	Citrus, tea, laurel, etc.	Scattered along transmission pipeline.	
Food crops	Rice, corn, sweet potato, soybean, etc.	Widely distributed	
Economic crops	Sugar cane, peanut, rape, etc.		

103. Terrestrial fauna. Site visits in the area for the water supply document were conducted by the EIA institute in December 2014. Interviews with residents, combined with incidental sightings, yielded a list of 133 terrestrial vertebrate species (Table V-16), of which 105 are on the Hunan Provincial protection list. All species are already known from the area (see previous tables). Despite the provincial listing, most of these species are widespread. There are no confirmed records of threatened species from the project sites.

Table V-16: Terrestrial Vertebrates in the Project Area of Water Supply Component

Class	Order	Family	Species	Protection Level		
				State Grade I	State Grade II	Hunan Provincial Level
Amphibia	2	7	13	0	0	13
Reptilia	2	9	25	0	0	24
Aves	12	29	75	0	0	54
Mammalia	6	12	20	0	0	14
Total	22	57	133	0	0	105

3. River Rehabilitation Component

104. The EIA institute contracted Wuhan Yimeijing Technology Limited Company to conduct biological resources survey in November 2014. Natural vegetation is well developed along the riverside. Dominant land categories along the riverbanks are forestry and shrubland (40.88% and 35.25% respectively) (Table V-17).

Table V-17: Current land use of the assessment area for river rehabilitation component

Land use type	Area (ha)	Patch	% of area	% of number of patches
Forest	456.48	1387	40.88%	39.78%
Shrubland	393.62	757	35.25%	21.71%
Farmland	204.17	931	18.28%	26.70%
Waters	18.52	93	1.66%	2.67%
Developed land	43.97	319	3.94%	9.15%
Total	1116.76	3487	100.00%	100.00%

a) Guangqiao River-Section A

b) Guangqiao River Section B

c) Lianping River-Shanglian Section

d) Lianping River-Tianping Section

e) Tianeshan River

f) Xingning River

Figure V-7: Land Cover of Riverside of Five Selected Rivers

105. Natural vegetation comprises 67% (forest and wetland) of riverbanks and adjacent lands (Tables V-18 to V-20). A total of three state Grade II protected species were found, Camphor, *Fagopyrum dibotrys* and *Glycine soja*. Camphor is distributed in the riverside of Lianping River. *Fagopyrum dibotrys* was found 200 m upstream from Qingyao Bridge. An area of 15 m^2 *Glycine soja* was found in the riverside of Qingyao tributary.

Table V-18: Ecosystem Types in the Assessment Area of River Rehabilitation Component

Ecosystem type	Forest	Agriculture	Wetland	Urban area
Area (ha)	570.10	304.17	198.52	43.97
Percentage (%)	50.56%	23.37%	16.44%	9.64%

Table V-19: Terrestrial Vegetation in the Assessment Area of River Rehabilitation Component

Vegetation Type		Community	Scientific Name	Distribution
Natural Vegetation				
Coniferous forest	Warm coniferous forest	*Pinus massoniana*		Banks, Tianeshan, Lianping Rivers
		Cunninghamia lanceolata		Banks, Qingyao River, Tianeshan River and Lianping River
Broadleaf forest	Evergreen broadleaf forest	*Castanopsis fargesii*		Banks, Tianeshan, Lianping Rivers
	Deciduous forest	*Pterocarya stenoptera*		Riverside and floodplain
		Ulmus parvifolia		Xingning River in Xingning town
Bamboo	Bamboo	*Phyllostachys pubescens*		Widely distributed
Shrubs	Shrubland	*Rhus chinensis*		Scattered at riverside and roadside
		Vitex negundo		Scattered at riverside
		Broussonetia papyrifera		Scattered at riverside and roadside
		Alangium chinense		Riverside, roadside at Xingning River
		Salix matsudana		Riverside and floodplain
		Ficus pumila		Riverside of Xingning River
		Melia azedarach		Riverside
	Grassland	*Dicranopteris linearis*		Riverside and floodplain
		Miscanthus floridulus		Widely distributed

Vegetation Type		Community Scientific Name	Distribution
		Imperata cylindrica	Widely distributed
		Neyraudia montana	Riverside, floodplain-Qingyao River
		Cyperus iria	Riverside and floodplain
		Polygonuhyd ropiper	Widely distributed at floodplain
		Potygonum thunbergii	Widely distributed, riverside and floodplain
		Setaria viridis	Widely distributed at riverside, roadside and floodplain
		Cynodon dactylon	As above
		Leersia hexandra	Widely distributed at floodplain
		Paspalum orbiculare	Scattered at floodplain
		Taalum febicuii	Entuaries of Xingning River
		Carex sp.	Scattered at floodplain
Cultivated Vegetation			
Economic forest	Timber	Chinese fir, camphor, neem tree, paulownia, bamboo, polar etc	Scattered at riverside
	orchards	Citrus, chestnut, tea, laurel,tung-oil tree, etc.	Scatered at river terraces
Crop	Food crop	Rice, corn, sweet potato, soybean, etc	River terraces
	Economic crop	Sugar cane, peanut, rape, cassava, ramie, etc.	

106. Aquatic flora. A total of 24 species of aquatic plants were identified. Common species include *Alternanthera philoxeroides, Vallisneria natans, Potamogeton crispus, Potamogeton malaianus, Myriophyllum spicatum, Polygonum hydropiper, Rumex acetosa, Phragmites australis* and *Arundo donax* (Table V-20).

Table V-20: Aquatic Flora in the Assessment Area of River Rehabilitation Component

Flora type	**Scientifc Name**
Floating plants	*Azolla imbricata*
	Salvinia natans
	Eichhornia crassipes
	Nelumbo nucifera
	Hydrocharis dubia
	Potamogeton distinctus
Emergent plants	*Alternanthera philoxeroides*
	Polygonum hydropiper
	Rumex acetosa
	Phragmites australis
	Miscanthus sacchariflorus
	Arundo donax
	Scirpus trigueter
	Juncellus serotinus
	Sagittaria sagittiflia
	Typha orientalis
	Juncus effusus
Submerged plants	*Hydrilla verticillata*
	Vallisneria natans
	Potamogeton crispus
	Potamogeton malaianus
	Myriophyllum verticillatum
	Myriophyllum spicatum

	Ceratophyllum demersum

107. Phytoplankton. Based on the fieldwork conducted by Wuhan Yimeijing Technology Limited Company in November 2014, 51 species of phytoplankton were identified. Common species include *Oscillatoria* sp., *Closterium* sp., *Melosira* sp. *Surirella* sp., and *Synedra* sp. (Table V-21). Of 11 samples from five rivers, Shanglian section of Lianping River has the least phytoplank density and biomass (6.2 x 104 individuals/L, 0.053 mg/L respectively), while Qingyao River has the most (18.7 x 104 indindividuals/L, 0.0156 mg/L respectively).

Table V-21: Phytoplankton in The Assessment Area of River Rehabilitation Component

No.	Name	Lianping River			Tianeshan River		Qingyao River		Guangqiao River		Xingning River	
		1	2	3	4	5	6	7	8	9	10	11
Ⅰ Cyanophyta												
	Merismopedia punctata						+			+		
	Oscillatoria sp.	+	+		+				+		+	
	Oscillatoria limosa						+					+
	Phormidium sp.			+				+				
	Microcystis sp.					+					+	
	Anabaena sp.									+		+
	Spirulina sp.						+					
	Microcolus sp.	+										
Ⅱ Bacillariophyta												
	Melosira sp.	+					+	+		+		
	Cyclotella sp.			+		+						
	Fragilaria sp.		+									
	Synedra sp.	+	+		+							
	Synedra ulna			+					+		+	
	Cymbella sp.	+							+			
	Cocconeirs placentula					+						
	Navicula sp.				+				+			
	Surirella sp.		+		+	+	+	+	+			+
	Pinnularia sp.			+						+		
	Diatoma sp.			+				+				+
	Achnanthes sp.				+			+				
	Gyrosigma sp.				+							
	Gomphonema sp.			+				+	+			
	Tabellaria sp.				+				+		+	
	Asterionella Formosa		+				+					
	Asterionella gracillima				+							
	Diploneis purlla			+			+					
	Diatoma vulgare						+					
	Stauroneis sp.	+						+			+	
Ⅲ Cryptophyta												
	Cryptomonas sp.					+						
Ⅳ Chrysophyta												
	Dinobryon sp.						+					
Ⅴ Pyrrophyta												
	Ceratium sp.				+							
	Gymnodinium sp.							+				
Ⅵ Euglenophyta												
	Euglena sp.		+									
	Euglena pisciformis									+		
Ⅶ Chlorophyta												

No.	Name	Lianping River			Tianeshan River		Qingyao River		Guangqiao River		Xingning River	
		1	2	3	4	5	6	7	8	9	10	11
	Ankistrodesmus sp.	+					+				+	
	Scenedesmus sp.				+					+		
	Scenedesmus quadricauda							+				
	Chlorella vulgaris			+								
	Pandorina morum											
	Closterium sp.				+							
	Actinastrum sp.							+				
	Closterium sp.	+	+						+		+	+
	Stigeoclonium sp.			+			+					
	Ulothris sp.	+										
	Chladophora sp.										+	
	Microspora sp.	+			+		+		+		+	
	Chlamydomanas sp.											
	Oocystis sp.					+						
	Staurastrum sp.		+									
	lyngbya sp.							+				
	Spirogyra sp.				+					+	+	

108. Terrestrial fauna. A total of 160 terrestrial fauna species was documented, comprising 16 amphibians, 30 reptiles, 90 birds and 24 mammals (Tables V-22–V-23). Six (6) state grade II protected species were identified.

Table V-22: Terrestrial Vertebrates in The Project Area of River Rehabilation Component

Class	Order	Family	Species	Protection Level		
				State Grade I	State Grade II	Hunan Province
Amphibia	1	5	16	0	1	7
Reptilia	2	11	30	0	0	8
Aves	16	41	90	0	5	36
Mammalia	6	11	24	0	0	7
Total	25	68	160	0	6	58

109. For amphibians (13 species) and reptiles (30 species), nearly all are included in Hunan provincial lists of protected species. However the majority are common species and all are listed as Least Concern by the IUCN Red List, in view of their wide distribution, presumed large population, ability to live in a range of modified rural habitats, and because they are unlikely to be declining fast enough to quality for listing in a more threatened category. Birds (77 species) include two PRC Grade II protected species (*Accipiter virgatus* and *Pucrasia macrolopha*) and 54 Hunan Provincial level protected species. Both nationally-protected species have large global ranges and/or populations and are IUCN Least Concern.[8,9] The global population of *A. virgatus* is estimated to number 100, 000 individuals (Ferguson-Lees et al. 2001), while PRC population sizes have been estimated at 10,000-100,000 breeding pairs. For mammals, there are records of 13 Hunan provincial protected species in the assessment area; all are IUCN Least Concern.

Table V-23: Terrestrial Vertebrates in the River Rehabilitation Component Area

Scientific Name	Habitat	Local distribution	Data source	Local status	Protection level
Amphibians					
Megophrys minor	Grassland	East Asia	Site survey	++	Provincial
Hyla sanchiangnensis	Grassland and shrubland	East Asia	Site survey	++	Provincial
Bufo melanostictus	Widely spread	East Asia	Site survey	++	Provincial

[8] http://www.iucnredlist.org/details/22695588/0
[9] http://www.iucnredlist.org/details/22679179/0

Bufo gargarizans	Wet forest and grassland		Widespread	Site survey	++	Provincial
Hylarana guentheri	Widely spread		East Asia	Literature	+++	Provincial
Fejervarya limnocharis	Widely spread		East Asia	Site survey	+++	Provincial
Paa spinosa	Wet forest		East Asia	Literature	+	Provincial
Odorrana schmackeri	Stream		East Asia	Literature	++	Provincial
Almolops ricketti	Stream and waterfall		East Asia	Interview	++	Provincial
Rhacophorus dennysi	Wet forest		East Asia	Interview	+	Provincial
Microhyla heymonsi	Paddy		East Asia	Literature	+	Provincial
Microhyla ornata	Paddy and pond		East Asia	Literature	++	Provincial
Pachytriton labiatus	stream		East Asia	Literature	+	Provincial
Reptiles						
Chinemys reevesii	Ditch, paddy, pond, reservior		East Asia	Literature	+	Provincial
Pelodiscus sinensis	River, lake, pond, reservior		Widespread	Site survey	+	Provincial
Gekko subpalmatus	Forest, grassland, rural areas		East Asia	Site survey	+++	Provincial
Eumecus chinensis	Farmland and grassland		East Asia	Site survey	++	Provincial
Eumeces elegans	grassland		East Asia	Interview	++	--
Sphenomorphus indicus	village		East Asia	Interview	+	Provincial
Takydromus septentrionais	shrubs		Widespread	Literature	++	Provincial
Dinodon rufozonatum	Village, hills, plains		Widespread	Interview	++	Provincial
Elaphe carinata	Plains and hills		East Asia	Interview	+++	Provincial
Elaphe taeniura	Hills, plains, forest, farmland		East Asia	Interview	+++	Provincial
Eutechinus major	Hills, forest, grassland, farmland		East Asia	Interview	++	Provincial
Zaocys dhumnades	Hills, forest, grassland, farmland		East Asia	Site survey	+++	Provincial
Calamaria septentrionalis	Wet caves		East Asia	Interview	++	Provincial
Elaphe rufodorsata	Riverside, farmland, pond		Widespread	Site survey	++	Provincial
Enhydris chinensis	Paddy, ditch, pond		East Asia	Site survey	++	Provincial
Lycodon ruhstrati	Hills, forest, grassland, farmland		East Asia	Interview	+	Provincial
Opisthotropis latouchii	stream		East Asia	Site survey	+	Provincial
Ptyas korros	Hills, forest, grassland, farmland		East Asia	Site survey	++	Provincial
Natrix tigrina	River, canals, lake, paddy		Widespread	Interview	++	Provincial
Sinonatrix percarinata	Stream, paddy		East Asia	Site survey	++	Provincial
Bungarus multicinctus	Village, ditch		East Asia	Interview	+	Provincial
Deinagkistrodon acutus	Rock, grassland near stream		East Asia	Literature	+	Provincial
Trimeresurus stejnegeri	Shrubs, grassland near stream		East Asia	Interview	++	Provincial
Gloydius brevicaudus	Rocks, grassland, farmland		Widespread	Interview	+	Provincial
Protobothrops mucrosquamatus	Shrubs, stream, hills, grassland		East Asia	Interview	+	Provincial
Birds (SV = summer visitor; WV = winter visitor)						
Egretta garzetta	Wetland, paddy	SV	East Asia	Interview	++	Provincial
Ardea cinerea	Wetland, paddy	Resident	East Asia	Site survey	++	Provincial
Butorides striatus	Wetland, paddy	SV	Widespread	Interview	+	Provincial
Ardeola bacchus	Wetland, paddy	SV	East Asia	Interview	++	Provincial
Nycticorax nycticorax	Wetland, paddy	SV	East Asia	Interview	++	Provincial
Accipiter virgatus	Forest	Resident	East Asia	Site survey	+	Grade II
Bambusico lathoracica	Shrub, bamboo, weed	Resident	East Asia	Interview	++	Provincial
Pucrasia macrolopha	Forest 1,000-4,000 m	Resident	Widespread	Interview	+	Grade II
Phasianus colchicus	Farmland, shrubland	Resident	Widespread	Interview	++	--
Streptopelia orientalis	Woods, farmland	Resident	Widespread	Site survey	++	Provincial
Streptopelia chinensis	Hills, woods	Resident	East Asia	Site survey	++	Provincial
Clamator coromandus	Hillside, plain	SV	East Asia	Literature	+	--
Cuculus micropterus	Forest	SV	Widespread	Interview	++	Provincial
Cuculus sparverioides	Forest	SV	East Asia	Site survey	++	Provincial
Cuculus canorus	Forest	SV	Widespread	Site survey	++	Provincial
Alcedo atthis	Hill, plainear paddy	Resident	Widespread	Site survey	+	Provincial
Halcyon pileata	Stream, lake, swamp	SV	East Asia	Literature	+	Provincial
Cerryle lugubris	Stream, lake, swamp	Resident	East Asia	Literature	+	Provincial
Picoides major	Woods, gardens, forest	Resident	Palaearctic	Site survey	++	Provincial
Picus canus	Hill, plain	Resident	Palaearctic	Literature	++	--

Cecropis daurica	village	SV	Widespread	Site survey	++	Provincial
Hirundo rustica	village	SV	Palaearctic	Site survey	++	Provincial
Motacilla alba	Farmland, grassland	Resident	Widespread	Site survey	++	--
Motacilla cinerea	Farmland, grassland	WV	Widespread	Site survey	++	--
Spizixos semitorques	Forest, shrubland	Resident	East Asia	Literature	+++	--
Pycnonotus sinensis	Forest, shrubland	Resident	East Asia	Literature	++	Provincial
Hypsipetes leucocephalus	Tall trees in forest	SV	Palaearctic	Literature	++	Provincial
Lanius schach	Farmland, forest, valley	Resident	East Asia	Site survey	++	Provincial
Lanius cristatus	Low hill, forest	SV	Widespread	Literature	++	Provincial
Dicrurus macrocercus	Forest, shrubland	SV	Widespread	Literature	++	Provincial
Acridotheres cristatellus	Forest, shrubland	Resident	East Asia	Interview	++	Provincial
Sturnus sericeus	Plain, farmland, jungle	Resident	East Asia	Literature	++	--
Sturnus cineraceus	Low hill, open field	WV	Palaearctic	Interview	++	Provincial
Urocissa erythrorhyncha	Forest, orchard	Resident	East Asia	Literature	++	Provincial
Pica pica	Villages, forest	Resident	Palaearctic	Site survey	++	Provincial
Garrulus glandarius	Forest 1200-2500 m	Resident	Palaearctic	Interview	++	Provincial
Turdus merula	Grassland, orchard	Resident	Widespread	Site survey	++	Provincial
Copsychus saularis	Hills, fields, forest	Resident	East Asia	Site survey	++	--
Rhyacornis fuliginosus	Stream, valley	Resident	East Asia	Literature	++	--
Tarsiger cyanurus	Shrubs, forest	WV	Widespread	Literature	++	Provincial
Garrulax perspicillatus	Shrubs, parks	Resident	East Asia	Literature	++	Provincial
Garrulax canorus	Shrubs, bamboo	Resident	East Asia	Interview	++	Provincial
Garrulax sannio	Plains, hills	Resident	East Asia	Literature	++	--
Pomatorhinus	Forest	Resident	East Asia	Interview	++	Provincial
Leiothrix lutea	Forest	Resident	East Asia	Interview	++	Provincial
Alcippe morrisonia	Forest	Resident	East Asia	Literature	++	--
Phylloscopus inornatus	Orchard, forest	Resident	East Asia	Literature	++	--
Paradoxornis webbianus	Shrubs	Resident	Widespread	Literature	++	Provincial
Prinia inornata	Farmland, shrubs	Resident	East Asia	Literature	++	--
Cettia fortipes	Dense shrubs	Resident	East Asia	Literature	++	--
Parus major	Woodland	Resident	Widespread	Site survey	++	Provincial
Parus monticolus	Forest edge	Resident	Widespread	Literature	++	Provincial
Parus venustulus	Hills	Resident	East Asia	Literature	++	Provincial
Aegithalos concinnus	Shrubs and woodland	Resident	Palaearctic	Interview	++	Provincial
Passer montanus	Farmland, villages	Resident	Palaearctic	Site survey	++	Provincial
Lonchura striata	Farmland, garden	Resident	East Asia	Site survey	++	--
Passer rutilans	Hilly plains, foothikks	Resident	Widespread	Site survey	++	--
Passer montanus	Villages	Resident	Palaearctic	Site survey	+++	--
Carduelis sinica	Woodland	Resident	Palaearctic	Literature	++	Provincial
Phoenicurus auroreus	Low shrubs	WV	Widespread	Interview	++	--
Anas crecca	Wetland	WV	Palaearctic	Site survey	++	Provincial
Anas formosa	Wetland	WV	Palaearctic	Site survey	++	Provincial
Gallicrex cinerea	Wetland	SV	East Asia	Interview	++	Provincial
Gallimula chlropus	Wetland	SV	Widespread	Interview	++	Provincial
Vanellus vanellus	Wetland	WV	Palaearctic	Literature	+	Provincial
Tringa nebularia	Wetland	WV	Palaearctic	Literature	+	Provincial
Tringa ochropus	Wetland	WV	Palaearctic	Interview	+	Provincial
Tringa glareola	Wetland	WV	Palaearctic	Interview	+	--
Tringa hypoleucos	Wetland	WV	Palaearctic	Interview	+	Provincial
Gallinago gallinago	Wetland	WV	Palaearctic	Literature	++	Provincial
Scolopax rusticola	Wetland	WV	Palaearctic	Literature	+	Provincial
Tyto capensis	Grassland	Resident	Widespread	Literature	+	--
Caprimulgus indicus	Woodland, forest edge	SV	East Asia	Interview	++	Provincial
Mammals						
Suncus murinus	Farmland, shrubland		East Asia	Interview	+++	--
Erinaceus europaeus	Shrubs, suburbs, villages		Widespread	Interview	++	Provincial
Mogera robusta	Hilly forest, forest edge		Palaearctic	Interview	++	Provincial
Rhinolophus ferrumequinum	Caves		Widespread	Interview	++	Provincial

Pipistrellus pipistrellus	Tree holes, roof, caves	Widespread	Interview	++	Provincial
Lepus sinensis	Shrubs, farmland	East Asia	Interview	++	--
Tamiops swinhoei	Forest	East Asia	Interview	++	Provincial
Callosciurus erythraeus	Forest	East Asia	Site survey	++	Provincial
Apodemus agrarius	Meadows, shrubs, fields	Palaearctic	Literature	++	--
Mus musculus	Warehouse, fields, woodlands	Palaearctic	Interview	+++	--
Rattus rattus	House, fields	East Asia	Interview	+++	--
Rattus flavipectus	Warehouse, house	East Asia	Literature	++	--
Rattus novegicus	Warehouse, kitchen	Widespread	Interview	+++	--
Hystrix brachyura	Bushes, caves	East Asia	Literature	++	Provincial
Mustela sibirica	Shrubs, marshes, plains	Palaeoarctic	Interview	+++	Provincial
Melogale moschata	Earth cave, weeds	East Asia	Literature	++	Provincial
Paguma larvata	Forest, shrubsland	East Asia	Literature	+	Provincial
Felis bengalensis	Forest, riverside shrubs, villages	East Asia	Site survey	+	Provincial
Sus scrofa	Forest, farmland	Palaeoarctic	Interview	++	Provincial
Muntiacus reevesi	Hilly shrubs	East Asia	Interview	+	Provincial

110. Fish. The five rivers for the planned dredging and embankment are small seasonal waterways. Twenty-five fish species have been recorded in these rivers, of which only four species were captured during the site survey in November 2014: *Pareformosania pingchowensis, Odontobutis sinensis, Cyprinus carpio,* and *Hemiculter leucisculus*. Based on the interview with villagers and fishery administrations, there are spawning, feeding, and /or wintering grounds of Cobitidae and Homalopteridaein species in the Lianping and Guangqiao Rivers.

Table V-24: Fish Inventory in the Assessment Area of River Rehabilitation Component

Scientific Name	Information Sources			Habitat for Eggs
	Historical record	Site capture	Interview	
Nemachilus potanini	+			Unknown
Cobitis sinensis	+	+		In suspension
Misgurnus anguillicaudatus	+	+		Channel bed
Zacco platypus	+		+	Channel bed
Opsariichthys bidens	+			Unknown
Hemiculter leucisculus	+	+		Unknown
Hemibarbus maculates	+	+		Unknown
Pseudorasbora parva	+			Aquatic plants
Squalidus argentatus	+			Unknown
Abbottina rivularis	+	+		Channel bed
Saurogobio dabryi	+			Aquatic plants
Acheilognathus barbatulus	+			Invertebrate
Cyprinus carpio	+	+		Aquatic plants
Lepturichtnys fimbriata				Unknown
Pareformosania pingchowensis				Unknown
Silurus asotus	+		+	Unknown
Pseudobagrus fulvidrico	+	+		Aquatic plants
Mystus guttatus	+	+		Unknown
Monopterus albus	+	+		Estuary
Odontobutis sinensis	+	+		Unknown
Rhinogobius sp.				In suspension
Channa maculata	+	+		Unknown
Macropodus opercuiaris	+	+		In suspension
Mastacembelus aculeatus	+	+		In suspension

111. Aquatic plankton. A total of 23 plankton species were identified from 11 samples, including 7 protozoa species, 9 rotifera species, 3 cladocera species and 4 copepoda soecies (Table V-25). Among the five rivers, Guangqiao River has the largest density and biomass of plankton (328.0 ind./L, 0.479 mg/L), followed by Lianping River (303.3 ind./L, 0.444 mg/L),

Qingyao River(302.5 ind./L, 0.3440mg/L), Tianeshan River (297.5 ind./L, 0.426 mg/L)and Xingning River (257.5 ind./L, 0.357 mg/L).

Table V-25: Aquatic Plankton Inventory in the River Rehabilitation Project Area – 5 rivers

No.	Scientific Name	Lianping			Tianeshan		Qingyao		Guangqaio		Xingning	
		1	2	3	4	5	6	7	8	9	10	11
1	*Arcella sp.*	+		+						+		
2	*Centropyxis sp.*					+						
3	*Difflugia sp.*		+									+
4	*Centropyxis discoides*				+							
5	*Amoeba radiosa*							+				
6	*Vorticella sp.*		+									+
7	*Tintinnopsis wangi*									+		
8	*Brachionus forficula*				+							
9	*Brachionus urceus*			+								
10	*Keratella valga*						+		+			
11	*Kerarella cochlearis*	+	+			+		+				+
12	*Brachionus caudatus*							+				
13	*Monostyla lunaris*									+		
14	*Asplanchna priodonta*			+		+		+		+		+
15	*Trichocerca pusilla*				+							
16	*Polyarthra dolichoptera*			+						+		
17	*Diaphanosoma brachyurum*			+								
18	*Bosmina longirostris*				+		+				+	
19	*Alona retangula*									+		
20	*Cyclops vicinus*			+						+		
21	*Thermocyclops hyalinus*									+		
22	*Limnoithona sinensis*					+					+	
23	*Nauplius*				+			+		+		

112. Benthic invertebrates. Twenty-one benthonic invertebrate species were identified from 11 samples, including 5 mollusc species, 5 annelida species and 11 arthropoda species (Table V-26).

