Environmental Impact Assessment (DRAFT)

Project number: 48468
December 2016

People's Republic of China: Guizhou High Efficiency Water Utilization Demonstration in Rocky Desertification Area Project

Prepared by the Guizhou Provincial Government for the Asian Development Bank

CURRENCY EQUIVALENTS

(As of 3 November 2016)
Currency Unit - Yuan (CNY)
CNY 1.00 = US$ 0.1499
US$ 1.00 = CNY 6.7576

ABBREVIATIONS

ACG	Anlong County government
ADB	Asian Development Bank
BOD_5	5-day biochemical oxygen demand
CNY	Chinese Yuan
COD	Chemical oxygen demand
EA	Executing Agency
EHS	Environment, health and safety
EIA	Environmental impact assessment
EIR	Environmental impact report
EIT	Environmental impact table
EMP	Environmental management plan
EMS	Environment monitoring station
EPB	Environmental protection bureau
EPD	Environmental protection department
FSR	Feasibility study report
FYP	Five year plan
GCCC	Guizhou Climate Change Center
GDP	Gross domestic product
GEPD	Guizhou environment protection department
GHG	Greenhouse gas
GPG	Guizhou provincial government
GRM	Grievance redress mechanism
GWIC	Guizhou water investment corporation
GWRD	Guizhou water resources department
IA	Implementing Agency
LIC	Loan implementation consultant
LIEC	Loan implement. environment consultant
MOE	Ministry of Environment
NCG	Nayong County government
PIU	Project implementation unit
$PM_{2.5}$	Particulate matter with diameter<2.5μ
PM_{10}	Particulate matter with diameter<10μ
PMO	Project management office
PRC	People's Republic of China
RMO	Reservoir Management Office
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

WEIGHTS AND MEASURES

^oC	degree centigrade
dB	decibel
g	gram
ha	hectare
km	kilometer
km^2	square kilometer
kW	kilowatt
L	liter
L_{Aeq}	Equivalent continuous A-weighted sound pressure
MW	megawatt
m	meter
m^2	square meter
m^3/a	cubic meter per annum
m^3	cubic meter
m^3/d	cubic meter per day
m^3/s	cubic meter per second
mg/kg	milligram per kilogram
mg/l	milligram per liter
mg/m^3	milligram per cubic meter
mm	millimeter
t	metric ton
t/d	metric ton per day
t/a	ton per annum

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

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EXECUTIVE SUMMARY

A. Introduction

1. The Guizhou Provincial Government (GPG), People's Republic of China (PRC) has requested the Asian Development Bank (ADB) to provide investment and technical assistance support for the Guizhou High Efficiency Water Utilization Demonstration in Rocky Desertification Area Project (the project). The project will help the GPG to improve water resource security and management and pilot measures for re-vegetation, soil erosion control, and agricultural production in degraded karst areas, in two pilot counties, Anlong and Nayong. Under the ADB Safeguard Policy Statement (SPS) (2009) the project is classified Category A for environment, requiring preparation of an environmental impact assessment (EIA).

2. This EIA has been prepared in accordance with SPS requirements. It is based on information from: (i) two domestic environmental impact assessments (one for each of two water resources development projects) prepared by domestic certified EIA institutes; (ii) two domestic feasibility study reports (FSRs) and preliminary design documents (PDDs) each for the two water resources development projects; (iii) two water and soil erosion control plans (WSECPs); (iv) provincial and county master plans, which identify the need to address rocky desertification, water resources management, soil erosion, and re-vegetation; and (v) environmental and social assessments and site visits conducted between March and September 2016 by a consultant team for the project preparatory technical assistance (PPTA), in cooperation with the provincial and county governments.

B. Background

3. Rocky desertification is a process of land degradation characterized by soil erosion and bedrock exposure, especially in regions dominated by karst (limestone) geology. In the PRC, rocky desertification is a critical issue in at least eight provinces, particularly in the south-western region, which supports among the largest karst areas in the world and a population of around 220 million people. Rocky desertification is mainly caused by intensive land use such as cropping and deforestation. For the south-west PRC, the issue has been well documented for several decades and is known to be a key contributing factor to declining water resources and agricultural productivity, increasing soil erosion, and increasing risks to food and water security and economic development.

4. Guizhou Province supports the largest rocky desertification area in the PRC (19% of the provincial area and 25% of the total rocky desertification area in the PRC), experiences frequent and severe drought, and has the lowest gross domestic product per capita in the country. Government efforts to halt the decline of rocky desertification have resulted in widespread awareness of the issue among government agencies and communities, and the implementation of provincial master plans which focus on water conservation, control of soil erosion, and re-vegetation of degraded karst areas. To support these efforts, the PRC government has selected Guizhou Province as a demonstration project for efficient water use and agriculture in degraded karst areas, particularly under a warming climate.

C. Project Components

5. The project impact will be the improvement of livelihoods of people living in rocky desertification areas in Guizhou and replication of high efficiency water utilization for rocky desertification management in Guizhou. The project outcome will be a demonstration of high

efficiency water utilization for rocky desertification management in Guizhou. The project has two outputs: 1 – water resources developed; and 2 – environment, ecology, and land productivity in rocky desertification areas restored. Output 1 focuses on water resources management and has two sub-components: (i) the construction of two dams, Pingqiao and Pingshan, and associated water transfer facilities; and (ii) the establishment of water users associations. Output 2 has three sub-components: (i) re-vegetation in selected demonstration sites in Anlong and Nayong counties, comprising a dual approach using fruit trees on lower slopes (for community benefit) and native species on higher slopes (for protection of headwaters); (ii) promotion of sustainable farming to reduce rocky desertification areas, including (a) developing approaches for irrigated and un-irrigated areas, and (b) publicity and promotion of sustainable farming; and (iii) support for policy reforms, capacity development, and knowledge dissemination. The project also includes support for project management and compliance with ADB procedures. Further details are given in Table ES-1.

Table ES-1: Summary of Project Outputs

Output	Quantity / Activity	Agency
Output 1: Water resources development		
1-1. Construction of Pingqiao and Pingshan Dams and water transfer facilities		
1-1-1. Construction of Pingqiao Dam and water transfer facilities	One rock-fill dam (height 74.5 m, maximum water storage capacity 78,980,000 m^3, flood control capacity 7,570,000 m^3, reservoir area 2.98 km^2, catchment area 193.4 km2) Water transfer facilities (57 km canals and pipes, 1 pump station) Water supply (35,720,000 m^3 / year for irrigation for 5,656.7 ha new and 1,408 ha existing irrigation areas; and 39,970,000 m^3 / year for drinking water supply use through 1 existing water treatment plant)	Pingqiao Dam Co., Ltd.
1-1-2. Construction of Pingshan Reservoir and water transfer facilities	One concrete face rock-fill dam (height 94.0 m, maximum water storage capacity 14,690,000 m^3, flood control capacity 980,000 m^3, reservoir area 0.46 km2, catchment area 34.30 km^2) Water transfer facilities (40.5 km canals and pipes, 1 regulation pond, 13 terminal tanks) Water supply (11,260,000 m^3 / year for irrigation for 3,594.7 ha new and 360.6 ha existing irrigation areas; and 4,740,000 m^3 / year for drinking water supply through 3 existing water treatment plants)	Pingshan RMO
1-2. Establishment of water users associations	Establishment of a water users association, with consultant support	Pingqiao Dam Co., Ltd; Pingshan RMO
Output 2: Restoration of environment, ecology, and land productivity in rocky desertification areas		
2-1. Re-vegetation		PMO
Along County	Plant fruit trees (930 ha) and non-fruit trees (669 ha)	
Nayong County	Plant fruit trees (615 ha) and non-fruit trees (413.6 ha)	
2-2. Promotion of sustainable farming to reduce rocky desertification areas		
2-2-1. Pilot projects		
Anlong County	Total pilot area: 70.6 ha	Pingqiao Dam Co., Ltd.
Sustainable farming measures for irrigated areas	• 67.3 ha pilot area including 2 parallel systems • Each system (connected to Pingqiao Dam via water transfer systems): 3.0 km pipe, remote control gate,	

Output	Quantity / Activity	Agency
	water storage tank, electronic magnetism bulb for remote control, 0.75 km pipe, integrated "fertigation" (fertilization and irrigation) system, 4.0 km pipes for field irrigation • Demand-based remote water allocation system remotely controls the gates and bulbs	
Sustainable farming measures for un-irrigated areas	• 3.3 ha pilot area including 5 small water storage tanks, 1.0 km canals, and farmlands	
Nayong County	Total pilot area: 72.4 ha	Pingshan RMO
Sustainable farming measures for irrigated areas	• 69.1 ha pilot area including 2 parallel systems • Each system (connected to Pingshan Reservoir via water transfer systems): 1.0 km pipe, high efficiency solar pump (for one system only), remote control gate, water storage tank, electronic magnetism bulb for remote control, 0.75 km pipe, integrated "fertigation" (fertilization and irrigation) system, 4.0 km pipes for field irrigation - farmlands • Demand-based remote water allocation system remotely controls the gates and bulbs	
Sustainable farming measures for un-irrigated areas	• 3.3 ha pilot area including 5 small water storage tanks, 1.0 km canals, and farmlands	
2-2-2. Publicity and promotion of sustainable farming	• On-site workshops in the pilot project sites inviting local farmers from other areas, with consultants' supports	PMO; Pingqiao Dam Co., Ltd; Pingshan RMO
	• Market surveys, and guidance to local farmers on how to select, grow, and sell crops; by consultants	
2-3. Policy reforms, capacity development, and knowledge dissemination	Establishment of eco-compensation mechanisms for Pingqiao and Pingshan Dams with consultant support	PMO; Pingqiao Dam Co., Ltd; Pingshan RMO
	Closure of important forest areas, with consultant support	Pingqiao Dam Co., Ltd; Pingshan RMO; Anlong and Nayong WRBs, FBs
	Review of policy and regulations and recommendations for improvements, by consultants	PMO
	Review of micro financing systems and recommendation for improvements, by consultants	PMO
	Overseas and domestic study tours for water and rocky desertification management, with consultants' supports	PMO
	Dissemination of project's initiatives, with consultants' supports	PMO
Project Management		
Project management activities	Procurement, consultant recruitment, contract management, and financial management	PMO; Pingqiao Dam Co., Ltd; Pingshan RMO; PIUs
	Monitoring of project progress and performance (achievement of project impact, outcome, and outputs)	PMO
	Environmental monitoring	PMO; PIUs; Anlong and Nayong County EPBs
	External M&E for land acquisition and resettlement	PMO; independent

Output	Quantity / Activity	Agency
		agency
	Consulting services for project management support	PMO

EPB = environment protection bureau, FB = forestry bureau, M&E = monitoring and evaluation, PIU = project implementation unit, PMO = project management office, RMO = reservoir management office, WRB = water resources bureau.

6. The construction of Pingqiao and Pingshan Dams are the largest components of the project. Domestic planning for both dams was conducted from 2010 to 2014. For Pingqiao Dam, the domestic EIA and FSR were approved in August 2012 and June 2013 respectively, and for Pingshan Dam, the domestic EIA and FSR were approved in May 2013 and June 2014 respectively. ADB financing and technical assistance was requested in 2014, and the first ADB project mission was fielded in August 2015. The advanced nature of domestic planning and approvals presented challenges for the ADB project to provide added value and/or address any major safeguard issues. Prior to further detailed planning, ADB funded two rapid assessments, for environmental and social safeguards respectively, to identify any safeguard issues which might threaten the project viability. The assessments were conducted between August and December 2015. The assessments noted a range of relatively minor safeguard issues and which could be addressed through project mitigation (and which are included in this report). Project planning proceeded on this basis. The initial PRC request for financing of the two dams also provided the opportunity for considerable added value, and all other project components (**Table ES-1**), were subsequently designed under the ADB project.

D. Project Benefits and Features

7. **Project benefits**. The project will result in improved water supply for domestic and irrigation use, demonstration of rocky desertification control, and sustainable agriculture, as follows: (i) supply of 89 million m^3/year of safe and reliable water for a beneficiary population of 362,920 in 118,385 households by 2025, and for irrigating 11,020 ha of farmland; (ii) the value added of agricultural production from the increase in irrigation water volume in the project areas will increase to CNY 13.5/m^3 by 2025 from CNY 8.5/m^3 in 2016; (iii) more water for agriculture and household use for downstream users, especially in the dry season; (iv) the re-vegetation component, as a rocky desertification control pilot program, will reduce rocky desertified areas in the two project counties by 2,771 ha to 4,136 ha by 2025 from 6,907 ha in 2016; and (v) the re-vegetation and sustainable agriculture components will promote ecotourism, farm-based tourism and cultural tourism and propel the development of the tourism industry in the two project counties, through beautification of the rocky desertified hills and mountains and provision of an additional 1,544.9 ha of fruit orchards and 1,082.6 forested land and green food products. Overall, the project will benefit 362,920 people in the direct project areas, of which 42.0% are women, 52.0% ethnic minorities and 20.7% under the poverty line, and over 1.49 million people in the indirect project areas, of which 44.9% are women, 50.3% are ethnic minorities and 12.8% are under the poverty line.

8. **Innovative features**. Several innovative features are built into the project designs. First, rocky desertification control will be piloted through re-vegetation combined with poverty reduction and eco-compensation. Re-vegetation of the rocky desertification areas will use fruit trees of local species that will not only reduce rocky desertification but also generate income for local farmers. Eco-compensation will be provided to local farmers to retire rocky desertification-prone farmland to fruit forests, therefore reducing the rate of rocky desertification. If successful, this pilot program can be replicated in other parts of the two project counties, other parts of Guizhou Province where 19% of the provincial area and 25% of the total rocky desertification area in the

PRC, and other south-western provinces in the PRC. Second, sustainable farming practices will be demonstrated in the two project counties, with the potential for replication nation-wide, through the adoption of high efficiency solar pump, efficient water transfer and irrigation saving technologies, and an integrated "fertigation" (fertilization and irrigation) system. Finally, the project will support the formation of water users associations to improve community-based water resources management.

E. Baseline Environment

9. The project area comprises a modified landscape of farmland and human settlements, due to long-term human disturbance. Most original vegetation has been cleared. There are narrow flood plains along the river channels and in between the plateaus which are mostly dryland with the lack of irrigation and hence low productivity, due to the lack of irrigation water supply and infrastructures. There are no protected areas in the project areas and no known records of rare, threatened, or protected flora or fauna, critical habitats, or physical cultural resources, except for four bird species under national-level II protection. Most rivers are still clean (Grades II-III) owing to low population density and low level of industrialization. Detailed environment baseline data for the project counties are described in **Chapter IV**.

F. Potential Environmental Impacts and Mitigation Measures

10. **Construction phase.** Key potential impacts are from the proposed construction of two dams and irrigation facilities. Dam and pipeline construction will require excavation, removal of vegetation, transport of borrows, transport and disposal of spoils, and preparation and transport of construction materials. This may cause soil erosion, sediments, dust, vibration and noise to local waterways and communities. Construction camps and machinery and equipment maintenance and repair shops will also produce wastewater and solid wastes. Dam and water pipeline construction will physically alter topography and habitats at the dam site and the impoundment area, and may result in loss of breeding habitat for fish and aquatic invertebrates. Inappropriate transport and disposal may damage roads along transport routes and cause leakage at spoil sites. Other construction risks include interference with traffic and municipal services during pipeline construction across roads and bridges, permanent and temporary acquisition of land, involuntary resettlement, and occupational and community health and safety. An in-depth analysis is undertaken of the potential effect of construction on the four bird species under national-level II protection. The Nayong county project area is not part of the critical habitats for the birds. Moreover, the loss of habitat for the protected bird species ranges from a high of 0.00025% to a low of 0.0000015% (**Table V-11**). With the implementation of the mitigation measures contained in the EMP, the impact on the bird species is assessed to be negligible.

11. Mitigation measures have been designed to minimize water pollution, air pollution, noise and vibration, solid waste, soil erosion, adverse ecological impacts, GHG emissions and climate change risks, land acquisition and resettlement, occupational health effects and community disturbance during the construction phase. Public consultations were undertaken during the domestic preparation process and the project preparatory technical assistance (PPTA). The public comments and suggestions have been used to improve project design and formulate the EMP. An environmental monitoring program has been developed as part of the EMP. Institutional roles and responsibilities have been outlined and a comprehensive training program has been prepared to strengthen the capacities of local partners in implementing the EMP. The costs for EMP implementation have been incorporated into the overall project investment plan.

12. **Operational phase.** The formation and operation of the two dams will alter local

hydrology within and downstream of the dam areas (see also below). The ecological impacts of altered hydrology are anticipated to be low, due to: (i) an ecological flow, equivalent to 10% of the average yearly flow, will be continuously released to maintain the basic functioning of downstream ecosystems; (ii) there are no documented records of threatened, protected, or economically important species of aquatic fauna within the watersheds of either dam site. For the project components on the dams and sustainable agriculture, a potential operational risk is non-point source pollution from agricultural chemicals, which may affect water quality in the dams and/or streams. Efficient systems for water transfer, water-saving irrigation technologies, and integrated "fertigation" systems will be adopted to ensure the efficient use of water and fertilizers to minimize the risk of non-point source pollution.

13. **Dam safety.** The largest project components are the construction of two medium-sized dams, Pingqiao and Pingshan. A review of the construction designs and plans for operation and maintenance (O&M) was conducted by the PPTA dam specialist, including structural integrity and safety. The specialist concluded that: (i) the selected dam locations are the optimal location for geological stability; (ii) all engineering designs meet PRC standards including for safety; (iii) both dams are designed for maximum dam safety: probabilities of dam failure for both dams are low (0.1% for Pingqiao Dam or once-in-one-thousand-year flood, and 0.05% for the Pingshan Dam or once in two-thousand-year flood); (iv) a regular maintenance and repair program and safety monitoring system will be installed at each of the dams; (v) both dams have well-established emergency response plans; and (vi) an independent dam safety panel has been established to review the detailed designs for the dams. PRC law and ADB's SPS require that project designs are reviewed by an independent dam expert panel. A panel of three national dam safety experts was convened by the GPG in July 2016. During the project construction and operation phases, the panel will convene at least twice a year to assess project progress and any issues. The findings of the panel will be included in the semi-annual environment reports to ADB.

14. **Indirect, induced, and / or cumulative impacts—construction.** There are no plans for building other dams in the catchments of the two watersheds. The dams are situated in remote mountainous areas where industrial development is not foreseen. The irrigation subcomponents are small-scale, will be widespread, and are located in rural settings where no intensive development activities are anticipated. In addition, the availability of farmland is restricted due to the rocky topographic conditions.[1] Overall, construction-related cumulative impacts are assessed to be minimal.

15. **Indirect, induced, and / or cumulative impacts—operation.** The operation of both dams will alter the hydrology of river and channel sections downstream of the dams. Both of the proposed dam sites are along relatively small waterways (flow rate of 3.70 m^3/s for the Pingqiao river on which the Pingshan Dam will be built, and 0.77 m^3/s for the Gantian river on which the Pingshan Dam will be built). Under the project, flow regulation by the dams in the wet season will reduce the risk of flooding and provide a more steady supply of water for residential and agriculture uses. In the dry season, flow regulation will increase the downstream flow and hence water supply for residential and agricultural users. Two induced impacts may arise from the increase in surface water availability under the project. First, the increased availability of water for communities, agriculture and industry may result in increased wastewater production. The existing and planned wastewater treatment plants in the two project counties will have adequate capacity to handle the incremental demand. Second, the two dams will make more water available for agricultural expansion. According to the agricultural development strategies of

[1] When the irrigation components are completed, 85–90% of the irrigation-suitable farmlands will have been covered. Communication with the PMO and design institutes.

Guizhou Province and the two project counties, the future direction is to develop “circular and ecological agriculture” using local crop species and ecological farming technologies and practices. Overall, operation-related cumulative impacts are assessed to be minimal.

G. Analysis of Alternatives

16. Alternative analyses were conducted for all subprojects and components. Alternative methods and designs were identified and compared against technical, economic, social, and environmental criteria for each project component. The primary objective with respect to environmental criteria was to identify options with the least adverse environmental impacts and maximum environmental benefits. Alternative designs were assessed for dam sites and locations, dam design, normal storage level, location of diversion tunnel, type of diversion tunnel, use of pump station versus elevated storage pond for primary water transmission, secondary water transmission, water transmission pipe materials, and sewage treatment. Key environmental and socio-economic factors were considered in the analyses were: (i) land acquisition and resettlement; (ii) minimization of community disturbance; (iii) adaptation to local context (climatic constraints, rocky desertification); and (iv) potential impacts on water, air and land.

H. Public Consultation and Grievance Redress Mechanism

17. Two rounds of public consultation were conducted in the project counties, with residents and government agencies. Public feedback comprised support for the project for improving water security, and included concern over potential construction disturbance, resettlement from the dam inundation zones, and the need to ensure water supply for downstream residents and agriculture. Measures to address these concerns have been incorporated in the project design and mitigation measures (**Attachment EMP-1**). Public consultation will continue during project construction and operation for early resolution of any grievances. A grievance redress mechanism (GRM) has been developed to address environmental, health, safety, and social concerns associated with the project.

I. Climate Change

18. A climate risk and vulnerability assessment was conducted and identified that the project infrastructure and planned activities are at high risk of adverse climate change impacts. Projected increased variability in precipitation relative to the historical baseline, and increasing flood and drought frequency and storm intensity, may affect project infrastructure by: (i) increasing sedimentation in the dams, due to increased erosion as a result of precipitation and/or flooding events; and (ii) causing mechanical damage to the dams, water transport channels, storage tanks, and other associated infrastructure, because of more severe storm or flood events, as well as potential subsidence and land slips. The project’s infrastructure designs address these risks. Under the most likely climate scenario, the annual average temperatures in the two project counties is projected to rise by 0.9^{o}C for 2016–2035 from the baseline years of 1986–2005, by 1.8^{o}C for 2046–2065 and by 2.7^{o}C for 2081–2100. Increasing temperatures may affect the survival and growth of the planted vegetation in the re-vegetation component. This risk will be mitigated by appropriate selection of climate (drought and flood) resilient plant species. Re-vegetation and promotion of sustainable (karst-specific) farming measures will contribute to increased climate adaptation in the project area, by preventing soil erosion (as well as to increased carbon sequestration). For the 5-year construction phase, greenhouse gas (GHG) emissions are estimated at 68,289 tCO_{2e}, which is below ADB’s threshold of 100,000 tCO_{2e}. Re-vegetation and sustainable farming practices will offset GHG emissions released over the following 10 years of operation phase and capture around 6,714.18 tCO_{2e}. A minor contribution to

GHG emissions capture will be provided by domestic biogas reuse in resettlement areas.