Table V-26: Benthic Invertebrates in the River Rehabilitation Project Area – 5 rivers

No.	Scientific Name	Lianping			Tianeshan		Qingyao		Guangqaio		Xingning	
		1	2	3	4	5	6	7	8	9	10	11
1	*Monopylephorus limosus*	+	+		+						+	
2	*Tubifex sinicus*	+			+	+	+				+	+
3	*Limnodrilus sp.*	+				+						
4	*Lumbriculus variegatum*			+				+				+
5	*Herpobdella sp.*	+	+		+						+	
6	*Lymnaea stagnalis*			+				+		+		+
7	*Bithynia sp.*		+			+						
8	*Gyraulus compressus*				+							
9	*Bellamya purificata*					+			+			+
10	*Corbicula fluminea*	+		+	+			+		+	+	+
11	*Macrobrachium nipponense*	+			+	+					+	+
12	*Caridina denticulate sinensis*		+	+								+
13	*Anisozyopiera larvae*	+	+			+						
14	*Sphaerodema sp.*		+			+						
15	*Dytisus sp.*	+			+							
16	*Perla sp.*			+						+		+
17	*Ecdyrus sp.*	+			+			+			+	+
18	*Ephemera sp.*		+			+	+					+
19	*Cryptochironomus sp.*	+			+	+			+			
20	*Tanypus sp.*											

21	*Chironomidae*	+	+	+	+	+		+	+	+	+	

4. Karst Vegetation

113. Karst areas (dolomite limestones) comprise around 27,152.1 ha in the project area (Fig. V-8). The PPTA team surveyed karst vegetation in October 2014 and recorded grass, shrub and secondary forest communities.

Grass is the major type of vegetation in the karst areas and main method for soil erosion control. The community is 1-2 m high, has >80% cover, and includes Japanese silvergrass, *aster baccharoides* and *Vitex*. Other species include *Smilax china, Broussonetia kazinoki, Paederia scandens, Multiflora rose, Rubus alceaefolius, Pueraria lobota, Rubus xanthoneurus, Clematis argentilucida, Camellia, Millettia dielsiana, Alangium platanifolium, Cayratia japonica, Rubus niveus, Rosa rubus, Berchemia sinica, China Berry, Cornus wilsoniana, Rhus chinensis, sassafras, Aster baccharoides, Awn, Arthraxon hispidus, Clinopodium chinense, Pteris nervosa, and Bidens pilosa*.

Shrubs mainly occur in the middle and higher part of the mountains. Woods in transitioning stage from degenerated vegetation communities (such as shrubs and herbosa) to secondary arbor forests make up the major part of the forest. The community is unstable and could quickly recover to secondary forests if protected well, but also could degenerate into herbosa and encounter serious soil erosion if damage continues. Canopy height is 6-7 m and canopy density of 0.6. Dominant species are oriental oak, white oak, *Cyclobalanopsis chungii*, *Cornus wilsoniana, Photinia davidsoniae, Nandina, Mallotus repandus, Ligustrum quihoui, Elaeagnus pungens, Rhamnella martinii* and *Sageretia thea.* Rare occurrence of herbosa vegetation includes: *Onychium japonicum, Ophiopogon japonicus, Senecio* and several *Carex* species.

Secondary forests are evergreen and deciduous broad-leaved mixed forests. Canopy height is 12-14 m, with arborous layer plants of 15-18 cm thickness and canopy density of 0.8. There is thick leaf litter. The arborous layer mainly consists: *Cornus wilsoniana, Celtis bungeana,* oriental oak, *Quercus chenii Nakai, Cyclobalanopsis chungii* and *Pittosporum breviealyx.* The shrub layer consists: *Nandina, Sageretia thea, Zanthoxylum armatum, Smilax glaucochina, Smilax china, Cayratia japonica, Photinia davidsoniae, kamala, Acer cinnamomifolium, yam, Loropetalum chinense* and *Serissa serissoides.* Sparse occurance of herbosa layer includes: *Ficus pumila, Onychium japonicum* and several *Carex* species.

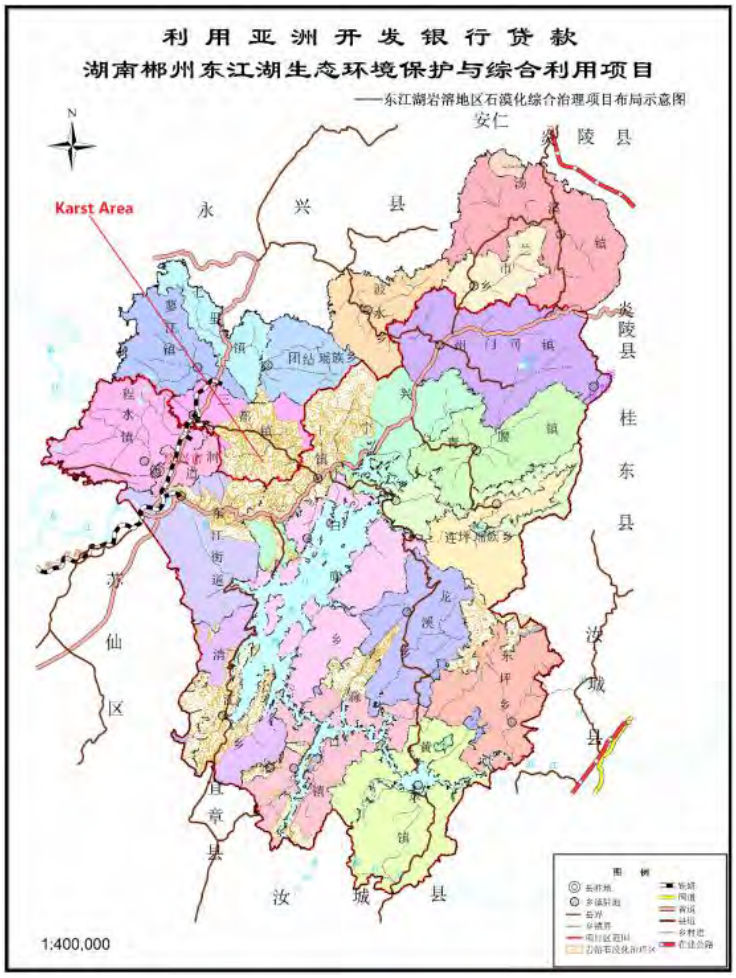


Figure V-8: Distribution of Karst Area in Zixing City

Grass Shrub

Secondary forest

Figure V-9: Typical vegetation type in Karst area, Zixing

114. Bamboo forest. Improved bamboo forest occurs at Tiane Mountain Forestry Park. Supporting trees were planted, such as *Cunninghamia lanceolata*, *Schima superba*, *Liquidambar formosana* and *Machilus ichangensis*. The site is managed and ground cover is cleared to improve bamboo growth.

Natural bamboo forest

"Improved" bamboo forest

Figure V-10: Typical bamboo forest, Zixing

5. Wetlands

115. Vegetation. Common species were recorded in the project sites (Table V-27). *Eichhornia crassipes* occurs at Xingning wetland and is an invasive species.

Table V-27: Common wetland flora species. F= Floating plants; H= Hygrophyte; S=Submerged Plants

Family	Scientific Name	Common Name	Form
蓼　科 Polygonaceae	*Polygonum hydropiper L.*	水蓼	H
	Polygonum lapathifolium L.	酸模叶蓼	H
水鳖科 Hydrocharitaceae	*Vallisneria natans (Lour.) Hara*	苦草	S
浮萍科 Lemnaceae	*Lemna minor L.*	浮萍	F
雨久花科 Pontederiaceae	*Eichhornia crassipes (Mart.) Solms*	凤眼莲	F
菊科 Compositae	*Bidens tripartita L.*	狼把草	H
	Eclipta prostrata	鳢肠	H
	Herba Asteris subulati	钻叶紫菀	H
苋科 Amarantaceae	*Alternanthera philoxeroides (Mart.) Grise H*	空心莲子草	H
眼子菜科 Potamogetonaceae	*Potamogeton crispus*	菹草	S
柳叶菜科 Onagraceae	*Ludwigia linifolia*	草龙	H
桔梗科 Campanulaceae	*Lobelia chinensis*	半边莲	H
茄科 Solanaceae	*Solallum nigrum L .ver Pauciflorum Liou*	乌点规	H
伞形科 Umbelliferae	*Oenanthe javanica*	水芹	H
木贼科 Equisetaceae	*Equisetum diffusum*	披散木贼	H
禾本科 Palmaceae	*Miscanthus floridulus*	五节芒	H
	Phragmites australis	芦苇	H
	Paspalum thunbergii	雀稗	H
	Leersia hexandra	李氏禾	H
	Isachne globosa	柳叶箬	H
	Hemarthria altissima	牛鞭草	H

Hangxi Wetland

Lianping river

Figure V-11: Typical Vegetation at Wetland/Riverside

D. Protected Areas and Physical Cultural Resources

116. Dongjiang Lake area is located within two overlapping reserves, the national 4A Dongjiang Lake Scenic Area and Dongjiang Lake Wetland Park. A third, the national Tiane Mountain Forestry Park, is located north-east of the lake. The Tianeshan River (one of the five project rivers) originates from Tiane Mountain Forestry Park and flows into Dongjiang Lake. Project activities are within and outside of these reserves. The three wetland rehabilitation sites are within both national reserves. Part of the transmission pipelines for the Yangdong Water Supply sub-component is within the wetland park. There are no known sites of physical cultural resources in the project area (although protection measures are included in the project environment management plan in the event that any are found during construction).

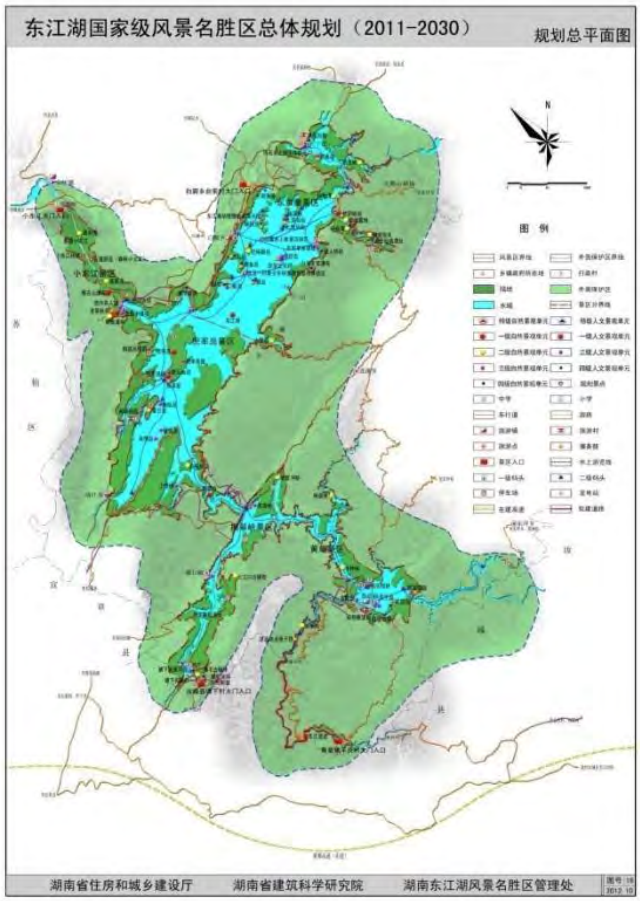


Figure V-12: Master Plan of Dongjiang Lake Scenic Area (2011-2030) (green shaded area)

Figure V-13: Master plan of Dongjiang Lake Wetland Park. Green shaded area denotes the extent of the reserve.

E. Socio-economic Conditions

117. Hunan Province covers 211,800 km^2 and is divided into 14 prefecture-level divisions (13 prefecture-level cities and one autonomous prefecture). The 14 prefecture-level divisions are subdivided into 122 county-level divisions (35 districts, 16 county-level cities, 64 counties, 7 autonomous counties); these in turn are divided into 1,131 towns, 952 townships and 305 district public offices. Chenzhou Municipality covers 19,388 km^2, divided into 11 administrative divisions: Beihu District, Suxian District, Guiyang County, Yizhang County, Yongxing County, Jiahe County, Linwu County, Rucheng County, Guidong County, Anren County and Zixing City. These are subdivided into 164 townships (including 11 Yao minority townships), 86 towns and 7 district offices. Zixing City covers 10 towns and eight townships, of which two are minority townships. The project areas covers 13 townships and 183 villages (Table V-28).

Table V-28: Project Administrative Township Subdivisions in 2013

Town / Street	Area (km^2)	Community committee	Administrative village	Village group
Tangdong Street	22	9	0	246
Dongjiang Street	148.18	9	8	213
Chukou town	164	1	15	132
Xingning town	220	1	33	368
Zhoumensi Town	189.98	1	26	251
Qingyao town	143	1	14	-
Huangcao town	186.8	1	15	130
Chengshui town	122.64	1	17	234
Dongping township	147.3	1	7	43
Lianping township	95.3	1	4	24
Qingjiang township	154	1	17	138

Longxi township	84	-	8	-
Bailang township	249.9	0	12	-

118. Hunan Province has a resident population of 66.9 million by 2013, including 33.78 million male and 31.92 female (Table V-29). The urban population is 32.09 million with an urbanization rate of 47.96%. The annual birth is 0.9 million with birth rate of 13.50%. The mortality rate is 6.96% and the natural population growth rate is 6.54%. **Chenzhou Municipality** had a resident population of 4,665,300 in 2013, including 2.19 million urban population and 2,471,200 rural population with an urbanization rate of 47.1%. The birth rate is 13.26%. The mortality rate is 6.99% and the natural population growth rate is 6.27%. **Zixing City** had a resident population of 3,413,100, including 174,500 male and 168,600 female (Table V-29). The new born population is 4,062 with a birth rate of 10.63%. There are 2,045 deaths with a mortality rate of 5.38%. The natural growth rate is 5.26% (Table V-30).

Table V-29: Regional Population Status in 2013

Region	Population (0,000)	Male (0,000)	Female (0,000)	Urban (0,000)	Rural (0,000)
Hunan	6690.6	3451.5	3239.1	3208.8	3481.8
	100%	51.6%	48.4%	48.0%	52.0%
Chenzhou	466.53	241.66	224.87	219.41	247.12
	100%	51.8%	48.2%	47.1%	52.9%
Zixing	34.31	17.45	16.86	20.69	13.62
	100%	50.9%	49.1%	60.3%	39.7%

Source: National Economic and Social Development Statistics Bulletin of Hunan, Chenzhou and Zixing (2013)

Table V-30: Population of Project Townships in 2013. Source: Zixing Statistical Yearbook (2014)

Township	Population	Male	Female	Female (%)
Tangdong Street	62507	31646	30861	49.4
Dongjiang Street	61972	31459	30513	49.2
Chukou town	12006	6095	5911	49.1
Xingning town	29396	14956	14440	49.3
Zhoumensi Town	16551	8393	8158	50.0
Qingyao town	9289	4649	4640	49.1
Huangcao town	9845	5008	4837	49.5
Chengshui town	26512	13398	13114	49.1
Dongping township	3181	1620	1561	49.2
Lianping township	1728	878	850	49.1
Qingjiang township	10302	5241	5061	49.1
Longxi township	3557	1809	1748	49.1
Bailang township	9732	4949	4783	49.3

119. Economic profile. The GDP in Hunan province was CNY2.45017 trillion in 2013. Per capita GDP was CNY36763. The ratio of three industries of the whole province was 12.7:47.0:40.3. Per capita disposable income of urban residents was CNY23414. Per capita consumption expenditure of urban residents was CNY15887. Per capita net income of rural residents was CNY8372 with per capita consumption expenditure of CNY6609. In **Chenzhou Municipality**, GDP was CNY168.55 billion in 2013 and per capita GDP was CNY36256. The ratio of three industries of the whole prefecture was 9.8:57.6:32.6. Per capita disposable income of urban residents was CNY21634. Per capita consumption expenditure of urban residents was CNY12662. Per capita net income of rural residents was CNY9692 with per capita consumption expenditure of CNY6315. In **Zixing City**, GDP was CNY24.74 billion in 2013. Per capita GDP was CNY7210. The ratio of three industries of the whole prefecture was 7.4:69.8:22.8. Per capita disposable income of urban residents in Chenzhou was CNY22585. Per capita consumption expenditure of urban residents was CNY10171. Per capita net income of rural residents was CNY12970 with per capita consumption expenditure

of CNY7910 (Tables V-31-V-32).

Table V-31: Regional Economic Profile in the Project Area in 2013 (CNY)

Region	Regional GDP (CNY0.1 billion)	Per capita GDP	Ratio of each industry (%)	Per capita disposable income urban residents	Per capita disposable income rural residents
Hunan	24,501.7	36,763	2.7:47.0:40.3	23,414	8,372
Chenzhou	1,685.5	36,256	9.8:57.6:32.6	21,634	9,692
Zixing	222.61	7,910	7.4:69.8:22.8	22,585	12,970

Source: National Economic and Social Development Statistics Bulletin of Hunan, Chenzhou and Zixing (2013)

Table V-32: Economic Indicators of Each Township in the Project Area (2013)

Township	GDP (x10,000 CNY)	Per capita GDP (CNY)	Net Income rural residents (CNY)
Tangdong Street	115,049	18,405	24,106
Dongjiang Street	842,563	135,958	21,335
Chukou town	54,613	10,962	10,325
Xingning town	137,893	46,908	10,289
Zhoumensi Town	98,576	59,558	13,737
Qingyao town	52,981	57,036	13,052
Huangcao town	41,668	42,324	9,609
Chengshui town	337,556	115,049	14,328
Dongping township	14,380	45,205	15,776
Lianping township	7,861	45,491	11,255
Qingjiang township	45,921	44,574	12,757
Longxi township	14,678	41,265	11,702
Bailang township	34,887	35,847	10,142

120. Health. (i) Heavy metals. Many parts of Hunan Province, including agricultural lands, are characterized by high levels of heavy metals and which have been linked with human health issues.[10] These are generally areas with heavy industry (e.g. smelters). There is no site-specific data on health-related issues for the project area. Baseline sampling in the project area (Section V.B) confirms that levels of some heavy metals exceed PRC standards. This is consistent across the project area and is a natural occurrence (Section V.B). There has not been any industrial activity in the project area, and the project is not supporting activities which would generate heavy metals, or, which would render communities vulnerable to them in the long term e.g. ingestion of crops from contaminated fields. The planned dredging may cause temporary and localized release of heavy metals from sediments: this is assessed in Sections VI.C.3 and VI.C.8. (ii) Schistosomiasis. This tropical disease is caused by *Schistosoma japonicum*. Standing waters, such as wetlands and rice fields, are the habitat for the host snail *Oncomelania hupensis*. The incidence and distribution of Schistosomiasis in the PRC is well documented and includes northern Hunan.[11,12] There are no records from southern Hunan. Given the extensive prevalence of standing water bodies (paddy fields) throughout the province, the addition of three small constructed wetlands is considered a low risk to contributing to spread of the disease, and is not considered further in this EIA.

F. Climate Change

121. Climate change predictions for the project area were made, based on historical climate

[10] Lei, M. et al. 2015. Heavy metal pollution and potential health risk assessment of white rice around mine areas in Hunan Province, China. *Food Security* 7: 45–54.

[11] Ross et al. 2001. Schistosomiasis in the People's Republic of China: Prospects and Challenges for the 21st Century. *Clinical Microbiology Reviews* 14: 270–295.

[12] Hu et al. 2013. Distribution of susceptible areas of schistosomiasis outside embankment in Hunan Province. *Zhongguo Xue Xi Chong Bing Fang Zhi Za Zhi* 25: 396-8. (In Chinese).

data from 1961 to 2013 collected at three local meteorological stations (Zixing, Guidong and Rucheng). Projections were derived from the *Climate Change Projection Dataset in China V3.0*. The dataset offers simple ensemble average results with resolution 1°×1° for the PRC of multiple scenarios under CMIP5.[13] Temperature, precipitation, potential evapotranspiration (PET), runoff, severe storm, flood and droughts were considered. The trend of the first four variables was analyzed, while the likelihood (the average number of events in 10 years) of the latter three variables was assessed. Historical annual temperature (mean-minimum-maximum) and precipitation were calculated using linear regression method. Fig. V-14 shows the climate trend for nine parameters from 1961 to 2013. The figure illustrates increasing trends for some precipitation (PREC, Pmax) and temperature (Tmean, Tmax, Tmin) variables and decreasing trends for others.

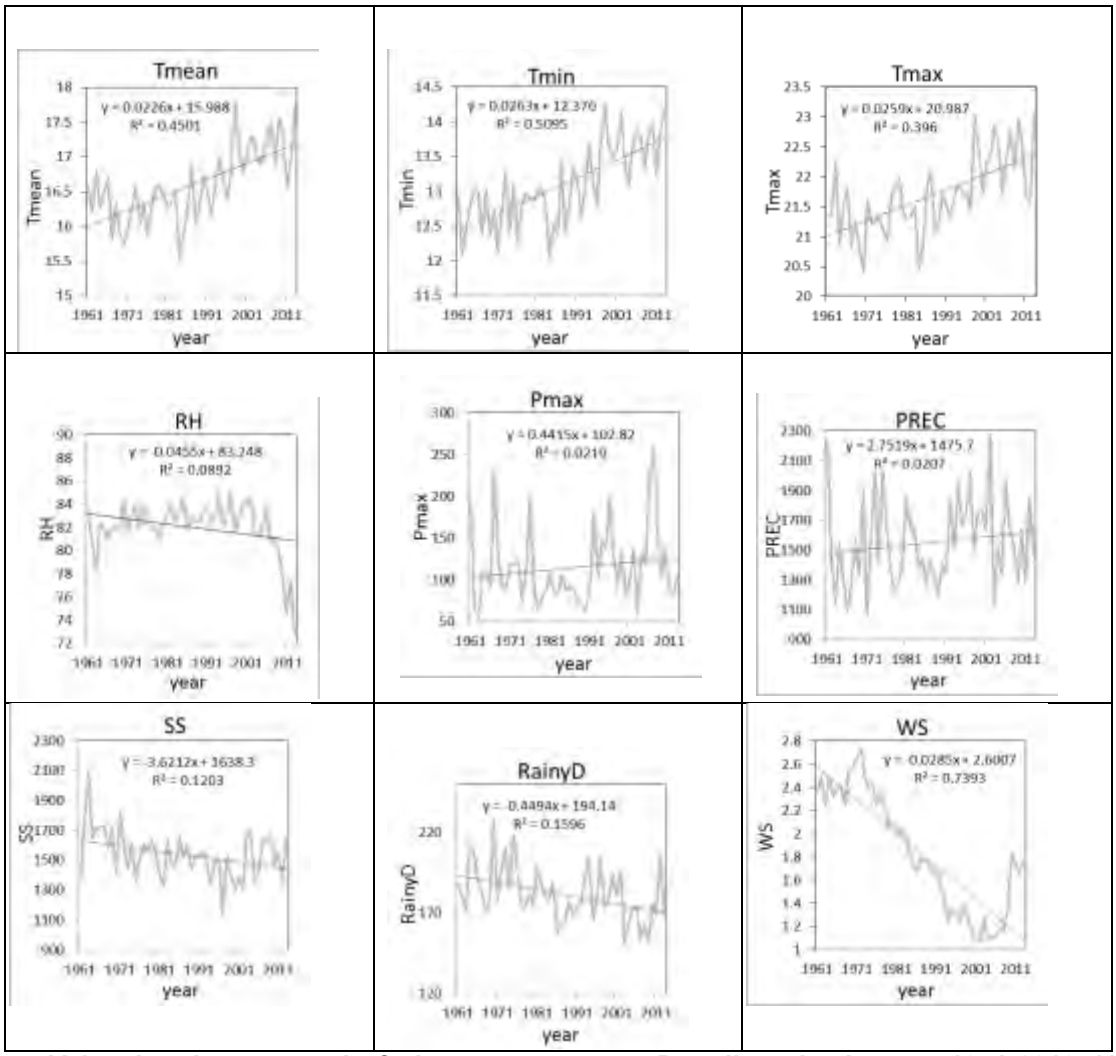


Figure V-14: the change trend of nine parameters at Dongjiang basin over 1971-2013. Note: Tmean= mean annual temperature; Tmin= minimum annual temperature; Tmax=maximum annual temperature; PREC= annual precipitation; RainyD=the number of rainy days; RH=mean relative humidity; SS=sunshine hours, WS=average wind speed; Pmax=the maximum daily precipitation.

122. The historical likelihood of severe storm, floods and droughts (average number of events in 10 years) was calculated using moving-average and linear regression methods based on data from 1961 to 2013. The moving-sum number of severe storms increased significantly with R^2 = 0.48 (Figure V-15). The moving-sum number of floods in 10 years increased significantly over 1961-2013 with R^2 = 0.86 (Fig. V-16). The moving-sum number of

[13] Coupled Model Intercomparison Project Phase 5.

droughts in 10 years decreased over 1961-2013 with R^2 = 0.20 (Fig. V-17).

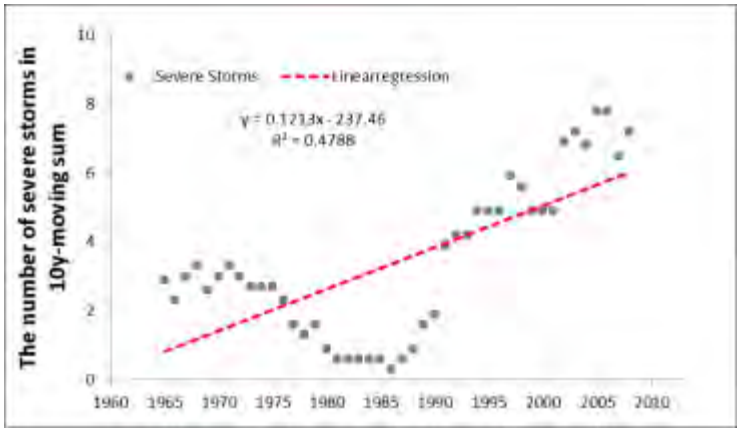


Figure V-15: The trend in number of severe storms in Dongjiang basin, 1961-2013

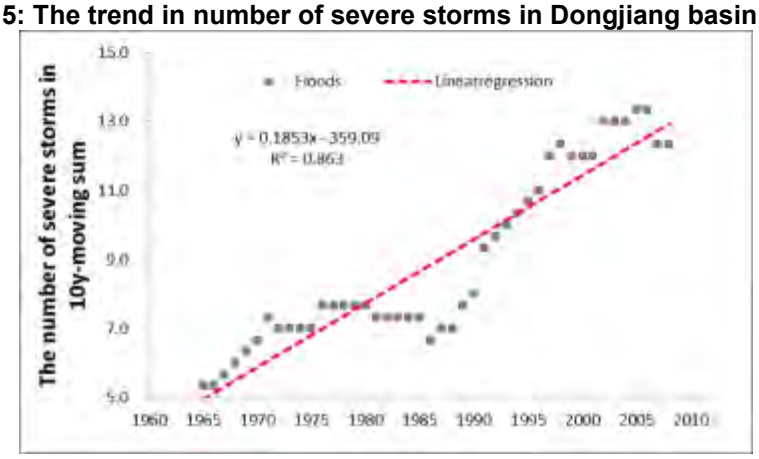


Figure V-16: The trend in number of floods in Dongjiang basin, 1961-2013

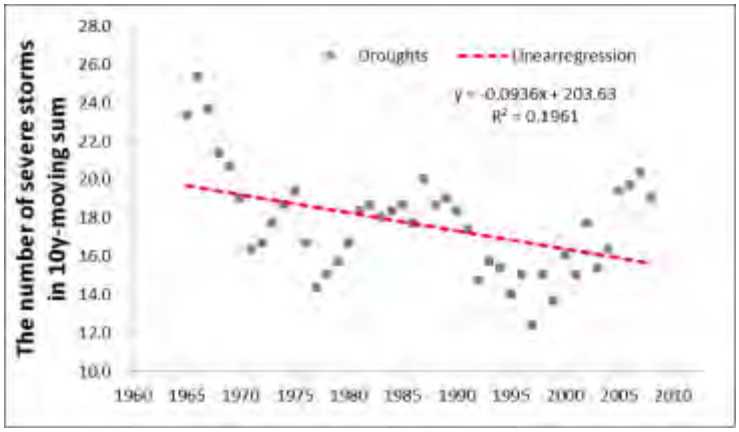


Figure V-17: The trend in number of droughts in Dongjiang basin, 1961-2013

123. These trends are summarized as follows.

- The slope of increasing trend of annual minimum temperature was a little higher than mean and maximum temperature in Dongjiang basin.
- Mean annual precipitation in Dongjiang basin displayed small increasing trend.
- Mean number of severe storms (daily rainfall >100mm) in 10 years was 2.7 from 1971-2000. The likelihood of severe storms showed an increasing trend.
- Mean number of floods which were *moderately intensive*, *intensive* and *very intensive* in 10 years was 8 during from 1971-2000; the likelihood of flood events showed a small increasing trend.
- Mean number of droughts which were *moderately intensive*, *intensive* and *very*

intensive in 10 years was 17.0 from 1971-2000; the likelihood of drought showed a decreasing trend.

124. **Projected climate change.** Projected climate change scenarios were based on 21 Global Circulation Models (GCM) for the time periods 2031–2040 and 2041–2060 from IPCC5- CMIP5 (Coupled Model Intercomparison Project Phase 5) using four Representative Concentration Pathways (RCPs) scenarios, RCP2.6, RCP4.5 and RCP8.5. Data for monthly average minimum temperature, monthly average maximum temperature, and monthly total precipitation for the near term (2026–2045) and middle term (2046–2065) were calculated basing on downscaled IPCC5 (CMIP5) data with the period 1986–2005 used as baseline for the climate change projection.

125. Under the three RCPs scenarios, the average temperature in Dongjiang Basin will continue to rise. Before 2040, each scenario shows a similar temperature rising trend, but differ from each other after 2040. Between 2011 and 2100, the temperature will rise by 0.09°C/10a, 0.2°C/10a and 0.5°C/10a respectively under RCP2.6, RCP4.5 and RCP8.5 (Fig. V-18). The average temperature warming of 0.23°C/10a RCP4.5 is close to the baseline trend of 30 years (1971-2000). This trend is similar to that for the whole of the PRC but warmer than Hunan province. The warming trend under RCP8.5 scenario is more than twice that of values from the past 58 years in the PRC.

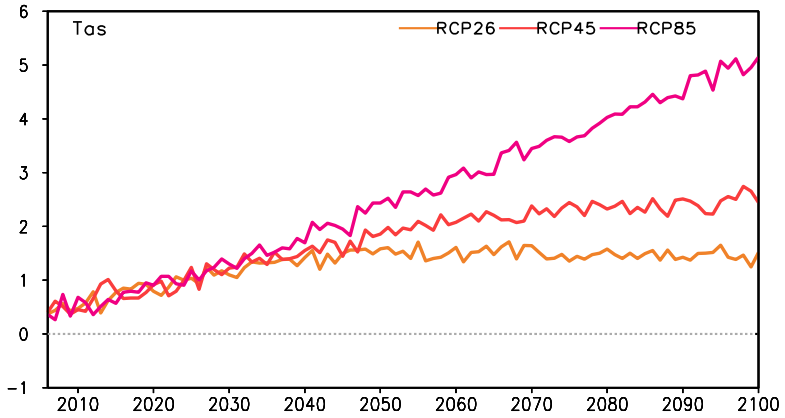


Figure V-18: Projected Annual Mean Temperature Changes in Dongjiang Basin 2010–2100

126. Mean annual precipitation in Dongjiang basin is predicted to increase by 0.46%, 0.72%, and 0.67% per decade respectively under RCP2.6, RCP4.5 and RCP8.5 up to 2100 (Fig. V-19). The average annual precipitation will increase 0.1% under RCP2.6 and decrease 0.5 and 3% under RCP4.5 and RCP8.5 respectively for 2016-2035. There is consistent increasing for annual precipitation under all scenarios for 2046-2065 and 2081-2100.

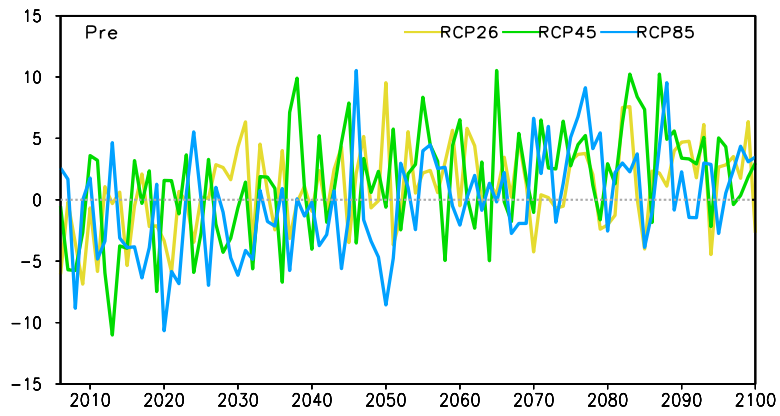


Figure V-19: Projected Annual Precipitation Changes in Dongjiang basin

127. Projected annual evapotranspiration increases in all three scenarios. This trend is <8% for 2016-2035, and ranges from 11.5% to 19.9% for 2045-2065, and 10.7-34.8% for 2081-2100 (Fig. V-20).

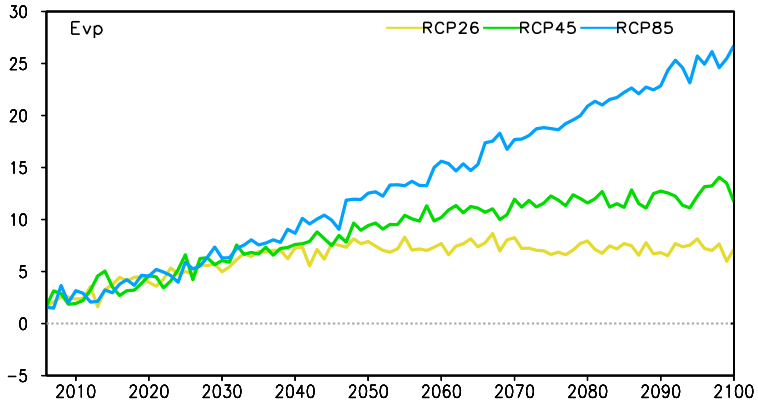


Figure V-20: Projected annual evapotranspiration changes in Dongjiang basin

128. Data for the baseline period of 1971 to 2000 indicates that the average inflow to the Dongjiang Reservoir was 3864 m^3. For comparison based on projections from RCP2.6, RCP4.5 and RCP 8.5 for 2015 - 2013, the mean annual inflow to Dongjiang Reservoir is 3870 million m^3 under RCP2.6 (+0.18% above baseline), 3836 million m^3 under RCP4.5 (-0.71% below baseline) and 3712 million m^3 (-3.91% below baseline) under RCP8.5.

129. In summary, the results of these models for the Dongjiang indicate that:

- During the 21st century, annual mean temperature will increase 1.0 to 1.1 °C between the years 2016 and 2035, by 1.5 to 2.6 °C in the period of 2046-2065, and by 1.5-4.6 °C in the period of 2081-2100. Generally, projected temperature increases in autumn and winter are higher than that in spring and summer.

- Changes in precipitation are expected to be slight with changes ranging between -3% to 0.1% for the period of 2016-2035, 0.1-2.1% for the period of 2046-2065, and 1.8-4.0% for the period of 2081-2100. There is general decrease for seasonal precipitation for 2016-2035, while there is general increase for 2045-2065 and 2081-2100.

- Evapotranspiration is generally increasing for 21st century. The increasing trend is less than 8% for 2016-2035, and ranges from 11.5% to 19.9% for 2045-2065, and 10.7-34.8% for 2081-2100. There is a general and consistent increase for projected seasonal evapotranspiration, especially in winter and autumn.

- Projected inflows into the Dongjiang Reservoir for 2015 to 2030 for each of three scenarios are similar to the baseline period.

VI. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Early Design Phase

130. During the early design phase for the project, some potential impacts were avoided through improved design, as follows.

- Effluent treatment standard for Qingjiang WWTP was originally planned to be Class 1B but was upgraded to 1A standard, the highest possible, in consideration of the water values of Dongjiang Lake.
- The capacity of the Yangdong Water Supply subcomponent was reduced from the original planned capacity of 30,000 m^3/d, to 20,600 m^3/d, an appropriate size considering current and predicted population sizes, thereby avoiding unnecessary construction and operation expenses and resource use.
- The number of solid waste transfer stations was reduced from 11 to seven after optimization of the solid waste collection route.
- The scope of non-point pollution control was expanded from 13 villages (in three townships) to 17 villages (in four townships).
- Pipeline routes were selected to avoid or minimize potential adverse impacts on the environment and surrounding communities.

B. Pre-Construction Phase

131. Prior to construction, the following measures will be implemented.

i) Institutional strengthening. (a) A full-time PMO Environment Officer will be assigned to the project (the same officer assigned throughout the project preparation phase of this EIA) to coordinate EMP implementation. (b) Under the loan consulting services, the PMO will hire a loan implementation environment specialist (LIEC) to provide external support. (c) The terms of reference for these personnel are in the EMP (Attachment 1).

ii) Updating the EMP. In the event of any changes in project design, the EMP will be updated as needed, including mitigation measures and monitoring. This will be the responsibility of the PMO, PIUs, and design institutes.

iii) Confirmation of land acquisition and resettlement. The LAR Plans will be updated with the final inventory and the results will be incorporated into the detailed designs.

iv) Training in environmental management. The LIEC and personnel from provincial EPD and municipal EPBs will give training in implementation and supervision of environmental mitigation measures to contractors and construction supervision companies (CSCs).

v) Grievance Redress Mechanism (GRM). The PMO and PIUs will implement the project GRM at least three months before the start of construction, to ensure that communities are well informed and have the opportunity to discuss any concerns (further to the public consultations already conducted for this EIA; Section IX).

vi) Bidding document and contract documents. The EMP will be included in the bidding documents and contracts for procurement of civil works, goods and services. All contractors and subcontractors will be required to comply with the EMP.

vii) Contractor obligations. In their bids, contractors will respond to the environmental clauses for contractual terms and EMP requirements. Prior to construction, each contractor will develop a Site EMP, based on the project EMP (Attachment 1), and assign a person responsible for environment, health, and safety (EHS). The site EMP shall include the following: (a) site drainage and soil erosion protection; (b) dredge spoil holding and treatment sites, material haulage routes, and waste disposal arrangements; (c) spill control and management; (d) health and safety; (e) surface water and groundwater protection; (f) temporary traffic management; and (g) construction site access control. The site EMP will be submitted to the environmental officers of each county PMO for approval, with support of the local EPBs.

C. Construction Phase

1. Sensitive receptors and project area of influence

132. Potential sensitive receptors to the construction and operation phases of the project were identified through field survey. The planned project works occur within or near over 40 villages in the Dongjiang Lake area (Table VI-1). Despite the wide range of activities to be conducted in the project, construction works for most involve similar concerns for earthworks, soil stabilization, dust and noise control, transport and haulage of building materials, and occupational and community health and safety. These, along with site-specific mitigation measures, are described in the following sub-sections.

Table VI-1: Nearest Sensitive Receivers to Proposed Construction Activities

Town	Village	Distance (m)	Impacted by construction of—
Dongping	Zhoutang	50-450	WWTP
		260-1100	SWTS
Qingjiang	Daitou	220-880	WWTP, SWTS
Longxi	Xiadong	50-750	WWTP
		410-750	SWTS
Qingyao	Zhoutang	260-1100	WWTP
	Haoyuanpu	30-400	River rehabilitation
	Qingyao downtown	20-100	River rehabilitation
Chukou	Huluding	50-200	WWTP
	Jinxing, Chukou downtown	5-400	Chukou Water Supply
	Jinxing	500-2000	SWTS
Lianping	Shanglian	280-580	WWTP
		20- 100	River rehabilitation
	Tianping	20-100	River rehabilitation
Dongjiang	Wenchangge	50-200	SWTS
Zhoumensi	Downtown Zhoumensi	130-1080	SWTS
	Tangjiawan	60-200	Yangdong WTP
	Xijiatian	450-700	Yangdong water pipeline
	Nanping Village along S322 Road	1-200	Yangdong water pipeline
	Yuanjiaping, Lanshi, Qingjiu, Boshui, Liujia	5-150	Yangdong water pipeline
Xingning	Fengxian, Xianqiao, Xingning downtown	10-100	River rehabilitation
	Hejiashan, Xicha, Shiying, Pingshi	5-200	Yangdong water pipeline
	Hejiashan, Dapu, Guangtian	30-100	River rehabilitation
Bailang	Niujiaowan	20-100	River rehabilitation
	Zhongdong	40-100	Xingning Wetland
	Taiqian	100	Xingning Wetland
	Bailang, Jiangkou, Jiangkouchaishang	3-100	Yangdong water pipeline
Tianeshan Forest Park	Villages along Tianeshan River	20	River rehabilitation

WTP = water treatment plant; WWTP = wastewater treatment system; WWTP = wastewater treatment plant.

2. Soil and earthworks

133. Excavation works, backfill, and surplus soil volumes were estimated for the project components involving earthworks. Domestic Soil Erosion Protection Plans (SEPP) were prepared by certified national institutes for these components and approved by the Hunan Water Resources Department.

134. For the water supply component, a total of 785,600 m^3 earth excavation will occur, of which 758,600 m^3 will be reused (Table VI-2a). Construction and in-filling of the water pipeline transmission easements will make maximum use of spoil through balancing excavation and fill volumes. The separated top soil will be stacked nearby for the revegetation after construction. The sites are within 800 meters of the works and have total capacity of 325,000 m^3 (Table VI-2a and VI-3).

Table VI-2a: Excavation, Backfill and Surplus Spoil of Water Supply Component. Unit: 10^4 m^3

Project Area			Excavation	Earth fill	Reused	Surplus spoil	Disposal
Yangdong	Water intake and transmission pipelines	Top soil	11.54	11.54	11.54		
		trench	34.56	34.56	34.56		
		Subtotal	46.10	46.10	46.10		
	Water Treatment Plant	Land levelling	5.01	3.16	3.16	1.86	Z1 spoil site
		Top soil	0.09	0.09	0.09		
		trench	0.03	0.01	0.01	0.02	Z1 spoil site
		Subtotal	5.14	3.26	3.26	1.88	Z1 spoil site
	Distribution stations	Foundation pit	1.09	1.09	1.09		
		trench	0.01	0.01	0.01		
		Subtotal	1.10	1.10	1.10		
	Construction camps	Land levelling	0.46	0.46	0.46		
		Top soil	0.11	0.11	0.11		
		trench	0.01	0.010	0.010		
		Subtotal	0.58	0.58	0.58		
	Construction access road	Land levelling	17.38	17.38	17.38		
		Top soil	2.37	2.37	2.37		
		trench	0.05	0.05	0.05		
		Subtotal	19.80	19.80	19.80		
	Spoil sites	Top soil	0.10	0.10	0.10		
Chukou	Weir	Land levelling	0.14	0.14	0.14		
		trench	0.02	0.02	0.02		
		Subtotal	0.16	0.16	0.16		
	Transmission and distribution pipelines	Top soil	0.55	0.55	0.55		
		trench	0.11	0.11	0.11		
		Subtotal	0.66	0.66	0.66		
	Water Treatment Plant	Land levelling	2.06	1.23	1.23	0.82	Z2 spoil site
		Top soil	0.04	0.04	0.04		
		trench	0.02	0.01	0.01	0.01	Z2 spoil site
		Subtotal	2.12	1.29	1.29	0.84	Z2 spoil site
	Construction camps	Land levelling	0.24	0.24	0.24		
		Top soil	0.06	0.06	0.06		
		trench	0.01	0.010	0.010		
		Subtotal	0.31	0.31	0.31		
	Construction	Land	2.08	2.08	2.08		

	access road	levelling					
		Top soil	0.33	0.33	0.33		
		trench	0.05	0.05	0.05		
		Subtotal	2.46	2.46	2.46		
	Spoil sites	Top soil	0.05	0.05	0.05		
Total			**78.58**	**75.860**	**75.860**	**2.71**	

135. For the river rehabilitation component, a total of 586,500 m^3 spoil will be excavated, comprising rocks, gravel, earth fill (Table VI-2b). An additional 156,200 m^3 spoil will be required for construction of the embankments, and will be sourced from six borrow pits having a total area 3.34 ha which consists of 2.78 ha "forestland" and 0.56 ha "uncultivated land". For each river there will be a management facility for storage of materials and staging of operation. To the extent possible existing roads will be used but some temporary works will be required for mixing of concrete and other construction operations.

136. In total, a total of 538,100 m^3 spoil will need to be disposed for both components. Surplus spoil will be disposed in 16 sites (Table VI-3). All sites have adequate capacity to receive spoil generated during project construction, have soil erosion protection plans which have been approved by the Zixing Land and Resource Bureau and Water Resources Bureau, and will be rehabilitated once filled.

Table VI-2b: Excavation, Backfill and Surplus Spoil of River Rehabilitation Component

Location	Length (m)	Excavation (10^4 m^3)				Fill (10^4 m^3)			Surplus spoil (10^4 m^3)		
		Total	Earth	Stone	Topsoil	Reused		Borrow	Subtotal	Earth	Stone
						earth	topsoil	earth			
Xingning River	3923	9.53	3.22	6.23	0.08	1.10	0.08	2.68	8.35	2.12	6.23
Guangqiao River (section A)	1894	3.31	0.54	2.73	0.04	0.23	0.04	0.28	3.04	0.30	2.73
Guangqiao River (section B)	5785	10.10	1.64	8.35	0.12	0.71	0.12	0.87	9.28	0.93	8.35
Guangqiap River (tributary of section B)	649	1.13	0.18	0.94	0.01	0.08	0.01	0.10	1.04	0.10	0.94
Qingyao River	4230	13.84	3.21	10.54	0.08	0.87	0.08	3.45	12.89	2.35	10.54
Lianping River (Shanglian section)	1792	3.50	1.19	2.27	0.04	0.18	0.04	1.94	3.28	1.01	2.27
Lianping River (Tianping section)	2652	5.17	1.76	3.36	0.05	0.27	0.05	2.87	4.86	1.50	3.36
Tianeshan River	5050	12.07	2.81	9.15	0.10	0.89	0.10	3.45	11.08	1.92	9.15
Total	25975	58.65	14.55	43.58	0.52	4.32	0.52	15.62	53.81	10.23	43.58

137. For the Integrated Ecosystem Rehabilitation component, construction works do not require any additional fill (Table VI-2c).

Table VI-2c: Excavation, Backfill and Surplus Spoil of Integrated Ecosystem Rehabilitation Component

Location	Excavation (10^4 m^3)			Fill (10^4 m^3)			Surplus spoil (10^4 m^3)
	Subtotal	Earth and stone	Topsoil	Subtotal	Earth and stone	Topsoil	
Fish releasing platform	1.16	1.04	0.11	1.16	1.04	0.11	0
Xingning wetland	28.73	22.29	6.44	26.6	20.16	6.44	2.13
Hangxi river wetland	37.08	25.5	11.59	37.08	25.5	11.59	0
Huangcao wetland	8.54	5.87	2.67	8.54	5.87	2.67	0
Total	75.51	54.7	20.81	73.38	52.57	20.81	2.13

138. Table VI-2d presents backfill and surplus spoil for the pollution control component. For the urban WWTPs and the rural WWTS there will be no excess material. For the SWTS, there will be about 1,400 m^3 which be placed at a Zhoumensi SWTS site (Table VI-3).

Table VI-2d: Excavation, Backfill and Surplus Spoil of Pollution Control Component

Project area	**Excavation**(10^4 m^3)	**Earth fill** (10^4 m^3)			**Spoil** (10^4 m^3)
		Subtotal	**Reused**	**Borrow**	
Urban WWTPs	3.95	4.15	3.78	0.2	0
Rural WWTSs	18.29	18.29	18.29	0	0
SWTSs	1.09	1.19	0.95	0.24	0.14

Total	23.33	23.63	23.02	0.44	0.14

139. The 16 spoil disposal sites will have a total area of 11.22 ha, including 1.03 ha dry land, 1.02 ha forest land and 9.17 ha uncultivated land. These will be located within 150 meters of the works to limit transport distances. The soils in the disposal site areas will have high clay content to prevent any movement of leachate into groundwater or the river. The spoil disposal sites will be of two designs, one with a sloping retaining wall and one a valley-fill design, tailored to local topography and covered with local vegetation afterward. To the extent possible, removed sand and gravels will be reused by the project.

Table VI-3: Approved Spoil Disposal Sites (m^3)

	Site	Location	Design Capacity (10^4 m^3)	Spoil Amount (10^4 m^3)	Distance to works site	Existing land use				
						Grassland	Cultivated land	Woodland	Uncultivated	Dryland
Yangdong WTP	1	Near Yangdong WTP site	2.16	2	800	0.32	0.2	0	0	0
Chukou WTP	2	Near Chukou WTP	1.09	0.84	200	0.08	0.17	0	0	0
River Rehabilitation	3	K0+250	4.0	3.34	60	0	0	0	0.63	0
	4	K3+400	6.0	5.01	60	0	0	0.26	0.66	0.21
	5	K1+350	3.5	3.04	150	0	0	0	0.57	0
	6	K4+850	12.0	10.32	50	0	0	0	2.15	0
	7	K1+950	6.0	5.8	50	0	0	0	1.06	0
	8	K4+250	4.79	4.51	50	0	0	0	0.87	0
	9	K4+350	3.0	2.58	50	0	0	0	0.52	0.12
	10	K0+700	3.5	3.28	30	0	0	0	0.88	0
	11	K0+150	5.0	4.86	50	0	0	0	0.61	0.24
	12	K1+300	2.5	2.22	60	0	0	0.16	0.22	0.11
	13	K2+250	3.5	3.32	50	0	0	0.13	0.43	0
	14	K4+150	3.0	2.44	140	0	0	0.17	0.25	0.35
	15	K4+550	3.5	3.10	20	0	0	0.30	0.32	0
Zhoumensi SWTS	16	Near Zhoumensi SWTS	0.26	0.14	10	0	0	0.06	0	0

SWTS = solid waste transfer station; WTP = water treatment plant.

140. Soil erosion. Erosion is anticipated during construction of the treatment plants, pipeline easements, and embankments, when surface vegetation and soil removed. Erosion may occur after construction if site restoration has been inadequate. Before construction, contractors will be required to prepare a Site Drainage and Soil Erosion Management Plan to prevent soil erosion. The plan will include the following measures.

i) During embankment construction: (a) maintain slope stability at cut faces by implementing erosion protection measures such as terraces and silt barriers; (b) construct berms or drainage channels around the perimeter of the construction site to capture soil runoff and direct rainwater away; and (c) plan and implement construction in staged sections, with one section completed and stabilized before beginning the next.

ii) Stabilize all cut slopes, embankments, and other erosion-prone working areas.

iii) Stabilize all earthwork disturbance areas within 30 days after earthworks are completed.

iv) Minimize open excavation areas during trenching and river regulation activities.

v) Use appropriate compaction techniques for pipe trench construction.

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

vii) Construct intercepting channels and drains to prevent runoff entering construction sites, and divert runoff from sites to existing drainage or open ground for watering the vegetation.

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 slope or re-vegetate disturbed surfaces e.g. pipeline trenches and cut banks.

xi) Protect slopes on both sides of embankment.

xii) All dredged sediment, channel soil and spoil disposal sites, embankments, and revetments, will be rehabilitated once they are completed (or full in the case of the disposal sites).

xiii) Landscaping will only use native plant species.

xiv) Construction camps and storage areas will be located to minimize land area required.

141. Compliance with these measures will be checked through internal inspection and monitoring by the construction supervision companies (CSCs), PMO Environment Officer, and county EPBs. Compliance inspection and monitoring will be conducted semi-annually during construction by licensed institutes. Results will be submitted to the PMO, PIUs, local EPBs and WRBs for progress reports and acceptance of construction.

3. Water quality

142. Construction-related risks to water quality of Dongjiang Lake and in-flowing streams are from construction wastewater and river dredging. If not controlled, pollutants could enter Dongjiang Lake.

143. Construction wastewater will be produced from the maintenance and cleaning of mechanical equipment and vehicles, water from mixing and curing concrete, inappropriate storage and handling of fuel, accidental spills, wash-down water for machinery and vehicles, and disposal of domestic wastewater from construction camps. The project will use commercial concrete: it is estimated that 0.5 m^3 wastewater containing 5,000 mg/L suspended solids (SS) will be produced each time a batch of concrete is prepared; in contrast, vehicle and machinery washing wastewater contain 500-1,000 mg/L SS. Approximately 2,520 workers will be employed over the five years of the construction phase, and which will generate wastewater. It is not possible to estimate the on-site wastewater volumes over this time, as worker numbers will vary between years and sites, and some workers will be local residents and will not reside on-site. Portable latrines and sewage management facilities are included in the project EMP. Estimated pollutant concentrations at construction camps is in Table VI-4.