J. Environmental Management Plan

19. A project environmental management plan (EMP) has been prepared (**Attachment 1**). Development of the EMP drew on the domestic environmental impact assessments, discussions with the PMO, PIUs and IAs, Guizhou EPD, local 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.

K. Risks and Assurances

20. The two project counties have no previous experience in ADB safeguard procedures and have low institutional capacity for environmental management. This may result in limited implementation of the project EMP and inadequate operation of the project facilities. These risks have been minimized as follows: (i) appointment of at least one full-time, qualified environment officer in the provincial project management office and at least one each in the two county project implementation units; (ii) the inclusion of a loan implementation environmental consultant (LIEC) in the loan consultant services; (iii) close coordination with the local environmental protection bureaus and monitoring stations to support EMP implementation; (iv) defined roles and responsibilities of all relevant agencies, including contractors and construction supervision companies; and (v) capacity building for EMP implementation. Environmental assurances (**Section X**) have been agreed upon and will be included in the loan and project agreements.

L. Conclusion

21. 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.

I. INTRODUCTION

1. The Guizhou Provincial Government (GPG), People's Republic of China (PRC) has requested the Asian Development Bank (ADB) to provide investment and technical assistance support for the Guizhou High Efficiency Water Utilization Demonstration in Rocky Desertification Area Project (the project). The project will help the GPG to improve water resource security and management and pilot measures for re-vegetation, soil erosion control, and agricultural production in degraded karst areas, in two pilot counties, Anlong and Nayong. Under the ADB Safeguard Policy Statement (SPS) (2009) the project is classified Category A for environment, requiring preparation of an environmental impact assessment (EIA).

2. This EIA has been prepared in accordance with SPS requirements. It is based on information from: (i) two domestic environmental impact assessments (one for each of two water resources development projects) prepared by domestic certified EIA institutes; (ii) two domestic feasibility study reports (FSRs) and preliminary design documents (PDDs) each for the two water resources development projects prepared by domestic certified institutes; (iii) two water and soil erosion control plans (WSECPs) each for the two water resources development projects prepared by domestic certified WSEC institutes; (iv) provincial and county master plans, which identify the need to address rocky desertification, water resources management, soil erosion, and re-vegetation; and (v) environmental and social assessments and site visits conducted between March and September 2016 by a consultant team for the project preparatory technical assistance (PPTA), in cooperation with the provincial and county governments.

3. The project impact will be the improvement of livelihoods of people living in rocky desertification areas in Guizhou and replication of high efficiency water utilization for rocky desertification management in Guizhou. The project outcome will be a demonstration of high efficiency water utilization for rocky desertification management in Guizhou. The project has two outputs: 1–water resources developed; and 2–environment, ecology, and land productivity in rocky desertification areas restored. The project also includes support for project management and compliance with ADB procedures (see **Table ES-1** for details).

4. The construction of two dams under output 1, Pingqiao and Pingshan, are the largest components of the project. Domestic planning for both dams was conducted from 2010 to 2014. The domestic EIA and FSR for each dam were approved in August 2012 and June 2013 respectively for Pingqiao Dam, and May 2013 and June 2014 respectively for Pingshan Dam. ADB financing and technical assistance was requested in 2014, and the first ADB project mission was fielded in August 2015. The advanced nature of domestic planning and approvals presented challenges for the ADB project to provide added value and/or address any major safeguard issues. Prior to further detailed planning, ADB funded two rapid assessments, for environmental and social safeguards respectively, to identify any safeguard issues which might threaten the project viability. The assessments were conducted between August and December 2015. The assessments noted a range of relatively minor safeguard issues and which could be addressed through project mitigation (and which are included in this report). Project planning proceeded on this basis. The initial PRC request for financing of the two dams also provided the opportunity for considerable added value, and all other project components (**Table ES-1**), were subsequently designed under the ADB project.

5. This project EIA is prepared in accordance with both PRC environmental laws and regulations and the SPS and based on a range of studies and approaches (**Table I-1**).

Table I-1: Methodology for the EIA Studies

Subject	Methodology	Objective
Alternative Analysis	Checklist	Analysis of alternatives
	Paired comparison	Optimizing and screening project construction plan
	Expert consultation	Professional judgment
Environmental baseline	Information collection	Basic socioeconomic and environmental data
	Site investigation	Water, air, land, ecosystems
	3S integrative sorption	Vegetation and land use
Environmental screening	Matrix method	Identification of environmental impact and screening of impact factor and define the related mitigation
Public consultations	Information disclosure and feedback	a) Initial round of consultations: disclosing project location, scope, objectives, potential impacts, TOR for the EIA; b) Second round of consultations: Summarizing findings and conclusions of the EIA, for finalizing the EIA report
	Questionnaire survey	Environmental concerns of local communities
	Expert consultations	Professional judgment
	Panel review	Reviewing project construction plan and draft EIA
Analysis of environmental impacts	Mathematical models	Impact predictions
	Sustainability assessment	Impacts on environmental and socioeconomic activities
	Comparative analysis	Impacts on environmental and socioeconomic activities
	Comparative assessment	Resettlement plan and environmental carrying capacity analysis of resettlement areas
Cumulative impact assessment	Expert consultation	Impact on rare or endangered species from project construction
	Matrix method	Cumulative environmental impact analysis
	Analysis of environmental carrying capacity	Environmental capacity analysis during project construction and operation
	Map overlap + GIS	Impact on terrestrial and landscape ecology

Note. (a) Paired Comparison Analysis (also known as Pairwise Comparison) assesses the importance of a options relative to one another. (b) 3S Integrative Sorption refers to the integrative use of remote sensing, geographical information systems and global positioning system technologies to assess the land use and land use changes on the basis of sorption of radiative spectrum. (c) Matrix method refers to a two dimensional matrix which assesses potential project impacts by cross-referencing project activities which may have adverse social and/or environmental impacts versus existing environmental and social values (e.g. Leopold matrix).

6. Project locations are shown in **Figures I-1** to **Figure I-4**.

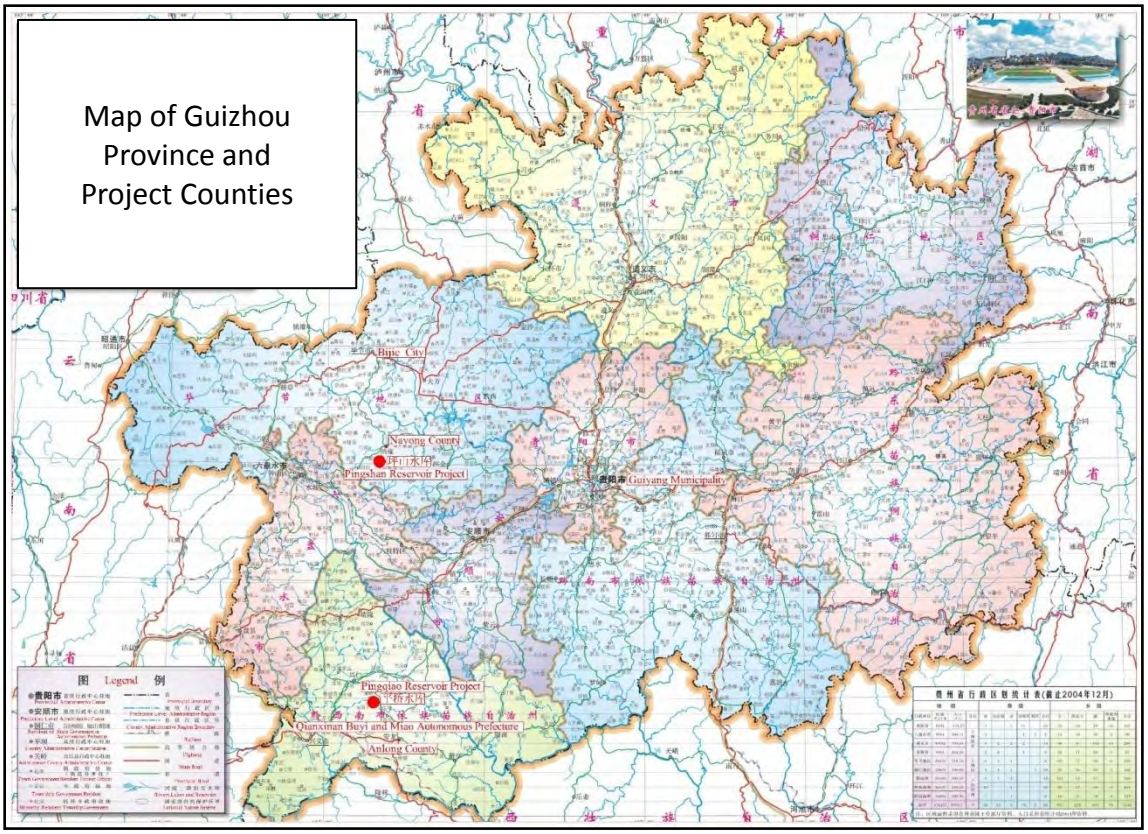


Figure I-1: Map of Guizhou Province and Project Location

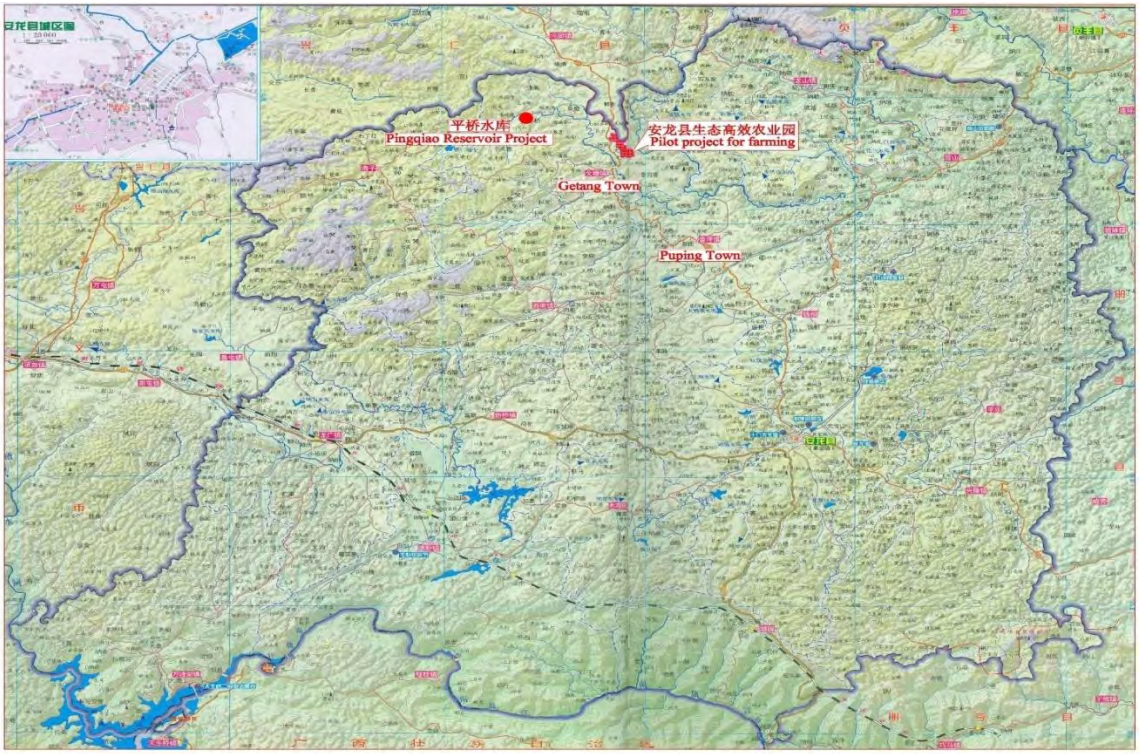


Figure I-2: Location of Pilot Project on Sustainable and High-Value Agriculture in Anlong County

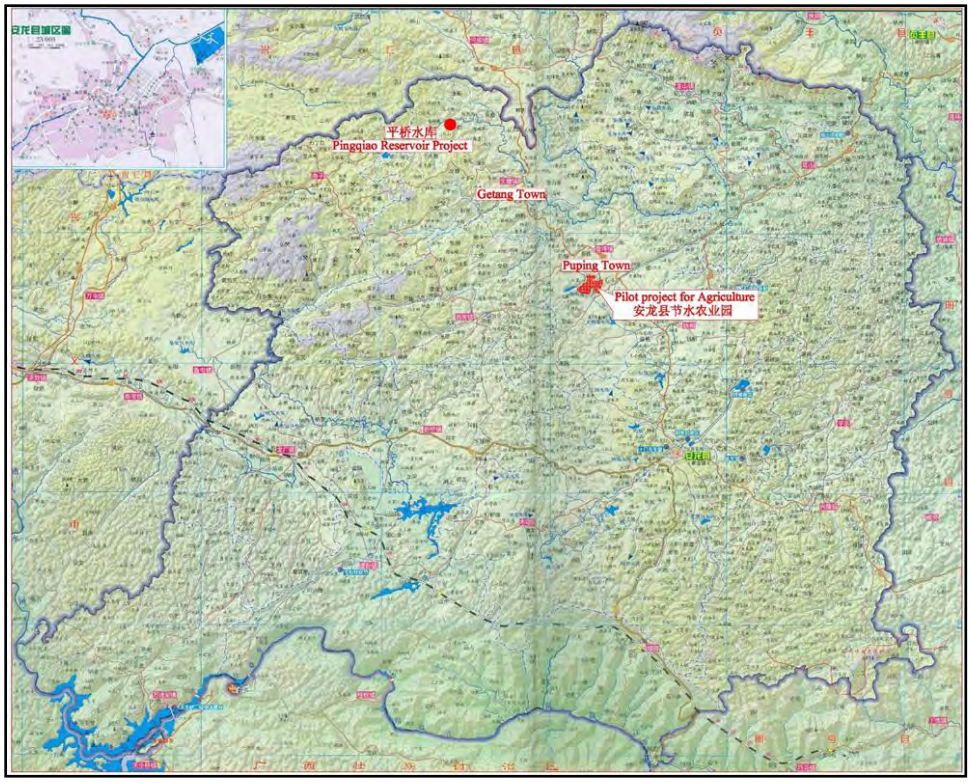


Figure I-3: Location of Pilot Project on Water-Saving Agriculture in Anlong County

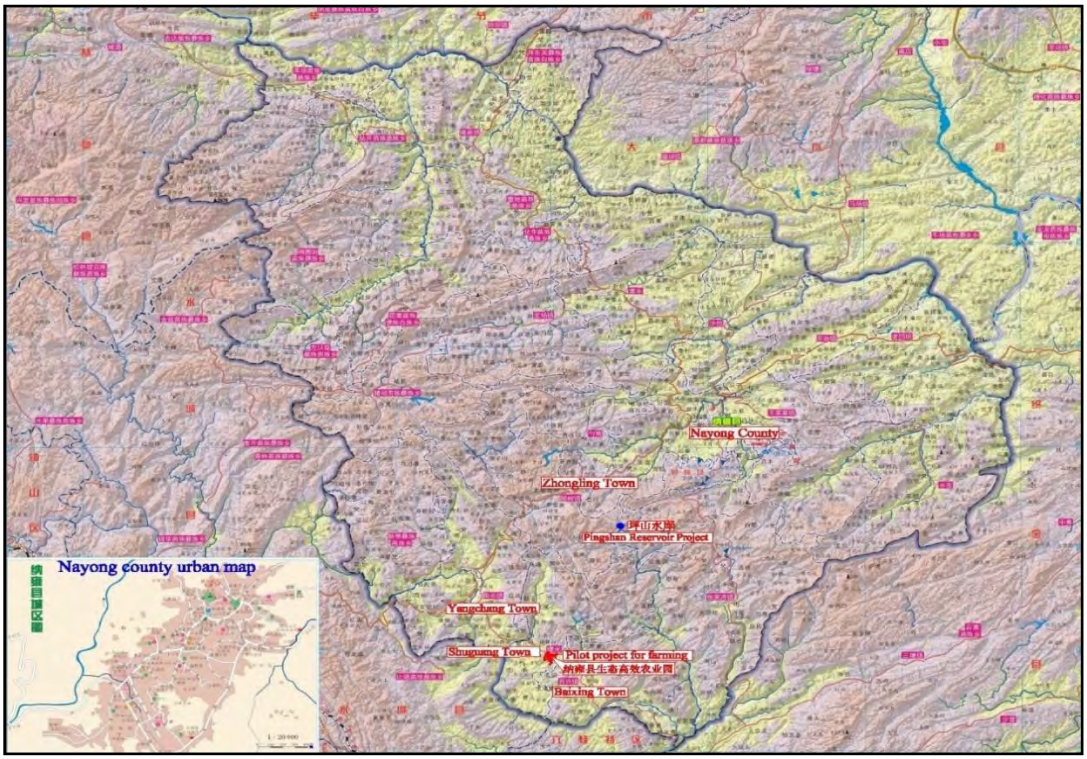


Figure I-4: Location of Pilot Project on Sustainable and High-Value Agriculture in Nayong County

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. Overview

7. The project is classified environmental 'Category A' under ADB's SPS, requiring preparation of a project EIA. Under PRC EIA regulation, the project is classified as 'Class I' (equivalent to ADB Category A) implying potentially "significant impacts". Two domestic Environmental Impact Statements[2] were prepared, one for each dam. These two domestic EIA reports (DEIAs) were prepared and approved in 2013-2015. No stand-alone domestic environmental assessments are required for the other project components on agriculture, re-vegetation, and water savings, which were instead addressed as chapters within the domestic FSRs. The project is consistent with the PRC 13th Five-Year Plan, Guizhou Province development master plans, and ADB's country partnership strategy.

8. The PRC has a wide range of laws, regulations, technical guidelines and standards that govern the way in which environmental protection and environmental impact assessment for projects must be implemented, including for pollution prevention and control on air, noise, water, ecology and solid waste, and technical guidelines on assessing atmospheric, noise, surface water, groundwater, and ecological impacts. The domestic environmental assessments upon which this project EIA is based were prepared in accordance with the PRC Law on Environmental Impact Assessment (2003), PRC Management Guideline on EIA Categories of Construction Projects (2008), Technical Guidelines for Environmental Impact Assessment (HJ/T2-93), Interim Guidelines on Public Participation in EIA by the PRC Ministry of Environment Protection (MEP; March 2006), Regulation for Public Disclosure of EIAs issued by the National Development and Reform Commission (NDRC) in 2012, and Requirements on Preparation of Environmental Impact Report Summary (2012), which requires that the summary of an EIA report to be disclosed on the local EPB websites. Key national laws and regulations that guide the domestic assessments are summarized below.

B. PRC Environmental Laws, Regulations, Guidelines, and Standards

9. The primary national laws and regulations that govern EIA are in **Table II-1** and **Table II-2** respectively. **Table II-3** shows the relevant local laws and regulations.

Table II-1: Relevant National Laws and Year Issued

Law	Year	Relevance to project
Environmental Protection Law (revised)	2014	
Urban and Rural Planning Law	2008	Project involves urban master plans
Solid Waste Pollution Prevention and Control	2005	Disposal of solid waste, dredge spoil
Environmental Impact Assessment Law	2003	
Water Law	2002	Water diversion, channel improvement
Cleaner Production Promotion Law	2002	Efficient pump stations, water diversion
Air Pollution Prevention and Control Law	2000	Air pollution during construction
Noise Pollution Prevention and Control Law	1999	Noise impact during construction
Land Administration Law	1999	Project involves land acquisition
Forest Law	1998	Reforestation, re-vegetation, landscaping
Wild Fauna Protection Law	2004	Protection of threatened fauna

[2] The PRC's *Directory for the Management of Different Categories of Project Environmental Impact Assessment* classifies EIAs into three categories with different reporting requirements: (i) Full EIA Report – for projects with potentially significant environmental impacts; (ii) Tabular Environmental Impact Assessment (TEIA) – for projects with less significant impacts; (iii) EIA Registration Form – for projects with the least environmental impacts.

Fishery Law	2000	Fisheries management in dams
Water and Soil Conservation Law	1991	Project involves soil erosion control
Water Pollution Prevention and Control Law	2008	Sewer collection pipeline component
Flood Control Law	1998	River rehabilitation and flood control
River Administration Law	1988	Project includes river regulation
Protection of Cultural Relics Law	2013	Cultural resources in project area

Table II-2: National Administrative Regulations and Year of Effectiveness

Regulation	Year	Relevance to project
Pollution Control for Drinking Water Protection Zone	1989	Water diversion for water supply
EIA of Plans and Programs	2009	Urban master plans
Environmental Protection for Construction Projects	2003	
Strengthening Wetland Protection and Management	2004	
Environmental Protection Rules for Construction	1998	
Protection of Wild Flora	1997	
Regulation on Wild Fauna Protection	1992	
Regulation on Aquatic Wildlife Protection	1993	
Requirements for EIA Summary of Construction Project	2010	
Classification of Construction Project Environmental Protection Management (MEP)	2001	
Culture Heritage Protection	2003	
River Course Management	1988	
Scenic and Historic Areas	2006	
Hazardous Chemicals Safety Management	2011	
Urban Water Supply	1994	
National Biodiversity Strategy and Action Plan	2011	2011–2030
Social Risk Assessment of Large Investment Projects	2012	
Public disclosure of EIAs (NDRC)	2012	Public consultation
Regulations for Road Transport of Dangerous Goods	2010	Spillage of dredged sediments

Table II-3: Guizhou Province Laws and Regulations and Year Issued

Law and Regulation	Year
Environmental Protection Act of Guizhou Province	1992
Cultural Relics Protection Regulations of Guizhou Province	2005
Ecological Function Zoning of Guizhou Province (No. 154)	2005
Forest Management Regulation of Guizhou Province	2002
Regulations on the Protection of Basic Farmland of Guizhou Province	2002
Integrated Plan of Rocky Desertification Control for Water Conservancy Construction and Ecological Construction of Guizhou Province	2011
Administrative Regulations for Engineering Site Earthquake Safety Assessment	June 2003
Regulations on Protection of Cultural Relics of Guizhou Province	2001
Guidelines on the Implementation of the PRC Water Law in Guizhou Province	1989
Interim Measures on Geohazard Prevention and Control Management	1997
Regulation on the River Channel Management of Guizhou Province	1998
Guidance on Accelerating the Development and Reform of Water Conservancy, CPC Guizhou Provincial Committee and Guizhou Provincial People's Government	2011
Approval of Guizhou Provincial Government on the Ecological Function Zoning	2005
Regulation on the Surface Water Environment Function Division, No.22	1994

10. Implementation of PRC laws and regulations is supported by associated management and technical guidelines. Those applicable to the project are summarized in **Table II-4**.

Table II-4: Applicable Environmental Guidelines

Guideline	Year/Code
Technical Guideline on EIA: Surface Water Protection	2006
List of Construction Projects Subject to Environmental Protection Supervision	2008
Guideline on EIA Classification of Construction Projects	2008
Guideline on Jurisdictional Division of Review and Approval of EIAs for Construction Projects	2009
Interim Guideline on Public Consultation for EIA	2006
Circular on Strengthening EIA Management to Prevent Environmental Risks	2005
Technical Guideline on EIA: Surface Water Environment	HJ/T 2.3-1993
Technical Guideline on Environmental Risk Assessment for Construction Project	HJ/T169-2004
Technical Guideline on EIA: Acoustic Environment	HJ 2.4-2009
Technical Guideline on EIA: Atmospheric Environment	HJ 2.2-2008
Technical Guideline on EIA: Ecological Assessment	HJ 19-2011
Technical Specification for Water and Soil Erosion Control for Construction	GB50434-2008
Industrial Restructuring Directory (2011)	2013

11. The national environmental quality standard system that supports and evaluates the implementation of the environmental protection laws and regulations in the PRC is classified into two categories by function, i.e. pollutant emission/discharge standards and ambient environmental standards. The relevant standards applicable to the proposed project are shown in **Table II-5**.

Table II-5: Applicable Environmental Standards

Standard	Code
Standard for Flood Control	GB50210-94
Urban Ambient Acoustic Quality Standard	GB3096-2008
Noise Limit of Industrial Enterprises	GB12348-2008
Noise Limit for Social Activities	GB22337-2008
Domestic Drinking Water Quality Standard	GB5749-2006
Surface Water Quality Standard	GB3838-2002
Standard on Pollutant Discharges from Municipal Wastewater Treatment Plants	GB18018-2002
Ambient Air Quality Standard	GB3095-1996
Integrated Emission Standard of Air Pollutants	GB16297-1996
Integrated Wastewater Discharge Standard	GB8978-1996
Soil Quality Standard	GB15618-1995
Groundwater Quality Standard	GB/T14848-1993
Noise Limit for Construction Sites	GB12523-1990
Control Standards for Pollutants in Sludge for Agricultural Use	GB4284-1984
Pollution Control Standard for MSW Landfills	GB16889-2008
PRC Specification of Domestic MSW Sanitation Landfill	CJJ17-2004

C. International Agreements

12. The PRC is signatory to major international agreements dealing with environmental protection and climate change. Relevant agreements are listed in **Table II-6**.

Table II-6: Applicable International Agreements

Agreement	Year	Purpose (relevance to project)
Convention on Biological Diversity	1993	Ecological values
UN Framework Convention on Climate Change	1994	Energy-efficiency
Kyoto Protocol to UN Framework Convention on Climate Change	2005	Reduce GHGs

Montreal Protocol on Substances That Deplete the Ozone Layer	1989	Protect ozone layer
UN Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification	1996	Fight desertification and mitigate effects of drought

D. Applicable ADB Policies and the World Bank EHS

13. ADB's SPS provides the basis for this EIA. All projects funded by ADB must comply with the SPS. The purpose of the SPS is to ensure that projects are environmentally sound, designed to operate in line with applicable regulatory requirements, and are not likely to cause significant environment, health, or safety hazards. The SPS also promotes the use of international standards, including the World Bank Group's Environmental, Health and Safety (EHS) Guidelines.[3] EHS guidelines relevant to the project include energy and water conservation, hazardous materials, waste management, noise control, sanitation, and community and occupational health and safety.

14. Compared with the PRC's EIA requirements, the SPS has additional requirements, including: (i) a project grievance redress mechanism (GRM); (ii) definition of the project area of influence; (iii) assessment of indirect, induced and cumulative impacts; (iv) due diligence of associated facilities; (v) protection of physical cultural resources; (vi) climate change mitigation and adaptation; (vii) occupational and community health and safety; (viii) impacts on livelihoods through environmental media; (ix) biodiversity conservation; and (x) a project-specific EMP. This project EIA complies with the SPS requirements. For this EIA, where EHS standards exist for parameters and are relevant, they are used in parallel with PRC standards.

E. Assessment Standards for Proposed Project Components

a. Drinking Water Quality

15. The project will provide water from the two dams to water treatment plants (WTPs) for subsequent drinking water supply to communities. Water to be supplied to residents must comply with PRC Drinking Water Quality Standard (GB5749-2006), in which 106 parameters and disinfectant guidelines must be met (**Table II-7** and **Table II-8**).

Table II-7: Drinking Water Quality Standards (GB5749-2006)

Parameter	Standard
Routine Parameter of Drinking Water Quality	
Microbiological parameter[4]	
Total coliform (MPN/100ml or CFU/100ml)	LD
Thermotoletant coliform (MPN/100ml or CFU/100ml)	LD
Escherichia Coli (MPN/100ml or CFU/100ml)	
Total plant count (CFU/ml)	100
Toxicological parameter	
Arsenic (As, mg/L)	0.01
Cadmium (Cd, mg/L)	0.005
Chromium Hexavalent (Cr 6+, mg/L)	0.05
Lead (Pb, mg/L)	0.01
Mercury (Hg, mg/L)	0.001

[3] World Bank Group. 2007. Environmental, Health, and Safety Guidelines. Washington, USA. http://www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

[4] MPN= Most Probable Number; CFU: Colony forming unit.

Parameter	Standard
Selenium (Se, mg/L)	0.01
Cyanide (CN-, mg/L)	0.05
Fluoride (mg/L)	1.0
Nitrate (mg/L)	10
Trichloromethane (mg/L)	0.06
Carbon tetrachloride (mg/L)	0.002
Bromate (when O3 is applied) (mg/L)	0.01
Formaldehyde (when O3 is applied) (mg/L)	0.9
Chlorite (when ClO2 is applied) (mg/L)	0.7
Chlorate (when compound chlorine dioxide is applied) (mg/L)	0.7
Sensory Properties and General Chemical Parameter	
Chromaticity (Unit of platinum cobalt color)	15
Turbidity (diffusing turbidity unit) NTU	1
Odor and Taste	No odor, no taste
Appearance	None
pH	6.5≤X<8.5
Aluminum (Al, mg/L)	0.2
Iron (Fe, mg/L)	0.3
Manganese (Mn, mg/L)	0.1
Copper (Cu, mg/L)	1.0
Zinc (Zn, mg/L)	1.0
Chloride (Cl-, mg/L)	250
Sulfate (SO4-mg/L)	250
TDS (mg/L)	1000
Total Hardness (CaCO3) (mg/L)	450
CODMn (mg/L)	3
Volatile phenols (phenol) (mg/L)	0.002
LAS (mg/L)	0.3
Radioactivity Parameter[5]	
Total α radioactivity (Bq/L)	0.5
Total β radioactivity (Bq/L)	1
Non-Routine Parameter	
Microbial indicators	
Giardia cysts (count/10L)	<1
Cryptosporidium oocysts (count/10L)	<1
Toxicological parameter (mg/L)	
Antimonium (Sb, mg/L)	0.005
Barium (Ba, mg/L	0.7
Beryllium (Be, mg/L)	0.002
Boron (B, mg/L)	0.5
Molybdenum (Mo, mg/L)	0.07
Nickel (Ni, mg/L)	0.02
Silver (Ag, mg/L)	0.05
Thallium (Ti, mg/L)	0.0001
Cyan chloride (CN- mg/L)	0.07
Chlorodibromomethane (mg/L)	0.1
Bromodichloromethane (mg/L)	0.06
Dichloroacetic acid (mg/L)	0.05
1,2-dichloroethane (mg/L)	0.03
Dichloromethane (mg/L)	0.02

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

Parameter	Standard
THMs	1
1,1,1 - trichloroethane (mg/L)	2
Trichloroacetic acid (mg/L)	0.1
Trichloroaldehyde (mg/L)	0.01
2,4,6- trichlorophenol (mg/L)	0.2
Bromoform (mg/L)	0.1
Heptachlor (mg/L)	0.0004
Malathion (mg/L)	0.25
PCP (mg/L)	0.009
HCH (total amount, mg/L)	0.005
Hexachlorobenzene (mg/L)	0.001
Dimethoate (mg/L)	0.08
Parathion (mg/L)	0.003
Bentazone (mg/L)	0.3
Parathion-methyl (mg/L)	0.02
Chlorothalonil (mg/L)	0.01
Carbofuran (mg/L)	0.007
Lindane (mg/L)	0.002
Chlopyrifos (mg/L)	0.03
Glyphosate (mg/L)	0.7
DDVP (mg/L)	0.001
Arazine (mg/L)	0.002
Deltamethrin (mg/L)	0.02
2, 4 - dichlorobenzene oxygen ethanoic acid (mg/L)	0.03
Dichloro-diphenyl-dichlorothane (mg/L)	0.001
Ethylbenzene (mg/L)	0.3
Dimethylbenzene (mg/L)	0.5
1,1- dichloroethylene(mg/L)	0.03
1,2- dichloroethylene(mg/L)	0.05
1,2- dichlorobenzene(mg/L)	1
1,4- dichlorobenzene(mg/L)	0.3
Trichloroethylene(mg/L)	0.07
Trichlorobenzene(mg/L)	0.02
Hexachlorobutadiene(mg/L)	0.0006
Acrylamide (mg/L)	0.0005
Tetrachloroethylene (mg/L)	0.04
Toluene (mg/L)	0.7
DEHP (mg/L)	0.008
ECH (mg/L)	0.0004
Benzene (mg/L)	0.01
Styrene (mg/L)	0.02
Benzopyrene (mg/L)	0.00001
Chloroethylene(mg/L)	0.005
Chlorobenzene(mg/L)	0.3
Microcystin-LR(mg/L)	0.001
Physical Properties and General Chemical parameters (mg/L)	
Ammonia Nitrogen(NH3-N, mg/L)	0.5
Sulfide (S, mg/L)	0.02
Sodium (Na, mg/L)	200

Table II-8: General Parameters and Requirements for Drinking Water Disinfectant

Disinfectant	Exposure duration with Water	Limit in water supplied (mg/L)	Residue in water supplied (mg/L)	Residues in network end (mg/L)
Chlorine and free chlorine (mg/L)	≥30 min	4	≥0.3	≥0.05
Monochloramine (total chlorine, mg/L)	≥120 min	3	≥0.5	≥0.05
Ozone (O_3, mg/L)	≥12 min	0.3	-	0.02/ ≥0.05 if chlorine is added
Chlorine Dioxide (ClO_2, mg/L)	≥30 min	0.8	≥0.1	≥0.02

b. Air Quality

16. **Ambient air quality.** The PRC ranks air quality into three classes according to the PRC 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 GB 3095-1996, and became 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. The project assessment of air quality was in accordance with Grade II of both standards (1996 and 2012) and World Bank EHS guidelines (**Table II-9**).

Table II-9: Ambient Air Quality Grade II Standard (mg/m^3)

Pollutant	Time	GB 3096-1996 (Grade II)	GB3095-2012 (Grade II)	EHS
SO_2	Annual average	0.06	0.06	n/a
	Daily average	0.15	0.15	0.125-0.05 (0.02 guideline)
	Hourly average	0.50	0.50	n/a
$PM_{2.5}$	Annual average	-	0.035	0.035
	Daily average	-	0.075	0.075
PM_{10}	Annual average	0.10	0.07	0.07-0.03 (0.02 guideline)
	Daily average	0.15	0.15	0.075-0.15 (0.05 guideline)
NO_2	Annual average	0.08	0.04	0.04 guideline
	Daily average	0.12	0.08	n/a
	Hourly average	0.24	0.2	0.20 guideline
CO	Daily average	4.0	4.0	n/a
	Hourly average	10.0	10.0	n/a

17. **Air emission standards for construction and operations.** For 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).

c. Noise Levels During Project Construction and Operation

18. **Construction.** Construction activities must comply with PRC Noise Limits for

Construction Site standard (GB12523-90): 70 dB(A) for daytime and 55 dB(A) for night time.

19. **Operation.** In accordance with the PRC Acoustic Environmental Quality Standard (GB3096-2008), the noise output of the project infrastructure must comply with Class II. Sensitive areas such as villages, residential communities, schools, and other noise sensitive spots are evaluated in accordance with Grade II standards according to the environmental function zoning identified by the local EPBs (**Table II-10**). The PRC standards are more stringent than those of EHS.

Table II-10: Acoustic Quality Standards (dB (A))

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

d. Surface Water Quality

20. For surface water quality, the applicable standard for the project under PRC Surface Water Environment Quality Standard (GB3838-2002) is Grade III (**Table II-11**). There is no EHS guideline or target for water quality in this respect.

Table II-11: Surface Water Quality Standards (mg/L, pH excluded)

Parameter	pH	COD_{Mn}	BOD_5	COD_{cr}	TP	TN	NH_3-N	Petroleum
Grade II Standard	6~9	≤4	≤3	≤15	≤0.1	≤0.5	≤0.5	≤0.05
Grade III Standard	6~9	≤6	≤4	≤20	≤0.2	≤1.0	≤1.0	≤0.05
Grade IV Standard	6~9	≤10	≤6	≤30	≤0.3	≤1.5	≤1.5	≤0.5
Grade V standard	6~9	≤15	≤6	≤40	≤0.4	≤2.0	≤2.0	≤1.0

Key: BOD_5= 5 days biochemical oxygen demand, CODcr = chemical oxygen demand, COD_{Mn} = permanganate index, NH_3-N=ammonia nitrogen; TN = total nitrogen; TP = Total Phosphorus.

e. Groundwater Quality Standards

21. For groundwater, quality will be assessed against the Class III standard of the PRC Quality Standards for Groundwater (GB/T14848-1993) (**Table II-12**). There are no equivalent EHS targets.

Table II-12: Groundwater Quality Standards

	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

f. Wastewater Discharge Standards for Construction and Operation

22. For 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. For the project, wastewater generated during construction will be discharged into Category II water bodies, and

Class I of the standard applies for the project construction sites (**Table II-13**).

Table II-13: Integrated Wastewater Discharge Standards (mg/L, pH excluded)

Parameter	Class I Discharge to Category III water body	Class II Discharge to Category IV and V water bodies	Class III Discharge to municipal sewers
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_{2-} (as P) mg/L	0.5	1.0	---
LAS (anionic surfactant) mg/L	5.0	10	20

g. Construction Emissions

23. Asphalt smoke during road re-pavement after pipeline works will be in accordance with Grade II of PRC Integrated Emission Standard of Air Pollutants (GB16297-1996) (**Table II-14**).

Table II-14: Integrated Emission Standard for Air Pollutants (mg/m^3)

Pollutant	Maximum allowable Emission	Fugitive emission limits at monitoring points
Particles	——	1.0
Asphalt Smoke	40-75	0

24. The PRC Government has a comprehensive program for the control and reduction of vehicle emissions.[6] This includes: (i) improvement and stricter enforcement of national emission standards for new vehicles; (ii) improvement of conventional fuels to make them cleaner with less GHG emissions; (iii) use of alternative or cleaner fuels; (iv) improved maintenance and inspection of vehicles; and (v) encouragement for the scrapping of older high emission vehicles.

h. Construction-induced Vibration

25. Construction activities will cause vibration impact, and must comply with PRC Standard for Urban Area Environmental Vibration (GB10070–88) (**Table II-15**).

Table II-15: Vertical (Z) Vibration Standard Value for Various Urban Areas

Scope of applicable area	Day (dB(A))	Night (dB(A))
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

[6] Ministry of Environment Protection. 2013. *PRC Air Pollution Control Action Plan*. Beijing.

i. Irrigation Water Quality Standards

26. Irrigation water is required to meet the PRC Standard for Irrigation Water Quality (GB5084-2005) (**Table II-16**).

Table II-16: Standards for Irrigation Water Quality

	Parameter	Paddies	Dryland	Vegetable
1	BOD_5 ≤	60	100	
2	COD_{cr} ≤	200	300	150
3	SS ≤	150	200	100
4	LAS ≤	5.0	8.0	5.0
5	Kjeldahl nitrogen ≤	12	30	30
6	TP (in P) ≤	5.0	10	10
7	Temperature (^oC) ≤	35		
8	pH ≤	5.5～8.5		
9	Total salt ≤	1000 (non-alkaline area) / 2000(alkaline area); higher values can be used for some areas		
10	Chloride ≤	250		
11	Sulfide ≤	1.0		
12	Total mercury ≤	0.001		
13	Total cadmium ≤	0.005		
14	Total arsenic ≤	0.05	0.1	0.05
15	Cr^{6+} ≤	0.1		
16	Total lead ≤	0.1		
17	Total copper ≤	1.0		
18	Total zinc ≤	2.0		
19	Total selenium ≤	0.02		
20	Fluoride ≤	2.0 (high-fluoride areas) / 3.0 (regular areas)		
21	Cyanide ≤	0.5		
22	Petroleum ≤	5.0	10	1.0
23	Volatile phenol ≤	1.0		
24	Benzene ≤	2.5		
25	Trichloro-aldehyde ≤	1.0	0.5	0.5
26	Acraldehyde ≤	0.5		
27	Boron ≤	1.0 (for sensitive crops) / 2.0 (for boron-resistant crops)		
28	Coliform，count / l ≤	10000		
29	Ascaris eggs，count / l ≤	2		

Note: unit = mg / l, unless otherwise specified, except for pH which is dimensionless.

j. Sludge Standards for Construction and Operations

27. For sludge disposal, the quality of sludge going to landfill disposal is required to 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.

F. Environmental Management Framework and EIA Approval Process

28. In the PRC, the enforcement of environmental laws and regulations rests with the

environmental protection authorities in each level of government. At the national level, the Ministry for Environmental Protection (MEP) is the regulatory authority. It is represented at the provincial level by an environmental protection department (EPD). The environmental management authorities at the city and county levels are the environmental protection bureaus (EPBs). The EPBs are supported by their environmental monitoring stations (EMSs) and environmental science research institutes. MEP's Guideline on Jurisdictional Division of Review and Approval of EIAs for Construction Projects (2003) provides two prescribed lists of projects for which EIAs must be reviewed and approved. The guideline was amended in 2009 to include a list of construction projects for which DEIAs require MEP approval, and a list of projects for which EIAs will be delegated to the provincial EPD. For this project, the Guizhou Province EPD is responsible for review and approval of the DEIAs.

29. Both project counties have an EMS, responsible for monitoring of ambient environmental quality and compliance monitoring of pollution sources. Each EMS will conduct compliance monitoring for the project sites semi-annually for the five years of project implementation.

III. DESCRIPTION OF THE PROJECT

A. Rationale

30. Rocky desertification is a process of land degradation characterized by soil erosion and bedrock exposure, especially in regions dominated by karst (limestone) geology. In the PRC, rocky desertification is a critical issue in at least eight provinces, particularly in the south-western region, which supports among the largest karst areas in the world and a population of around 220 million people. Rocky desertification is mainly caused by intensive land use such as cropping and deforestation. For the south-west PRC, the issue has been well documented for several decades and is known to be a key contributing factor to declining water resources and agricultural productivity, increasing soil erosion, and increasing risks to food and water security and economic development.

31. Guizhou Province supports the largest rocky desertification area in the PRC (19% of the provincial area and 25% of the total rocky desertification area in the PRC), experiences frequent and severe drought, and has the lowest gross domestic product per capita in the country. Government efforts to halt the decline of rocky desertification have resulted in widespread awareness of the issue among government agencies and communities, and the implementation of provincial master plans which focus on water conservation, control of soil erosion, and re-vegetation of degraded karst areas. To support these efforts, the PRC government has selected Guizhou Province as a demonstration project for efficient water use and agriculture in degraded karst areas, particularly under a warming climate.

32. Water capture and management in the karst landscape of south-western PRC is limited by the seasonal distribution of precipitation (around 85% of annual rainfall occurs in a five-month period, May to September), high porosity of limestone, and rocky terrain. In Guizhou Province, water use on a per-capita basis is less than one third of the national average. Water shortages are common, and this is enhanced by increasing droughts and a warming climate.

33. The proposed project interventions are located in two counties, Anlong and Nayong. Both are among the most severely impacted regions in south-western PRC for rocky desertification, and are listed as national poverty counties. Both are part of a national pilot area for poverty reduction under the Comprehensive Poverty Reduction Plan for the Wumeng Mountain Region,[7] and are also situated in a region designated by the Guizhou Provincial Government (GPG) as the West Rocky Desertification Rehabilitation and Prevention Area. For example, in the Anlong project area, agricultural productivity and security of water supply for residents of Pingqiao Village is limited by frequent water shortages. The major water storage facility is a pond with 10,000 m^3 capacity, which can only irrigate around 8 mu of farmland out of the 565 ha farmland present. Annual rice production is 200–300 kg/mu, much lower than the yield could be in fully irrigated land (400–500 kg/mu).

34. The project is consistent with: (i) a decision of the Third Plenary Session of the 18th Central Committee of the Communist Party of the PRC (2013); (ii) ADB's recommendations for preparation of the Thirteenth Five-Year Plan of the PRC, 2016–2020; (iii) ADB's upcoming Country Partnership Strategy for the PRC, 2016–2020;[8] (iv) ADB's Strategy 2020 and the

[7] The rates of population below the national poverty line of CNY 2,300 against the rural population are 20.7% and 20.6% in Anlong and Nayong Counties, respectively, at the end of 2014.