Table VI-4: Pollutant concentrations of municipal wastewater from construction camps

Indicator	BOD_5	CODcr	SS	NH_3-N
Range (mg/L)	200-250	300-400	200	30-40

144. The planned dredging on five rivers may cause: (i) temporary increases in turbidity

levels; and (ii) release of heavy metals. Baseline sampling for the project indicates that most lands in the project area have relatively high levels of some heavy metals (Section V.B). If not managed, these may enter the water column, harming aquatic organisms, and/or contaminate soils at the disposal sites. The dredged channels will also be subject to embankment, which may increase water velocity and in-channel erosion. For the Yangdong WTP, the water pipelines will cross five rivers (Yongle, Zhoumensi, Xiadong, Xingning) and one irrigation canal (Yangdong). The pipes will be aligned under the bridge or along the weir, and will not disturb the river channel.

145. The following measures will be implemented to minimize water pollution and the risks of dredging and embankment. It is concluded that the risks of heavy metal contamination are minimal and will be adequately mitigated by the measures described below. This conclusion is made within the context of the relatively unusual situation of widespread high heavy metal levels across the Dongjiang Lake area including the project rivers.

Construction sites

i) Contractors will develop actions for control of oil and other dangerous substances as part of their site EMPs.

ii) All areas where construction equipment is being washed will be equipped with water collection basins and sediment traps.

iii) Fuel storage, maintenance workshop and vehicle cleaning areas will be stationed at least 300 m away from the waterbody.

iv) Storage facilities for fuels, oil, and other hazardous materials will be within secured areas on impermeable surfaces, and provided with bunds and cleanup installations.

v) 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).

vi) Wastewater from construction activities will be collected in sedimentation tanks, retention ponds, and filter tanks to remove silts and oil. Oil-containing wastewater will require the installation of oil-water separators before the sedimentation tank. After site treatment, construction wastewater will comply with (GB8978-1996) Integrated Wastewater Discharge Standard.

Worker camps

vii) Labor camps will be located at least 300 m from the nearest waterbody.

viii) Portable toilets and on-site wastewater pre-treatment systems will be installed at construction camps along with proper maintenance protocols.

ix) Water quality will be monitored by local EMSs during construction as per the EMP.

Dredging and embankment

x) The contractor will develop detailed dredging measures, emergency preparedness and response plan prior to commencement of dredging activities, to be approved by the local EPBs.

xi) The technical requirements and mitigation measures for dredging will be included in the bidding documents and construction contracts. The contractor will be required to develop a sound environmental management plan, including dredging machinery maintenance, dredged material dewatering site management, internal monitoring procedures, emergency preparedness and response mechanism.

xii) A second round of sediment sampling (e.g. to reaffirm the presence of heavy metals) is not considered necessary, because soil and sediment sampling across the project area, including all five project rivers, show consistently high levels of some heavy metals.

xiii) River embankment and dredging works shall be conducted in the dry season (September to February), the time of lowest water level and slow flow. Construction during the high-flow season (March to August) will be prohibited. This is the main approach taken to avoid risks of dispersion of suspended solids and heavy metals.

xiv) Channel material will be extracted using small excavators or manual labor to minimize physical disturbance.

xv) Access to all sites will be done through existing roads or at points where minimum clearing is required or impacts to terrestrial habitat are minimal. If not possible, access will be done on the river bed upstream from silt protection barriers.

xvi) Dredging will be conducted in discrete sections 500-800 m length, to minimize disturbance at any one time. Dredging will be limited to the upper one meter of the stream beds.

xvii) Works will be conducted concurrently along separate rivers to avoid the rainy season.

xviii) Sediment traps and fences will be applied within and along the river section to minimize dispersion of silt.

xix) Prior to disposal excess water will be drained off and spoil will be allowed to dry in sludge drying areas and transported to disposal areas in covered trucks.

xx) Dredged sediment will be disposed in 16 approved sites near each river (Table VI-3). This will reduce distance and cost of transport to sites further away, and also ensure that heavy metals are retained within the river area they are from.

xxi) Disposal sites were identified on the basis of criteria which included consideration of managing potential risks from exposure of heavy metals: (i) all sites are close to each excavation area and within 75 m of the project river, ensuring that sediments are retained within the river system (rather than transported and introduced elsewhere); (ii) sites have a high clay content, which will act as a natural liner to prevent leakage into subsurface soils, and, the metals will be adsorbed to the clay, rendering them inert; (iii) nearby sites will also reduce the costs and risks (spillage, traffic interruptions) associated with transport.

xxii) The spoil disposal sites currently support secondary shrub growth and/or old (unused) farmland. Once full, the sites will be covered with soil and rehabilitated. Spoil will not be used in agricultural land.

xxiii) Sites will be inspected monthly and after storms to check channel condition.

4. Air quality

146. Anticipated sources of air pollution from construction activities include: (i) dust from blasting, excavation, moving equipment, traffic on unsealed roadways, loading and unloading operations, stockpile stacking and land reclamation operations; (ii) vehicle emission from construction vehicles ($PM_{2.5}$, gaseous CO and NO_x) and heavy diesel machinery and equipment; and (iii) asphalt flue gas during road pavement. The impact distance of fugitive dust (total suspended particulates, TSP) from construction works is modeled to be within 150 m downwind of the source. These various sources of air pollution could affect nearby sensitive receivers. The following measures will be implemented to minimize air pollution.

i) TSP levels must comply with Class II of GB 3095-1996/2012[14], except for activities in the Dongjiang Lake Scenic Area, Dongjiang Lake Wetland Park, and Tianeshan Forest Park, which must comply with Class I.
ii) Spray water on construction site and roads to reduce dust from earthwork excavation, transport, loading and uploading and stacking.
iii) Avoid construction activities during strong windy days as possible.
iv) Transport the spoil and other solid waste in a timely manner. Cover the construction materials during temporary stacking and transport to avoid spillage and dust.
v) The asphalt pavement construction should be done when the weather condition is conducive for pollutant diffusion.
vi) Locating asphalt plants and mixers >500 m downwind from the nearest residential areas and other sensitive receptors.
vii) Storing petroleum or other harmful materials in appropriate places and covering to minimize fugitive dust and emission.
viii) Ensure vehicle and machinery emissions comply with PRC standards of GB18352-2005, GB17691-2005, GB11340-2005, GB2847-2005, and GB18285-2005.
ix) Timely monitoring of air quality and inspections during construction, as defined in the project EMP (Attachment 1).
x) It is expected that the works related to the pipe laying works would be carried out section by section. The dust generated from each section of the pipe laying works would be small scale, localized, and short term.

147. These mitigation measures are expected to maintain air quality in compliance with the standards specified above.

5. Noise

148. A significant increase in noise is expected during construction, due to various construction and transportation activities. Construction activities will involve excavator, bulldozers, graders, stabilizers, concrete-mixing, drills, stone-crushing, rollers and other heavy machinery. Noise during pipeline construction will be generated by the trench excavator, roller and compaction machine. Noise will be temporary and localized. Noise limits for the project are based on PRC Standard of Noise Limits for Construction Site (GB12523-2011) and are 70dB (A) during daytime and 55dB (A) during nighttime. Construction noise presents the risk of hearing injury, stress, and general disturbance, to residents and workers, if not managed. The following predictive model was used to forecast noise levels:

$$L_i = L_0 - 20\lg\left(\frac{R_i}{R_0}\right) - \Delta\mathrm{L}$$

Where: L_i and L_0 are equipment noise level at R_i and R_0 respectively, dB(A); $\Delta\mathrm{L}$ is additional diffusion attenuation caused by barriers, vegetation, air and earth, dB(A);

149. Predicted noise levels at different distances without any barriers are shown in Table VI-5. Construction machinery may produce noise levels of 44-66 dB up to 100 m away. Key noise risks are from: (i) construction of the water pipelines along Roads S322, S205, S349, X022 and X030, where the nearest residents are about 3-5 m away from the easements; and (ii) dredging in the five project rivers. At Tianeshan River, 20 households are 5-10 m from the river; at Lianping River, 200 residents, including one primary school (100 students), are 50 m from the river; at Qingyao River, 1,000 residents, including one middle school (300 students)

[14] GB 3095-2012 will come into effective since 1st January 2016.

and one primary school (500 students) are 30-50 m from the river; at Guangqiao River, 1,000 residents, including one primary school (400 students), are 30 m from the river; and at Xingning River, 2,000 residents, including one middle school, are 30 m from the river.

Table VI-5: Noise from construction machineries at different distance (Unit: dB (A))

Machinery	Distance to machinery (m)	Sound Level (dB(A))	Predicted sound level with different distance to the source (dB(A))							
			10m	20m	30 m	50 m	100 m	150 m	200 m	300 m
Driller	5	92	86	80	76	72	66	62	60	56
Hand driller	1	100	80	74	70	66	60	56	54	50
Excavator/bulldozer	5	85	79	73	69	65	59	55	53	49
Concrete mixer	2	80	66	60	56	52	46	42	40	36

150. The following measures will be implemented to comply with PRC construction site noise limits and protect sensitive receptors.

(i) Ensure noise levels from equipment and machinery conform to PRC standard of GB 12523-2011; properly maintain machinery to minimize noise.
(ii) Equipment with high noise and high vibration will not be used near village or township areas. Only low noise machinery or equipment with sound insulation will be employed.
(iii) Temporary anti-noise barriers will be installed to shield the nearby residences when there are residences within 50 m of the noise source.
(iv) No night time (between 22:00 and 06:00) construction within 300 m of sensitive receptors.
(v) Regularly monitor noise at sensitive areas (see Attachment 1). If noise is exceeded by more than 3dB, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation.
(vi) Provide the construction workers with suitable hearing protection.
(vii) Control the driving speed of vehicles and machinery on-site.
(viii) Inform residents prior to construction about the anticipated noise levels and duration. For residents very near the construction site and subject to prolonged noise exposure, provide hearing protection.
(ix) Conduct regular interviews with residents adjacent to construction sites to identify feedback. This will be used to adjust work hours of noisy machinery.

6. Vibration

151. Vibration impacts are expected during construction of treatment plants, pipeline trenches, and river dredging, including from pilling, pipeline trench compaction, and embankment stone crushing. Mechanical vibration may be sudden and discontinuous, which can cause stress among workers and communities. To address these issues: (i) piling and compaction operations will be prohibited at night; (ii) communities will be consulted prior to large earthworks to ensure they are informed, and, to avoid sensitive timing e.g. exams at nearby schools or festivals.

7. Solid waste

152. Solid waste will be generated from construction waste and worker camps. Around 2,520 workers will be employed during the five-year construction phase (data from FSR). Assuming that each worker produces an average of 0.7 kg garbage/day (estimates from construction projects elsewhere in the PRC) and is employed for at least 20 days, around 35,280 t solid waste over five years could be produced during the construction phase. In practice, solid waste volumes would be less because many of the workers will be local residents from Zixing City, who would be present and contributing to solid waste irrespective of the project. Mitigation measures are included in the project EMP (Attachment 1) for the collection and management of this waste, including the placement of garbage bins, regular emptying, and

disposal at the Changyilong Landfill. This has a total capacity of 3.85 million m^3 and maximum daily design treatment capacity of 300 ton. It has been put into service in 2011 and has a total design service period of 31 years. These disposal measures for solid waste achieve compliance with the PRC Law on Prevention and Control of Environmental Pollution by Solid Waste and scrap material and demolition waste disposal standards by the Ministry of Housing and Urban-Rural Construction.

8. Ecology and biodiversity

153. **River rehabilitation component – dredging and embankment.** The five project rivers support mostly modified bankside regrowth of shrubs and grasses, but also patches of low secondary forest in some short steep sections. The rivers are small and seasonal. Channel habitats include submerged and exposed rocks, gravel, small pools, and wood debris. At least 25 fish species have been recorded in these rivers, including species which breed there (Section V.C). Levels of some heavy metals in the channel sediments exceed the relevant PRC standard, similar to soils and sediments throughout the project area, apparently a natural condition. Construction risks include: (i) temporary release of heavy metals and sediments into the water stream. The metals may be taken up by aquatic invertebrates and fish and cause direct mortality of aquatic organisms and/or threats to human health if fish are consumed; (ii) smothering of aquatic organisms from sediment dispersion; (iii) disruption of fish breeding and/or dispersal, while the channel is blocked during dredging; and (iv) loss or degradation of riverbank vegetation. Operational risks include the potential loss of breeding habitat for fish and other organisms, due to removal of natural channel debris and subsequent channel maintenance.

154. These risks are assessed to be manageable, and with implementation of the following mitigation measures, net impacts are concluded to be low. This is for the following reasons.

(i) A wetland specialist will be recruited for six person-months as part of the loan consultant implementation team. The specialist will design fauna habitat features for the embankments to help minimize the loss of riverbank habitats, conduct detailed checking of the target river sections prior to construction works, be present on-site throughout the dredging and embankment works, and conduct post-construction inspection. The terms of reference for this position is in Appendix 1 of the EMP.

(ii) Dredging will only be conducted in the dry season, from September to February. In at least three of the five rivers, flows stop or almost stop for some of this time. In all rivers, water levels are low (usually <0.5 m) in these months. Dredging at this time will minimize the downstream dispersion of sediments and heavy metals.

(iii) Under the project plan, three companies will be engaged to conduct all river rehabilitation works, and which will be completed within 12 months (April 2016–June 2017). The FSR design institute estimates that dredging will be conducted in sections 500-800 m long, each of which will take about two weeks to complete. Total dredge length is 14.612 km. This equates to a dredge rate of 36–57 meters per day i.e. a total of 8.5–14 months. With the workload divided among three companies, the total works would be completed in three to five months. This timing is tight, but fits within the planned timing of September to January within a safety margin of one month (February is still the dry season) in case of construction delays.

(iv) Dispersion of sediments (and heavy metals adsorbed to these) will be closely controlled by sediment traps and fences and the staged and linear nature of the works. See Section VI.C.3 for additional measures to manage the dredging. This will localize the dredging works.

(v) The scale of dredging is small. Total dredging length ranges from 849 m to 4.3 km per river (Table VI-2b).

(vi) The Lianping and Guangqiao Rivers are known to be spawning, feeding, and/or wintering grounds for some fish species (Section V.C.3). The exact location of fish breeding grounds in these rivers, and whether they occur in the sections to be dredged, is unknown. Prior to dredging, the wetland specialist will conduct inspections of all individual river sections to assess the possibility of breeding sites and conduct rapid targeted sampling if necessary. The dredging length is about 0.6% and 10.5% respectively of the total length of similar lowland sections of these rivers: given the relatively small area of habitat to be impacted, and absence of any threatened species, significant impacts are unlikely.

(vii) The heavy metals which exceed (or almost exceed) the PRC standards, cadmium, arsenic and zinc, adsorb to sediment particles i.e. do not remain free-floating in suspension. This naturally limits the downstream range of dispersion and duration of possible contamination.

(viii) None of the five rivers are used as drinking water sources, further limiting the risk to people.

(ix) During dredging, signs will be displayed along the river and the nearest downstream communities, warning people not to fish in the river in this time. Potential risks will be explained to communities as part of the on-going community consultation during implementation (Section F of project EMP; Attachment 1).

(x) Due to the intactness of upstream river sections, it is anticipated that the dredged sections will be re-colonized by sediment organisms i.e. disturbance will be temporary.

(xi) Embankment designs include textured and porous surfaces which will enable plant growth.

(xii) During all dredging, the PMO Environment Officer, EPB officer, and/or wetland specialist will be present on-site to oversee the works and ensure compliance with the EMP.

155. **Treatment plants and water pipeline easements**. The construction of the six wastewater and two water treatment plants, rural wastewater treatment system and over 700 km of primary, secondary and tertiary water pipeline easements, will involve the impact of about 45.5 ha of roads (19.78 ha), woodland (0.28 ha), non-used land (0.14 ha), and non-irrigated land (25.3 ha). All facilities are located in settled areas around Dongjiang Lake and the vegetation is secondary growth (grasses, shrubs) with low ecological value. Site rehabilitation will include re-planting with native vegetation.

156. **Fisheries.** Fisheries at Dongjiang Lake are declining due to over-harvesting. As part of efforts to increase fish stocks, the project will support the stocking of millions of fish eggs and fry into the lake every year for five years (Section IV.4). Eight species will be released: Black Carp *Mylopharyngodon piceus*, Grass Carp *Ctenopharyngodon idellus*, Black Amur Bream *Megalobrama terminalis*, *Xenocypris davidi*, *Xenocypris argentea*, Common Carp *Cyprinus carpio*, Bighead Carp *Aristichthys nobilis* and Silver Carp *Hypophthalmichthys molitrix*. All are commercial fish species which were introduced to the lake many years ago. All except one, Black Amur Bream, are native species to Hunan Province, and all are widely used in commercial fisheries globally. About 74 fish species have been recorded in Dongjiang Lake, which include native and introduced species (Table V-10).

157. Potential ecological risks considered for the project were altered community composition and/or increased competition between some species, due to the large volumes of a small number of species to be stocked, and, the invasion of stream habitats by these species. Streams are the original natural wetland habitat of the project area (prior to dam construction no large lakes were present) and the potential for impacts from introduced fish, if any, could be higher here than in the lake. These risks are considered low because: (i) Dongjiang Lake and its fish fauna are an entirely artificial habitat, created with the construction of Dongjiang Lake; (ii) the fish fauna is already highly modified by previous fish stocking, fisheries, and the mix of native and non-native species; (iii) all project species already occur in the lake; and (iv) the eight project species occur naturally in slow-flowing rivers and lakes, not in small, shallow rocky streams, and do not conduct migrations up such streams. There are no potential impacts related to fish feed (e.g. impacts to water quality) as no fish feed will be used for the project – the stocked fish will only utilize existing food resources in the lake.

9. Social issues

158. About 2,835 mu of land will be required for permanent use by the project (184 mu collective land and 2,651 mu state-owned land) Another 979 mu of land will be used on a temporary basis (783 mu state-owned and 195 mu collective). Around 1,539 m^2 of houses will be demolished during the project. A total of 123 households with 403 persons will be affected permanently, from 18 villages in 8 townships (Dongping Xiang, Longxi Xiang, Qingyao, Dongjiang Sub-district, Chukou, Zhoumensi, Xingning, Bailang Xiang). In general, land uses in areas to be affected by the project include farming on non-irrigated land, woodlands, cultivated vegetables and gardens, and areas where construction has taken place. Woodlands consist of fir forest, bamboo forest, pine trees and shrub. The main crops in the project area are rice, corn, sweet potatoes and soybean. The main fruit species are oranges, pears, peaches, and loquats. A resettlement plan has been prepared in accordance with PRC and ADB requirements and to ensure that affected residents receive adequate compensation and/or support. Detailed analyses of impacts to livelihoods, resettlement, and economic analysis are included in these plans, which will be available in Chinese language at the PMO office and ADB website.

10. Community and worker health and safety

159. The construction industry is considered to be one of the most hazardous industries. Intensive use of heavy construction machinery, tools, and materials present physical hazards including noise and vibration, dust, handling heavy materials and equipment, falling objects, work on slippery surfaces, fire hazards, and chemical hazards such as toxic fumes and vapors. Contractors will each prepare an environmental, health and safety management plan, which will include the following.

(i) Provide a clean and sufficient supply of fresh water for construction sites and camps.

(ii) Provide adequate number of latrines at construction sites and work camps, and ensure that they are cleaned and maintained in a hygienic state.

(iii) Garbage receptacles at construction sites and camps will be set up, which will be periodically cleared to prevent outbreak of diseases.

(iv) Provide personal protection equipment to comply with PRC regulations e.g. safety boots, helmets, gloves, protective clothing, goggles, ear plugs.

(v) Emergency preparedness and response plan for accidents and emergencies, including environmental and public health emergencies associated with hazardous material spills

and similar events. These plans will be submitted to the local EPBs for review and approval. Emergency phone link with hospitals in the project towns will be established. A fully equipped first-aid base in each construction camp will be organized.

(vi) 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.

(vii) Occupational health and safety matters will be given a high degree of publicity to all work personnel and posters will be displayed prominently at construction sites.

(viii) All workers will be given basic training in sanitation, general health and safety matters, and work hazards. An awareness program for HIV/AIDS and other communicable diseases will be implemented for workers and the local communities.

(ix) Core labor standards will be implemented. Civil works contracts will stipulate priorities to (i) employ local people for works, (ii) ensure equal opportunities for women and men; (iii) pay equal wages for work of equal value, and pay women's wages directly to them; and (iv) not employ child or forced labor. Specific targets for employment have been included in the gender action plan (GAP).

160. Roads in the project area are rural, narrow and winding, and pass through villages with few or no sidewalks. Without management there is a potential for safety hazards and traffic congestion. Construction may cause unexpected interruptions in municipal services and utilities because of damage to pipelines for water supply, drainage, heating supply and gas supply, as well as to underground power cables and communication cables (including optical fiber cables). Contractors will implement the following EMP measures to reduce risks to community health.

(i) Traffic management. A traffic control and operation plan will be prepared, to be approved by the Zixing City police 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.

(ii) Underground facilities survey and protection. Pipeline construction activities will be planned so as to minimize disturbances to utility services.

(iii) Information disclosure. Villagers, residents and businesses will be informed in advance through media and information boards at construction sites of the construction activities, given the dates and duration of expected disruption.

(iv) Construction site protection. Clear signs will be placed at construction sites in view of the public, informing people about the project grievance redress mechanism, and warning people against potential dangers such as moving vehicles, hazardous materials, and excavations, and raising awareness on safety issues. Heavy machinery will not be used at night. All sites will be secured, disabling access by the public through appropriate fencing whenever appropriate.

161. Construction may require relocation of municipal utilities such as power, water, communication cables. Construction of the water pipeline trenches and water intake structures may disrupt water flow and cause temporary interruptions in water supply to communities. Temporary suspension of services (planned or accidental) can affect the

well-being and business of residents. These risks will be avoided and/or minimized as follows.

(i) Contractors will assess construction locations in advance for potential disruption to services and identify risks before starting construction. Any damage or hindrance to local businesses caused by premature removal or insufficient replacement of public utilities will be subject to compensation by the contractor.

(ii) If temporary disruption is unavoidable the contractor will, in collaboration with relevant local authorities e.g. for power, water supply, communications, develop actions to minimize disruption and communicate the dates and duration in advance to all affected people.

(iii) Construction billboards, which include construction contents, schedule, responsible person and complaint phone number, will be erected at each construction site.

(iv) Local communities will be informed at least two days before any planned water interruptions and given time to store water.

(v) For dredging along the five project rivers, the use of coffer dams and temporary diversion channels, to maintain continued water flow while works are conducted.

(vi) In the event of any accidental interruption (e.g. unintended damage of an existing water supply pipeline during excavation), downstream communities would immediately be informed and assisted with water or power supply until the issue is resolved.

11. Physical Cultural Resources

162. No cultural heritage or archaeological sites are known from the project areas. However, construction activities have the potential to disturb unknown underground cultural relics. The EMP mitigation measures include immediate suspension of construction activities if any archaeological or other cultural relics are encountered, in accordance with the PRC Cultural Relics Protection Law 2002. The Chenzhou Cultural Heritage Bureau, PMO, and implementing agency will be promptly notified. Construction will resume only after investigation and with the permission of the appropriate authority. The clause for protection of unknown underground cultural relics will be included in construction contracts.

D. Operational Phase

1. Wastewater Treatment Plants

163. Operation of the six WWTPs will require management of disposal of the treated effluent, solid waste generated by staff, and air and noise emissions. Two WWTPs, Qingjiang and Chukou, will be near Dongjiang Lake, and the other four are located along or near rivers. The following risks have been assessed and mitigation measures developed.

164. **Cumulative nutrient loading and risks to water quality.** The treated effluent will meet Class 1A or 1B of the PRC Pollutant Discharge Standard for Town Sewage Treatment Plants (GB18918-2002) (Table VI-6). To meet these standards, treatment will result in reductions of pollutant levels in influent for COD – by 416% (163.16 t/a), BOD_5 – by 795% (105.49 t/a), TN – by 175% (330 t/a), TP – by 450% (12.96 t/a), and SS – >1000% (171.92 t/a) (based on Table IV-4). Treated effluent will be discharged into Dongjiang Lake and four rivers (Table VI-6). The treated effluent contains nutrients (albeit much reduced levels) which could cumulatively affect water quality. Dongjiang Lake and the four rivers are classified under the PRC Surface Water Standard as “functional zone category III”, and the effluent needs to meet

the stated levels of this category (Table VI-7).

Table VI-6: Effluent Discharge Standards for the WWTPs

WWTP Name	Designed Capacity m^3/d	Designed Effluent Quality	Destination
Qingyao	600	Class 1B	Qingyao River
Lianping	100	Class 1B	Lianping River
Qingjiang	300	Class 1A	Dongjiang Lake
Chukou	800	Class 1A	Dongjiang Lake
Dongping	100	Class 1B	Dongping River
Longxi	100	Class 1B	Changhuo River

165. To assess the risk of cumulative nutrient loading, the rate of dilution for the two most significant water quality parameters indicating pollution, COD and ammonium nitrate (NH_3-N), was modeled for one river, Qingyao, using the *2-D Steady State Mixed Decay Model*. River flow rates and volumes applied were from the dry season at lowest flow, to assume a worst-case scenario in which the treated effluent is only slowly diluted. The results confirm that both parameters are completely diluted within less than 100 m downstream from the WWTP: at 100 m downstream, pollutant levels not only comply with the PRC standard but considerably exceed it – COD is only about 50% of the maximum limit and NH_3-N about one-tenth (Table VI-7).

Table VI-7: Mixing Zones of COD and NH_3-N Upon Effluent Discharge

Parameter	Treated effluent quality	Background level in Qingyao River	Category III Water Quality Standard	Concentration 100 m downstream
COD	60 mg/l	10.18	20 mg/l	10.23 mg/l
NH_3-N	5 mg/l	0.81	1 mg/l	0.11 mg/l

166. None of the four rivers are used for drinking supply, limiting the risk to communities. All are permanent rivers, limiting the risk of nutrient accumulation in slow-flowing pools and subsequent eutrophication. The river sections immediately downstream of the WWTPs will be subject to continuously elevated pollutant loads prior to dilution, but the modeling indicates these impacts would be less than 100 m in distance (modeling was conducted in 100 m-increments). On the basis of these findings risk to local communities and aquatic ecology is considered low.

167. Ineffective storage and maintenance of WWTP chemicals could also impact the water quality of rivers and Dongjiang Lake. Under PRC standards for WWTPs, clearly defined storage facilities are required for fuels, oil, and other hazardous materials, which are in secured areas and on impermeable surfaces. Under the project training program, WWTP operators will also receive training in safety procedures. Assuming full implementation of these measures, this risk is anticipated to be minimal.