[8] The project is included in the *Country Operations Business Plan of ADB for the PRC, 2015–2017* as an ensuing loan in 2018 lending pipeline.

midterm review of the strategy;[9] and (v) ADB's Water Operational Plan, 2011–2020.[10]

B. Impact, Outcome and Outputs

35. The project impact will be the improvement of livelihoods of people living in rocky desertification areas in Guizhou and replication of high efficiency water utilization for rocky desertification management in Guizhou. The project outcome will be a demonstration of high efficiency water utilization for rocky desertification management in Guizhou. The project has two outputs: 1) – water resources developed; and 2) – environment, ecology, and land productivity in rocky desertification areas restored. Output 1 focuses on water resources management and has two sub-components: (i) the construction of two dams, Pingqiao and Pingshan, and associated water transfer facilities; and (ii) the establishment of water users associations. Output 2 has three sub-components: (i) re-vegetation in selected demonstration sites in Anlong and Nayong counties, comprising a dual approach using fruit trees on lower slopes (for community benefit) and native species on higher slopes (for protection of headwaters); (ii) promotion of sustainable farming to reduce rocky desertification areas, including (a) developing approaches for irrigated and un-irrigated areas, and (b) publicity and promotion of sustainable farming; and (iii) support for policy reforms, capacity development, and knowledge dissemination. The project also includes support for project management and compliance with ADB procedures. Further details are given in **Table ES-1**.

C. Output 1: Water Resources Developed

a. Output 1.1: Pingqiao and Pingshan Dams and Water Transfer Facilities

Output 1.1.1: Pingqiao Dam

36. The proposed Pingqiao Dam is located in Anlong County, Qianxinan prefecture. The Pingqiao Dam will provide urban drinking water and irrigation water for seven towns (Xinan, Getang, Puping, Qianxiang, Shaiyu, Xinqiao, and Muzha). The dam location is in the upper reaches of the Lugou river, a tributary of Datian river in the administrative area of Pingqiao village in Getang town. The dam site is located 1 km upstream from Pingqiao village. The dam will provide water for urban and rural drinking supply and agricultural irrigation. The selected location is based on: establishing as large a catchment area as possible; minimizing resettlement and ecological impacts; maximizing storage capacity; capturing upstream waters of high quality; and geological stability and other safety issues. The selected site meets the engineering requirements, supports few residents, and is not located in any protected areas.

37. The dam project involves construction of a concrete-face rock-filled dam (CFRD) and associated water transfer facilities, including a spillway, flood discharge tunnel (310 m long), a water transfer canal and pipelines, and a pump station (Figures III-1 and III-2). The discharge structure will be built on the banks by using an open-type sluice-controlled spillway. All water transfer will be by gravity flow. The design flood occurrence is once in a hundred years or 1%, and the design maximum flood occurrence is once in two thousand years or 0.05%. The anti-seepage treatment, grouting design, and layout and thickness of the concrete face panels, meet the corresponding regulatory specifications. The proposed dam safety monitoring plan correctly focuses on deformation and seepage, and the proposed monitoring instrumentation is

[9] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank, 2008–2020*. Manila. ADB. 2014. *Midterm Review of Strategy 2020.* Manila.

[10] ADB. 2011. *Water Operational Plan*. Manila.

correct. All designs comply with the PRC Flood Control Standard (GB 50201-94), Water Conservancy and Hydropower Engineering and Flood Classification Standard (SL 252-2000), and other PRC dam engineering standards. Dam construction of the dam is planned to take around 48 months, including 10 months for construction planning, 12 months for preparation, 23 months for construction, and 3 months for completion. Summary design features are in **Table III-1**.

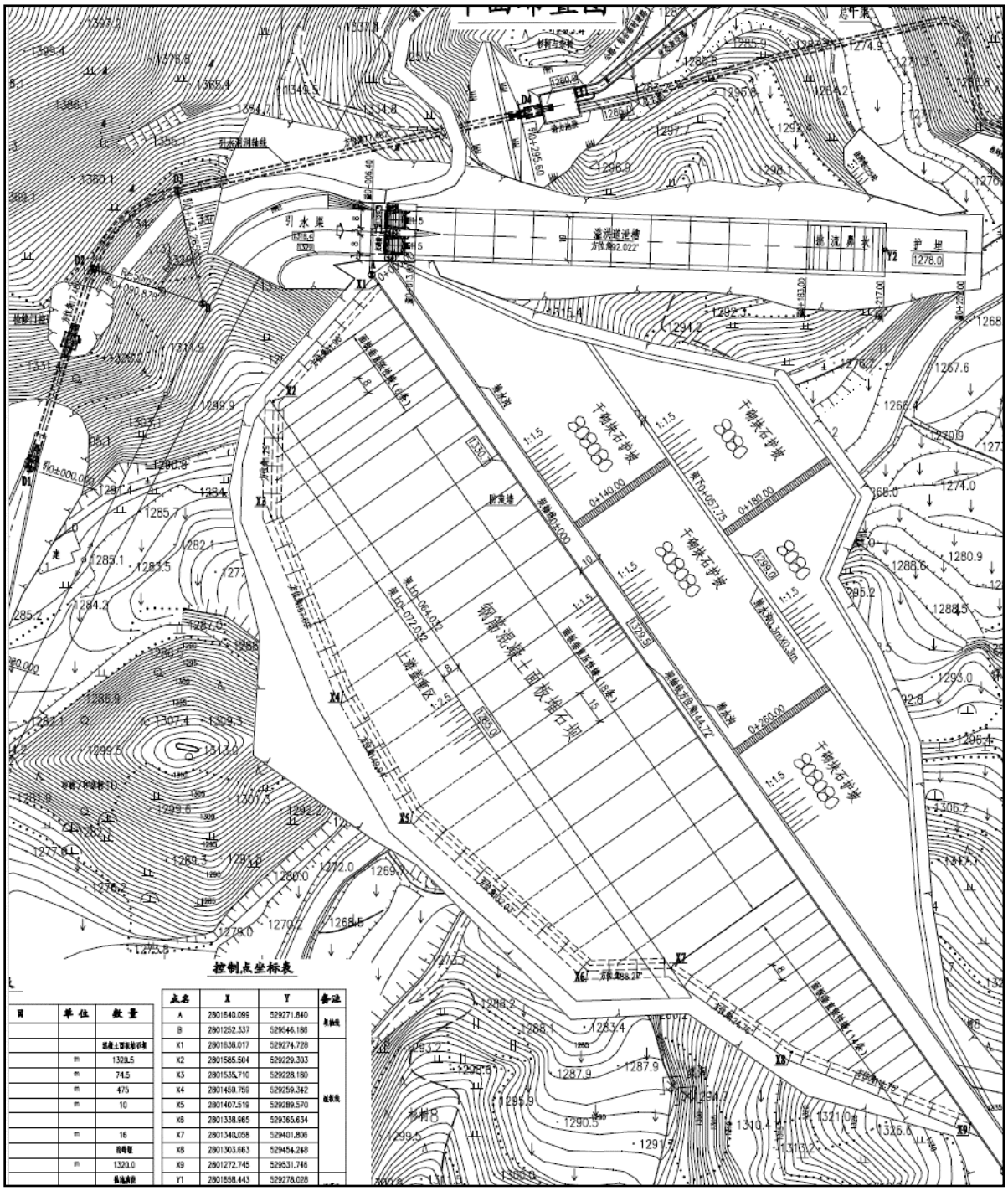


Figure III-1: Layout of Pingqiao Dam

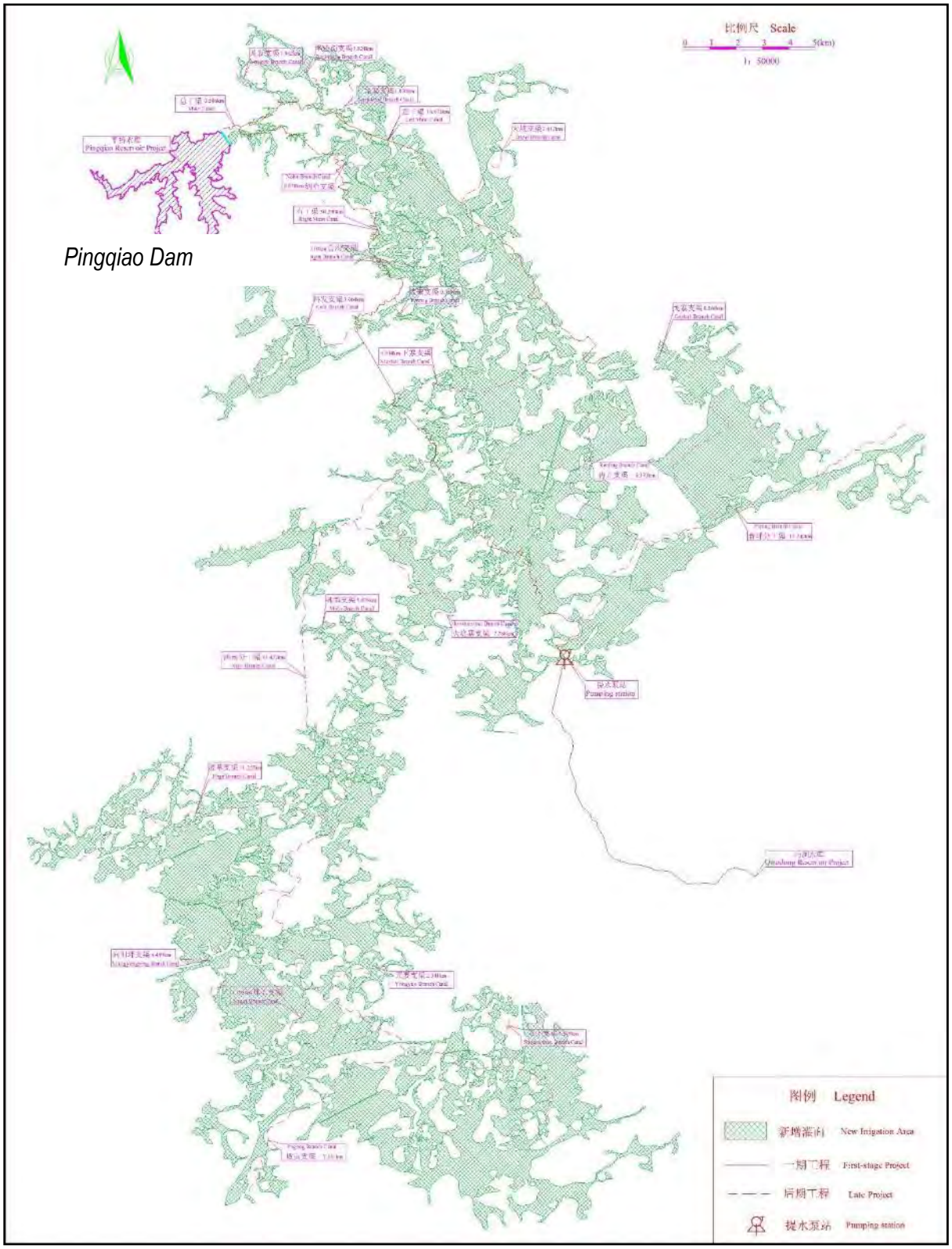


Figure III-2: Map of Pingqiao Dam

38. Dam construction and operation will be overseen by a management office, comprising

five departments (secretary, management, operation, finance, and dam) and around 28 staff.

Table III-1: Summary Design Features of Pingqiao and Pingshan Dams

Parameter	Unit	Pingqiao	Pingshan
Permanent works			
Dam type		Reinforced concrete rock fill	Reinforced concrete rock fill
Dam height	m	67.6	98
Crest elevation	m	1,329.5	1,688
Crest length	m	475	293
Crest width	m	10	10
Spillway structure		Open lock bolt control (left bank)	Open lock bolt control (right bank)
Transmission pipes (gravity-fed)	km	187.73	39.4
Water supply and irrigation project structure	km	187.13 km (main canal = 107.11 km; 4 branch canals = 80.02 km) and 16 branch pipes. Canals have 8 tunnels, 55 aqueducts, 8 inverted siphons, 1 pump station	Water supply intake tunnel = 5,470 m; south main pipe = 16.146 m; west main pipe = 10,660 m; and 12 branch pipes = 8,254 m??
Project management office	m^2	3,350 (for 59 staff)	360 (for 14 staff)
Access roads	km	7.79 (from project management office to the nearest highway)	6 km (= 3 km entrance gravel road from Yuetai village; and, 3 km gravel road around dam)
Catchment area	km^2	193.4	34.3
Annual flow	m^3/s	3.7	0.75
Dead water level	m	1,290	1,642
Dead storage capacity	million m^3	6.52	1.85
Normal operating level	m	1,326	1,685
Normal operating capacity	million m^3	71.41	13.71
Maximum water level	m	1,328.46	1,686.99
Maximum storage capacity	million m^3	78.98	14.69
Annual water supply	million m^3	75.69	13.71
Annual drinking water supply	million m^3	39.97 (P=95%)	4.74 (P=95%)
Drinking water supply	person	292,500	92,800
Annual irrigation water supply	million m^3	35.72 (P=80%)	11.26 (P=80%)
Irrigation area	mu	84,850 (49,213 dryland; 35,637 irrigated land)	53,916 (40,437 dryland; 13,479 irrigated land)
Irrigation beneficial population	person	60,540??	86,014
Inundation area	mu	12,612.7	551.51
Total cost estimate	CNY million	1,730.94	699.53
Construction period	Month	38	44
Construction works (temporary)			
Construction roads	km	145 km (external traffic = 40 km; construction roads = 100 km; water source area = 5 km)	2.377
Spoil site	sites	12 (1 for water source subcomponent; 11 for irrigation subcomponent)	4 (1 gravel site, 2 spoil disposal sites)
Support systems		Aggregate and concrete processing system, water and electricity, communications, processing plant, machinery repair	Aggregate and concrete processing system, water and electricity, communications, processing plant, machinery repair
Material storage sites		3	2
Construction camps		14	1
Water and soil conservation and pollution control			
Ecological flow	m3/s	0.37	0.077
Soil and water conservation		Rehabilitation of at least 95% of disturbed land areas	Rehabilitation of at least 95% of disturbed land areas
Pollution control		Reuse treated wastewater (zero	Reuse treated wastewater (zero

		discharge), modular treatment units / septic tanks for construction camps, solid waste transported to municipal landfill sites, water spray to suppress dust on sites and roads	discharge), septic tanks for construction camps, solid waste transported to municipal landfill sites, water spray to suppress dust on sites and roads

Output 1.1.2: Pingshan Dam

39. The proposed Pingshan Dam is located in Nayong county, Bijie prefecture. The dam will provide urban drinking water and irrigation water for three towns (Xiangyang, Baixing, Shuguang). The dam location is in the upper reaches of the Gantian river (180 m downstream from the confluence with the Youxi river), in the administrative area of Mahuangqing village in Zhongling town. The river channel above the dam is about 9.84 km long. The dam site is located 7 km upstream from Zhongling town and 19 km from the county center. The selected location is based on: establishing as large a catchment area as possible; minimizing resettlement and ecological impacts; maximizing storage capacity; capturing upstream waters of high quality; and geological stability and other safety issues. The selected site meets the engineering requirements, supports few residents, and is not located in any protected areas.

40. The dam project involves construction of a CFRD (the same design as Pingqiao) and associated water transfer facilities, including a spillway, flood discharge tunnel, a water transfer canal and pipelines, and a pump station (**Figure III-3** and **Figure III-4**). The discharge structure will be built on the banks by using an open-type sluice-controlled spillway. All water transfer will be by gravity flow. The design flood occurrence is once in fifty years, and the design maximum flood occurrence is once in 100 years. The anti-seepage treatment, grouting design, and layout and thickness of the concrete face panels, meet the corresponding regulatory specifications. The proposed dam safety monitoring plan correctly focuses on deformation and seepage, and the proposed monitoring instrumentation is correct. All designs comply with the PRC Flood Control Standard (GB 50201-94), Water Conservancy and Hydropower Engineering and Flood Classification Standard (SL 252-2000), and other PRC dam engineering standards. Summary design features are in **Table III-1**.

41. Dam construction will be overseen by a project management unit, comprising five sections (project management, engineering management, reservoir management, financial management, and general office) and 22 staff. The operation of the dam and reservoir project will be managed by a staff 28 in six sections including production and operation, engineering management, water affairs inspection and supervision, finance, personnel and the general office.

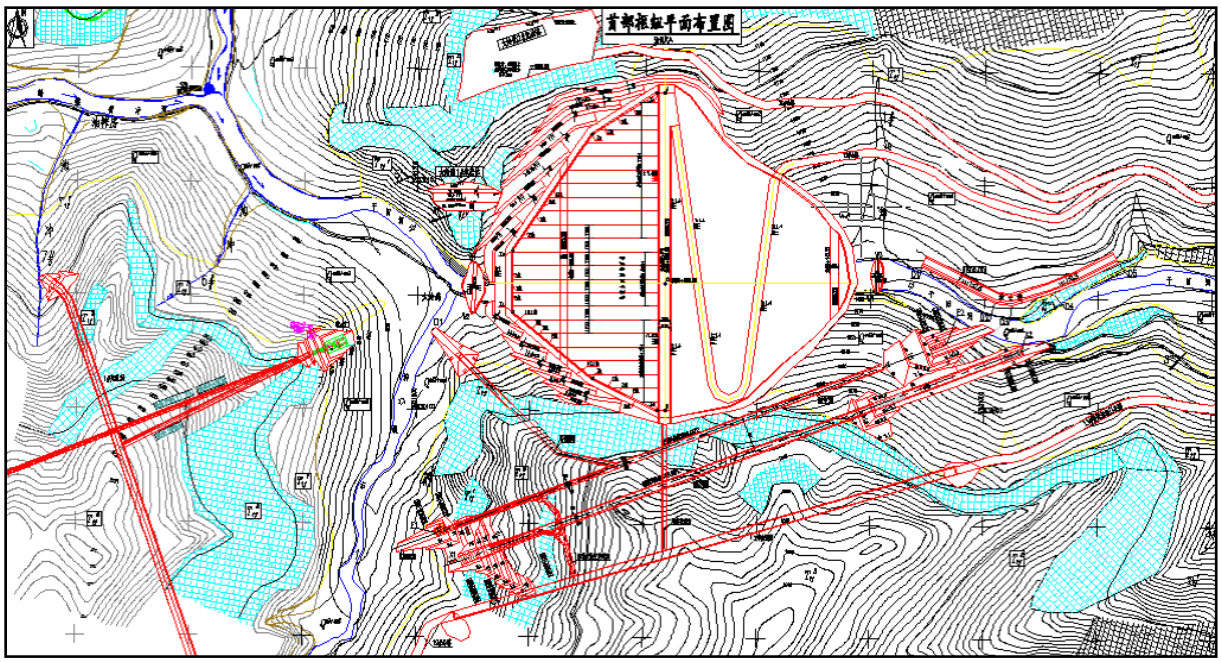


Figure III-3: Layout Map of Pingshan Dam

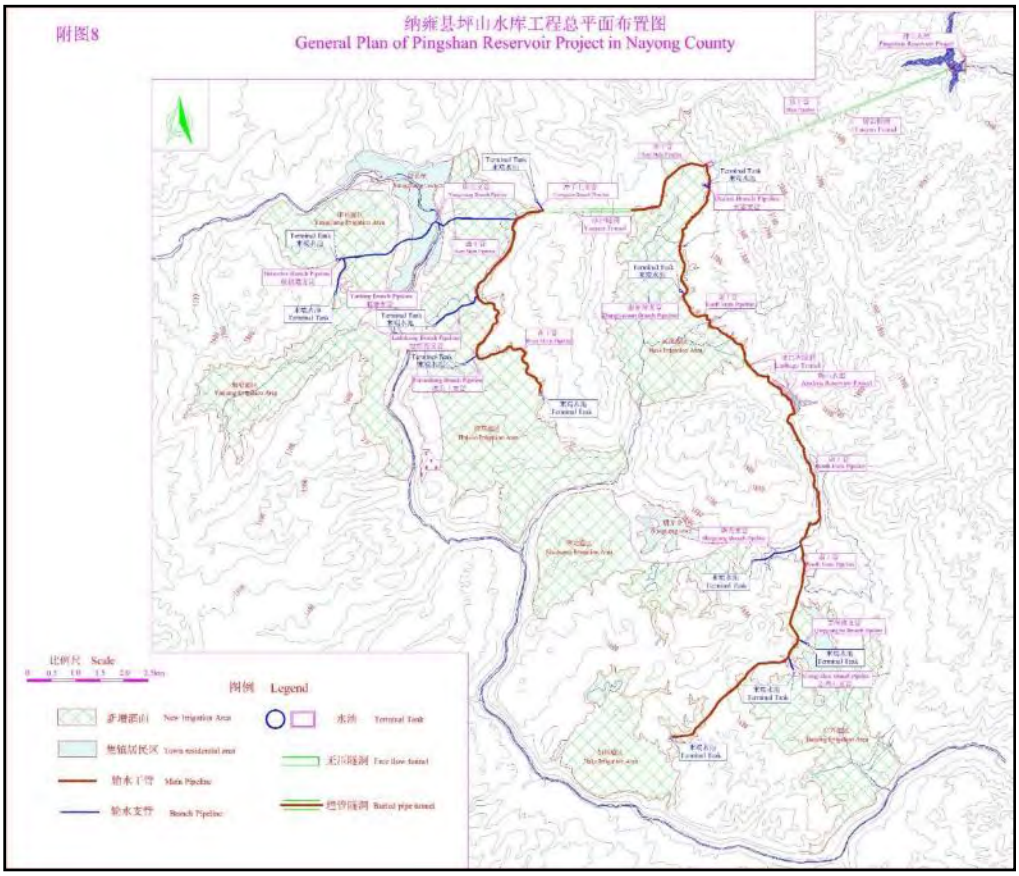


Figure III-4: Layout Map of Pingshan Dam

b. Output 1.2: Water users associations

The project will provide support to the establishment of water users associations in the 38 project villages. This method of participatory irrigation management by farmers contributes to good water governance. Water user associations will have the responsibility for managing water delivery and tariff collection, maintaining the branch irrigation networks, and for resolving water use conflicts on their own. It will enhance farmers' sense of the irrigation networks for good care and for water savings. Technical assistance will be provided to conduct public awareness building and outreach activities. Training of trainers program will be carried by the loan implementation consultant for the reservoir management authorities and county and township water resource bureaus who will in turn train association leaders and interested farmers on water delivery, water conservation, fertigation, facility maintenance and financial management.

D. Output 2: Rocky Desertification Areas Restored

a. Output 2.1: Re-vegetation

42. Overall, there are 84,500 mu (5,633 ha) planned irrigation areas in Anlong county, comprising 23,000 mu "waste hill land" and 61,500 mu "farmland". For Nayong county, the planned irrigation area is 53,916 mu (3,594 ha) of land, of which 40,437 mu are "dryland" and 13,479 mu are "farmland". This project output will re-vegetate around 2,628 ha of land, comprising around 1,599 ha and 1,029 ha in Anlong and Nayong counties respectively. In Anlong county, this will comprise around 930 ha of fruit trees and 669 ha of native vegetation; and in Nayong county, around 615 ha of fruit trees and 413.6 ha of native vegetation (**Table ES-1**). Areas for re-vegetation with fruit trees and native species will be zoned based on location and elevation: lower slopes will be re-vegetated with fruit trees, to provide community benefits. Project farmers will decide on whether to convert their lands from dryland to irrigated land. No official government approval is required for such conversion. Upper slopes will be re-vegetated with native species, for headwater protection. The re-vegetation sites and plant species were selected on a basis of a series of criteria, including location upstream of the dams for maximum protection of the dams, suitable topography, relatively easy access and proximity to villages for convenient tending and harvesting, native species for best adaptation to local environment, and species that will provide the best financial returns to local communities, market demand for fruit products, in addition to cost considerations. Local villagers will be engaged for tree planting and tending. The implementation and operation of the re-vegetation components will be led by the county governments, with the participation of the forestry and other sector agencies and local communities.

b. Output 2.2: Promotion of Sustainable Farming

43. This output comprises two sub-outputs. Output 2.2.1 (pilot projects) will comprise the piloting sustainable farming measures for irrigated areas and un-irrigated areas, including the provision of training and basic equipment and works to local farmers. The activities will cover a total of 143 ha: 70.6 ha in Anlong county (67.3 ha in irrigated sites and 3.3 ha in un-irrigated sites); and, 72.4 ha in Nayong county (69.1 ha in irrigated sites and 3.3 ha in un-irrigated sites) (**Table ES-1**). The pilot sites for sustainable farming were selected on the basis of access, distance for water transfer, topography, community benefits, costs and financial and economic benefits. The implementation and operation of the re-vegetation components will be led by the county governments, with the participation of the agriculture, water resources and other sector agencies and local communities. Output 2.2.2 will focus on publicity and promotion of sustainable farming. It will include such things as community mobilization, outreach and training

in water-saving irrigation, fertigation and integrated pest management.

c. Output 2.3: Policy reforms, capacity development, and knowledge dissemination

44. This output comprises five sub-components: (i) establishment of eco-compensation mechanisms for Pingqiao and Pingshan Dams with consultant support; (ii) closure of important forest areas, with consultant support; (iii) review of policy and regulations and recommendations for improvements; (iv) review of micro financing systems and recommendation for improvements; (v) overseas and domestic study tours for water and rocky desertification management; and (vi) dissemination of project's initiatives (**Table ES-1**). It will provide the necessary policy environment, institutional capacity and community knowledge and skills for implementing the project components and operating the project facilities.

E. Associated Facilities

45. Associated facilities are facilities which are not funded by the project but whose viability and existence depend exclusively on the project and whose goods or services are essential for successful operation of the project (SPS 2009). For this project, the associated facilities comprise four water treatment plants (WTPs) and 9 wastewater treatment plants (WWTPs).

46. **WTPs.** One WTP will be in Anlong County and will be constructed by the government at Qiaodong reservoir (water will be transferred from Pingqiao Dam, via the project pipelines, into a storage tank to be constructed under the project next to Qiaodong reservoir). Three WTPs will be in Nayong county, and will constructed by the government to receive and treat the Pingshan water prior to distribution. The total designed water supply capacity of the four WTPs is 75,500 m^3/d with a design beneficial population of 327,500 (**Table III-2**). The construction / expansion of the WTPs will all meet the PRC National Drinking Water Quality Standard of GB 5749-2006.

Table III-2: Summary of Associated Water Treatment Plants

County	WTP	Design Capacity (m^3/d)	Actual Capacity (m^3/d)	Scope of Water Supply
Anlong	Chengbei (planned)	80,000	0	Will supply 320,000 people
Nayong	Yangchang Town (planned)	15,000	0	Supply a total of 127,500 people in full design capacities
	Baixing Town	8,000	6,100	
	Shuguang Town	2,500	2,000	
Total		**75,500**	**8,100**	447,500

47. **WWTPs.** Total designed treatment capacity of the 6 associated WWTPs (including two planned) in Anlong county is 19,000 m^3/d (actual current treatment load is 11,553 m^3/d). Total designed treatment capacity of the 3 associated WWTPs in Nayong county is 10,000 m^3/d (actual current treatment load is 4,500 m^3/d). The effluent of all WWTPs meet Class I-A and Class I-B of PRC WWTP Effluent Quality Standard of GB 18918-2002.

Table III-3: Summary of Associated WWTPs (m^3/d)

County	WWTP	Designed capacity (m^3/d)	Actual capacity (m^3/d)	Wastewater Treatment process	Quality of effluence
Anlong	Chengdong	8,000	6,600	Oxidation ditch	Class I-A
	Chengxi	6,000	4,000	Obel integrated oxidation ditch	Class I-B
	Chengnan (planned)	3,000	n/a	n/a	Class I-B
	Chengbei (planned)	1,000	n/a	n/a	Class I-B

	Puping Town	800	400	Oxidation ditch	Class I-B
	Jinshou Farming Culture Park	200	153	Artificial wetland	Class-I-B
	Total	**19,000**	**11,553**		
Nayong	Yangchang Town	6,000	4,500	Integrated oxidation ditch	Class I-B
	Baixing Town (under construction)	2,000	n/a	PASG	Class I-B
	Shuguang Town	2,000	n/a	n/a	Class-I-B
	Subtotal	**10,000**	**4,500**		
Total		**29,000**	**16,053**		

Note: n/a = not available.

F. Anticipated Project Benefits

48. Improved water supply for domestic and agricultural uses and piloting sustainable rocky desertification control. The project will generate several major benefits, including improved water supply for domestic and irrigation uses, demonstration of rocky desertification control, and sustainable agriculture. First, the project will supply 89 million m^3/a of safe and reliable water for a beneficiary population of 362,920 in 118,385 households by 2025, and for irrigating 11,020 ha of farmland. The value added of agricultural production from the increase in irrigation water volume in the project areas will increase to CNY 13.5/m^3 by 2025 from CNY 8.5/m^3 in 2016. The two dams will also provide more water for agriculture and household use for downstream users, and improve the controllability of dam releases, especially in the dry season. Second, the re-vegetation component, as a rocky desertification control pilot program, will reduce rocky desertified areas in the two project counties by 2,771 ha to 4,136 ha by 2025 from 6,907 ha in 2016. Overall, the project will benefit 362,920 people in the direct project areas, of which 42.0% are women, 52.0% ethnic minorities and 20.7% under the poverty line, and over 1.49 million people in the indirect project areas, of which 44.9% are women, 50.3% are ethnic minorities and 12.8% are under the poverty line.

49. The improved water supply will also benefit the tourism industry. Anlong County has experienced drastic growth in tourist numbers and revenues, from 257,000 of tourists and CNY 60 million in 2010 to 4.72 million of tourists and CNY 2.28 billion in tourism revenue by 2015. For Nayong County, the number of tourists increased from 690,000 in 2010 to 3.35 million by 2015, and tourism revenue grew from CNY 705 million in 2010 to CNY 1.91 billion by 2015. The re-vegetation components will beautify the rocky desertified hills and mountains and meanwhile provide an additional 1,544.9 ha of fruit orchards and 1,082.6 forested land for developing ecotourism and cultural tourism, further propelling the development of the tourism industry in the two project counties. The water supply from the Pingqiao and Pingshan Dams will provide around 44.71 million m^3/a of drinking water supply and 46.98 million m^3/a of irrigation water supply, improving water and food security for tourism and the local economy.

50. **Climate change adaptation.** Climate resilience, particularly against declining precipitation and rising temperatures, has been included in the project design and infrastructure as follows: (i) establishment of two medium-sized dams to improve water storage, strengthening resilience against drought; (ii) selection of climate-resilient plant species for the project re-vegetation and agriculture components, including fruit and crop species and locally-occurring native species with a wide north-south distribution (i.e. along a wide temperature gradient), to provide resilience against rising temperatures; and (iii) training of farmers, to improve water conservation and efficiency for irrigated and un-irrigated areas.

51. **Social and gender benefits.** The project will help achieve improved sustainability and

security of water resources for communities and agriculture. The project outputs are public facilities with equitable gender benefit. The project will also promote the employment of women for project construction and operation, including the re-vegetation, agriculture, and capacity building.

52. **Support for key planning documents.** The proposed project activities for water security, control of soil erosion, improved agriculture, and re-vegetation, directly support the aims of the *Guizhou Provincial Master Plan for Water Resources Development, Ecological Development, and Rocky Desertification Management* (2011) (the project sites are listed in the master plan as priority areas to manage rocky desertification); the *Guizhou Province Ecological Function Zoning* (2005) (soil and water conservation, rocky desertification treatment, establish models for soil erosion control and re-vegetation); and, the *Anlong Integrated Land Utilization Planning* (2006-2020) (focus and intensify development, flood and drought control).

IV. DESCRIPTION OF THE ENVIRONMENT (BASELINE)

A. Environmental Setting of Western Guizhou Province

53. The proposed project is located in the western region of Guizhou Province. Elevations in the project area range from 1,500 m to 2,500 m. Anlong and Nayong counties are situated on the Yungui plateau, featuring high mountains and peaks. Karst (limestone) is the principal landscape and geology of the region, and includes valleys, funnels, sink holes, subterranean rivers, and caves. Key geological strata are limestone, sandstone, shale, and basalt. The most widely distributed soil types are yellow and brown soils and paddy rice soils.

54. Guizhou Province is located in the subtropical climatic zone, and is dry and cold in winter and spring, and wet and mild in summer and autumn. The average annual temperature is 12–15^{o}C, and annual rainfall is 1,000–1,400 millimeters. The prevailing wind blows from the southwest to northeast, with a mean velocity at 1.5–2.5 meters per second. Numerous small rivers flow through the project areas. These belong to two major river systems, the Zhujiang (Pearl) and Changjiang (Yangtze). Steep gradients characterize these mountain rivers, providing abundant hydropower reserves.

55. Land degradation is a major issue in western Guizhou Province, and is caused by rapid population growth, unsustainable agricultural activities, and resource extraction, especially on steep slopes. Forest cover is only 3.9% of the total land area. Lands with slope of less than 10 degrees account for only 25% of the total dry cultivated land area in western Guizhou. Due to the predominantly high gradients, soil erosion is widespread, resulting in a generally thin arable stratum. Over 63% of the cultivated land area has less than 0.15 m of arable soil. Bare, steeply sloping cultivated land with marginal farming has been prevalent for decades. Remnant natural vegetation is fragmented and degraded in many places, and scrub is widely seen on slopes and mountain foothills, including grass species and herbs. Tree species include pines, firs, cypress, birch, and poplar. Agricultural crops are the dominant vegetation, and are distributed in terraced fields in valleys, low-lying lands in the mountains, and mountain foothills. The main crops are rice, corn, potato, wheat, and bean.

B. Environmental Setting of Anlong County and the Project Area

(a) Overview

56. **Location and topography.** Anlong county is located in the southwest of Guizhou Province. The proposed Pingqiao Dam is located in the northwest of the county, in the Miao autonomous prefecture. The region is part of the Yunnan-Guizhou plateau. The county extends east–west from longitude E104°59’ to 105°40' and north–south from latitude N24°55' to 25°23'. The county borders five other counties in Guizhou Province, Ceheng, Zhenfeng, Xingren, Xinren and Xinyi cities. The total land area is 2,237.60 km^2. The county is higher in the south west and lower in north east. Elevations range from 1,360–1,570 m, with small valleys and steep mountain peaks.

57. **Climate.** The annual average temperature is 15.1^{o}C (1971-2009). The coldest month is January (daily average 6^{o}C) and the hottest is July (daily average 21.8^{o}C). Annual average rainfall is 1,227.5 mm (1959–2009). The flood season is from May to October, in which 82.7% of annual rainfall is deposited. The dry season is from November to April, and accounts for 12.3% of annual rainfall. The annual average evaporation of 1,546.2 mm.

58. **Geology and soil.** The dominant geology is sedimentary rock with limestone, sandstone, shale and dolomite. Soil types are complex and diverse. Limestone soils are the most widely distributed, accounting for 61.5% of total land area, followed by yellow soil (28.6%), and red soil (5.6%). Mountain yellow-brown, dry red, and purple soil types also occur.

59. **Seismic activity.** According to the PRC Seismic Ground Motion Parameter Zonation Map (GB 18306-2001), the project area is relatively stable, with a ground motion peak acceleration of 0.05 g and seismic basic intensity of VI. There are no deep fractures in the dam area or fundamental structural weakness that increase vulnerability to earthquakes. The possibility of dam-induced earthquakes is low.

60. **Hydrology.** The proposed location of the Pingqiao Dam is along the upstream section of the Lugou river (also known as Xiangche or Dongguang), a tributary of Datian river, in the administrative area of Pingqiao village (part of Getang Town). The dam site is located 1 km upstream from Pingqiao village. The total length of the Lugou river is 26 km, with a river catchment area of 392 km^2.

61. **Socioeconomic profile**. The major socioeconomic indicators of Nayong County are summarized in **Table IV-1**.

Table IV-1: Major Socioeconomic Indicators in Anlong County Project Area

No.	Major Indicator	Unit	Quantity
1	Total Land Area	km^2	2,237.6
2	Total Population	No.	471,528
2.1	Agricultural population	No.	436,101
2.2	Non-agricultural population	No.	35,427
3	Cultivated Land Area	mu	750,220
4	Gross Domestic Product (GDP)	CNY 10,000	730,482
4.1	Primary industry	CNY 10,000	161,696
4.2	Secondary industry	CNY 10,000	248,763
4.3	Tertiary industry	CNY 10,000	320,023
5	Sowed Area	hectare	58,948
6	Values of Major Agricultural Products		
6.1	Grain	ton	190,400
6.1.1	Paddy rice	ton	86,265
6.1.2	Wheat	ton	19,711
6.1.3	Corn	ton	61,205
6.2	Oil plants	ton	5,109
6.2.1	Peanut	ton	374
6.2.2	Rapeseed	ton	4,697
6.3	Vegetable	ton	206,466
6.4	Sugarcane	ton	32,613
7	Average Per-Capita Net Income for Rural Residents	CNY	6,086
8	Average Per-Capita Disposable Income for Urban Residents	CNY	20,017
9	Newly Increased Employment in the County and Towns	No.	3,780

Source: Statistical Bulletin of National Economic and Social Development in Anlong County in 2014.

(b) Project area

62. The site of the Pingqiao Dam and reservoir is situated in a narrow V-type valley on the Lugou river, about 1,000 m upstream of the Pingqiao village, Getang town. Spread along the river channel are primarily low-lying lands with sparsely distributed small family farm plots

ranging from 0.1 to 1 mu entirely for subsistence. Up from the drawdown areas are terraced farmland and sparsely treed hills with a slope ranging from 30 to 45 degrees. Clusters of houses, numbering 10~20 houses per cluster, can be seen along the river above the drawdown areas. There are neither industrial nor commercial establishments in the immediate dam and reservoir area, except for small convenience stores selling daily necessities. The nearest sizable human settlement is the Getang town with a population of 24,000 about 8 km downstream the dam site. There is no paved road to the dam site from the downstream Getang town, except for stony trails that motorized vehicles cannot travel. The sites for sustainable agriculture are distributed in seven towns and townships. These are relatively large, flat alluvial plains of the Lugou river and its tributaries, or flat-top plateaus in the Lugou valley. They are easily accessible through paved local highways and roads. The project lands are either existing dryland or poorly-equipped irrigated land or barren non-cultivated but arable lands. Severe rocky desertified hills and mountains can be seen from the Getang town and project villages. The desertified hills and mountains, where bare rocks with almost no vegetation (trees, bushes and grasses) dominate the landscape, are the pilots sites under the project for demonstrating rocky desertification control and ecological rehabilitation.

Dam site and surroundings

Close view of dam site

Impoundment area

Access road at the dam site

Vegetation near dam site

Figure IV-1: Landscape at Pingqiao Dam and Reservoir Area (Photo Taken During Consultant Site Visit in April 2016)

(c) Surface water quality

63. Baseline sampling (**Table IV-2**) was conducted from 18-20 July 2011 in four locations: the downstream end of the dam site (Tiechanghaizi), the middle of the dam site (Cha river), dam site, and 2 km downstream from the dam site. Results were compared against Class III standard of the PRC Environmental Quality Standards for Surface Water (GB3838-2002). All parameters met the requirement of Class III of the standard.

Table IV-2: Surface Water Quality at Pingqiao Dam Site

Item	Monitoring result				Unit
	1# (end of dam)	2# (middle of dam—Cha River)	3# (dam site)	4# (2 km downstream of dam site)	
pH	7.46	7.54	7.49	7.42	N/a
Cu	0.01L	0.01L	0.01L	0.01L	mg/L
Zn	0.006L	0.006L	0.007	0.008	mg/L
Hg	0.00005L	0.00005L	0.00005L	0.00005L	mg/L
As	0.007L	0.007L	0.007L	0.007L	mg/L
Pb	0.01L	0.01L	0.01L	0.01L	mg/L
NH3-N	0.145	0.115	0.250	0.142	mg/L
TP	0.03	0.02	0.02	0.02	mg/L
BOD_5	0.5L	0.5L	0.5L	0.5L	mg/L
Cr6+	0.004L	0.004L	0.004L	0.004L	mg/L
Volatile Penol	0.0022	0.0022	0.0021	0.0014	mg/L
SS	7	6	6	6	mg/L
fluoride	0.69	0.13	0.40	0.38	mg/L
Sulfide	0.005L	0.005L	0.005L	0.005L	mg/L
Cyanide	0.004L	0.004L	0.004L	0.004L	mg/L
Dissolved oxygen	5.42	5.08	5.76	5.80	mg/L
CODcr	5L	5L	5L	5L	mg/L
COD_{Mn}	1.60	1.11	1.20	1.47	mg/L
Oil	0.01L	0.02	0.01L	0.01L	mg/L
TN	2.73	2.73	2.88	2.89	mg/L

Unit: mg/L, except pH and fecal coliform; L = not detected (i.e. not present or value below detection limit).

(d) Air quality

64. Air quality sampling was conducted for six consecutive days from 15-20 July 2011, in two locations, the proposed dam site and Pingqiao village. Parameters were sampled four times a day (02h00, 08h00, 14h00, 20h00) except for total suspended particulates (TSP) (sampled once a day for 12 hours). The applicable standard is Grade II of the PRC Ambient Air Quality Standard (GB3095-1996). All samples met the standard, reflecting the relatively high air quality in the project area (**Table IV-3** and **Table IV-4**).

Table IV-3: Hourly Concentration Monitoring Results for SO_2 and NO_2

Date (2011)	Time	SO_2		NO_2	
		Dam site	Pingqiao Village	Dam site	Pingqiao Village
July 15	02:00~03:00	0.007L	0.010	0.015L	0.015L
	08:00~09:00	0.008	0.014	0.018	0.019
	14:00~15:00	0.012	0.016	0.021	0.025
	20:00~21:00	0.009	0.012	0.019	0.020
July 16	02:00~03:00	0.008	0.010	0.015L	0.015L
	08:00~09:00	0.009	0.014	0.016	0.018
	14:00~15:00	0.010	0.010	0.022	0.021
	20:00~21:00	0.012	0.012	0.018	0.017
July 17	02:00~03:00	0.008	0.007L	0.015	0.016
	08:00~09:00	0.016	0.011	0.022	0.023
	14:00~15:00	0.012	0.018	0.020	0.020
	20:00~21:00	0.009	0.015	0.018	0.021
July 18	02:00~03:00	0.010	0.008	0.016	0.017
	08:00~09:00	0.016	0.010	0.020	0.022
	14:00~15:00	0.018	0.015	0.018	0.023
	20:00~21:00	0.011	0.013	0.024	0.021
July 19	02:00~03:00	0.007L	0.008	0.015L	0.018
	08:00~09:00	0.013	0.009	0.019	0.020
	14:00~15:00	0.013	0.012	0.025	0.023
	20:00~21:00	0.011	0.008	0.022	0.026
July 20	02:00~03:00	0.008	0.007L	0.015	0.019
	08:00~09:00	0.010	0.011	0.017	0.026
	14:00~15:00	0.012	0.015	0.022	0.020
	20:00~21:00	0.014	0.010	0.018	0.021
July 21	02:00~03:00	0.007L	0.009	0.015L	0.016
	08:00~09:00	0.009	0.011	0.019	0.020
	14:00~15:00	0.014	0.012	0.017	0.023
	20:00~21:00	0.008	0.015	0.021	0.025
Evaluation Standard		0.50		0.24	

Unit: mg/m^3.

Table IV-4: Daily Average Concentration Monitoring Results for TSP, SO_2 and NO_2

Date (2011)	Item	Dam Site	Pingqiao Village	Evaluation Standard
July 15	TSP	0.203	0.197	0.30
	SO_2	0.011	0.014	0.15
	NO_2	0.018	0.022	0.12
July 16	TSP	0.217	0.220	0.30
	SO_2	0.010	0.016	0.15
	NO_2	0.018	0.020	0.12

July 17	TSP	0.155	0.168	0.30
	SO_2	0.015	0.016	0.15
	NO_2	0.020	0.021	0.12
July 18	TSP	0.192	0.167	0.30
	SO_2	0.014	0.015	0.15
	NO_2	0.021	0.022	0.12
July 19	TSP	0.198	0.208	0.30
	SO_2	0.013	0.011	0.15
	NO_2	0.022	0.023	0.12
July 20	TSP	0.177	0.148	0.30
	SO_2	0.013	0.014	0.15
	NO_2	0.017	0.024	0.12
July 21	TSP	0.148	0.193	0.30
	SO_2	0.013	0.013	0.15
	NO_2	0.019	0.020	0.12

Unit: mg/m^3.

(e) Acoustic environment

65. Noise sampling was conducted over two consecutive days and nights, from 19-20 July 2011, in two locations, the proposed dam site and Pingqiao village. Samples met Grade II of the PRC Environmental Quality Standard for Noise (GB 3096-2008), reflecting the lack of industrial activity and small populations in the area (**Table IV-5**).