168. **Noise and odor.** Operation will generate noise and odor (ammonia, NH_3 and hydrogen sulphide, H_2S). Noise will be generated by mechanical equipment such as waste water lift pumping, return sludge pump and grid screen rotation. Station operators will maintain the equipment in good working condition as part of standard operating procedures. Modeled noise levels at the boundary of each WWTP are predicted to be <50 dB(A) (Table V-8). WWTPs are all located at least 50 m from their boundary to the nearest residence. These levels comply with the Class I and/or II of the PRC *Noise Standards at the Boundary of Industries and Enterprises* (GB12348-2008). For odor, levels of ammonia and hydrogen sulphide emission were modeled[15] and will be less than 1.5 mg/m^3 and 0.06 mg/m^3 respectively at the boundaries of the WWTPs. This complies with Grade II of PRC *Discharge*

[15] Using the *air environmental protection distance computation method* in PRC Technical Guidelines for Environmental Impact Assessment - Air Environment (HJ 2.2-2008).

Standard of Pollutants from Municipal Wastewater Treatment Plant (GB18918-2002). A calculation of the distance from the plant where maximum concentration of these gases occurs has been undertaken using the air environmental protection distance computation method regulated in *Technical Guidelines for Environmental Impact Assessment - Air Environment (HJ 2.2-2008*). The maximum ground concentrations (NH_3: 0.8578E-03 mg/m^3; H_2S: 0.7751E-04 mg/m^3) are at 110 m downwind. This confirms that odor standards comply with the relevant standards. The nearest residential area is 260 m.

Table VI-8: Noise Levels Predicted During Operation of WWTPs [dB(A)]

	Contribution value	Status monitor maximum value (background)		Synthesis of sound level (forecast)		GB 12348-2008
		Daytime	Night	Daytime	Night	
East boundary	44	47.6	36.9	46.1	36.9	Class I: Daytime: 60 Night: 50 Class II: Daytime: 55 Nighttime: 45
South boundary	49.7	48.7	38.1	47.5	38.1	
West plant	36.8	49.7	39.5	47.5	39.5	
Northern boundary	36.2	45.1	42.2	43.8	42.2	

169. **Solid waste.** Initial filtering of wastewater removes large objects such as discarded plastic, sticks and leaves. These materials, along with incidental litter produced by operating staff, will be transported by municipal waste collection vehicle to the Changyilong Landfill (Section VI.D.2). Subsequent filtering and treatment produces sludge, from the grit chamber, oxidation channel and secondary settling tank. A 600 m^3/d WWTP produces 0.3 to 0.45 tons of sludge (80% water content) per day. The sludge will initially be stored in a drying tank then moved to a small drying pond next to the station building (Fig. VI-1). The dried sludge will be used as fertilizer for landscaping around the WWTPs and other project sites. The sludge cannot be used for farmland fertilizer given the possibility it might not meet PRC quality requirements (usually coagulants such aluminum ions are used to settle the phosphate, causing aluminum content in the sludge).

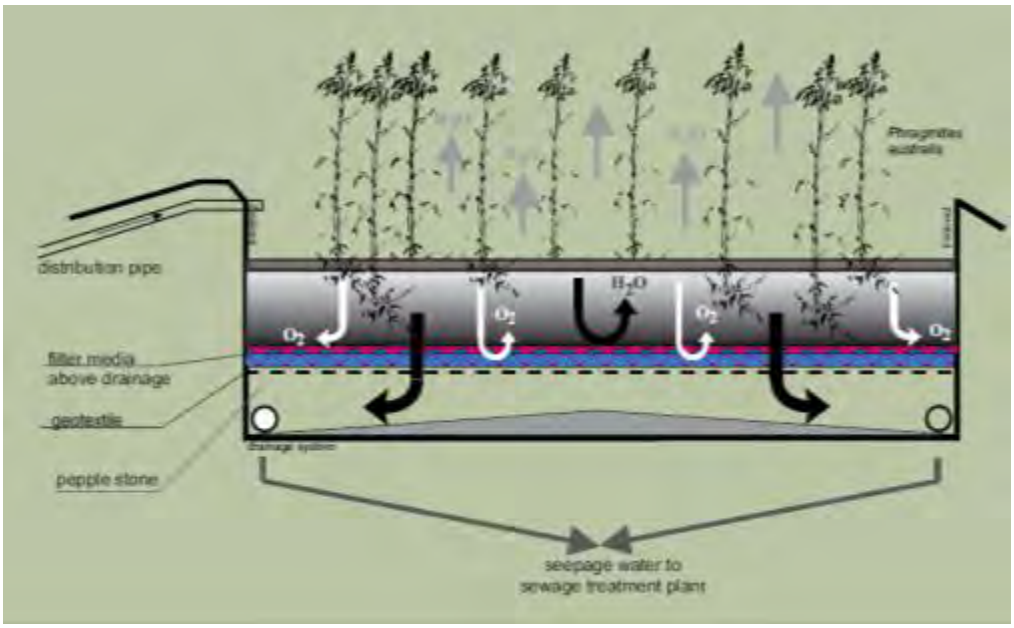


Figure VI-1: Schematic diagram of sludge storage and treatment

170. Health and safety. Plant operators may be injured by slips on wet floors, falls into treatment ponds, and splashes of treatment chemicals. The following measures will be implemented to safeguard the safety and health of WWTP operators: (i) use of safety shoes or boots with non-slip soles; (ii) posting of safety instructions in each workshop regarding the storage, transport, handling or pouring of chemicals; (iii) check electrical equipment for safety

before use; verify that all electric cables are properly insulated; take faulty or suspect electrical equipment to a qualified electricity technician for testing and repair; (iv) wearing of safety goggles in all cases where the eyes may be exposed to dust, flying particles, or splashes of harmful liquids; and (v) wearing of respiratory mask in the sludge dewatering and de-odor workshops and when moving and transporting sludge. Finally, health and safety will be incorporated into the regular staff training programs.

171. Emergency plan. Each WWTP will prepare and implement an emergency preparedness and response plan before operation. This will comply with the requirements of the Hunan Plan for Public Emergency Preparedness and Response, which is based on the National Master Plan for Public Emergency Preparedness and Response (State Council, 2006). Each plan will include requirements for training, resources, responsibilities, communication, and procedures. Appropriate information about emergency preparedness and response activities, resources, and responsibilities will be disclosed to affected communities.

2. Solid Waste Management

172. Solid waste collection, transport and treatment will: (i) generate odor, leachates and noise at the transfer stations; (ii) generate dust and traffic noise by the collection vehicles; (iii) require efficient separation of waste materials prior to disposal; and (iv) require clear operating procedures and personnel training, for worker and community health and safety. A facility operation plan will be developed and include operating schedule, staff roles and responsibilities, procedures for waste collection, transport and sorting, handling of hazardous materials and leachate, maintenance of facilities, employee training, health and safety, and record keeping. A detailed waste collection schedule and route will be developed for each station. The plan will set daylight operating hours and weekly collection of waste. Drivers will be trained to drive safely and at prescribed speed limits.

173. For odor and noise at the stations, the project design includes: (i) a minimum width of buffer zone and green belt around each station, to comply with PRC Technical Specifications for Domestic Solid Waste Transfer Stations (CJJ47-2006); (ii) stations will be fully closed to minimize release of odors to the surrounding environment – ventilation is ensured in the designs; (iii) equipment and stations will be regularly cleaned with disinfectant to maintain hygiene, reduce the risk of disease, and control odor and pests.

174. Leachate. The accumulated waste in the stations, and use of disinfectant, will generate leachates with possibly high pollutant concentrations. The station floors are designed with drainage to capture runoff. This will be stored in sealed leachate storage tanks, to avoid seepage and pollution of surface water or groundwater. The leachate will be transported in sealed containers in the waste collection vehicles to the leachate treatment center at the Changyilong Landfill for final treatment and disposal.

Figure VI-2: Zixing Changyilong Landfill

175. All employees will be trained in health and safety measures and to identify problems such as accidental release of trash from trucks, or the risk of “hot loads”. This is where trash has been disposed which is partly burning or smoldering (but which is unnoticed by residents or the vehicle operator), is subsequently collected, and fire starts within the waste collection vehicle or back at the station. Fire safety equipment will be present in the stations and collection vehicles. Emergency plans will include immediate reporting to the local fire station and warning local neighbors.

176. All solid waste except materials to be recycled (e.g. aluminum cans, cardboard, paper) will be disposed at the Zixing Changyilong Landfill (Fig. VI-2). This has a total capacity of 3.85 million m^3 a maximum daily design treatment capacity of 300 ton. It has been put into service since 2011 and has a total design service period of 31 years. Materials to be recycled will be disposed at the Zixing Domestic Solid Waste Sanitary Landfill in Xingtang Village Changyilong, Hua County. This site is 19.5 ha (292 mu) and has a total daily treatment capacity of 130 ton.

3. Water Treatment Plants

177. Operation of the Yangdong and Chukou WTPs will require abstraction of water from Yangdong Irrigation Canal and Chu River respectively and involve noise emissions, staff health and safety, and disposal of solid waste generated by staff. The following risks have been assessed and mitigation measures developed.

178. **Risk of reduced water supply for downstream communities.** The Yandong WTP will utilize water from the Yangdong Irrigation Canal which has released by the Yangdong Hydropower Station. The hydropower station is located immediately below the reservoir i.e. at the top of the canal. Currently, the water discharges into the canal and provides irrigation water for downstream communities as well as a cascade of several smaller hydropower dams, which generate electricity for nearby communities. A water balance analysis was conducted to assess the extent of reduced water availability to downstream communities. The results (Table VI-9) show that the total annual demand for water abstraction for the Yangdong WTP will be around 15% of total water available in the reservoir, although in the low flow months (September to February) it is about 47%. Calculation of the abstraction volumes and irrigation needs, and accounting for evaporation and leakage, shows that even during the months of low water level, water abstraction by the WTP will not impact the irrigation requirements of downstream communities. For electricity supply, all communities are connected to the county electricity grid and will not have their electricity supply impacted.

Table VI-9: Water balance analysis for Yangdong WTP (unit: 10^4 m^3)

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
Inflow	9.97	106.31	270.88	139.48	350.56	283.97	213.07	562.51	11.72	105.46	130.55	3.92	2188.41
Evaporation and leakage	1.3	0.75	0.37	2.88	3.63	6.46	8.62	6.88	5.15	1.95	1.24	1.92	41.13
Irrigation	0	0	0	0	0	0	314	665	265	110	0	0	1354
Water available	134.93	176.08	270.88	422.41	708.29	924.77	755.59	580.62	256.6	185.11	249.86	190.74	4855.88
Water demands of the project	63.86	57.68	63.86	61.8	63.86	61.8	63.86	63.86	61.8	63.86	61.8	63.86	751.9
% of Total	47%	33%	24%	15%	9%	7%	8%	11%	24%	34%	25%	33%	15%

179. For the Chukou WTP, water will be provided from the Chu River. Mean annual runoff of the river is 175. 52 million m^3 and mean flow rate is 0.10 m^3/s. Minimum ecological flow requirement is 0.01 m^3/s (estimated by the Tennant method i.e. 10% of average flows). After deduction of the ecological flow requirement, the available water volume is 145.41 million m^3 per year and the minimum daily available water is 967.9 m^3. The WTP will utilize 620 m^3/d i.e. is well within the supply capacity of the river.

180. **Noise impacts to nearby residents.** The WTPs will emit operational noise from mechanical equipment such as pumps and blowers. At each WTP, cumulative noise is estimated to be 85 dB(A). All equipment will be enclosed within the station building and shielded. The level of external noise at the plant boundaries complies with (i.e. is lower than) the Class III Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008).

181. **Management of dewatered sediment, domestic wastewater, and solid waste.** The treatment process will use a flocculent (usually PAM or PAC) to remove sediment from the raw water. Dewatered sediment from Yangdong WTP (about 117 m^3/a) will be disposed in one of the five project spoil disposal sites (Table VI-3). The site's capacity is 21,600 m^3; 18,800 m^3 will be used during construction. The remaining capacity is adequate for WTP operation for about 24 years. For Chukou WTP, the dewatered sediment amount will be very small due to the small size of the plant, and will be disposed by the Chukou solid waste transfer station (to be constructed under the project). For domestic wastewater, about 31 and 14 staff will operate the Yangdong and Chukou WTPs and will produce around 4.7 m^3/d and 1.4 m^3/d wastewater respectively. At Yangdong WTP, domestic sewage will be treated in an on-site septic tank then discharged into Yongle River. At Chukou WTP, the sewage will be transferred to the Chukou WWTP for treatment. Solid waste generated by employees will be collected and disposed by the project solid waste system (Section VI.D.2).

182. **Occupational health and safety.** The water treatment process uses chlorine dioxide for water disinfection. Hazards exist in preparing, transporting, storing and handling hydrochloric acid and sodium chlorite used for chlorine dioxide generation. Chemicals will be mixed in a batch reactor tank in a chlorination room in each WTP. The product, a gas-liquid mixture of chlorine dioxide and chlorine, is added to the intake water to achieve chlorine disinfection and oxidation. There is the risk of chemical leakage and from handling. PRC safety requirements for WTPs require safe handling, use of protective equipment and clothing, emergency response measures (including auto-alarms in the chlorination rooms in the event of chlorine leakage), and employee training. All of these form essential parts of the WTP design and operation and compliance is required for domestic auditing and approval prior to the commencement of operation.

E. Indirect, Induced, and Cumulative Impacts

183. 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. Cumulative impacts are 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.

184. **Indirect impacts.** Hydrology and ecology of the five project rivers might be affected downstream of the dredged and embanked sections, and also due to the subsequent maintenance (keeping the channels clear or debris). These potential risks are low as (i) no in-channel structures will be constructed, (ii) the short length of works in each river. In the longer term, the project may result in a range of induced impacts. By improving natural habitats and features at Dongjiang Lake, this may result in increased tourism (due to improved fisheries and amenities), increased fishing activity on Dongjiang Lake (including motorized boats and risks of fuel spill), increased general awareness of the environment and maintaining water quality, and improved agricultural practices in project area, further reducing nutrient loading. The project training, planning, and information management systems being implemented will help strengthen the capacity of the ZCG to manage these issues in the

context of existing and future basin master plans.

185. **Cumulative impacts.** In general, activities in the Dongjiang Lake area have caused significant non-point pollution through inadequate wastewater treatment, poor solid waste management and agricultural runoff, soil erosion on hill slopes and river banks, limited storm water management, and high nutrient loading in Dongjiang Lake from cage fish farming. The ZCG is undertaking a range of domestically funded programs to address soil erosion, water quality, and economic development, which complement the current project. Relevant cumulative benefits from the project which complement these other programs include: (i) reduced water pollution, through the installation of rural wastewater systems, treatment plants, and water treatment plants; (ii) promotion of formulated fertilizer and improved agriculture; (iii) the collective benefits of (i) and (ii) are estimated to reduce, over the project duration, TP by 100 t, TN by 227 t, COD by 1,389 t, and garbage by 80,000 t. Overall, the project and existing programs collectively contribute to achieving the targets of the Dongjiang Lake and ZCG master plans for development and environmental protection.

186. The project, together with existing programs, contributes to achieving the targets of the *Dongjiang Lake Ecological Implementation Plan 2012-2015* for water pollution and security. As part of the latter plan, Dongjiang Lake has been selected as a pilot lake under the PRC "One Lake, One Strategy" program. In this program, actions are being taken to address pollution threats to the lake which are not being addressed under the current project, especially mining in upstream areas and the re-location of pig farms from the lake banks. The combined impact of these efforts will help improve the lake water quality to a uniform Category II or higher (some parts of the lake are Category III) of the PRC Surface Water Quality Standard.

F. Climate Change and Greenhouse Gas Emissions

187. **Greenhouse gas emissions.** Project GHG emissions will be generated during construction (vehicles, machinery, workers) and operation (electricity use at the treatment plants, emissions of station vehicles, emergency generators during power black-outs). Electricity will be supplied through the municipal grid. The SPS requires that estimates of GHG emissions are made for projects which may emit >100,000 t CO_{2e} per year. An estimate of major project GHG emissions was derived using the assumptions presented in Table VI-11. It was estimated that during construction 15,313 tons CO_2 equivalent (t CO_{2e}) would generated per year and for operations 1,583 t CO_{2e} per year. These values are well below the SPS threshold level. Additional emissions may come from the release of gasses in sediment dredged from the five rivers; however since over 90% of dredge material will consist of rock and gravel, such emissions would be minimal.

Table VI-11: Estimation of GHG Emission by the Project

Construction	Units	tons CO_2 equivalent
Workers (consume 1 kg meat/d for 3 years)	2,520	15,120
Large trucks or equipment – (6600 km/yr)	18	44
Light commercial truck (10t) –(13,200 km/yr)	36	131
Construction wastes (15,000 tons/y)		18
Total		15,313
Operation		
Workers (consume 1 kg meat/d for 3 years)	112	672
Light commercial truck (10t) –(13,200 km/yr)	20	73
Boats	5	18
WWTPs (kw-hr/year)	246,740	215
Solid Waste Management (kw-hr/year)	66,000	57
Non-point Pollution (kw-hr/year)	3,650	3
Water Treatment Plant (kw-hr/year)	474,500	413
River Rehabilitation (kw-hr/year)	2,500	2

Aquatic Platform and Center (kw-hr/year)	11,000	10
Wetland (kw-hr/year)	1,679	1
Monitoring (kw-hr/year)	15,600	14
Research Center (kw-hr/year)	4,300	4
Solid Waste Management (tons)	82,000	102
Total		**1,583**

Note: estimated using online GHG calculator (www.carbonneutral.au). Estimates of unit numbers are from the detailed engineering design report for the project.

188. **Potential climate change impacts to the project.** A climate risk vulnerability assessment (CRVA) was conducted for the project based on the likelihood of change in selected variables assuming a project design life of 30-40 years (Section V.C; *Supplementary Document 10* of the *PPTA Draft Final Report*). Project operations at risk from climate change, and the adaptation measures which have been included in the project design, are as follows.

(i) Treatment capacity and plant location. The increasing probability of severe storm events could strain pipeline capacity and threaten plant facilities located alongside waterways. These risks are low: (a) pipeline diameter has been designed for 1 in 10 year flooding, double the current flood capacity (1 in 5) of existing infrastructure at Dongjiang Lake; (b) of the eight plants (six WWTPs and two WTPs), two are located at Dongjiang Lake, where the water level can be quickly regulated through the Dongjiang Dam; and (c) the rivers along which the remaining plants are located are small and already subject to flood control embankments.

(ii) Solid waste management. Rising temperatures may increase health hazards associated with increased bacterial action, especially at the waste transfer stations, where waste is accumulated. Health and safety measures for waste handling, and emergency response measures in the event of health incidents, are required as part of the operational procedures of the stations and will be part of the training and capacity building component of the project.

(iii) Flood control and riverbank protection. Increasing frequency and severity of storms could damage land and property (as occurred during local floods in 2006). The project is supporting the dredging and embankment of sections of these rivers to reduce flood risks, to achieve a flood control capacity of 1 in 10 year flood interval.

(iv) Constructed wetlands. Increased storm events may cause physical damage to the wetlands and/or increase sediment loads, while rising temperatures may facilitate the spread of pathogens or invasive species. Schistosomias occurs in Hunan Province but is not recorded from southern Hunan, including the project area (Section V.E). Rising temperatures and warming waters might facilitate the spread of the host snail *Oncomelania* for the disease to southern Hunan. Management staff will, as part of standard operating procedures, be required to use appropriate rubber boots and gloves when working in the wetlands e.g. inspecting subsurface pipes.

(v) **Conclusion.** Climate change is concluded to present a *low* risk to project viability, particularly after the adaptation measures described above are implemented. It is likely the risk is also *low* prior to consideration of such measures. This conclusion differs from the preliminary climate risk assessment of *medium* made in the early stages of project planning (ADB *Rapid Environment Assessment Checklist*, 7 February 2014), but which did not consider adaptation measures.

VII. ANALYSIS OF ALTERNATIVES

189. During project preparation, alternative designs were assessed in consideration of technical, economic, and energy efficiency and environmental and social impacts. Six alternatives were assessed: (i) 'no project' scenario; (ii) use of different wastewater treatment technologies; (iii) sludge dewatering equipment selection; (iv) solid waste disposal methods; (v) different engineering wetland schemes; and (vi) alternative methods of embankment and revetment.

1. No-Project Alternative

190. The result of no action was assessed to be gradual and long-term deterioration of the lake water quality and natural environment, causing adverse impacts on the municipal economy in terms of financial losses and added costs due to (a) continued and increased outflow of wastewater to residential areas, drainage channels, and ultimately into the Dongjiang Lake; (b) illegal dumping of solid waste causing environmental nuisances; (c) degradation of natural resources and biodiversity; (d) increase soil erosion and low efficiency bamboo forest; and (e) continued/increased risk of damage to individual homes and properties from flooding.

2. Design Options

191. **Comparison of wastewater treatment process.** Commonly used treatment processes for domestic wastewater are activated sludge process (conventional AS, A/O, A/A/O, SBR, CAST, oxidation ditch), biofilm process (bio-filter, bio-disk, biological contact oxidation), and natural purification (stabilization pond, wetland). The following factors were assessed: (i) limited available land (limiting the use of natural methods); (ii) anaerobic digestion method sometimes can be used for rural wastewater treatment, but its poor performance cannot meet the effluent water quality standards; (iii) the AS method does not achieve good N and P removal, but requires less technical capacity than the biofilm method; and (iii) AS process usually produces large amounts of sludge and can cause sludge bulking problems (Table VII-1).

Table VII-1: Commonly Used Wastewater Treatment Processes

Method	Performance	Cost	Investment	Remarks
AS	0.2-0.6 kg BOD_5/m^3-day; BOD removal 80-90%, good N,P removal	Fair	Land area large, capital cost high	Poor load impact resistance; sludge volume large; good treatment performance
Biofilm	3-6 kg BOD_5/m^3-day; BOD removal 80-95%; N, P removal fair	Low	Land area small, capital cost low	Fair performance, stable effluent quality; low sludge volume
Anaerobic digestion	COD removal $<$ 80%; low NP removal	Low	Land area large, capital cost fair	Poor treatment (cannot meet the standards)
Natural purification	Performance dependent on area and weather	Lowest	Largest land area, capital cost fair	Requires large land area; risk of secondary pollution

192. Based on these considerations, an improved AS method (instead of conventional AS) will be used. There have been many AS applications methods, such as A/O, A/A/O, SBR, CAST, IDEA, and improved extended aeration AS process. Many integrated or packaged systems are available which integrate and combine these processes, and which have the advantage of short construction period, easy installation and good performance. This subcomponent will adopt the package systems that integrate the enhanced extended aeration AS process.

193. For small (<10 households) rural wastewater treatment, the FSR compared septic tank, biogas tank, contact oxidation tank, and 4-tank system (Table VII-2). The selected system is

the 4-tank system. This is also promoted by a national rural cleaning project by the Ministry of Agriculture.

Table VII-2: Alternatives for Small Rural Wastewater facilities

Name	Advantage	Disadvantage
Septic tank	Simple structure; easy to construct; low capital cost; easy to maintain; no energy consumption; low operation cost; good sanitation performance	Large volume of sediments, need regular cleanup; potential of leakage; poor treatment performance and effluent quality
Biogas tank (digestion)	Simple process; low capital cost; zero operation cost; can be used as fertilizer	Subject to influent concentration and temperature; poor effluent quality; NP removal limited
Contact oxidation (biofilm)	Low land area; low sludge volume; no sludge bulking. resistance to load shock (quality and volume); easy to operate; good removal	Higher capital cost on filling media. Not flexible. Poor P removal
4-tank system	Low cost, low land requirement; easy to maintain. Stable performance	Small load. Not applicable to large load cases

194. **Solid waste disposal methods.** Dongping Town is located in the southeast of Zingxing City, 118.3 km from downtown Zixing. Three alternatives were considered for the final disposal of garbage generated in Dongping Town (Table VII-3). For smaller, more isolated communities in the project area, burning of litter, composting, and development of sanitary landfills was considered but rejected due to environmental impacts from air emissions and costs. The selected approach for the project is the development of a solid waste transfer station located at Dongping Town including an efficient and regular litter collection process visiting all communities.

Table VII-3: Comparison of Solid Waste Disposal Methods

Variable	Transfer to Changyilong Landfill	On-site sanitary landfill	Pyrolysis (high-temperature incineration)
Technical reliability	Reliable	Reliable	Unclear. No national technical specification
Applicability	Municipal solid waste	Not suitable for protection zones at Dongjiang Lake	Suitable for remote rural areas
Site selection	Easy	Difficult	Difficult
Pollution	Minor	Risk of secondary pollution	Unsure
Land area	Small	Large	Large
Construction cost (CNY/ton)	3.4 million	2 million	4.84 million
Operation cost (CNY/ton)	80	70	230
Final disposal	Another 50 CNY/ton needed for final disposal	N/A	Hazardous residues; difficult to manage

195. **River rehabilitation component** – embankment and dredging of the five project rivers. The rationale for the planned embankment and dredging, and a range of embankment designs, was assessed. For rationale, the stated objective is flood control, with the justification being damage caused by the last recent flood (2006). In the PRC, hard engineering solutions are the normal approach to address flooding, rather than attempting to maintain the existing natural riverbanks and condition and supplementing this with vegetation plantings and flood-risk zones in which development is regulated. Several embankment designs were assessed: (a) precast concrete block revetment – environmental-friendly with aesthetic appearance; durable (steel wire Renault pads with corrosion protection treatment can be used for nearly 60 years, are easy to repair, and construction time is nearly half of the precast block revetment); flexible revetment, will conform to uneven surfaces; (b) brick slope revetment – common and easy to implement, but not suitable for revegetation.

196. Note that the PPTA team findings did not entirely align with the domestic design institutes. It was unclear whether modeling of flooding and silt loads had been conducted to identify zones of flood risk, and therefore, whether embankment structures and dredging were in fact the most effective approach to flood management. It is possible that such modeling could indicate alternative approaches, such as re-vegetation, flood risk zoning, and less dredging and embankment. Such approaches could cause fewer environmental impacts. This is especially relevant in Tianeshan National Forest Park, where there are no residents.

197. **Yangdong water supply.** Based on site investigation, three locations for the Yangdong WTP were considered, on the basis of geological conditions, land use, earthwork load, and operation cost (Table VII-4). The site at Lengshuikeng was selected due to lower costs and earthworks compared to the other options.

Table VII-4: Site Options for Yangdong WTP

Factor	Lengshuikeng	Longxingshan	North of Shuinan Village
Geological conditions	At top of hill. Build access road. Excavation more than earth filling	At top of hill. Build access road. Excavation more than earth filling	At top of hill. Build access road. Excavation and earth filling could be balanced
Land use	Land cover: 1.09 ha, shrub and woodlands	Land cover: 1.05 ha, shrub and woodlands	Land cover: 1.36 ha, shrubs, farmland, wood-land
Construction	The elevation differences of the site and tractor road is about 40 m, convenience for construction	The elevation differences of the site and tractor road is about 90 m, difficult for construction	The elevation differences of the site and tractor road is about 70 m
Operation	Favorable to maintain proper water pressure	Favorable to maintain proper water pressure	Far to the downtown, higher operation cost. Water pressure will be too high

198. Wetland restoration and management facilities. A multi-level surface flow and subsurface wetland system was proposed by the design institute for the Xingning wetland. This design was not recommended by the PPTA team due to complicated design, higher cost and inconvenient management. A simplified subsurface and surface flow wetland system was proposed (see section IV) and subsequently accepted by the PMO and design institute.