Table IV-5: Baseline Noise Monitoring Results for Anlong Project Area

Location	Date (2011)	Monitoring period	Leq (dB(A))
Pingqiao Village	July 19	Daytime (13:15~13:25)	54.4
		Night time (22:15~22:25)	41.1
	July 20	Day time (13:00~13:10)	53.9
		Night time (22:00~22:10)	43.3
Dam site	July 19	Day time (13:40~13:50)	51.6
		Night time (22:40~22:50)	39.3
	July 20	Day time (13:40~13:50)	49.3
		Night time (22:30~22:40)	40.2

Note: compared against the Class II day time standard (55 dB(A) and night time (45 dB(A) standard).

(f) Ecological environment

66. Within the immediate area including the catchment area of the reservoir, borrow and spoil sites, resettlement sites, the right of way of the water transfer pipes and construction traffic routes, ecological information was gathered through field surveys and secondary documents. It covered: the composition, types, distribution behavior of plant and animal species, as well as protection status of rare, endangered and protected species. Vegetation is characterized by scattered patches of secondary broad-leaf or temperate-coniferous plant species, and vegetables and corn in family farm plots near the dam site and within the future impoundment. In the sustainable agriculture project area, the farm crops are dominated by rice, wheat, corn, soy bean, etc. There are neither nature reserves, scenic spots, parks, nor other protected areas in the project area, nor critical, natural or modified habitats.

67. Anlong county is located in the subtropical zone biome, which is characterized by evergreen and broad-leaf trees. Due to the long history of human settlement in the county, most

natural vegetation and habitats outside of protected areas are modified and degraded. Rivers are small, relatively shallow, and do not support large fish populations. Small mountain streams are often seasonal. Based on site visits and desktop review, there are no rare or endangered or protected species.

68. **Vegetation classification**. In the Guizhou vegetation zoning system, the project area belongs to the Weining-Panxian plateau-mountainous mixed evergreen-deciduous forest subdivision of the central subtropical evergreen broad-leaf vegetative zone. Plants of acidic-calcium-yellow soil, *Pinus yunnanensis*, *Pteridium aquilinum var. latiusculum, Dicranopteris dichotoma, Platycladus orientalis*, *Ligustrum lucidum*, *Pyracantha fortuneana*, *Rosa cymosa Tratt*, are widely distributed. Due to long history of human activities, the primitive vegetation has disappeared and been replaced by secondary broad-leaf forest, temperate-needle-leafed forests, bushes and grasses. Agricultural crops are dominated by wheat, corn and rice. Field surveys and literature search did not reveal the existence of endemic, rare, endangered or threatened plant species in the project area.

69. Typical tree, bush and grass communities in the Anlong water source development and transfer project area are summarized in **Table IV-6**. A list of plant species is provided in **Table IV-7**. The biomass of the various vegetation types is summarized in **Table IV-8**.

Table IV-6: Typical Floral Communities in Anlong County Project Area

Species	Count / Abundance	Average Height (m)	Max Height (M)	Average Diameter (cm)	Max Diameter (cm)	Type
Pinus yunnanensis Community----Forest						
Pinus yunnanensis	13	10	14	14	28	Evergreen tree
Quercus senescens Hand.-Mazz.	5	10	13	14	16	Evergreen tree, bush
Quercus variabilis Blume	4	8	12	10	20	Evergreen tree, bush
Cyclobalanopsis delavayi (Franch.) Schott.	2	9	10	9	13	Evergreen tree
Pyracantha fortuneana	Cop2	0.7	1.5	1.5	3	Semi-evergreen bush
Hypericum patulum Thunb.	Cop1	1.5	1.5	1	1.5	Deciduous bush
Arthraxon guizhouensis S. L.	Cop2	0.4	0.4	/	/	Grass
Potentilla fulgens	Cop2	0.6	0.6	/	/	Grass
Platycladus orientalis Community----Forest						
Platycladus orientalis	15	10	12	18	25	Evergreen tree
Castanea seguinii Dode	6	2	4	3	5	evergreen tree, bush
Lyonia ovalifolia var.elliptica	Cop2	3	5	5	7	Deciduous tree
Myrsine africana Linn	Cop1	2	4	2	4	Bush
Spiraea salicifolia L.	Cop1	1	1.5	1	1.5	Bush
Philadelphus incanus Koehne	Cop1	1.6	2	1.5	2	Deciduous bush
Atropa belladonna L.	Cop1	2	3.5			Grass
Eragrostis nigra	Cop2	0.4	0.4			Grass
Eupatorium Adenophorum Spreng	Cop2	0.6	0.6			Grass
Cunninghamia lanceolata (Lamb.) Hook Community----Forest						
Cunninghamia lanceolata (Lamb.) Hook.	13	8	11	18	25	Evergreen forest
Quercus acutissima	5	5	7	4	7	Evergreen forest, bush
Lyonia ovalifolia var.elliptica	Cop1	3	5	5	7	Deciduous bush
Spiraea salicifolia L.	Cop1	1	1.5	1	1.5	Bush
Philadelphus incanus Koehne	Cop1	1.6	2	1.5	2	Deciduous bush
Dicranopteris dichotoma	Cop2	0.3	0.3			Grass

Pteridium aquilinum var. latiusculum.	Cop2	0.4	0.4			Grass
Quercus fabri- Rhus chinensis Community-*Bush*						
Quercus fabri	Cop2	1.5	2	1	2	Semi-evergreen tree
Castanea seguinii Dode	Cop2	2	1	1	1.6	Semi-evergreen tree
Rhus chinensis	Cop2	1.5	1.5	1	1.5	Evergreen bush
Camellia oleifera	Cop1	2	4	2	3	Evergreen bush
Vaccinium bracteatum	Cop1	2	2	2	4	Evergreen bush
Miscanthus	Cop1	1	1			Grass
Imperata cylindrica (Linn.) Beauv.	Cop1	0.8	0.8			Grass
Rhizoma Cibotii	Cop1	0.3	0.3			Grass
Betula luminfera +Populus yunnanensis Dode Community----Bush						
Betula luminfera	15	10	15	30	50	Deciduous forest
Populus yunnanensis Dode	12	15	20	40	60	Deciduous forest
Quercus variabilis Blume	13	8	12	10	25	Evergreen forest, bush
Coriaria nepalensis	2	5	4	6	6	Deciduous bush
Pyracantha fortuneana	Cop2	3	1.5	2	3	Semi-evergreen forest
Rosa cymosa Tratt	Cop2	2	1	1	1.6	Semi-evergreen bush
Hypericum patulum Thunb.	Cop1	1.5	1.5	1	1.5	Deciduous bush
Potentilla fulgens	Cop2	0.6	0.6			Perennial grass
Quercus-Rhus semialata Murray Community----Bush						
Quercus fabri	Cop2	1.5	2	1	2	Semi-evergreen bush
Castanea seguinii Dode	Cop2	2	1	1	1.6	Semi-evergreen bush
Rhus chinensis	Cop2	1.5	1.5	1	1.5	Deciduous bush
Camellia oleifera	Cop1	2	4	2	3	Evergreen bush
Vaccinium bracteatum	Cop1	2	2	2	4	Evergreen bush
Miscanthus	Cop1	1	1			Grass
Imperata cylindrica (Linn.) Beauv.	Cop1	0.8	0.8			Grass
Rhizoma Cibotii	Cop1	0.3	0.3			Grass
Capillipedium parviflorum- Themeda triandra Forsk. Var. Japonica (Willd) Makino Community-----Grass						
Capillipedium parviflorum	Cop3	0.4	0.4			Perennial grass
Themeda triandra Forsk. Var. Japonica (Willd) Makino	Cop3	0.5	0.5			Perennial grass
Miscanthus	Cop1	1	1			Grass
E. Quadrinervis (Hack.) Kuntze	Cop1	0.5	0.5			Grass
Ischaemum ciliare Retz	Cop1	0.3	0.3			Grass
Eremopogon delavayi	Cop3	0.4	0.4			Perennial grass
Capillipedium parviflorum	Cop2	0.5	0.5			Perennial grass
Themeda hookeri.	Cop1	0.2	0.2			Perennial grass
Heteropogon contortus (L) Beauv.	Cop1	0.7	1			Grass

Table IV-7: List of Plant Species in Anlong County Project Area

PTERIDOPHYTA
Pteridiaceae
Pteridium aquilinum var. latiusculum.
Hypolepis punctata
Rhizoma Cibotii
Gleicheniaceae
Dicranopteris dichotoma
GYMNOSPERMAE
Pinaceae
Pinus yunnanensis
Taxodiaceae

Cunninghamia lanceolata (Lamb.) Hook.
Cupressaceae
Platycladus orientalis
DICOTYLEDONEAE
Fagaceae
Quercus fabri
Quercus acutissima
Quercus variabilis Blume
Quercus aliena
Quercus senescens Hand.-Mazz.
Castanea seguinii Dode
Cyclobalanopsis delavayi (Franch.) Schott.
Lauraceae
Litsea cubeba.
Betulaceae
Corylus heterophylla var. sutchuenensis
Betula luminfera
Araliaceae
Aralia chinensis
Salicaceae
Salicaceae
Hamamelidae
Liquidamba formosana Hance
Rosaceae
Pyracantha fortuneana
Potentilla fulgens
Spiraea salicifolia L.
Coriariaceae
Coriaria nepalensis
Melastomataceae
Osbeckia opipara
Asteraceae
Eupatorium Adenophorum Spreng
Ericaceae
Lyonia ovalifolia var.elliptica
Gaultheria yunnanensis
Vaccinium bracteatum
Aquifoliaceae
Myrsine africana Linn
Anacardiaceae
Rhus chinensis
Saxifragaceae
Philadelphus incanus Koehne
Hypericaceae
Hypericum patulum Thunb.
Solanaceae
Atropa belladonna L.
Monocotyledoneae
Poaceae
Arthraxon guizhouensis S. L.
Eragrostis nigra
Miscanthus
Imperata cylindrica (Linn.) Beauv.
Capillipedium parviflorum
Themeda triandra Forsk. Var. Japonica (Willd.)Makino
Ischaemum ciliare Retz.
E. Quadrinervis (Hack) Kuntze
Eremopogon delavayi
Heteropogon contortus (L) Beauv.

Themeda hookeri.
Oryza sativa Linn
Zea mays
Triticum aestivum Linn.

Table IV-8: Vegetation Biomass in Anlong County Project Area in 2011

Vegetation	Area (ha)	Average Biomass (t/ha)	Total Biomass (t)
Forest	4,258.3	89.2	379,840
Bush fallow	3,613.3	26.7	96,475
Scrub-grassland	4,152.3	12.8	53,149
Dry land vegetation	9,092.4	8.15	74,103
Paddy field	4,149.6	8.22	34,110
Total	25,265.9		637,678

70. **Terrestrial fauna**. Assessment of animal species was conducted through site visits, interviews with local residents and literature reviews. Animals sighted during the site visits were photographed and compared with the pictures of the Guizhou provincial animal archives. The commonly distributed animal species include: pond frog, swamp frog, black-spotted frog, lizard, pond dragonfly, black-eyebrow-golden snake, skylark, pheasant, golden-winged lark, mountain lark, sparrow, vole, brown vole, and weasel. No endemic, rare, endangered or threatened animal species are found in the project area.

Table IV-9: Available Documented Records of Terrestrial Fauna in Anlong County Project Area

Species	Listed under provincial and/or national protection regulations?
Amphibians	
Rana limnocharis	No
Rana nigromaculata	No
Rana guentheri	No
Reptiles	
Gekko japonicus	No
Gecko sp.	No
Elaphe taeniurus	No
Ptyas korros	No
Zaocys dhumnade	No
Birds	
Skylark	No
Pheasant	No
White wagtail	No
Goldfinch	No
Tree sparrow	No
Oriental white eye	No
Tomtit	No
Mammals	
Apodemus chevrieri	No
Rattus confucianus	No
Cricetulus barabensis	No
Field mouse	No
Microtus mandarinus	No
Yellow weasel	No

71. **Fish and other aquatic biodiversity.** Fish in the Lugou river were surveyed through site visits, interviews with fishermen and habitat assessments. At least 23 fish species occur in the Pingqiao Dam catchment area. Family *Cypriniformes* account for about 69% of documented species, including common carp, *crucian* carp, bighead carp, grass carp, black carp, and catfishes, and which are also the main group of economic importance. Other fish include loaches, *Nemacheilus macrotaenia, Leptobotia rubrilaris, Opsariichthys bidens, Pseudorasbora parva, Capoeta semifasciolata, Onychostoma sima, Semilabeo notabilis, Cranoglanis sinensis, Schizothorax, Brevifilis, Channa asiatica, Hemiculter leucisculus, Monopterus albus,* and *Spinibarbus caldwelli.* No documented fish migration routes, or significant spawning sites, are known from the proposed dam site. Wattle-necked soft-shell turtle, freshwater shrimp, crabs, shellfish and other economic animals have been recorded. Local fisheries are small (estimated to be 2-5 tons of catch per year) and comprise individual, opportunistic fishing using non-commercial methods. The Lugou river basin has at least 83 species of phytoplankton and 82 species of zooplankton, over 10 species of aquatic vascular plants (e.g. *Hydrilla verticillata, Potamogeton pusillus, Azolla, Polygonum lapathifolium, Alternanthera philoxeroides*).

Carassius aumtus

Cyprinus carpio

Both belong to the *Cypriniformes* family, which accounts for 69.2% of the fish species in the rivers in Anlong project area

Acrossocheilus yunnanensis (left) and *Silurus asotus Linnaeus* (right), less common local species that are expected to appear in the reservoir and become economic fishery species

Figure IV-2: Fish Species in Rivers of Anlong County Project Area

72. Field surveys and literature reviews did not reveal: i) rare, endangered or protected fishes; ii) spawning grounds; iii) wintering grounds; and iv) concentrated feeding grounds.

(g) Physical cultural resources

73. According to the Archaeological Investigation and Assessment Report for Inundated Area of Anlong Pingqiao Dam developed by Anlong County Cultural Relics Administration in April 2012, six relic sites were expected to be flooded by proposed Pingqiao Dam and one relic site

was expected to be affected by construction activities of Pingqiao Dam. All these sites were identified with certain physical cultural value; however, none of them is under official protection.

Table IV-10: Identified Cultural Sites within Inundated Area of Pingqiao Dam

No.	Name of Cultural Relic	Location	Key Features
1	Puji Bridge	25°19'11.8"N 105°17'34.6E	A single-span stone arch bridge across Cha river, built with bluestone in Qing Dynasty (1831), located in Pingqiao village. 19-m long and 3.4-m wide. Guardrail and bridge surface damaged already. With a quadrangular stele at bridge head.
2	Hexin Bridge	25°18'14.5"N 105°16'37.4"E	A stone bridge across Cha river in Chahe village of Getang town, built in 1956, 11.7m long and 1.8m wide. Guardrail damaged already. With stele.
3	Yangwang's Tomb	25°19'09.4"N 105°16'41.9"E	A tomb of common citizen of Qing Dynasty (1832), with beautiful carving. In good conditions.
4	Chahe Cave	25°18'00.6"N 105°16'35.4"E	Cave relics of Paleolithic Age in Chahe village, with stone cores and stone flakes found. With evidence of artificial damage. With important research value.
5	Wei's Tombs	25°18'49.0"N 105°17'02.3"E	Nine tombs of common citizens of Qing Dynasty. In normal conditions. With evidence of artificial damage.
6	Wei Faming's Tomb	25°18'43.4"N 105°17'05.2"E	A tomb of common citizen built in 1936, with beautiful carving.
7	Yu Shanglun's Tomb	25°18'36.7"N 105°17'08.9"E	A tomb of common citizen located in Chahe village built in Qing Dynasty

(h) Socioeconomic conditions

74. **Demographic features**. According to socioeconomic surveys by the PPTA consultants, the family size is 3.58 persons for each household in the project area. Females account for 41% of the total population, which was lower than that of males at 59%. The average age of the surveyed population in the project area is 36.9, with male's average age being at 36.1 and female's average age at 37.8.

75. **Education**. The overall education level in the project area is relatively low. Of the total population above 15 years old, 36.3% of them have primary school education, 24.7% secondary school education, 25.6% high school and vocational school education, and only 13.5% undergraduate and graduate or above education level. The education level between females and males shows a significant gap. Women have higher enrollment for primary school, but much lower enrollment in secondary school, high school/vocational school, undergraduate and graduate or above than their male counterpart. In general, women have a higher proportion of illiteracy, lower education level, and lower proportion for higher education level.

76. **Occupation**. There is higher proportion of women out of the total female population in the Project area as farmland plantation farmer, accounting for 45.2%. For fruit tree plantation farmers women out of the total female population account for 19%. Women out of the total female population involved in animal husbandry account for 9.7%. Women out of the total population involved in household duties account for 6.4%. Men have higher rate for migrant seasonable labor at 9.7%, than women at 2.5%. While more men move out for seasonable labor opportunities, an increasing proportion of women are left behind to perform both the household and agricultural activities.

77. **Income**. In the project area, the average annual net income of the farmers in 2015 was CNY 20,980 per household. The annual net income in 2015 was CNY 5,860 per capita, which is lower than the average annual net income of CNY 6,086 per capita for the county as a whole. The household income of the project areas has kept increasing continuously in recent years, thanks to the development of poverty reduction efforts, and farmland and orchard development. A large proportion of the farmer household income comes from farming, breeding and orchard farming. The grain crop farming is ranked as the first income sources of the households, followed by seasonable labor, orchards, and animal breeding. Orchards have increasingly become the important livelihood of the local farmers in recent years.

78. **Farmland**. The average area of farmland holding in the flat land area is 3.99 mu per household compared to 1.11 mu per capita for Anlong County as a whole. Of this about 38.21% of the farmland are irrigated (including irrigated land and paddy rice land) and 61.8% dryland. The remaining land uses are orchard land, wood land, waste land, un-used land, and rocky desertification land, accounting for 0.18 mu, 0.56 mu, 0.02 mu, 0.05 mu and 0.08 mu per household respectively. In addition, each household has average of 1.54 mu of dryland or 0.43 mu per capita in the slope land area. They also have orchard land, wood land, waste land and rocky desertification land, accounting for 0.1 mu, 0.98 mu, 0.07 mu and 0.03 mu per household respectively.

(i) Pollution sources

79. Until around 2015, a small gold mining industry occurred in Getang town, upstream of the proposed dam site. The industry was closed in 2015, and there is no mining upstream of the dam site. Due to the low human populations and low intensity of agricultural development in and near the dam catchment area, relatively small volumes of pesticides and fertilizers are used. Agricultural non-point source pollution is not considered a threat to the future water quality of the dam. The catchment area of the dam site retains fragmented natural vegetation, and the environment condition is relatively good.

C. Environmental Setting of Nayong County and Project Area

(a) Overview of Nayong County

80. **Location and topography.** Nayong county is located in the northwest of Guizhou Province, at longitude 104°55'40"~105°38'04", and latitude N26°30'16"~27°05'54, 56 km long from the east to the west and 48 km wide from the north to the south. The highest elevation is 2,476 m and the lowest elevation is 1,050 m. The county is under administration of Bijie Prefecture. The total land area is 2,448 km^2. It is a region with extensive karst. The proposed dam site is in the upstream reaches of the Gantian river. The terrain slopes from north to south, and west to east. Elevations range from 1,200 to 2,200 m. Landforms comprise small valleys and steep peaks.

81. **Climate.** Nayong county is located in the north subtropical monsoon climate zone. Average annual precipitation is 1,243.9 mm (1960–2007), with maximum and minimum annual rainfall of 1,692.4 mm and 929.6 mm respectively. Average annual evaporation is 1,045.8 mm. The average annual temperature is 13.6^oC (maximum 34.1^oC; minimum -7.0^oC). The maximum average annual wind speed is 12 m/s. The wet season is from May to September, with most storm events in June to July.

82. **Geology and soil.** Dominant rock types are sedimentary rocks with limestone, dolomite,

sandstone, shale and mudstone. Soils in the project area are mainly yellow, paddy, and lime soils. Yellow soil thickness is 0.15–0.40 m and pH is about 6.5. Lime soil thickness is 0.20–1.00m and pH is about 6.9. Paddy soil thickness is 0.20–2.00m and pH is about 6.9.

83. **Seismic activity.** According to the PRC Seismic Ground Motion Parameter Zonation Map (GB18306-2001), the proposed dam site is relatively stable, with a ground motion peak acceleration of 0.05 g and a seismic basic intensity of VI. There are no deep fractures in the dam area. The risk of dam-induced earthquakes is considered to be low.

84. **Hydrology.** The proposed site of the Pingshan Dam is located on the Gantian (or Shuigong) river. The Gantian river is a tributary of the Sancha river. The headwaters (upstream of the dam site) are at 2,217.3 m elevation. The Gantian river catchment is 145 km² and the river is 28 km long. It has a natural drop of about 1,000 m and an average river channel ratio of 32‰. At the dam site, the river average annual discharge is 0.770 m^3/s. The channel length above the dam site is 9.84 km. Upstream tributaries feeding into the Gantian are the Heitan, Mahuangqingchong, and Youxi. Runoff depth is 700–800 mm (Contour Map of Guizhou Annual Runoff Depth in Parallel Period from 1956 to 2000). Most (>80%) annual runoff is from May to October.

85. **Socio-economic profile**. The major socioeconomic indicators of Nayong County are summarized in **Table IV-11**.

Table IV-11: Major Socioeconomic Indicators of Nayong County

No.	Major Indicator	Unit	Quantity
1	Area of Land	km^2	2,448
2	Total Population	No.	1,018,142
2.1	Agricultural population	No.	965,343
2.2	Non-agricultural population	No.	52,799
3	Cultivated Land Area	ha	94,504.75
4	Gross Production Value	CNY 10,000	1,486,885
4.1	Firs industry	CNY 10,000	219,829
4.2	Second industry	CNY 10,000	792,472
4.3	Tertiary industry	CNY 10,000	474,585
5	GDP Per Capita	CNY	22,095
6	Total Consumption	CNY10,000	480,437
6.1	Rural resident consumption	CNY10,000	346,265
6.2	Urban resident consumption	CNY10,000	134,172
7	Average Net Income of Rural Residents Per Capita	CNY	5,873.3
8	Average Disposable Income of Urban Residents Per Capita	CNY	20,395
9	Urban Newly Increased Employment in the County and Towns	No.	9,576

Source: Statistical Bulletin of National Economic and Social Development in Nayong County in 2014.

(b) Project Area

86. For the purpose of the EIA study, the project area refers to the catchment area of proposed Pingshan Dam (34.3 km^2), flooding area (0.368 km^2), downstream limit of expected project impacts (about 1.5 km downstream of Pingshan Dam), both sides of proposed water transfer channels and pipelines, project irrigation areas and resettlement areas, totaling about 71.62 km^2. The dam will be built on the Gantian river. The sandstone is widely distributed in the impoundment area with V-shape gullies and primarily bushes on the hills. Similar to the Pingqiao project area, clusters of houses, numbering 10~20 houses per cluster, can be seen along the river above the drawdown areas. Most of the houses are stone-wood-mud-straw

structures. Some houses have been abandoned as the families have left for migrated to towns and cities. There are neither industrial nor commercial establishments in the immediate dam and reservoir area, except for one or two small convenience stores selling daily necessities. In the reservoir area, there are only muddy-stony trails that motorized vehicles cannot travel. The sites for sustainable agriculture are distributed in three towns and township (Changying town, Baixing town and Shuguang township). These are relatively large, flat alluvial plains of the Sancha river and its tributaries, or flat-top plateaus in the Sancha river valley. They are easily accessible through paved local highways and roads. The project lands are either existing dryland or poorly-equipped irrigated land or barren non-cultivated but arable lands. Severe rocky desertified hills and mountains can be seen from the project towns and villages. The desertified hills and mountains, where bare rocks with almost no vegetation (trees, bushes and grasses) dominate the landscape, are the pilot sites under the project for demonstrating rocky desertification control and ecological rehabilitation. The project is located in the underdeveloped rural area, involving no natural reserve, landscape, geological park, forest park and physical cultural resource.

Dam site looking upstream

Downstream the dam site

Farming in the impoundment area

Homestead vegetable plot

Abandoned house

Typical house and farm plot

Figure IV-2: Landscape at Pingshan Dam and Reservoir Area (Photo Taken During Consultant Site Visit in April 2016)

(c) Surface water quality

87. Baseline sampling was conducted from 11-13 September 2012, in seven locations (**Table IV-12**), by the Shenzhen Zhongke Testing Co., Ltd. Results were compared against Class III standard of the PRC Environmental Quality Standards for Surface Water (GB3838-2002). A range of parameters were sampled and all samples met the requirement of Class II of the standard (**Table IV-13**). The 2012 monitoring data shows that the river water quality is good enough to meet Class III requirements for surface water (GB3838-2002).

Table IV-12: Surface Water Sampling Locations in Nayong County Project Area

Sampling Location	Section	
W1	Water way	Mahuang Jingchong Ditch
W2		Heitan River
W3		Fadihe Ditch
W4		Youxi Ditch
W5	Dam area (100 m front of Pingshan Dam site)	
W6	1,500 m downstream of dam (500 m from confluence with Zuozi ditch)	
W7	Nayong river (downstream of return water in irrigation area) – to measure water quality in downstream irrigation areas	

Table IV-13: Surface Water Quality in Nayong County Project Area

Parameter	Monitoring result				Unit
	W1 Average	W3 Average	W5 Average	W6 Average	
pH	7.69	7.69	7.90	7.87	N/a
Cu	0.01L	0.01L	0.01L	0.01L	mg/L
Zn	0.005L	0.007L	0.007L	0.008	mg/L
Hg	0.00005L	0.00006L	0.00005L	0.00005L	mg/L
As	0.008L	0.007L	0.008L	0.007L	mg/L
Pb	0.02L	0.01L	0.02L	0.01L	mg/L
NH3-N	0.04	0.058	0.067	0.11	mg/L
TP	0.01	0.01	0.053	0.13	mg/L
BOD5	1.93	2.07	1.13	1.02	mg/L

Parameter	Monitoring result				Unit
	W1 Average	W3 Average	W5 Average	W6 Average	
Cr6+	0.005L	0.004L	0.004L	0.004L	mg/L
Volatile Penol	0.0027	0.0022	0.0021	0.0014	mg/L
SS	8	7	6	6	mg/L
fluoride	0.05	0.05	0.06	0.38	mg/L
Sulfide	0.005L	0.005L	0.005L	0.005L	mg/L
Cyanide	0.004L	0.004L	0.004L	0.004L	mg/L
Dissolved oxygen	6.73	6.63	6.9	5.80	mg/L
CODcr	6L	5L	5L	5L	mg/L
COD_{Mn}	1.50	1.16	1.42	1.47	mg/L
Oil	0.01L	0.02L	0.01L	0.01L	mg/L
TN	1.73	0.82	0.09	1.89	mg/L

Unit: mg/L, except pH and fecal coliform L = not detected (i.e. not present or value below detection limit).

(d) Ground water quality

88. Ground water sampling was conducted for three consecutive days from 11-13 September 2012, at two ground water wells, Pingshanxi and Heitanhe. Both wells are used for drinking water and irrigation supply. The applicable standard is Class III of the PRC Groundwater Quality Standard (GB/T14848-93). All samples met the Class III standard (**Table IV-14**).

Table IV-14: Ground Water Quality Sampling in Nayong County Project Area

Parameter	11-Sep 2012	12-Sep 2012	13-Sep 2012	Average	Standard index	Class III of GB/T14848-93
Heitanhe Well						
pH	7.98	7.93	7.95	7.95	0.64	6.5~8.5
NH3-H	0.028	0.031	0.033	0.031	0.15	0.2
Nitrate	1.22	1.19	1.24	1.22	0.06	20
Nitrite	0.003	0.002	0.033	0.013	0.63	0.02
Volatile Penol	0.002L	0.002L	0.002L	0.002	1.00	0.002
Cyanide	0.002L	0.002L	0.002L	0.002	0.04	0.05
As	0.01L	0.01L	0.01L	0.01	0.20	0.05
Hg	0.0002L	0.0002L	0.0002L	0.0002	0.20	0.001
Cr 6+	0.004L	0.004L	0.004L	0.004	0.08	0.05
Total hardness	100	98.5	99.6	99.4	0.22	450
Pb	4.8×10-3	4.9×10-3	4.7×10-3	0.0048	0.096	0.05
Fluoride	0.2L	0.2L	0.2L	0.2	0.20	1.0
Cd	2.9×10-3	2.7×10-3	2.8×10-3	0.0028	0.28	0.01
Fe	0.03L	0.03L	0.03L	0.03	0.10	0.3
Mn	0.01L	0.01L	0.01L	0.01	0.10	0.1
Total dissolved solids	144	146	142	144	0.14	1000
COD_{Mn}	1.08	1.06	1.10	1.08	0.36	3.0
Sulfate	28.5	29.7	27.4	28.5	0.11	250
Chloride	2.34	2.46	2.39	2.40	0.01	250
Total coliforms	< 2	< 2	< 2	< 2		3.0
Total bacterial count	46	42	46	45	0.45	100
Pingshanxi Well						
pH	7.99	7.94	7.96	7.96	0.64	6.5~8.5
NH3-H	0.040	0.036	0.035	0.037	0.19	0.2
Nitrate	2.05	2.03	2.02	2.03	0.10	20
Nitrite	0.003	0.002	0.002	0.0023	0.12	0.02
Volatile Penol	0.002L	0.002L	0.002L	0.002	1.00	0.002
Cyanide	0.002L	0.002L	0.002L	0.002	0.04	0.05
As	0.01L	0.01L	0.01L	0.01	0.20	0.05

Hg	0.0002L	0.0002L	0.0002L	0.0002	0.20	0.001
Cr 6+	0.004L	0.004L	0.004L	0.004	0.08	0.05
Total hardness	82.1	82.8	83.2	82.7	0.18	450

Unit: mg/L, except for pH, total bacterial count (per ml), and total coliforms (per L), L = not detected (i.e. not present or value below detection limit).

(e) Air quality

89. Air quality sampling was conducted for seven consecutive days from 11-17 September 2012, in 2 locations. The applicable standard is Grade II of the PRC Ambient Air Quality Standard (GB3095-1996). All samples met the standard, reflecting the relatively high air quality in the project area (**Table IV-15**).

Table IV-15: Results of Ambient Air Quality Sampling Nayong County Project Area

Item / Monitoring Point		Hourly Concentration		Daily Average Concentration		
		SO_2	NO_2	SO_2	NO_2	TSP
G1	Range of concentration	0.020~0.042	0.019~0.040	0.024~0.029	0.022~0.026	0.109~0.123
	Over standard rate	0	0	0	0	0
	Imax	0.084	0.167	0.193	0.217	0.410
	Evaluation standard	0.50	0.24	0.15	0.12	0.30
G2	Range of concentration	0.021~0.042	0.019~0.041	0.023~0.028	0.021~0.026	0.106~0.123
	Over standard rate	0	0	0	0	0
	Imax	0.084	0.171	0.187	0.217	0.410
	Evaluation standard	0.50	0.24	0.15	0.12	0.30

Unit: mg/m^3; G1 = Datun village, 900 m upstream from dam site; G2 = Yaoyan village, 2,000 m downstream from dam site, as a sensitive receptor.

(f) Acoustic environment

90. Noise sampling was conducted over two consecutive days and nights, from 11-12 September 2012, in four locations: Yaoyan village (2,000 m from the proposed dam site and 5.1 km from a stock yard) (N1), the proposed dam site (no residents) (N2), Laiguya stock yard (300-500 m from Laiguya residential area) (N3), and at an intake tower of a nearby irrigation area (no residents) (N4). Samples met Class II of the PRC Environmental Quality Standard for Noise (GB3096-2008), reflecting the lack of industrial activity and small populations in the area (**Table IV-16**).

Table IV-16: Baseline Noise Monitoring Results Nayong County Project Area

Result / Location	11 Sep 2012		12 Sep 2012		Grade II Standard		Meet Standard?	
	Day	Night	Day	Night	Day	Night	Day	Night
N1–Yaoyan Village	43.1	34.2	43.4	34.4	60	50	Yes	Yes
N2–dam site	43.7	34.8	43.9	34.7	60	50	Yes	Yes
N3–Laiguya stock yard	44.2	35.0	44.3	35.1	60	50	Yes	Yes
N4–Irrigation intake tower	42.9	34.0	43.1	33.9	60	50	Yes	Yes

(g) Ecological environment

91. **Terrestrial flora.** Vegetation in the project area comprises six broad categories (**Table IV-17**), of natural and planted species. Most natural vegetation in the project area, especially in the lowlands, is fragmented and modified due to the long history of settlement and agriculture in the county. According to field survey and literature review as part of the domestic EIA studies, no flora species listed as national and/or provincial protected species, on the IUCN Red List, and/or as heritage trees, are known to exist in the project area.

Table IV-17: Vegetation Classification for Nayong County Project Area

Type	Category	Form	Village / Township / Town
Natural vegetation			
Needle-leaf forest	Temperate evergreen needle-leaf forest	*Cryptomeria japonica*	Naodi, Yuzhafeng villages
		Cryptomeria japonica, Betula luminifera	Youzhafang, Dawuji villages
Broad-Leaf forest	Deciduous broad-leaf forest	*Catalpa bungei*	Yangchang township
		Juglans regia, Catalpa bungei, Betula luminifera, Paulownia duclouxii	Zongling township
		Betula luminifera	Whole area
Bamboo forest	Tropical, low-mountain-hill riverine bamboo forest	*Phyllostachys sulphurea*	Youzhafang, Dawuji, Yuetai villages
Bush, bush-grass	Bush	*Debregeasia longifolia*	Riverine areas
		Pyracantha fortuneana，*Rosa* spp.*Rubus* spp.	Hilly karst area
		Betula luminifera，*Coriaria nepalensis*，*Rhus chinensis*	Whole area
	Grass	*Artemisia* spp.，*Miscanthus sinensis*	Whole area
		Cyclosorus acuminatus	Youzhafang
		Iris japonica	Riverine damp areas
		Trifolium repens，*Stellaria media*	Roadside, alluvial plains, barren land
Made-made vegetation			
Economic forest	Evergreen fruit forest	Pepper forest	Youzhafang
	Deciduous fruit forest	Walnut forest	Yaoyan, Xiaotun, Guomu villages
Farm vegetation	Dryland crop	Secale cerete and white-flowered honewart-dominated grassland	Naodi village
		Corn-canola (wheat)-dominated crops	Whole area
	Irrigated crops	Rice-canola (wheat)-dominated crops	Whole area

92. The project area supports a range of natural flora, but which comprise a small proportion of the total provincial flora (about 5.3%) (**Table IV-18**). Flora in the project area has the following characteristics: (i) plant species composition is relatively poor; (ii) secondary vegetation is obvious; (iii) lack of forest vegetation, poor quality and uneven distribution; and (iv) dryland crops comprise most vegetation. Around 16 species of aquatic plants occur in the Gantian River in the project area. Farmland accounts for 4,358.04 ha (60.85%) of the county area, including 788.93 ha paddy fields and 3,569.11 ha dryland crops, higher than the provincial average (20.95%). Most areas are settled and cultivated. Vegetation types and biomass in the project area are summarized in **Table IV-19**. Dryland crops are the largest proportion, and forest vegetation only accounts for 11.41% of total biomass in the project area. Field surveys have revealed no critical habitats for rare, endangered or protected wildlife species in the construction areas.

Table IV-18: Main Vascular Flora in Project Area

Group	Family	Genera	Species	Proportion of Total Recorded in Guizhou Province (%)
Ferns	17	26	32	3.48
Gymnosperms	3	7	10	14.29
Angiosperm	83	267	403	5.48

Table IV-19: Vegetation Types and Biomass in Nayong County Project Area

	Type	No. of Parcels	Area (ha)	Area %	Biomass (t/a)	Biomass %
1	Forest parcels dominated by *Betula luminifera*, *Cryptomeria fortunei*, catalpa, walnut tree species	93	118.44	1.65	704.35	1.31

2	Bush parcels dominated by *Pyracantha*, *Rosa multiflora*, and *Debregeasia orientalis*	422	1182.45	16.51	6,151.08	11.46
3	Grass parcels dominated by awn, *Artemisia* and white clover	416	852.97	11.91	2,214.87	4.12
4	Irrigated farmland parcels dominated by rice paddies and wheat	219	788.93	11.02	12,252.01	22.82
5	Dryland parcels dominated by corn and wheat	211	3569.11	49.83	32,371.87	60.29
6	Water parcels dominated by rivers and ponds	927	27.75	0.39	—	—
7	Human-made ecosystems dominated residential, industrial and commercial land uses	8	622.23	8.69	—	—
	Total	**2,296**	**7,161.87**	**100.00**	**53,694.18**	**100.00**

93. **Terrestrial vertebrate fauna.** Around 79 species of terrestrial vertebrates have been recorded in the project area, comprising birds, mammals, reptiles, and amphibians (**Table IV-20**). Information for the project area includes records of four bird species which are listed as National Level II protected animals (**Table IV-21**). These species have wide distributions in the PRC and/or eastern Asia. The project area does not represent critical habitat for any of these species.

Table IV-20: Terrestrial Vertebrates in Nayong County Project Area

Group	Order	Family	Species	Provincial Species	Proportion of Province Total (%)	Proportion for Project Area (%)
Amphibians	1	5	12	74	16.22	15.19
Reptiles	2	5	13	104	12.50	16.46
Birds	10	22	38	509	7.47	48.10
Mammals	4	7	16	141	11.35	20.25
Total	17	39	79	828	9.54	100.00

Provincial data from *Guizhou Wildlife Directory* (March 2010) (statistics sourced from published literature up to 2008).

Table IV-21: Distribution of National Protected Birds in Evaluation Area

Species	Distribution in Project Area	Abundance	Protection Level
Falco tinnunculus	Xiaotun Village, Baixing, Shuguang	++	National II level
Chrysolophus pictus	Naodi, Xiaotun Village	++	National II level
Milvus imgrams	Everywhere	++	National II level
Tyto capensis chinensis	Everywhere	++	National II level

94. **Fish.** Fish species richness and abundance in the project area is low due to the small and semi-seasonal nature of most waterways. Around six fish species have been recorded in the Gantian river catchment (**Table IV-22**). The species richness comprises 3% of the total number of fish species (202 species) recorded in Guizhou Province (202 species). Through the field surveys, interviews and literature review, no national protected fish species and/or endemic species with restricted distributions occur in the project area, nor there are spawning, wintering grounds; and concentrated feeding grounds.

Table IV-22: Fish Species Recorded in Nayong County Project Area

Species	Habitat	Abundance	Local Distribution
CYPRINIFORMES			
Cobitidae			
Misgurnus anguillicaudatus	Paddy fields, marshes	+++	Widespread
Opsariichthys bidens	Common in rivers and lakes in southern Yangtze river system	+++	Widespread
Cyprinus carpio rubrofuscus	Benthic	+++	Widespread

Carassius auratus	Middle and lower body of water	+++	Widespread
Pseudorasbora parva	Rivers	+++	Widespread
PERCIFORMES			
Gobiidae			
Ctenogobius giurinus	Small rocky streams	+++	Widespread

Number is accessed to collection and investigation and calculated qualitatively: "+" stands for the number is rare, "++" stands for a certain amount, "+++" stands for larger quantities.

95. **Phytoplankton and zoobenthos.** According to the sampling, identification and analysis, phytoplankton species composition comprises diatoms, green algae, cyanobacteria, dinoflagellates and Cryptophyta. For the zooplankton, rotifers, cladocerans, and copepods were recorded. Sampling in the Gantian river recorded *Lumbricidae* (*Oligochaeta*; *Annelida*), *Tubifex sinicus* (*Tubificidae*), cone snail *Radix lagotis* (*Gastropoda*; *Mollusca*) and dragonfly or mayfly larvae (*Odonata*; *Insecta*). Tubifex worms accounted for 33.3% of the total number of species recorded.

(h) Socio-economic conditions

96. **Demographic features**. According to socioeconomic surveys by the PPTA consultants, the family size is 3.29 persons for each household in the project area. Females account for 45.6% of the total population, which was lower than that of males at 54.4%. The average age of the surveyed population in the project area is 39.1, with male's average age being at 38.1 and female's average age at 40.3.

97. **Education**. The overall education level in the project area is relatively low. Of the total population above 15 years old, 35.6% of them have primary school education, 24.5% secondary school education, 25.1% high school and vocational school education, and only 14.8% undergraduate and graduate or above education level. The education level between females and males shows a significant gap. Women have higher enrollment for primary school, but much lower enrollment in secondary school, high school/vocational school, undergraduate and graduate or above than their male counterpart. In general, women have a higher proportion of illiteracy, lower education level, and lower proportion for higher education level.

98. **Occupation**. There is higher proportion of women out of the total female population in the Project area as farmland plantation farmer, accounting for 66.2%. For fruit tree plantation farmers women out of the total female population account for 4.4%. Women out of the total female population involved in animal husbandry account for 1.5%. Women out of the total population involved in household duties account for 10.3%. Men have higher rate for migrant seasonable labor at 20.6%, than women at 8.8% respectively. While more men move out for seasonable labor opportunities, an increasing proportion of women are left behind to perform both the household and agricultural activities.

99. **Income**. In the project area, the average annual net income of the farmers in 2015 was CNY 18,320 per household. The annual net income in 2015 was CNY 5,570 per capita, which is lower than the average annual net income of CNY 5,873 per capita for the county as a whole. The household income of the project areas has kept increasing continuously in recent years, thanks to the development of poverty reduction efforts, and farmland and orchard development. A large proportion of the farmer household income comes from farming, breeding and orchard farming. The grain crop farming is ranked as the first income sources of the households, followed by seasonable labor, orchards, and animal breeding. Orchards have increasingly become the important livelihood of the local farmers in recent years.

100. **Farmland**. The average area of farmland holding in the flat land area is 2.17 mu per household compared to 0.67 mu per capita for Nayong county as a whole. Of this about 5.77% of the farmland are irrigated (including irrigated land and paddy rice land). Plus, each household has average of 2.07 mu of dryland or 0.63 mu per capita in the slope land area. Some households also have a very small piece of paddy land, wood land, waste land and rocky desertification land.

101. **Sources of pollution.** Four small coal mines and one farm are located upstream of the dam site, and present potential pollution sources to the reservoir water quality: (i) Yongxing mine (in Pingjing village), with an annual output of 0.15 million t coal and an annual COD discharge of 1.66 t/a and NH_3-N discharge of 0.22 t/a; (ii) a complex of three mines (Luqian, Pinjing, Shaba), with a total annual output of 0.09 million t and an annual COD discharge of 2.48 t/a and NH_3-N discharge of 0.5 t/a; and (iii) a farm with a maximum of 10,000 head of pigs per year and annual wastewater discharge of 47,799.6 m^3/a, of which all is processed in a bio-digestion facility and used as organic fertilizers for a tea plantation (also part of the farm). All three activities are monitored by the Nayong Environment Protection Bureau and are required to comply with prescribed discharge limits. For the farm, zero discharge of COD and NH_3-N is the requirement (EPB instruction 14 June 2013). The farm has installed a biogas digester to process the waste and the residual waste is applied to the farm's own tea plantation. The farm is in compliance with the prescribed standards and operating conditions.

102. Other pollution risks to the reservoir water quality include primarily the discharge of untreated human waste, and agricultural non-point source pollution from the use of pesticides and fertilizers. There are 12 clusters of settlements in the upstream areas with a total population of 500 people. Human waste in villages is collected and treated in village septic tanks, and the treatment rate is 100%. For the use of agricultural chemicals, in 2010, the three towns of Yangchang, Baixing, and Shuguang (which supported 1,043 ha cultivated land in 2010) applied a total of 520 t nitrogenous fertilizer, 250 t phosphatic fertilizer, 16 t potash fertilizer, and 746 t compound fertilizer. The application amount per unit of cultivated land area was 0.50 t / ha of nitrogenous fertilizer, 0.24 t/ha of phosphatic fertilizer, 0.02 t/ha of potash fertilizer, and 0.72 t/ha of compound fertilizer. These figures indicate the widespread use of agricultural chemicals in the project area. But they are downstream of the reservoir catchment area and have no impact on the water quality of the reservoir.