VIII. PUBLIC CONSULTATION, PARTICIPATION AND INFORMATION DISCLOSURE

199. Meaningful participation and consultation during project planning, feasibility study, design and implementation are important safeguard requirements. The PRC Environmental Protection Law and Regulations on the Administration of Construction Project Environmental Protection (Order No. 253 of the State Council) require that a DEIA solicits the opinions of organizations concerned and residents within and near the project sites. In August 2012, the PRC National Development and Reform Commission (NDRC) issued a requirement for "Social Risk Assessment of Large Investment Projects", which emphasizes the importance of public consultation in an effective manner, and requires that the results of public consultation are clearly summarized in the DEIA report, including the dates of consultations, number of stakeholders, who the affected people are, and the comments received. ADB's SPS (2009) also requires meaningful public participation, consultation and information disclosure. The consultation process for this project followed PRC law and the SPS.

200. The following sections describe the public consultations for the environmental assessment, undertaken between September 2014 and February 2015. Consultation included: (i) information disclosure; (ii) questionnaire surveys; (iii) informal visits to villages and households in the project area; and (iv) stakeholder meetings attended by residents and other concerned stakeholders, including a questionnaire survey after the meetings. Concurrent with this process, social and poverty analyses were conducted by the PPTA social, resettlement and gender specialists based on group discussions with key agencies, beneficiaries, and adversely affected communities. For the preparation of resettlement plans, information disclosure and public consultations were conducted, by questionnaire surveys, community meetings, and focus group discussions.

A. Information Disclosure and Public Consultation to Date

201. Two rounds of information disclosure for the proposed project were conducted by the EIA institutes (Figs. VIII-1 to VIII-3). The first round disclosure was designed to solicit public comments and suggestions on the project and on the terms of reference for the EIA. The project profile, contact details of the IA and the EIA institute were disclosed on posters (Fig. VIII-1), a local newspaper (Zixing Daily, 29 September 2014 and 20 October 2014) (Fig. VIII-2) and the website of the ZCG (Fig. VIII-3).

Lianping Town

Xingning Town

Jiangkou Village, Bailang Town

Pengshi Downtown, Zhoumensi Town

Nanping Village, Zhoumensi Town

Chulou downtown, Lanshi Town

Figure VIII-1: Community Information Posters

Digital version

Hard copy

Figure VIII-2: First round of project information disclosure in Zixing Daily

http://www.zixing.gov.cn/sitepublish/site1/zwgk/zwdt/tzgg/content_37376.html

Figure VIII-3: First round of project information disclosure on website of Zixing City government

202. The second round of information disclosure was undertaken once the draft FSR and domestic EIAs were available, to solicit public comments on the preliminary EIA findings. The EIA findings will be disclosed on the website of Hunan EPD.

B. Public Consultation

203. First round of consultation. A total of 144 questionnaires were distributed by the EIA institute to 119 affected persons from different age groups and education backgrounds, and to 35 organizations (Table VIII-1). Survey results are summarized in Table VIII-2. Most respondents felt that the project will address key local issues of pollution and soil erosion; most individuals and agencies are supportive of the project and believe it will contribute to social and economic development. Stakeholders noted the following concerns and suggestions: (i) construction may affect traffic and disturb residents, and requested that these activities are planned well; (ii) spoil disposal sites should be well selected and planned; and (iii) solid waste at Lianping township is planned to be transported to the Qingyao Solid Waste Transfer Station, but which is far and will require high costs; and (iv) to continue consulting communities and agencies during the project final detailed design and construction phases. These concerns have been addressed in the project design and EMP. For the issue of solid waste management at Lianping township, the collection areas for the project solid waste transfer stations have been planned to cover several townships to share collection loads and maximize operational and cost efficiency.

Table VIII-1: Respondents of 1st Round of Questionnaire Survey

APs consulted	Basic information of consulted persons		#Respondents	%
	Age group	<25	6	5%
		35-50	80	67%
		50	33	28%
	Gender	Female	16	13%
		Male	103	87%
	Education	Primary	9	7.5%
		Secondary	54	45%
		High school	32	27%
		College degree/above	24	20.5%
Originations consulted			35	

Table VIII-2: Results of 1st Round of Questionnaire Survey

No.	Question	Options	#Respondents	%
1	Have you heard about this project?	Yes	98	83%
		No	21	17%
2	Do you know of the Dongjiang Lake Scenic Area/Wetland Park/Drinking water source protection area?	Yes	101	85%
		No	18	15%
3	What do you consider the major environmental issues of Dongjiang Lake?	Water pollution	78	65%
		Vegetation destruction	28	24%
		Soil erosion	32	27%
		Flood disaster	11	9%
		Air pollution	12	10%
		Solid waste	64	54%
4	Which of the following subcomponents do you feel are most relevant?	Pollution Control	78	65%
		Water Supply	35	32%
		River rehabilitation	18	15%
		Ecological restoration	11	9%
5	Which of the following are you concerned about during construction?	Water pollution	92	77%
		Air pollution	19	16%
		Noise pollution	12	10%
		Soil erosion	22	18%
		Vegetation destruction	63	53%
		Inconvenient traffic	72	60%
		Other	5	4%
6	Which environmental mitigation measures do you suggest be used during construction?	Build wastewater treatment facilities?	71	60%
		Spray water to reduce dust and improve landscaping?	25	21%
		Effective construction management	92	77%
		Other measures	4	3%
7	Which of the following are you concerned about during operation?	None	60	50%
		If yes, please identify:		
		Water pollution	49	41%
		Air pollution	17	14%
		Noise	5	4%
		Soil erosion	18	15%
		Ecology	14	12%
		Other	7	6%
	What environmental mitigation measures do you suggest during operation?			
8	Do you think the project will be beneficial to local social and economic development?	Beneficial	86	72%
		Not sure	15	13%
		Not beneficial	17	14%
9	If all the mitigation measures are implemented effectively, what do you think would be your attitude towards the project?	Very supportive	72	61%
		Support	41	34%
		Do not mind	5	4%
		Not support	1	1%
		Strongly opposed		

Table VIII-2b: Results of 1st Round of Questionnaire Survey on organizations

No.	Question	Options	#Respondents	%
1	Have you heard about this project?	Yes	33	94%
		No	2	6%
2	What do you consider the major environmental issues of Dongjiang Lake?	Water pollution	28	80%
		Vegetation destruction	16	46%
		Soil erosion	19	54%
		Flood disaster	10	29%
		Air pollution	4	11%
		Solid waste	25	71%
3	Which of the following subcomponents do you feel are most relevant?	Pollution Control	20	57%
		Water Supply	13	37%
		River rehabilitation	14	40%
		Ecological restoration	13	37%
4	Which of the following are you concerned about during construction?	Water pollution	21	60%
		Air pollution	7	20%
		Noise pollution	6	17%
		Soil erosion	13	37%
		Vegetation destruction	17	49%
		Inconvenient traffic	12	34%
		Other	2	6%
5	Which environmental mitigation measures do you suggest be used during construction?	Build wastewater treatment facilities?	18	51%
		Spray water to reduce dust and improve landscaping?	11	31%
		Effective construction management	31	89%
		Other measures	1	3%
6	Which of the following are you concerned about during operation?	None	24	69%
		If yes, please identify:		
		Water pollution	8	23%
		Air pollution	5	14%
		Noise	0	0%
		Soil erosion	6	17%
		Ecology	4	11%
		Other	0	0%
	What environmental mitigation measures do you suggest during operation?			
7	Do you think the project will be beneficial to local social and economic development?	Beneficial	34	97%
		Not sure	1	3%
		Not beneficial	0	0%
8	If all the mitigation measures are implemented effectively, what do you think would be your attitude towards the project?	Very supportive	29	83%
		Support	6	17%
		Do not mind	0	0%
		Not support	0	0%
		Strongly opposed	0	0%

204. Second Round of Consultation. A public discussion forum was held on 30 January 2015 chaired by the PMO and supported by the domestic EIA institutes together with the PPTA team (Fig. VIII-4). Participants included government representatives from relevant bureaus, community representatives and local residents. The project grievance redress mechanism (GRM) was introduced to participants. Questionnaires were also distributed to the

participants during the consultation meeting. Stakeholder concerns raised in the meeting, and responses, are in Table VIII-3.


Figure VIII-4: Public Consultation Forum

Table VIII-3: Public Concerns Raised and Mitigation Measures Included in EMP

Concern raised	Mitigation measures proposed
The existing Chukou WWTP is not functional. How to ensure the proposed upgraded WWTP will operate well?	Existing WWTP cannot provide services due to lack of a sewage collection system. Project will finance sewers to ensure the sewage can be delivered to the WWTP
Yangdong WTP is close to downtown. Will the construction affect public utilities?	If temporary disruption is unavoidable, contractor will, in collaboration with PMO and power, water supply, and/or communication companies, develop a plan to minimize the disruption and communicate the dates and duration in advance to all affected people
Construction of water transmission line along S322 road will affect traffic	(i) Transmission pipes will be laid section by section so that the impact is localized; (ii) traffic signs will be arranged on site to ensure traffic safety; (iii) transport bureau and residents will be consulted in advance to develop a reasonable traffic management plan
The solid waste transfer center will generate unpleasant smell	Garbage will be transferred regularly. Odor treatment facilities will be installed in each center
Effluent from WWTP may contaminate the water quality of receiving water body	WWTP are designed based on Class 1A or B standard to remove pollutants before discharge into rivers / lake
What is the risk of landslides during construction?	Geological hazard risk survey and assessment will be undertaken prior to detailed design

C. Future Information Disclosure and Public Consultation

205. Information disclosure and public consultation relating to environmental and social safeguards will continue throughout project implementation, by the PMO Environment and Social Officers, Chenzhou Municipal EPB, and Zixing EPB. Project environmental information will be disclosed by the PMO (coordinated by the PMO Environment Officer), Chenzhou Municipal EPB, Zixing EPB, and ADB as follows: (i) continuing dialogue with project communities – questionnaire surveys, household visits, workshops, and public hearings; (ii) copies of the domestic EIA reports (in Chinese) will remain available on request from the municipal and county EPBs; and (iii) the project EIA, and semi-annual environment progress reports, will be disclosed on the project website at www.adb.org. The future public consultation program is included in the project EMP.

IX. GRIEVANCE REDRESS MECHANISM

206. A grievance redress mechanism (GRM) has been developed in compliance with ADB's SPS (2009) requirement to address environmental, health, safety, and social concerns associated with project construction, operation, land acquisition, and leasing arrangements. The GRM is designed to achieve the following objectives: (i) provide channels of communication for local communities to raise concerns about environment- and social-related grievances which might result from the project; (ii) prevent and mitigate adverse environmental and social impacts to communities caused by project construction and operation, including those associated with resettlement; (iii) improve mutual trust and respect and promote productive relationships between the project agencies and local communities; and (iv) build community acceptance of the project. The GRM is accessible to all members of the community, including women, youth, and poverty-stricken residents. Multiple points of entry are available, including face-to-face meetings, written complaints, telephone conversations, e-mail, and social media.

207. Public grievances to be addressed by the GRM will most likely include disturbance of agricultural activities, traffic, dust emissions, construction noise, odor caused by sediment dredging, soil erosion, inappropriate disposal of construction wastes, damage to private houses, safety measures for the protection of the general public and construction workers, and/or water quality deterioration. Grievances related to involuntary resettlement may relate to the lack, or un-timely payment of, compensation monies, other allowances, and/or lease monies as per entitlements described in the resettlement plan and associated documents.

208. Currently in Hunan Province (and generally in the PRC), when residents or organizations are negatively affected by a development, they may complain, by themselves or through their community committee, to the contractors, developers, the local EPB, provincial EPD, or by direct appeal to the local courts. The weaknesses of this system are: (i) the lack of dedicated personnel to address grievances; and (ii) the lack of a specific timeframe for the redress of grievances. The project GRM addresses these weaknesses. The GRM meets the regulatory standards of the PRC that protect the rights of citizens from construction-related environmental and/or social impacts. Decree No. 431 Regulation on Letters and Visits, issued by the State Council of PRC in 2005, codifies a complaint acceptance mechanism at all levels of government and protects the complainants from retaliation. Based on the regulation, the former State Environmental Protection Administration (SEPA) published updated Measures on Environmental Letters and Visits (Decree No. 34) in 2006.

209. The Zixing Urban and Rural Environmental Protection Finance Center has appointed the PMO Environment Officer and PMO Social Officer to coordinate the GRM. The officers will instruct contractors and construction supervision companies (CSCs) on the GRM procedures. The officers will coordinate with Zixing City EPB and Chenzhou Municipal EPB and other government divisions, and will be supported by the Loan Implementation Environmental Consultant (LIEC) hired under the project implementation support. The GRM will establish a GRM tracking and documentation system, to include procedures for retrieving data and reporting purposes.

210. The details of the GRM, including a time-bound flow chart of procedures, are included in the project Environmental Management Plan (EMP) in Attachment 1.

X. ENVIRONMENTAL MANAGEMENT PLAN

211. A project environmental management plan (EMP) has been prepared (Attachment 1). Development of the EMP drew on the domestic EIA reports, discussions with the PMO, implementing agencies, Chenzhou and Zixing EPBs, other government agencies, and local communities. The EMP defines mitigation measures for the anticipated environmental impacts, institutional responsibilities, and mechanisms to monitor and ensure compliance with PRC's environmental laws, standards and regulations and ADB's SPS. The EMP specifies major environmental impacts and mitigation measures, roles and responsibilities, inspection, monitoring, and reporting arrangements, training, and the grievance redress mechanism. The EMP will be updated after detailed design, as needed. It will be included as separate annex in all biding documents for subcomponents involving civil works. Contractors will be required to develop site-EMPs that are fully responsive to the EMP.

XI. CONCLUSIONS

212. The project will improve water resources management in the Dongjiang Lake area, help secure and maintain the high water quality of the lake, reduce soil erosion at the lake and surrounding hills, and improve wetland, fisheries, and community forestry management. Cumulatively, the project will complement a range of domestically-funded programs, which together will help achieve the targets of the Dongjiang Lake area master plans for development and environmental management.

213. Key construction risks arise from: (i) the planned dredging and embankments, which may cause heavy metals to be released, short-term increases in turbidity and loss of degraded but still relatively natural riverbanks. Aquatic organisms may be impacted by heavy metals, smothering of individuals and habitats from sediment dispersion, and loss of breeding or foraging habitat. Inappropriate transport could damage roads or cause leakage at spoil sites; and (ii) impacts to soil, water, air, and communities, from construction noise, fugitive dust, earthworks, solid waste disposal, interference with traffic and municipal services during pipeline and treatment plant construction, permanent and temporary acquisition of land, involuntary resettlement, and occupational and community health and safety. Operational risks considered were: (i) cumulative nutrient loading in Dongjiang Lake and rivers from the release of treated effluent from the six WWTPs; (ii) noise and air emissions from the wastewater and water treatment plants; and (iii) reduced water availability for residents downstream of Yangdong Reservoir as a result of altered reservoir management procedures.

214. Measures to avoid, minimize, and mitigate potential project impacts have been developed within the project EMP (Attachment 1). Meaningful public consultation has been conducted in the five project counties in accordance with PRC and ADB requirements. Public concerns have been integrated into the domestic feasibility study reports and project EMP. Public consultation will continue throughout project implementation. A project GRM has been developed and will be implemented at the county and site levels.

215. A climate risk vulnerability assessment (CRVA) was conducted to identify the threat that climate change presents to the viability of the project, assuming a design life of 30-40 years. Modeling predicted that mean annual temperature will increase 1.0-1.1^{o}C from 2016-2035 and 1.5-2.6^{o}C by 2065, annual precipitation will remain the same or slightly decrease, and evapotranspiration will increase. Projected inflows to Dongjiang Lake for 2015-2030 remain similar to the baseline period of 1971-2000. Declining seasonal flows could reduce the efficiency of the constructed water pipelines and treatment rates of the wastewater and water treatment plants, while altered storm intensity could impact the project rivers. Overall, climate-related risks are concluded to be low because: (i) large changes in precipitation are not predicted; (ii) the sub-tropical location of the project area is subject to high rainfall (>1.3

m/year), which imparts a partial buffer to change; (iii) initial designs were for larger treatment plants, which would have been more at risk from reduced water supply, yet plant sizes were down-graded to align with current and forecast demand; (iv) for flood control, project structures have been designed for a 1 in 10 year capacity and reflects climate modeling; and (v) embankments have been designed to be porous for improved infiltration.

216. Project assurances. As with all ADB-funded projects, the project is required to comply with a standard set of loan assurances for compliance with national laws and the project EMP. In addition, the following project-specific assurances are included in the project agreement between ADB and the ZCG. All assurances have been discussed and agreed between the ZCG and ADB.

(i) Environment-related impacts to livelihoods. SPG shall ensure that project construction and operation shall not result in any changes to the availability or allocation of freshwater to downstream communities, which might negatively impact their water security or livelihood.

(ii) ZCG shall ensure that all project activities requiring the use of plants, including the project embankments, constructed wetlands, landscaping, planting of green belts at wastewater treatment plants, and post-construction rehabilitation, will only use native plant species from Zixing City and which are locally sourced to strengthen the rehabilitation of natural habitats and avoid the introduction of non-native invasive weeds. If the use of fast-growing non-native species (e.g. grasses) is required for stabilizing bare construction surfaces, only sterilized seedlings (i.e. which cannot propagate) shall be used.

(iii) For dredging planned in the five project rivers of Xingning, Qingyao, Quangqiao, Lianping, and Tianeshan, the ZCG shall ensure that prior to any dredging: (i) clarify technical justifications, including analysis of flood risks; (ii) conduct a second round of sediment sampling to clarify the extent of heavy metals; and (iii) take appropriate remedial measures to minimize the impacts. These measures will be jointly reviewed by the ZCG and ADB.

(iv) ZCG shall ensure that minimum ecological flows for Chukou River will be incorporated into the official management of the site for the Chukou weir.

217. Conclusion. Based on the information presented in this EIA, and assuming full and effective implementation of the project EMP, training, and loan assurances, potential adverse environmental impacts are expected to be minimized and/or mitigated to within the standards applied in this EIA.

ATTACHMENT 1. ENVIRONMENTAL MANAGEMENT PLAN

ENVIRONMENT MANAGEMENT PLAN FOR THE HUNAN DONGJIANG LAKE ENVIRONMENTAL PROTECTION AND INTEGRATED UTILIZATION PROJECT

People's Republic of China

Prepared by the Zixing City Government for the Asian Development Bank

A. Objectives

1. This Environmental Management Plan (EMP) is for the Hunan Dongjiang Lake Environmental Protection and integrated Utilization Project in Zixing City of Hunan Province, the People's Republic of China (PRC). The EMP complies with the Asian Development Bank's (ADB) Safeguard Policy Statement (SPS, 2009) and is based on the domestic Environmental Impact Assessments (DEIAs) prepared by Guangdong Environmental Protection Engineering Design Institute (Pollution Control Component), Zhongnan Engineering Corporation Limited (Urban-rural water supply component and River Course Rehabilitation Component) and Chenzhou Municipal Environmental Protection Research Institute (Ecosystem Rehabilitation Component) and project EIA.

2. The EMP describes: roles and responsibilities of all project agencies to implement this EMP; mitigation measures; inspection, monitoring, and reporting arrangements; training and institutional strengthening; grievance redress mechanism (GRM); and future public consultation.

3. In the design stage the PMO will pass this EMP to the design institutes for incorporating mitigation measures into the detailed designs. The EMP will be updated at the end of the detailed design, as needed. To ensure that bidders will respond to the EMP's provisions, the PMO and local project implementation units (PIUs) will prepare and provide the following specification clauses for incorporation into the bidding documents: (i) a list of environmental management requirements to be budgeted by the bidders in their proposals, (ii) environmental clauses for contractual terms and conditions, and (iii) component DEIAs, and project EIA including updated EMP for compliance.

B. Organizations and Their Responsibilities for EMP Implementation

4. The EMP implementation arrangements and responsibilities of governmental organizations are summarized in Table EMP-1. Zixing City Government (ZCG) is the project Executing Agency (EA). The EA is responsible for communication with ADB, loan on-lending and repayment, as well as supervision and guidance of the Zixing Project Management Office (PMO) and implementing agencies (IAs) during the project implementation. A Project Leading Group (PLG) has been established, chaired by the mayor and comprises senior officials from relevant government agencies, to facilitate inter-agency coordination, and resolve any institutional problems affecting project implementation at municipal level.

5. The Project Management Office (PMO) will conduct daily management and coordination during project implementation on behalf of PLG.

6. Zixing City Urban and Rural Environmental Protection Financing Center (ZUREPFC) is the Implementation Agency (IA). Within the ZUREPFC, there are four functional departments, Administration, Finance, Technical Engineering, and Contract Management. The ZUREPFC will: (i) engage and supervise engineering design institutes, tendering company and the project management consulting service during project implementation; and (ii) report on progress.

Table EMP-1: Project Operation and Maintenance Arrangements in Zixing City

	Component / Sub-component	Activity	Implementing Unit	Operation and Maintenance Unit
A	**Improved pollution control**			
A.1	Domestic wastewater treatment	WWTP-urban area	HURB	Towns where facility is located
		WWTP-rural area	ZEPB	Villages
A.2	Solid waste collection,	Collection, transfer	SD	Township government; sanitation

	compaction, transfer, disposal	Landfill		department; and/or outsourced operation
		Incineration		
A.3	Agricultural non-point source pollution management	Soil testing; fertilizer	AB	Farmers
		Crop pest control	AB	
		Training		
B	**Established urban-rural water supply system**			
B.1	Yangdong WTP and distribution project		WRB	Water Supply Company
B.2	Chukou water supply project		WRB	Chukou Town Government
C	**Integrated ecosystem rehabilitation and management**			
C.1	River modification	Xingning River	WRB	TWMS
		Guangqiao River	WRB	TWMS
		Qingyao River	WRB	TWMS
		Lianping River	WRB	TWMS
		Tian'e Mountain River	WRB	National Forestry Park
D	**Integrated ecosystem rehabilitation and management**			
D.1	Dongjiang Lake aquatic ecosystem rehabilitation	Fish release structures	DRMB	Aquatic Product Seeding Plant
		Fish release	DRMB	DRMB
		Breeding facility	DRMB	Zixing Aquatic Product Seeding Plant
		Fish monitoring station	DRMB	Fishery Administration Group
D.2	Wetland restoration and management facilities	Embankment	FB	FB
		Restoration	FB	FB
		Research	FB	FB
		Education	FB	
D.3	Karst area desertification rehabilitation project	Reforestation	FB	Will supervise; provide technical support; priority given to the forestry owner
		Regeneration	FB	
D.4	Ecological forest protection		FB	
D.5	Bamboo forest improvement		FB	
E	**Environmental Monitoring and Capacity Building for Ecological System Protection**			
E.1	Capacity building for environmental monitoring		ZEPB	EPB
E.2	Deep water research center		ZEPB	EPB
E.3	Training on livelihood skills		HRSS	HRSS
E.4	Project management and capacity building	Studies	PMO	
		Workshops		
		Training		
E.5	Project monitoring and evaluation system		PMO	

AB = agriculture bureau; DRMB = Dongjing Reservoir Management Bureau; EPB = environment protection bureau; FB = forestry bureau; HRSS = Human Resource and Social Security Bureau; HURB = Housing, Urban and Rural Development Bureau; PMO = project management office; SD = sanitation department; TWMS = Town Water Management Station; WRB = water resource bureau; WTP = water treatment plant; WWTP = wastewater treatment system; WWTP = wastewater treatment plant.

7. **Environment staff within PMO and PIUs.** The PMO will have main EMP coordination responsibility. The PMO has appointed a PMO Environment Officer to be responsible for the environmental issues during the project implementation. These officers will take charge of (i) coordinating the implementation of the EMP and developing implementation details; (ii) supervising the implementation of mitigation measures during project design, construction and operation; (iii) ensuring that environmental management, monitoring, and mitigation measures are incorporated into bidding documents, construction contracts and operation management plans; (iv) submitting annual EMP monitoring and progress reports to ADB; (v) coordinating the GRM; and (vi) responding to any unforeseen adverse impacts beyond those mentioned in this EMP. The PMO Environmental Officer will be technically supported by the loan implementation environment consultant (LIEC).

8. **Project Implementation Units (PIUs)** are set in Zixing Water Resources Bureau, Housing, Urban Rural Development Bureau, Forestry Bureau, Environmental Protection Bureau, Sanitation Department, Agricultural Bureau and Dongjiang Lake Reservoir Management Bureau respectively to implement relevant subprojects. Each PIU has assigned an environmental coordinator to assist the PMO Environment Officer.

9. **Loan Implementation Environment Consultant (LIEC).** A LIEC (nine person months) will be hired under the loan implementation consultant services. The LIEC will advise the PMO, PIUs, contractors and construction supervision companies (CSCs) on all aspects of environmental management and monitoring for the project. The LIEC will (i) assist in updating the EMP and environmental monitoring program, as needed; (ii) support the implementation of the EMP; (iii) support the PMO to prepare semi-annual progress reports to ADB in English and Chinese; (iv) provide training to the PMO, PIUs, and CSCs, on EMP implementation, GRM, relevant laws and policies, and ADB's SPS, EMP implementation (Table EMP-6); (v) identify any environment-related implementation issues, and propose necessary corrective actions; (vi) undertake site visits for EMP inspection as required.

10. Terms of Reference for key personnel are in Appendix 1.

11. **Construction Contractors and Construction Supervision Companies (CSCs).** Construction contractors will be responsible for implementing relevant EMP mitigation measures during construction, under the supervision of the CSCs and PIUs. Contractors will develop site-specific EMPs on the basis of this project EMP. CSCs will be selected through the PRC bidding procedure by the PIUs. The CSCs will be responsible for supervising construction progress and quality, and EMP implementation on construction sites. Each CSC shall have at least one environmental engineer on each construction site to: (i) supervise the contractor's EMP implementation performance; and (ii) prepare the contractor's environmental management performance section in monthly project progress reports submitted to the PIUs and PMO.

12. **Environmental Monitoring Station (EMS).** ZUREPFC will contract the EMS under the local Environmental Protection Bureau to implement the external monitoring program defined in this EMP (Table EMP-4).

C. Potential Impacts and Mitigation Measures

13. Prior to construction, the PMO will assess the project environmental readiness using Table EMP-2 and review with ADB. If necessary, corrective actions will be identified to ensure that all requirements are met.

Table EMP-2: Project Readiness Assessment Indicators

Indicator	Criteria	Assessment	
		Yes	No
EMP update	The EMP was updated after technical detail design, and approved by ADB	☐	☐
Compliance with loan covenants	The borrower complies with loan covenants related to project design and environmental management planning	☐	☐
Public involvement effectiveness	• Meaningful consultation completed • GRM established with entry points	☐ ☐	☐ ☐
Environmental supervision in place	• LIEC is in place • Environment Officer appointed by ZUREPFC • EMS and CSCs contracted by ZUREPFC • EMC appointed by each PIUs	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Bidding documents and contracts with environmental	• Bidding documents and contracts incorporating the impact mitigation and environmental management	☐	☐

safeguards	provisions of the EMP.		
Site construction planning (Environmental)	Site environmental management and supervision plan prepared for each work site by the ZUREPFC, PIUs and contractors.		
EMP financial support	The required funds have been set aside by contractors, ZUREPFC and PIUs to support the EMP implementation	☐	☐
Note. ADB=Asian Development Bank; EMS = Environment Monitoring Station, IA = Implementing Agency, LIEC = Loan Implementation Environmental Consultant, PIU=Project Implementing Unit, ZUREPFC=Zixing City Urban and Rural Environmental Protection Financing Center.			

14. Table EMP-3 lists the potential project impacts, and mitigation measures. The mitigation measures will be incorporated into the detailed design, bidding documents, construction contracts and operational management manuals, by the design institutes (during detailed design) and contractors (during construction), under the supervision of CSCs and PIUs, with technical support from the LIECs. The effectiveness of these measures will be evaluated based on environmental inspections and monitoring to determine whether they should be continued, improved or adjusted.

Table EMP-3: Potential Impacts and Mitigation Measures during Pre-construction and Construction Phases

Item	Potential issues	Mitigation measures	Implement	Supervise
A. DESIGN AND CONSTRUCTION PHASES				
Detail design stage	Detailed design (WWTPs, rural WWTP, WTPs, buildings, embankments, dredging, landscaping, and wetlands)	• Plan the dredging and embankment for September to December; allow one month (February) for settling of sediment. • Include habitat features for aquatic flora, turtles, frogs, in design of embankments. • Confirm final designs and layout for all project infrastructure. • Locate odor-generating and noise-producing facilities furthest from residences.	IAs, design institute, wetland specialist	PMO
	Institutional strengthening for EMP Implementation and supervision	• At least six months before construction: (i) appoint PMO Environmental Officer, PIU Environment Officer, LIEC, and Wetland Specialist. See TOR in Appendix 1. • At least six months before construction, train staff for EMP implementation and supervision. • PIUs have contractual agreements with EMS to conduct environmental monitoring in this EMP. • All EMSs are qualified centers which are part of county-level or higher EPBs • Conduct training on this EMP for PMO, IAs, PIUs, contractors, and CSCs.	PMO, PIUs	EA, ADB
	Update EMP	• Update mitigation measures defined in this EMP based on final detailed design. • Submit the updated EMP to ADB for review. • In case of major changes of project location and/or components, conduct EIA and public consultation. Submit to EPD and ADB for approval and disclosure.	PMO, LIEC	EPB, ADB
Construction Preparation	Sediment quality	• Conduct second-round sediment sampling at sites for borrow pits, dredging, spoil disposal.	EMS	EPB
	Bidding and contract documents	• Incorporate mitigation measures in this EMP to bidding documents. • Bidding documents are sent to ADB for review. • Prepare environmental contract clauses for contractors.	DIs, PMO, PIUs	LIEC, EPB, ADB
	Dredging	• Bid documents for dredging will include all specific mitigation measures in this EMP. • Bid documents will require contractor to have sufficient dredge experience in sensitive areas.	DIs, PMO, PIUs	LIEC, EPB, ADB
	EMP training	• LIEC, EPD, and EPBs provide training on EMP implementation.	LIEC, PMO	EPD, ADB
	Establish GRM	• PMO and PIU Environmental Officers and PMO Social Officer establish GRM with LIEC. • All PMO and PIU personnel trained in GRM. • Distribute contact details for GRM on PMO and EPB public websites and construction sites.	PIUs	PMO, LIEC, ADB
B. CONSTRUCTION PHASE				

Item	Potential issues	Mitigation measures	Implement	Supervise
Topography and Soils	Earthwork, soil erosion, soil contamination	• Define spoil disposal sites and borrow pit locations, in the construction tender documents. • Construct intercepting channels to prevent construction runoff entering waterways. • Divert runoff from sites to sedimentation ponds or existing drainage. • Limit construction and material handling during periods of rains and high winds. • Stabilize cut slopes, embankments, and other erosion-prone areas during works. • Minimize open excavation areas and use compaction techniques for pipe trenches. • Properly store petroleum products, hazardous materials and wastes on impermeable surfaces in secured and covered areas. • Rehabilitate all spoil disposal sites and construction sites. • All landscaping will only use native plant species. • Situate construction camps and storage areas to minimize land area required. • Remove construction wastes from the site to the approved disposal sites. • Establish emergency preparedness and response plan for spills including cleanup equipment at each construction site and training in emergency spill response procedures. • Stabilize earthwork areas within 30 days after earthworks have ceased at the sites.	Contractor CSCs	PIUs, EPBs, WRB, LIEC
Ambient Air	Dust generated by construction activities, gaseous air pollution (SO_2, CO, NOx) from construction machinery and asphalt pavement after pipeline laying	• Equip material stockpiles and concrete mixing equipment with dust shrouds. • Spray water on construction sites and earth/material handling routes. • For odor impacts during sediment dredging, immediately transport spoil to disposal site after de-watering, in sealed containers. • Cover materials during truck transport. • Purchase pre-mixed asphalt for road surface paving after water diversion pipeline laying; if asphalt is heated and mixed onsite, asphalt mixers must be located $\geq$200 m from villages and other sensitive receptors. • Store petroleum or other harmful materials in appropriate places. • Ensure emissions from vehicle and machinery comply with PRC standards of GB18352-2005, GB17691-2005, GB11340-2005, GB2847-2005, and GB18285-2005. • Equipment and machinery is maintained to a high standard to ensure efficient running and fuel-burning. High-horsepower equipment will be installed with tail gas purifiers to ensure emissions be in compliance with PRC-GB16297-1996. • Provide high-horsepower equipment with tail gas purifiers.	Contractor CSCs	PIUs, LIEC

Item	Potential issues	Mitigation measures	Implement	Supervise
Noise	Noise generated from construction activities	• Ensure construction machinery conform to PRC standard of GB12523-90. • Properly maintain vehicles and machineries to minimize noise. • Apply noise reduction devices or methods where piling equipment is operating, such as construction of bridges and other hydraulic structures, within 300 m of sensitive sites. • Locate sites for rock crushing and concrete-mixing ≥500 m from sensitive areas. • Prohibit operation of machinery generating high levels of noise, such as piling, and movement of heavy vehicles along urban and village roads between 20:00 and 06:00. • Place temporary hoardings or noise barriers around noise sources during construction. • Monitor noise at sensitive areas and consult residents at regular intervals (see monitoring plan in this EMP). If noise standards are exceeded, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation. • Conduct interviews with residents adjacent to construction sites to identify and resolve issues, including adjustment of work hours of noise-generating machinery.	Contractor CSCs	PIUs, LIEC
Surface water pollution and dredging	Impact of embankment and dredging construction	• Extract channel material with small excavators or manual labor to minimize disturbance. • Access sites through existing roads or at points where minimum clearing is required. • If not possible, enter the river bed upstream from silt protection barriers. • Place all disposal sites in low permeable material (permeability <10-6 cm/sec). Cover site with a clay and topsoil cap. Reseed using local species of grasses. • Conduct dredging in <800 m sections to minimize the extent of disturbance at any one time. • Only conduct works in dry season **between September and January**, time of lowest water depth and flow. Complete 1 month before rainy season. • Install silt fences or other appropriate method downstream from excavated areas. • Avoid any known fish breeding sites, especially in Lianping and Guangqiao Rivers. • Remove all dredged material at suitable sites within 75 meters of the disturbed areas, to avoid unnecessary transport minimizing the release of contaminated dust and sediment. • Prior to disposal, drain off excess water. Dry the dredge material in sludge drying areas.	Contractor, CSCs, EMS	PIUs, LIEC, EPBs, WRB, reservoir authorities
	Impact of wastewater pollution	• Construction wastewater collected in retention ponds and filter tanks to remove silts, oil. • Machine wash-down sites are equipped with water collection basins and sediment traps. • Locate storage / cleaning areas for fuel, machinery and vehicles ≥500 m from waterways. • Storage facilities for fuels, oil, and other hazardous materials will be within secured areas on impermeable surfaces, and provided with bunds and cleanup installations. • 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). • All earthworks along waterways will be accompanied by measures to minimize sediment runoff, including sediment traps.	Contractor	IA, PMO

Item	Potential issues	Mitigation measures	Implement	Supervise
		• Labor camps will be located ≥300 m from waterways. • Portable toilets and on-site wastewater pre-treatment systems will be installed at construction camps along with proper maintenance protocols. • Water quality (for pollutants such as SS, COD_{cr}, NH_3-N and petroleum) in the project waterways will be monitored by local EMS during construction (see monitoring table in this EMP).		
Solid Waste	Solid waste generated by construction activities and from workers' camps	• Provide appropriate waste collection and storage containers at locations away from surface water or sensitive receivers. • Arrange with municipal waste collection services for regular collection of waste. • Properly remove and dispose residual materials, wastes and contaminated soils. Paving or vegetating shall be done as soon as the materials are removed to 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 by the municipal waste collection systems.	Contractor CSCs	PIUs, LIEC
Biological resources	Protection of flora and fauna around construction sites	• Prior to construction, demarcate existing vegetation and fauna habitats e.g. vegetated roadsides, trees, riverbanks. • As far as possible avoid clearance of any vegetation. • After construction, immediately replant vegetation in any sites subject to clearance. • In compliance with PRC Forestry Law, the compensatory planting must be the same as, or larger than, the area cleared. • Use only native plant species of local provenance for all re-vegetation. • Any fauna found during construction, especially turtles, will be immediately reported to the EPBs and PMO Environment Officer, photographed, and released on the same day in the nearest suitable habitat.	Contractor, CSCs	PIUs, LIEC
Socio-economic resources	Impact on physical cultural resources	• Establish chance-find procedures for physical cultural resources. • If a new site is unearthed, work shall be stopped immediately and local BCR and the PIU promptly notified.	Contractor, CSCs	PIUs LIEC, cultural bureau
	Temporary interruption to water supply from pipeline or embankment construction	• Use coffer dams and temporary diversion channels to maintain continued water flow while works are conducted. • Prior to works, re-confirm the planned construction schedule and site EMP actions. • Inform residents at least two days before any planned water interruptions. • Assist residents if requested with community water storage during the interruption period. • Interruptions to water supply should not be longer than one (1) day. • In case of accidental interruption (e.g. unintended damage of an existing pipeline), immediately inform affected communities and assist with water supply until the issue is resolved.	Contractor, CSCs,	PIU, EPB

Item	Potential issues	Mitigation measures	Implement	Supervise
	Community health and safety	• Prepare and implement a traffic control plan, for approval by the county traffic management administration. To schedule or divert construction traffic to avoid peak hours, regulate traffic at road crossings, select routes to reduce disturbance, reinstate roads, and open them to traffic when construction is completed. • Underground facilities survey and protection. Pipeline construction activities will be planned to minimize disturbances to utility services. Three-dimensional detection of underground facilities will be conducted before construction where appropriate. • Residents and businesses will be informed in advance through media and information boards of the construction activities, dates and duration of expected disruption. • Signs will be placed at construction sites informing people of the project GRM, potential dangers (e.g. moving vehicles, hazardous materials, excavation) and safety issues. • Heavy machinery will not be used at night. • All sites will be secured from unauthorized public access.	Contractor, CSCs	PIUs LIEC, labor bureau
	Occupational health and safety	• Prepare environmental, health and safety plan which complies with PRC State Administration of Worker Safety Laws and Regulations, including: • Clean and sufficient supply of fresh water for construction sites, camps, offices. • Sufficient latrines and other sanitary arrangements at construction sites and work camps. • Garbage receptacles and regular emptying. • Provide protective equipment and clothing (goggles, gloves, respirators, dust masks, hard hats, steel-toed boots) for construction workers and enforce their use. • Place signs around the construction areas to provide safety advice and warnings. • Ensure sites and machinery are off-limits to the general public. • For residential areas next to construction (especially loud noise), ensure residents are aware of the duration and nature of works, potential hazards, and offer to provide ear plugs/dust masks/other basic safety equipment. • Emergency response plan for accidents prepared and approved by PIUs and EPB. Establish emergency phone links with township hospitals and maintain a first-aid base in each construction camp. • Establish a records management system for occupational accidents, diseases, incidents. The records will be reviewed during compliance monitoring and audits. • Safety communication. Ensure that occupational health and safety matters are given a high degree of publicity to all persons on-site. Display posters prominently. • Training, awareness and competence. Train all workers in basic sanitation, health and safety matters, and work hazards. Implement awareness and prevention program for HIV/AIDS and other diseases – target the local community and construction workers.	Contractors	CSCs, PIUs, EPB, LIEC
C. OPERATION PHASE				

Item	Potential issues	Mitigation measures	Implement	Supervise
Water	Performance testing of WWTP processes, water source protection	• Prior to commissioning, test the ability to achieve the required treatment standard. • Install wastewater quality monitoring devices for real-time monitoring at WWTPs. • Establish real-time monitoring framework. • Close all direct wastewater discharge outlets and re-direct to WWTPs. • No riverside loading or unloading facilities which include the handling of garbage, manure or fecal waste or toxic or hazardous substances. • Monitor Yangdong Reservoir levels and flows at the Chukou WTP intake and inform other users when limited access to water resources may occur. • Place monitoring wells around SWM facilities and annually monitoring groundwater quality.	WWTP O&M Units, SWM O&M Units	PMO
Air	Odor from WWTPs and SWMs	• Equip odor generating facilities with ventilation or odor containment. • Implement regular sludge removal and avoid stockpiling. • Institute regular check, repair and maintenance of all treatment facilities and equipment.	WWTP and SWM O&M Units	PMO
Noise	Noise produced plant operation and SWM mechanical equipment	• Implement noise and vibration reduction measures. Adopt low noise level equipment. • Create green buffer zone/noise absorption zone along WWTP and WTP boundaries using native trees and shrub planting.	WWTP and WTP O&M Units	PMO
Solid waste	Separate and manage solid waste	• Develop and implement a solid waste handling process covering packaging, transportation, and disposal at a SWM facility.	As above	PMO
Flora and fauna	Manage the built habitats – landscaped embankments and constructed wetlands	• Maintain the landscaping – watering, weeding, stabilizing, survival and growth of planted trees, shrubs and herbs, with replacement and corrective action as necessary. • Provide security and surveillance to guard against misuse, theft and littering. • Regularly remove litter and transport to landfill.	WRB	PMO
Emergency preparedness and response	WWTP maintenance and health and safety of surrounding residents	• Prepare emergency preparedness and response plan before each WWTP, WTP, and SWM facility is operational. The plan will include staff training, resources, responsibilities, communication, procedures, and other aspects required to respond effectively to emergencies.	WWTP O&M Units	PMO
Health and safety	Health and safety of WWTP, WTP, and SWM facilities operating staff	• Compulsory use of safety equipment and clothing as necessary (e.g. non-slip boots, chemical resistant clothing, safety goggles, respiratory mask). • Safety instructions for storage, transport, handling or pouring of chemicals	WWTP O&M Units	PMO
	Handling of agricultural chemicals – bamboo plantations	• Worker training and strict safety procedures for storage, transport, and handling of pesticides. • Provide safety clothing and equipment for chemical preparation, pesticide application, equipment cleaning, or spill cleanups.	Community plantation units	PMO

Sources: ADB = Asian Development Bank, EIA = Environmental Impact Assessment, EMS = Environmental Monitoring Station, EPB = Environment Protection Bureau, IA = Implementing Agency, DI = Design Institute, LIEC = Loan Implementation Environmental Consultant, O&M = Operation and maintenance, PMO = Project Management Office, SEMSP = Site Environmental Management and Supervision Plan, SRT = Sludge Retention Time, WTP = water treatment plant, WWTP = Waste Water Treatment Plant, SWM = Solid Waste Management facility.

D. Monitoring and Reporting

15. Three types of project monitoring will be conducted under the EMP: (i) internal monitoring – to be conducted by the PIUs and the construction supervision companies (CSCs); (ii) external monitoring – of air, water, noise and soil standards – to be conducted by the local EMS; and (iii) compliance monitoring – to be conducted by the LIEC, to ensure the EMP is being implemented. The project monitoring program is in Table EMP-4. Monitoring shall comply with the PRC standards for environmental monitoring and quality.

16. **Internal monitoring.** During construction, the PIUs and CSCs will be responsible for conducting internal environmental monitoring in accordance with the monitoring plan.

17. **External monitoring.** The PIUs will contract the Zixing EMS to conduct environmental monitoring in accordance with the monitoring program. A detailed cost breakdown will be provided by the local EMS when the environmental monitoring program is updated at the start of each component implementation. Monitoring will be conducted during construction and operation period, until a project completion report (PCR) is issued. Semi-annual monitoring reports will be prepared by the EMS and submitted to PMO and the PIUs.

18. **Compliance monitoring for EMP and progress reporting.** The LIEC will review project progress and compliance with the EMP based on field visits, and the review of the environmental monitoring conducted by the EMS. The findings of the LIECs will be reported to ADB through the annual EMP monitoring and progress reports. The reports will include (i) progress made in EMP implementation, (ii) overall effectiveness of the EMP implementation (including public and occupational health and safety), (iii) environmental monitoring and compliance, (iv) institutional strengthening and training, (v) public consultation (including GRM), and (vi) any problems encountered during construction and operation, and the relevant corrective actions undertaken. The LIECs will help PMO prepare the reports and submit the English report to ADB for appraisal and disclosure.

19. **Project completion environmental audits.** Within three months after each subproject completion, or no later than one year with permission of the local EPBs, environmental acceptance monitoring and audit reports of each subproject completion shall be (i) prepared by a licensed environmental monitoring institute in accordance with the PRC Guideline on Project Completion Environmental Audit (2001), (ii) reviewed for approval of the official commencement of individual subproject operation by environmental authorities, and (iii) finally reported to ADB through the annual EMP monitoring and progress reporting process.

20. **Quality assurance (QA) /quality control (QC) for compliance monitoring.** To ensure accuracy of the monitoring, QA/QC procedures will be conducted in accordance with the following regulations:

i) Regulations of QA/AC Management for Environmental Monitoring issued by the State Environmental Protection Administration in July 2006;
ii) QA/QC Manual for Environmental Water Monitoring (Second edition), published by the State Environmental Monitoring Centre in 2001; and
iii) QA/QC Manual for Environmental Air Monitoring published by the State Environmental Monitoring Centre in 2001.

Table EMP-4: Environmental Monitoring Program

Subject	Parameter	Location	Frequency	Implement	Supervise
1. Pre-construction					
Heavy metal contents	As, Cd	Spoil disposal sites and borrow pits for river	Once before construction	PIU	ZUREPFC

Subject	Parameter	Location	Frequency	Implement	Supervise
		rehabilitation component			
2. **Construction**					
Internal monitoring (contractors, CSCs, ZUREPFC environmental officer, PIU)					
Ambient air quality	Dust mitigation measures in EMP; equipment maintenance	Visual inspection at all construction sites	1 time / week	Contractor, CSC	PIU, LIEC, ZUREPFC, EPB
Solid waste	Garbage and construction waste	Visual inspection at all construction sites and work-camps	Daily	Contractor, CSC	PIU, EPB, ZUREPFC, sanitation bureau
Wastewater	Provision and operation of domestic and construction wastewater	Visual inspection at all construction sites and work-camps	Daily	Contractor, CSC	PIU, ZUREPFC, EPB
Soil erosion and re-vegetation	Soil erosion intensity	Visual inspection at spoil sites and all construction sites, especially roadsides, water pipelines, banks of rivers, wetland	1 time / week; and immediately after heavy rainfall	Contractor, CSC	PIU, LIEC, ZUREPFC, WRB
	Re-vegetation of embankments, spoil disposal sites, construction sites	Visual inspection at all sites	At least 4 times / year	Contractor, CSC	PIU, WRB
Occupational health and safety	Camp hygiene, safety, availability of clean water, emergency response plans	Inspection at all construction sites and work-camps	1 time / month	Contractor, CSC	PIU, ZUREPFC,
External monitoring (Local environment monitoring station)					
Quality of sewage and discharge channels at work camps	pH, SS, NH_3-N, COD_{Cr}, BOD_5 oil, fecal coliforms	Domestic wastewater discharge at work-camps	4 times/year during construction	EMS	EPB, PIU, ZUREPFC
Construction wastewater	SS, oil, pH	at wastewater discharge points of all construction sites	4 times/year during construction	EMS	EPB, PIU, ZUREPFC
Surface water quality	pH, SS, NH_3-N, COD_{Cr}, oil, As, Cd	200 m upstream and 500 m downstream of the construction site of fiver selected rivers;	2 times / year during construction	EMS	EPB, PIU, ZUREPFC
Ambient air quality	TSP, PM_{10}, NO_x	All construction sites (at least 1 point upwind, 1 point downwind) and nearby sensitive receivers (described in Section IV of EIA)	4 times / year during construction	EMS	EPB, PIU , ZUREPFC, LIEC
Noise	LAeq	Boundaries of all construction sites and sensitive receivers (described in Section IV of EIA)	2 times / year (twice a day: once in day time and once at night time, for 2 consecutive days)	EMS	EPB, PIU, ZUREPFC, LIEC

Subject	Parameter	Location	Frequency	Implement	Supervise
Solid Waste (garbage, construction waste)	Work camps and construction waste at construction sites	Visual inspection at all construction sites and work-camps	Once a year	LIEC	EPB, PIU, ZUREPFC
Soil erosion and re-vegetation	Soil erosion intensity	Visual inspection at spoil sites and construction sites, especially water pipeline route and embankments of rivers, wetlands	Twice a year, and 1 after completion of construction	LIEC	EPB, PIU, ZUREPFC
	Re-vegetation of embankments, spoil disposal sites and construction sites	Visual inspection at sites, and temporary occupied lands	Compliance Monitoring: Twice a year, and 1 after completion of construction	LIEC	EPB, PIU, ZUREPFC
Occupational health and safety	Work camp hygiene, safety, availability of clean water, emergency response plans	Inspection at all construction sites and work-camps	Twice a year, and once after completion of construction	LIEC	Sanitation, labor bureaus, PIU, ZUREPFC
Operation phase					
Wastewater discharge	pH, SS, NH_3-N, oil, COD_{cr}, BOD_5, TN, TP, fecal coliforms	(i) Inflow and outflow of 6 WWTPs and Xingning Wetland; (ii) leachate of SWTSs; (iii) outlet of wastewater discharge of Yangdong WWTP;	4 times during the first year of operation	EMS	EPB, PIU, ZUREPFC
Surface water quality	COD, dissolved oxygen, TN, TP	(i) At Dongjiang Lake near Xingning, Hangxihe and Huangcao wetlands; (ii) wastewater receiving water bodies of Yangdong WTP (Yongle River) and WWTPs (Changhuo River, Qingyao River, Lianping River	4 times during the first year of operation	EMS	EPB, PIU, ZUREPFC
	As, Cd	Five selected rivers	Once after construction	EMS	EPB, PIU, ZUREPFC
Noise	LAeq	(i) boundary of pump stations (Xingning distribution pump station, Xindong distribution pump station and Yangdong WTP; (ii) nearby sensitive receivers along access road to Xingning wetland and pumps; (iii) boundary of SWTS	4 times during the first year of operation	EMS	EPB, PIU, ZUREPFC
Odor	H_2S, NH_3	Boundary of WWTP and SWTS	4 times during the first year of operation	EMS	EPB, PIU, ZUREPFC
Soil and Vegetation	Plant survival and coverage	All re-vegetated sites	Spot check, twice a year	PIU	PIU, ZUREPFC, WRB

BOD_5 = 5-day biochemical oxygen demand; COD_{cr} = chemical oxygen demand; CSC = construction supervision company; EMS = environmental monitoring station; EPB = environmental protection bureau; FB = county forestry bureau, IA = implementation agency; LAeq = equivalent continuous A-weighted sound pressure level; LSMI =

licensed soil erosion institute; NH_3-N = ammonia nitrogen; NO_x = nitrogen oxides; OPF = operators of project facilities; PM_{10} = particles measuring ≤10μm; PMO = Project Management Office; SO_2 = sulfur dioxide; SS = suspended solids; TSP = total suspended particle.

21. Environmental reporting for the project will follow the program in Table EMP-5.

Table EMP-5: EMP Reporting Plan

Reports		From	To	Reporting Frequency
Construction Phase				
Internal progress reports by contractors	Internal project progress report by construction contractors, including monitoring results by CSCs	Contractors, CSCs	PIUs, ZUREPFC	Monthly (during construction season)
Environmental impact monitoring reports	Environmental impact monitoring report	EMS	PIUs, ZUREPFC	Quarterly (during construction season)
Reports to ADB	Project progress report (including section on EMP implementation and monitoring)	ZUREPFC with support of LIEC	ADB	Semi-annually
	Environment progress and monitoring reports	ZUREPFC with support of LIEC	ADB	Semi-annually
Acceptance reports	Environmental acceptance monitoring and audit report	Licensed institute	Chenzhou EPB	Once for each engineering subcomponent, not later than one year after completion of physical works
Operation Phase				
Environmental impact monitoring	Environmental impact monitoring report (during first year of operation)	EMS	PIUs, ZUREPFC	Quarterly
Reports to ADB	Project progress report (including section on EMP implementation and monitoring)	ZUREPFC with support of LIEC	ADB	Semi-annually
	Environment progress and monitoring report	EMS	PIUs, ZUREPFC	Quarterly
		ZUREPFC with support of LIEC	ADB	Once (after first year of operation)
Notes: ADB=Asian Development Bank; EMS = Environment Monitoring Station, LIEC = Loan Implementation Environmental Consultant, PIU=Project Implementing Unit, ZUREPFC=Zixing City Urban and Rural Environmental Protection Financing Center.				

E. Training

22. The project agencies have no previous experience with ADB-funded projects or safeguard requirements. To ensure effective implementation of the EMP, a capacity building program will be implemented on: (i) the EMP, including the mitigation measures, monitoring, and reporting; (ii) sustainable integrated watershed management. Training will be provided by the Hunan EPD, Chenzhou and Zixing EPBs, and LIEC. Trainees will include the PMO, IAs, PIUs, contractors, CSCs, and water resource bureaus. The PMO will arrange and support the training programs, supported by the loan implementation consultants. The training program is in Table EMP-6.

Table EMP-6: Training Program

Training	Attendees	Contents	Times	Period (days)	No. of persons
EMP adjustment and implementation	ZUREPFC, PIUs, contractors, CSCs, local EPB	Development and adjustment of the EMP, roles and responsibilities, monitoring, supervision and reporting procedures, review of experience (after 12 months)	Twice - Once prior to, and once after one year of project implementation	2x0.5	40
Grievance Redress Mechanism	ZUREPFC, PIUs, contractors, CSCs, local EPB	Roles and responsibilities, Procedures, review of experience (after 12 months)	Twice - Once prior to, and once after one year of project implementation	2x0.5	40
Wetland management	As above	Management and rehabilitation of (i) the riverbanks, (ii) the constructed wetlands	Twice – Once prior to construction and once during operation	2x1	40
Environmental aspects of facilities operation	ZUREPFC, O&M unit	Environmental housekeeping; Sludge treatment and disposal process; Safety operation regulations Emergency preparedness and breakdown response procedures	Once during project operation	1	50

O&M = operations and maintenance

F. Public Consultation

23. Two rounds of public consultation were conducted during project preparation (Section VIII of the EIA). During construction, the project will continue to seek public consultation and raise awareness of project activities, especially those which may impact the public such as noise or dust. The project public consultation plan is in Table EMP-7, and includes public participation in evaluating environmental benefits and impacts. The PIUs are responsible for public participation during project implementation. They will be supported by the PMO Environment and Social Officers and the LIEC.

Table EMP-7: Public Consultation and Participation Plan

Organizer	Approach	Times/Frequency	Subjects	Participants
Construction				
PMO, PIUs, LIEC	Questionnaire survey, site visits, informal interviews	Once a year during peak construction	Construction impacts; adjusting mitigation measures if necessary; feedback	Workers, residents in construction areas
	Public workshops	At least once during peak construction	EMP implementation progress; construction impacts; adjusting mitigation measures if necessary; feedback	Residents, affected persons, social sectors
Operation				
PMO, PIU, operators of project facilities	Public consultation and site visits	At least once in first year of operation	Effects of mitigation measures, impacts of operation, feedback	Residents, affected persons adjacent to project facilities
	Public workshop	As needed based on public consultation	Effects of mitigation measures, impacts of operation, feedback	Residents, affected persons, social sectors
	Public satisfaction	At least once after	Comments and	Project

Organizer	Approach	Times/Frequency	Subjects	Participants
	survey	one year of operation	suggestions	beneficiaries

EIA = environmental impact assessment, OPF = operator of project facilities, PIU = project implementing unit, LIEC = loan implementation environmental consultant.

G. Grievance Redress Mechanism

24. A grievance redress mechanism (GRM) has been established to receive and manage any public environmental and/or social issues which may arise due to the project. The PMO Environmental and Social Officers will coordinate the GRM. However, all project agencies and staff will be trained in the GRM and will take an active role in supporting these staff as and when necessary.

25. At the PMO level, the PMO Environmental and Social Officers will establish a GRM tracking and documentation system, conduct daily coordination with the PIU officers, arrange meetings and conduct site visits as necessary, maintain the overall project GRM database, and prepare the reporting inputs for progress reports to ADB. At the PIU level, the environment and social officers will instruct contractors and construction supervision companies (CSCs) on the GRM procedures, and coordinate with the county EPBs and other government divisions as necessary. PMO and PIU staff will be trained and supported by the LIEC and Loan Implementation Social Consultant (LISC).

26. The contact persons for different GRM entry points, such as the PMO and PIU Environmental and Social Officers, contractors, operators of project facilities (OPFs), and county EPBs, will be identified prior to construction. The contact details for the entry points (phone numbers, addresses, e-mail addresses) will be publicly disclosed on information boards at construction sites and on the websites of the PMO and county EPBs.

27. Once a complaint is received and filed, the PMO and PIU officers will identify if complaints are eligible. Eligible complaints include those where (i) the complaint pertains to the project; and (ii) the issues arising in the complaint fall within the scope of environmental issues that the GRM is authorized to address. Ineligible complaints include those where: (i) the complaint is clearly not project-related; (ii) the nature of the issue is outside the mandate of the environmental GRM (such as issues related to resettlement, allegations of fraud or corruption); and (iii) other procedures are more appropriate to address the issue. Ineligible complaints will be recorded and passed to the relevant authorities, and the complainant will be informed of the decision and reasons for rejection. The procedure and timeframe for the GRM is as follows and also summarized in Figure EMP-1.

- **Stage 1 (5 days)**: If a concern arises during construction, the affected person may submit a written or oral complaint to the contractor. Whenever possible, the contractor will resolve the issue directly with the affected person. The contractor shall give a clear reply within five (5) working days. The contractor will keep the PIU fully informed at all stages.

- **Stage 2 (5 days)**: If the issue cannot be resolved in Stage 1, after five days, the PIU and/or PMO will take over responsibility. Eligibility of the complaint will be assessed and a recommended solution given to the complainant and contractors within five (5) working days. If the solution is agreed by the complainant, the contractors and/or facility operators will implement the solution within seven days. Written records will be made of all stages and outcomes.

- **Stage 3 (10 days)**: If no solution can be identified by the PMO and/or PIU, and/or the complainant is not satisfied with the proposed solution, the PMO and/or PIU will organize, within ten (10) days, a stakeholder meeting (including the complainant, contractor and/or

operator of the facility, county EPB, PIU, PMO). A solution acceptable to all shall be identified including clear steps. The contractors (during construction) and facility operators (during operation) will immediately implement the agreed solution. Written records will be made of all stages and outcomes.

28. The GRM does not affect the right of an affected person to submit their complaints to any agency they wish to, for example the local village committee, community leaders, courts, PMO, PIU, and/or Asian Development Bank.

29. The PMO and PIUs shall bear any and all costs of implementing the GRM, including meeting, travel, and/or accommodation costs of the project staff or affected person. The GRM will be implemented throughout project construction and at least the first year of operation for each project facility.

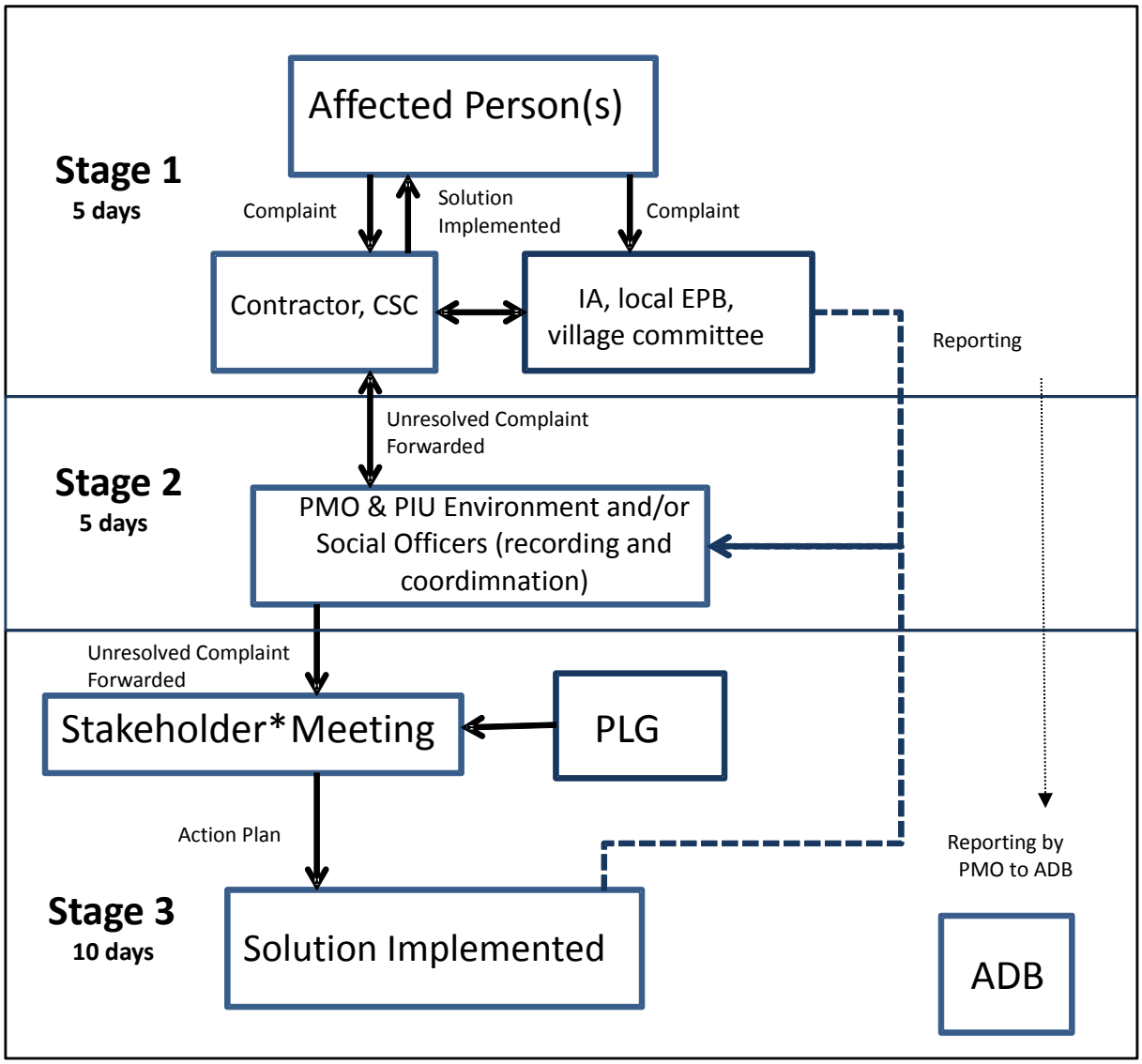


Figure EMP-1: Grievance Redress Mechanism

H. Cost Estimates

30. This section provides an estimate of the cost of EMP implementation. The cost comprises three categories: mitigation measures (Table EMP-3); monitoring (Table EMP-4);

and training (Table EMP-6). Costs are presented for the construction phase of five years and the first year of operation i.e. a total of six years. The costs do not include: (i) detailed design revisions and adjustments; (ii) internal monitoring/inspection of solid wastes disposal, soil erosion and re-vegetation, occupational health and safety during construction, as this will be included in the construction supervision contracts; and (iii) salaries of PMO and PIU staff. Costs for mitigation measures and training are based on estimates in the domestic EIAs and/or the experience of the PPTA team from other projects. All costs were discussed with the EIA Institute, PMO and IAs.

31. The total estimated cost for EMP implementation is CNY15.943 million (USD2,571,452) for five years construction (Table EMP-8). The estimated cost for the PMO is CNY 754,000 (4.7%) and for contractors is about CNY14,594,000 (91.5%). About CNY595,000 (3.7%) will be paid from the ADB loan consulting services and remaining costs by the IAs. Total costs are small given the large scale of the project and when spread over five years.

Table EMP-8. Estimated Cost for EMP Implementation for Five Years Construction and First Year Operation (xCNY10,000). Construction-phase costs will be paid by the contractors (as part of their contracts). **Operational-phase costs** will be paid by each project implementing agency (IA).

Item	Unit cost	No. units	5-yr Cost (CNY)
MITIGATION (Table EMP-3)			
PRE-CONSTRUCTION			
1.1 Public consultations	5000	2	10,000
1.2 LIEC	45000	6 person-months	270,000
1.3 Wetland Specialist	45000	6 person-months	270,000
1.4 GRM	5000	1	5,000
Sub-total			**555,000**
CONSTRUCTION			
2.1 Domestic wastewater	5000	8	40,000
2.2 Construction wastewater	5000	32	160,000
2.3 Dust management	5000	32	160,000
2.4 Vehicle emissions	2000	32	64,000
2.5 Odor	2000	32	64,000
2.6 Noise and vibration	3000	32	96,000
2.7 Domestic waste	2000	32	64,000
2.8 Construction waste	12500	20	250,000
2.9 Soil erosion	400000	32	12,800,000
2.10 Site hygiene	1000	32	32,000
2.11 Community safety	1000	32	32,000
2.12 Site safety	1000	32	32,000
2.13 Public consultation	5000	1	5,000
Sub-total			**13,799,000**
3. MONITORING (Table EMP-4)			
CONSTRUCTION			
3.2 Internal monitoring	250,000	32	**800,000**
Ambient air quality	5,000	32	
Solid waste	5,000	32	
Wastewater	5,000	32	
Soil erosion and re-vegetation	5,000	32	
Occupational health and safety	5,000	32	
3.3 External monitoring			
3.3.1 PRE-CONSTRUCTION			
Spoil site heavy metals testing	5,000	13	65,000
3.3.2 During construction			
Water Quality	10,000	8	80000

Noise	5,000	32	160000
Ambient air quality	10,000	32	320000
3.3.3 During operation			
Water Quality	3,000	23	69000
Noise	1,000	15	15000
Ambient air quality	3,000	15	45000
Sub-total			**754,000**
4. TRAINING (Table EMP-6)			
EMP Implementation	10000	2	20,000
GRM	5000	2	10,000
Environmental operation of facilities	5000	1	5,000
Sub-total			**35,000**
GRAND TOTAL CNY			**15,943,000**
Total USD (USD1=CNY6.2)			**2,571,452**

EMS = Environmental Monitoring Station; GRM = Grievance Redress Mechanism; LIEC = Loan Implementation Environmental Consultant; PM = person-months; WWTP = wastewater treatment plant

I. Mechanisms for Feedback and Adjustment

32. Based on environmental inspection and monitoring reports, the PMO and PIUs shall decide, in consultation with the LIEC, whether (i) further mitigation measures are required as corrective actions, or (ii) some improvements are required for environmental management practices. The effectiveness of mitigation measures and monitoring plans will be evaluated by a feedback reporting system. Adjustment to the EMP will be made, if necessary. The PMO Environmental Officers will play a critical role in the feedback and adjustment mechanism.

33. If during inspection, substantial deviation from the EMP is observed or any changes are made to the project that may cause substantial adverse environmental impacts or increase the number of affected people, then the PMO and PIUs will immediately consult with ADB and form an environmental assessment team to conduct additional environmental assessment. If necessary, further public consultation will be undertaken. The revised domestic EIAs and project EIA, including this EMP, will be submitted to the ADB for review, appraisal, and public disclosure. The revised EMP will be passed to the contractors, CSCs and OPFs for implementation.

APPENDIX 1. DRAFT TERMS OF REFERENCE FOR ENVIRONMENTAL POSITIONS

PMO ENVIRONMENT OFFICER

BACKGROUND

1. Development projects supported by the Asian Development Bank (ADB) routinely include a Project Management Office (PMO). The PMO is responsible for project implementation and comprises the provincial and/or municipal agencies involved in the project. Compliance with the Loan and Project Agreements includes implementation of an Environment Management Plan (EMP), which is prepared as part of the project environment impact assessment. The EMP is the critical guiding document to manage, monitor, and report upon potential project environmental impacts. Implementation of the EMP is a full-time task. For this reason, the PMO assigns at least one full-time officer for this role. These terms of reference describe the requirements for this officer.

SCOPE AND DURATION OF WORK

2. The officer will work on behalf of the PMO to implement the project EMP. The officer will report directly to the PMO. The position is for the entire project duration.

QUALIFICATIONS

3. The officer will have: (i) an undergraduate degree or higher in environmental management or related field; (ii) at least five years of experience in environmental management, monitoring, and/or impact assessment; (iii) ability to communicate and work effectively with local communities, contractors, and government agencies; (iv) ability to analyze data and prepare technical reports; (v) willingness and health to regularly visit the project construction sites and in different seasons; and (vi) ideally, proficiency in spoken and written English.

DETAILED TASKS

4. The PMO Environment Officer will have a detailed understanding of the project EMP and supporting documents, including the domestic environmental reports, the project EIA, and project environmental assurances. The officer will have the following tasks.

(i) Assess whether the EMP requires updating due to any changes in project design which may have occurred after the EMP was prepared.

(ii) Distribute the Chinese language version of the EMP to all relevant agencies, including the implementing agencies, provincial and municipal agencies for environment protection. This should occur at least three months before construction begins.

(iii) Conduct meetings with agencies as necessary to ensure they understand their specific responsibilities described in the EMP.

(iv) Ensure that relevant mitigation, monitoring and reporting measures in the EMP are included in the bidding documents, contracts and relevant construction plans.

(v) Confirm that the Implementing Agencies (IAs) responsible for the internal environment monitoring described in the EMP understand their tasks and will implement the monitoring in a timely fashion.

(vi) At least two months before construction begins, establish and implement the project Grievance Redress Mechanism (GRM) described in the EMP. This will include: (a) prepare a simple table and budget identifying the type, number and cost of materials needed to inform local communities about the GRM and starting dates and scope of construction; (b) design, prepare and distribute these materials, and plan and conduct the community meetings; (c) prepare a form to record any public complaints; (d) prepare a summary table to record all complaints, including dates, issues, and how they were resolved; and (e) ensure that all relevant agencies, including contractors, understand their role in the GRM.

(vii) Prior to construction, ensure that IAs and their contractors have informed their personnel, including all construction workers, of the EMP requirements. This will include all mitigation measures relating to impacts to air, water, noise, soil, sensitive sites, ecological values, cultural

values, worker and community health and safety, respectful behavior when communicating with local communities, and responding to and reporting any complaints.

(viii) During project construction, make regular site visits with LIEC to assess progress, meet with contractors and/or local communities, and assess compliance with the EMP.

(ix) Ensure that all relevant agencies submit required progress reports and information, including environmental monitoring and reports of any issues or grievances.

(x) Compile, review, and store environmental progress reports from the IAs, records of any grievances, and any other relevant issues. Maintain digital copies of all information. When necessary, enter data into summary tables in digital format (e.g. to transfer records of grievances from hard copy forms). Ensure that all information is stored in the PMO filing system, backed up, and can be easily retrieved.

(xi) Prepare semi-annual environment progress reports.

(xii) Work closely with the PMO, IAs, loan implementation consultants, and other agencies and personnel as necessary to conduct these tasks.

REPORTING REQUIREMENTS

Semi-annual environment monitoring reports, using the template provided by ADB or a domestic format reviewed and approved by ADB.

LOGISTICAL SUPPORT PROVIDED BY PMO TO THE ENVIRONMENT OFFICER

(i) Provision of hard and soft copies of the project EMP, domestic and project environmental reports, feasibility study reports, loan and project agreements, maps, and other supporting materials as necessary to ensure the officer can implement the tasks.

(ii) Vehicle transport, office materials, and other logistical support as necessary for the officer to visit the project construction sites and local communities, arrange and conduct meetings, and prepare and distribute consultation materials.

(iii) Overall coordination, including review of the draft semi-annual monitoring reports and final responsibility for submission of the monitoring reports to ADB.

PROJECT IMPLEMENTATION UNIT (PIU) ENVIRONMENT OFFICER

BACKGROUND

1. The project will be coordinated by a Project Management Office (PMO). Overall coordination of the project Environment Management Plan (EMP) is the responsibility of the PMO Environmental Officer. At the field level, implementation of the EMP will be undertaken by the Project Implementation Unit (PIU). For this purpose, the PIU requires a PIU Environment Officer.

SCOPE AND DURATION OF WORK

2. The officer will work on behalf of the PIU to implement the project EMP. The officer will report directly to the PIU manager and work closely with the county Environment Protection Bureau (EPB), Environment Monitoring Station (EMS), and PMO Environment Officer. The position is for the entire project duration (five years).

QUALIFICATIONS

3. The officer will have: (i) an undergraduate degree or higher in environmental management or related field; (ii) at least five years of experience in environmental management, monitoring, and/or impact assessment; (iii) ability to communicate and work effectively with local communities, contractors, and government agencies; (iv) ability to analyze data and prepare technical reports; (v) willingness and health to regularly visit the project construction sites and in different seasons; and (vi) ideally, proficiency in spoken and written English.

DETAILED TASKS

4. The PIU Environment Officer will have a detailed understanding of the project EMP and supporting documents, including the domestic environmental reports, project EIA, and project environmental assurances. The officer will have the following tasks.

(i) Work closely with the PMO Environment Officer, EPB, EMS, contractors, construction supervision companies (CSCs) and all other relevant agencies, to implement the EMP.
(ii) Distribute the Chinese language version of the EMP to all relevant agencies, including the implementing agencies, provincial and municipal agencies for environment protection. This should occur at least three months before construction begins.
(iii) Conduct meetings with agencies as necessary to ensure they understand their specific responsibilities described in the EMP.
(iv) Ensure that contractors implement the relevant mitigation measures in the EMP.
(v) Implement the monitoring and reporting requirements in the EMP, including timely submission of progress reports to the PIU and PMO Environment Officer.
(vi) Implement the project grievance redress mechanism (GRM).
(vii) Make regular inspections of construction sites to assess progress, meet with contractors and/or local communities, and assess compliance with the EMP.
(viii) Maintain digital records of all progress and information.
(ix) Support the PMO Environmental Officer in all of their tasks.

REPORTING REQUIREMENTS

Monthly reports to the PIU and PMO Environmental Officer.

LOAN IMPLEMENTATION ENVIRONMENTAL CONSULTANT

I. BACKGROUND

1. The project will be coordinated by a Project Management Office (PMO), whose overall responsibility includes implementation of the project Environment Management Plan (EMP). At the field level, the project will be implemented by a Project Implementation Unit (PIU). The PMO and PIUs will be assisted by a Loan Implementation Consultant team. The Loan Implementation Environmental Consultant (LIEC) will be a part of this team and will support the PMO and PIUs to implement the project EMP.

II. SCOPE AND DURATION OF WORK

2. This is an independent position (recruited as part of a consultant team or individually) which is not part of the PMO in-house environmental team. The specialist will report to the PMO. The position is for the entire project duration. The LIEC should be recruited as soon as possible after loan effectiveness, as the first task is to confirm project environmental readiness.

III. QUALIFICATIONS

3. The specialist will have: (i) an undergraduate degree or higher in environmental management or related field; (ii) at least eight years of experience in environmental management, monitoring, and/or impact assessment; (iii) familiarity with ADB project management requirements and national environmental management procedures; (iv) ability to communicate and work effectively with local communities, contractors, and government agencies; (v) ability to analyze data and prepare technical reports; (vi) willingness and health to regularly visit the subproject sites; and (vii) proficiency in spoken and written English.

IV. TASKS

Working closely with the PMO and PIU Environmental Officers, the LIEC will do the following.

Before construction

(i) Ensure project environmental readiness, including: (i) all contractor contracts include, and will comply with, the EMP; and (iii) relevant sections of the EMP are incorporated in construction plans and contracts.
(ii) Assist the PMO and PIUs to implement the GRM, including: (i) establish and publicize the GRM; and (ii) collate and evaluate grievances received.
(iii) Develop procedures to: (i) monitor EMP implementation progress; (ii) collate and evaluate data collected in the EMP environmental monitoring program; and (iii) prepare and submit the semi-annual environmental monitoring reports to ADB (to continue until Project Completion Report).
(iv) Train project agencies in on-site ecological management and rehabilitation for the river dredging component, and, operation of the constructed wetlands.
(v) Provide hands-on support and on-the-job training to the PMO, IAs and contractors on the specific requirements of the EMP as required.

During project implementation

(i) Undertake site visits to all IAs during subproject construction and operating phase.
(ii) Assist in the ongoing public consultation process as described in the project EIA.
(iii) Conduct EMP compliance assessments, identify any environment-related implementation issues, and propose necessary responses in corrective action plans.
(iv) Undertake training of project agencies as required by the EMP training plan.
(v) Assist PMO to prepare semi-annual environmental monitoring progress reports for submission to ADB.

WETLAND AND ECOLOGICAL CONSULTANT

I. BACKGROUND

1. The project will be coordinated by a Project Management Office (PMO), whose overall responsibility includes implementation of the project Environment Management Plan (EMP). At the field level, the project will be implemented by a Project Implementation Unit (PIU). The PMO and PIUs will be assisted by a Loan Implementation Consultant team. The Wetland and Ecological Consultant will be a part of this team and will support the PMO and PIUs to implement the project EMP. The specialist will focus on providing ecological management support during the planned dredging and embankment of five rivers in the Dongjiang Lake project area.

II. SCOPE AND DURATION OF WORK

2. This is an independent position (recruited as part of a consultant team or individually) which is not part of the PMO in-house environmental team. The specialist will report to the PMO. The position is for six person-months. The timing of the position will be planned to coincide with the project dredging and embankment, between Year 1 and 3 of the five-year project (see below).

III. QUALIFICATIONS

3. The specialist will have: (i) an undergraduate degree or higher in wetland ecology or related field; (ii) at least 10 years' experience in the applied management of natural wetlands, rivers and lakes, and ecological survey, research and management of aquatic fauna, especially fish biodiversity conservation; (iii) preferably, management experience with embankment and dredging; (iv) ability to communicate and work effectively with local communities, contractors, and government agencies; (v) ability to analyze data and prepare technical reports; (vi) willingness and health to regularly visit the project sites; and (vii) ideally, proficiency in spoken and written English.

IV. TASKS

Working closely with the PMO and PIU Environmental Officers, the specialist will do the following.

Before construction

(vi) Design the habitat features for the planned embankments along the five project rivers, tailoring the features specifically to the native fauna and flora of the Dongjiang Lake area.
(vii) Conduct regular field visits to the five project rivers – especially the target sections for dredging and embankment – to gain a detailed familiarity with these sites and the key aquatic ecological values which need to be protected.
(viii) Through site surveys, desktop review, and interviews with experts and residents, as far as possible identify any specific sites of ecological significance in the planned dredge sections, especially any fish and/or turtle breeding sites.
(ix) Assist with integration of these habitat features into the final detailed engineering designs of the embankments.
(x) Review and if necessary strengthen the planned mitigation measures in the project Environment Management Plan (EMP) for dredging.
(xi) Develop simple on-site procedures, to be implemented together with the construction team, during the dredging and embankment e.g. checking of the channel by the specialist immediately before dredging commences.

During project implementation

(vi) On-site support throughout the dredging and embankment, to check the channel, remove and release any fauna found trapped or injured by the construction, and to ensure implementation of the EMP ecological protection measures.
(vii) Conduct post-construction site inspection to assess the effectiveness of, and compliance with, the EMP and habitat designs.
(viii) Prepare a progress report after each major trip to the project site; and a final report. The PMO will include these reports in the government's semi-annual environment progress reports to the Asian Development Bank.