V. ANTICIPATED IMPACTS AND MITIGATION MEASURES

A. Pre-Construction Phase

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

(a) Institutional strengthening. (a) One full-time environment officer and social officer will be appointed within the Guizhou PMO (potentially the same officers who were 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) At the county level, the Project Implementation Unit (PIU) for each county will include a full-time PIU environment officer and social officer. The terms of reference for these personnel are in the EMP (Attachment 1).

(b) 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.

(c) 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.

(d) Training in environmental management. The LIEC and personnel from the Guizhou EPD and Anlong and Nayong EPBs will give training in implementation and supervision of environmental mitigation measures to contractors and construction supervision companies (CSCs).

(e) Grievance Redress Mechanism (GRM). The PMO and PIUs will implement the project GRM within at least 60 days of project effectiveness, 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 VII).

(f) 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.

(g) 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) spill control and management; (c) health and safety; (d) surface water and groundwater protection; (e) temporary traffic management; (f) 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.

B. Construction Phase

(1) Sensitive Receptors within Anlong County Project Area of Influence

104. Based on the project activities and local environmental conditions, the sensitive receivers within the project area of influence for Anlong county was identified. The area of influence for construction of Pingqiao Dam is defined to cover: (i) a radius of 200 m from the immediate construction site, material preparation and storage sites, spoil and borrow sites and along the transportation routes; and (ii) the inundation zone for the reservoir. Surveys have confirmed that there are no protected areas, rare or protected species, scenic spots, forest parks or drinking water source areas within the area to be inundated or for construction of project facilities. Therefore, the key sensitive receptors are villages which may be affected by construction noise, air impacts, and other direct disturbance (**Table V-1**).

Table V-1: Noise- and Air-Sensitive Receptors for Anlong County Project Area

	Village	Source of Impact	Distance (m)	Remarks
1	Longxin	Construction site, camp and roads	150	Dam, left main canal, branch canals
2	Banbianzhai		120	
3	Sanjiazhai		120	
4	Limo		85	
5	Dapo		85	
6	Laowangqing		60	
7	Kazi		150	
8	Pingqiao	Construction site and camp and construction roads	65	Dam, artery canal, right main canal, branch canals
9	Naha		60	
10	Zhangjiawan		75	
11	Posong		55	
12	Tianwan		75	
13	Mojiaoshan		150	
14	Longtanpo		80	
15	Qiaolu		50	
16	Tingbi		50	
17	Bakan		120	
18	Poqu		60	
19	Daidong		80	
20	Qiaodong		40	
21	Huoshaozhai	Construction area, camp and roads	60	Sayu main canal, branch canals
22	Midu		120	
23	Zhongjianbao		180	
24	Poge		200	
25	Xiangyangping		180	
26	Puzha		145	
27	Nagai		195	
28	Chenyao		105	
29	Pogong		55	
30	Poqing		60	
31	Ranjing	Construction area, camp and roads	120	Puping main canal, branch canals
32	Shichong		80	
33	Gezhai		60	
34	Duimenpo		190	
35	Nongli		200	
36	Zongke		180	

(2) Sensitive Receptors within Nayong County Project Area of Influence

105. For Nayong county project, the construction area of influence is defined to: (i) cover 200 m from the immediate construction site, material preparation and storage sites, spoil and borrow sites and long the transportation routes; and (ii) the inundation zone for the reservoir. Surveys have confirmed that there are no protected areas, rare or protected species, scenic spots, forest parks or drinking water source areas. Therefore, the sensitive receptors are villages within the area of influence. They are summarized in **Table V-2**.

Table V-2: Noise- and Air-Sensitive Spots for Nayong County Project Area

	Village	Source of Impact	Distance (m)
1	Mahuangqing village (8 people)	Quarry site	400
2	B Zhayoufang village (196 people)	Dam site	530
3	Naigucun village (152 people)	Quarry site	300
4	Tiziyan village (1 households)	Concrete mixing site	400
5	Dawancun village (1 household)	Spoil site	80
6	Yuetai village (3 households)	Spoil site	150

(3) Geology and Soil

106. Soil erosion: The natural soil erosion intensity in the two project counties is 693-1,907 tons per square kilometer per year for the project area.[11] Light soil erosion rates[12] are expected during construction when surface vegetation and soil are damaged or disturbed. Soil erosion can also occur after completion of construction where site restoration is inadequate. Project construction may cause soil erosion, contamination, and compaction. Soil erosion may be caused by excavation for the dams, water transmission and distribution pipelines, irrigation canals, stockpiles and spoils from earthwork during construction of the works. The most vulnerable soil erosion areas for the project are the construction sites, borrow and spoil sites, temporary construction sites, and other areas where surface soil is disturbed. Estimated soil erosion amounts are shown in **Table V-3**.

Table V-3: Estimated Soil Erosion Amount for Each Component during Construction

	Erosion-Prone Area (ha)	Existing Soil Erosion ($t/km^2/a$)	Project-Induced Soil Erosion (t)	Existing and Project-Induced Erosion (t)
Pingqiao subproject	432.41	677	66,796	71,641
Pingshan subproject	74.98	1,907	7,212	12,072
Total	**507.39**	**--**	**74,008**	**83,713**

Source: Detailed design reports.

107. Borrow: Two borrow sites are proposed for the Pingqiao subproject. One is a quarry site with an area of 2.73 ha, and the other is for mining earth with an area of 8.30 ha. The quarry site is located 1 km northeast downstream of the dam site. The earth site includes the hills on the right bank downstream of the dam.

108. For the Pingshan subproject, the rock and earth materials for building the main structures total 2.28 million m^3. The rocks for building the main structures will come from the slopes on the left bank of the dam. The borrow site is mainly lime stones with an area of 8.74 ha, a thickness of

[11] Pearl River Planning, Survey and Design Co. Ltd. 2012. Project Water and Soil Erosion Control Plan (WSECP).
[12] In the PRC, water and soil erosion is classified into 6 levels: slight (<1,000 $t/km^2/a$), light (1,000~1,500), moderate (2,500~5,000), heavy (5,000~8,000), very heavy (8,000-15,000) and extremely heavy (>15,000).

80~120 m and a total supply capacity of 10.29 million m^3. With easy access to a highway, it has a distance of 6.6 km to the dam site. The earth materials will be mined from the hills and slopes in the reservoir area. According to past project experiences, it is desirable to remove the earth from the slopes of the inundated reservoir area. In the case of Pingshan Dam, the total removal earth will be 0.25 million m^3, of which 0.16 million m^3 will be used for the dam structures; and the rest for landscaping.

109. Spoil: For the Pingqiao project, two spoil sites are proposed. The first spoil site is located on the left bank 1 km downstream from the dam site. It occupies an area of 5.8 ha and has a capacity of 0.7 million m^3. The site plan is shown in **Figure V-1**. The second spoil site is located 0.4 km upstream from the dam site. It occupies an area of 2.5 ha and has a capacity of 0.25 million m^3. It is situated below the dead water level and therefore will be fully submerged.

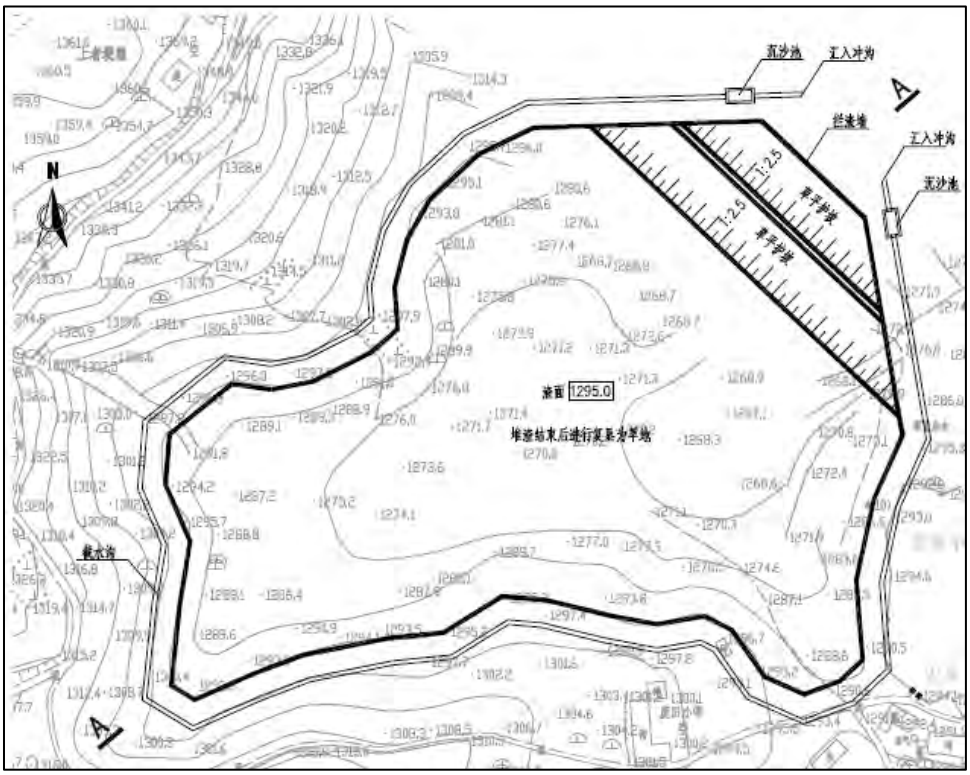


Figure V-1: Layout Plan for #1 Spoil Site for Pingqiao Dam Component

110. Seven spoil disposal sites are proposed for the irrigation component of the Pingqiao project (**Table V-4**). These sites are barren lands. Field surveys have revealed that the project area is exclusively rural with no industrial facilities in history; therefore there are no heavy metals or other pollutants in the spoil that might present environmental or social risks and which would require special mitigation measures in the disposal sites. There are no residential houses and businesses near these disposal sites, nor important public infrastructures especially flood pathways and drainages. The geological conditions are assessed to be stable.

111. For the Pingshan subproject, 0.28 million m^3 of spoils will be produced. Three sites are proposed (**Table V-4**). The first site is located in a gully, 2 km from the right shoulder of the dam. It occupies 6.36 ha, has a capacity of 1.12 million m^3 and will receive the spoils from construction of the dam, diversion tunnel, spillway, and water intake. The second site is located 2.0 km

upstream of the dam site. It occupies 5.01 ha, has a capacity of 1.30 million m^3 and will receive the spoils from construction of the camps, management facilities, and access roads. The third site is for the irrigation component, and situated in the center of the irrigation areas, with an average distance of 3 km. It occupies 2.5 ha, has a capacity of 0.21 million m^3 and will receive the spoils from construction of the irrigation facilities. Field surveys have revealed that the project area is exclusively rural with no industrial facilities in history; therefore there are no heavy metals or other pollutants in the spoil that might present environmental or social risks and which would require special mitigation measures in the disposal sites. There are no residential houses and businesses near these disposal sites, nor important public infrastructures especially flood pathways and drainages. The geological conditions are assessed to be stable

Table V-4: Approved Spoil Disposal Sites

Item	Pingqiao Dam	Pingqiao Irrigation	Pingshan Dam
Site location	1-1 km downstream from dam site; 2-0.4 km upstream from dam site	7 sites along the irrigation corridor	3 sites along the irrigation corridor
Design capacity (million m^3)	0.95 (1=0.7; 2=0.25)	1.415 (1=0.12; 2=0.15; 3=0.20; 4=0.24; 5=0.105; 6=0.3 7=0.3)	2.63 (1=1.12; 2=0.30; 3=0.21)
Available capacity	0.95 million m^3	1.415 million m^3	2.63 million m^3
Distance to works site	1=1 km 2=0.4 km	0.5~1 km	0.2~1.5 km
Existing land use	Barren gullies	Barren gullies	Barren gullies
Land ownership	State owned	Collectively owned	State owned
Site preparation	Compacted with clay	Compacted with clay	Compacted with clay
Rehabilitation plan	Yes	Yes	Yes
Approval year (and authority)	August 2012 (Anlong County Water Resource Bureau)	August 2012 (Anlong County Water Resource Bureau)	May 2013 (Nayong County Water Resource Bureau)
Water and soil erosion control plan	Yes	Yes	Yes

Note: a) For Pingshan irrigation component, all spoils will be used as refill materials and no spoil sites are needed; and 2) Source: Water and Soil Erosion Control Plans and Preliminary Design Documents for the Pingqiao and Pingshan county projects.

112. Measures for soil erosion control to be applied in both sub-projects. Before construction, the contractor 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) Maintain slope stability at cut faces by implementing erosion protection measures such as terraces and silt barriers.

ii) Construct berms or drainage channels around the perimeter of the construction site to capture soil runoff and direct rainwater away.

iii) Plan and implement construction in staged sections, with one section completed and stabilized before beginning the next.

iv) Stabilize all cut slopes, spoil disposal sites, and other erosion-prone working areas.

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

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

vii) Use appropriate compaction techniques for pipe trench construction.

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

ix) 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.

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

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

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

xiii) All borrow and spoil disposal sites, retaining walls and revetments, will be rehabilitated once they are completed (or full in the case of the disposal sites).

xiv) Landscaping will only use native plant species.

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

113. A soil erosion inspection and monitoring program is defined in the domestic EIAs and WSCPs, and also incorporated into the preliminary design reports. Internal inspection and monitoring will be conducted by contractors and CSCs. 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.

114. Due to the non-contaminated nature of the spoil, no special mitigation measures are required within the spoil disposal sites e.g. lining of pits. To reduce the risk of soil contamination from construction machinery, contractors will:

i) Store petroleum products, hazardous materials and wastes on impermeable surfaces in secured and covered areas;

ii) Remove all construction wastes from the site to approved waste disposal sites;

iii) Establish emergency preparedness and response actions;

iv) Provide spill cleanup measures and equipment at each construction site; and,

v) Train contractors and crews in emergency spill response procedures.

(4) Hydrology, Water Quality and Water Availability

115. Excavation for the dam structures and pipeline construction in both subprojects could result in soil runoff to waterways, while inappropriate storage and handling of fuel, accidental spills, disposal of domestic wastewater from construction camps, and wash-down water for machinery and vehicles, could contaminate surface or groundwater. Construction wastewater will come from washing aggregates, pouring and curing concrete, cleaning of mechanical equipment and vehicles, and human waste. Daily domestic wastewater discharge and solid waste production is estimated as 0.10 m^3 and 1 kg respectively per worker per day. During construction, the Pingqiao subproject is estimated to generate 1,082 m^3 / d of wastewater, including 852 m^3 / d of construction wastewater and 230 m^3 / d of sewage from construction camps and management offices. For the Pingshan subproject is estimated to generate 140.4 m^3 / d of wastewater, including 80 m^3 / d from construction wastewater and 60.4 m^3 of sewage from the construction camps and management offices. The domestic solid waste from the construction camps during the construction phase is estimated at 2,300 kg / d for the Pingqiao subproject, and 604 kg / d for the Pingshan subproject. Estimated volumes of construction and domestic wastewater and domestic solid waste are shown in **Table V-5**.

Table V-5: Wastewater and Solid Waste Generated during Construction

Item	Pingqiao	Pingshan	Total
# construction sites	2	2	**4**
# workers at peak construction	2,300	604	**2,904**
Total # of labor (worker-days)	1,903,980	500,000	**2,403,980**
Construction wastewater (m^3/d)	852	80	**932**
Domestic wastewater (m^3/d)	230	60.4	**290.4**
Domestic solid wastes (kg/d)	2,300	604	**2,904**

116. The following measures will be implemented to minimize water pollution.

i) During excavation, contractors will pump slurry to shore and properly dispose it. This will reduce the impact to water quality.

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

iii) Wastewater from construction activities will be collected in sedimentation tanks, retention ponds, and filter tanks to remove silts and oil.

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

v) Fuel storage, maintenance workshop and vehicle cleaning areas must be stationed at least 500 m away from the water body.

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

vii) 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).

viii) Earthworks along rivers, dams and wetlands will be accompanied by measures to minimize sediment runoff into the water bodies, including sediment traps.

ix) Labor camps will be located at least 500 m from water body.

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

xi) Water quality will be monitored by the EMAs during construction as per the EMP.

xii) Coffer dam diversions will be used along small channels.

117. Pipeline construction may require temporary interruptions in water supply to communities. This risk will be avoided and/or minimized by: (i) the use of coffer dams and temporary diversion channels, to maintain continued water flow while works are conducted; (ii) prior to any works along waterways, the contractor, construction supervision company, PIU Environment Officers, and county EPBs, will collectively re-confirm the planned construction schedule and site EMP actions; (iii) local communities will be informed at least two days before any planned water interruptions and given time to store water; (iv) interruptions to water supply would not be longer than one (1) day; and (v) 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 supply until the structure is fixed. Overall, the risk of interrupted water supply is considered low because in most areas, water supply is from groundwater wells.

(5) Air Quality

118. Air pollution sources include: (i) dust from earth excavation, filling, loading, hauling, bare earth surfaces, uncovered construction areas, and vehicle movements on unpaved roads, especially in windy days; (ii) aggregate preparation and concrete-mixing; and (iii) vehicle and machinery emissions (gaseous CO, CH and NO_2). Repaving roads after pipe laying will also produce emissions. During the asphalt heating and mixing process, the fuel burning will produce smoke, and the asphalt will produce flue gas. Modern asphalt mixing equipment used in the PRC releases typical flue gas emission concentrations of 30 mg/m^3, which complies with discharge requirements of 80-150 mg/m^3 of the PRC Atmospheric Pollutant Emission Standard (GB16297-2012) and PRC Ambient Air Quality Standard (GB3095-2012), which limits the concentration of benzopyrene at 0.01 μg/m^3 (at 100 m downwind from the asphalt mixing station). These various sources of air pollution could affect nearby sensitive receivers, including villages, and residential areas identified in subsection B(1) above.

119. The quantity of dust generated will depend on wind, humidity of the material and earth, and state of site. By reference to projects of similar nature, the concentrations of total suspended particulates (TSP) were predicted for the Pingqiao and Pingshan Dam construction components. At the peak construction, the incremental value for the daily average concentration of the TSP are predicted to be 0.45 mg / m^3, 0.33 mg / m^3 and 0.20 mg / m^3 respectively at 30 m, 50 m and 80 m downwind of the construction sites (dam site, borrow and spoil sites, material preparation sites), assuming the average wind speed of 2.5 m / s. Overlapping this onto the background value of 0.033 ~ 0.083 mg / m^3, the daily average concentration of TSP will be 0.483 ~ 0.533 mg / m^3, 0.363 ~ 0.413 mg / m^3 and 0.233 ~ 0.283 mg / m^3 respectively at 30 m, 50 m and 80 m downwind of the construction site. Thus the TSP concentration at 80 m downwind of the dam site

(0.233 ~ 0.283 mg / m^3) will meet the Class II (0.300 mg / m^3) of the PRC Ambient Air Quality Standard (GB 3095-2012). For the Pingqiao Dam component, there is one sensitive receptor, the Pingqiao village, which is located 65 m away from the dam site. The village will be relocated before the commencement of construction. There are six sensitive receptors for the Pingshan Dam component. The six sensitive receptors are located between 80 m (Dawan village) and 4,000 m (Mahuangqin village) from the construction sites. The use of wet construction method (wetting the dust-prone ground before construction and spraying) will further suppress dust generation. Therefore, the ambient TSP concentrations at the sensitive receptors are expected to meet the Class II of the PRC Ambient Air Quality Standard (GB 3095-2012). Construction machinery and vehicles may emit NOx and CO. All such machinery and vehicles are certified to pass emission limits. The impact of such emissions is judged to be insignificant, considering the good dispersion conditions at the construction site and by reference to other projects of similar nature.

120. Mitigation measures to reduce impacts on air quality are as follows. The construction contractors will be required to include these mitigation measures in the site EMPs.

i) Spraying water daily on construction sites where fugitive dust is being generated.

ii) Locating asphalt plants and mixers ≥500 m downwind from the nearest residential areas and other sensitive receptors.

iii) Dust suppression near sensitive receptors e.g. schools, hospitals, residential areas.

iv) Storing petroleum or other harmful materials in appropriate places and covering to minimize fugitive dust and emission.

v) Covering materials during truck transportation, in particular, fine material, to avoid spillage or dust generation.

vi) Ensure vehicle and machinery emissions comply with PRC standards of GB18352-2005, GB17691-2005, GB11340-2005, GB2847-2005, and GB18285-2005.

vii) Timely monitoring of air quality and inspections during construction, as defined in the project EMP (**Attachment 1** – **Table EMP-4**).

(6) Noise

121. Construction will involve excavators, bulldozers, scrapers, dredgers, concrete-mixer, trucks and other heavy machinery. Noise during pipeline construction will be generated by trench excavators, rollers and other compaction machine. Noise will be temporary and localized. Estimated construction noise values (at 5 m distance from the machineries and vehicles) are shown in **Table V-6**.

Table V-6: Testing Values of Construction Machinery Noise

No.	Machine Type	Maximum Sound Level Lmax (B)
1	Excavator	85-95
2	Concrete mixer	86
3	Bulldozer (100 horse-power)	78-96

4	Scraper	85-95
5	Heavy truck	88-93 (speed up), 84-89 (steady speed)
6	Medium-duty truck	85-91 (speed up), 79-85(steady speed)
7	Drilling machine	96
8	Wheel loader	85-92
9	Vibrating roller	86
10	Two-wheeled two-vibrating roller	81
11	Asphalt concrete paver	82
12	Generating set	88-92

122. Estimating noise levels. Construction equipment is a point sound source. The predictive model applied in this project is:

$$L_i = L_0 - 20\lg\frac{R_i}{R_0} - \Delta L$$

Where, L_i and L_0 are equipment noise sound levels at R_i and R_0 respectively. ΔL is additional diffusion attenuation produced by barriers, vegetation and air.

123. As for the impact of multiple construction machineries on a certain future position, sound level superposition is needed:

$$L = 10\lg\Sigma 10^{0.1\times L_i}$$

124. Prediction results. Noise levels at different distances were derived after calculating the impact scope of equipment noise during construction as defined in the table below. The PRC Standard of Noise Limits for Construction Sites (GB12523－90) specifies the noise limit in Class II areas as 70 dB (A) during daytime and 55 dB (A) during nighttime. The standard compliance noise impact scope (m) of different machineries is listed in the table below.

Table V-7: Noise Values of Construction Machineries at Different Distances in dB (A)

Machinery Name	Distance to Machinery								
	15 m	20 m	40 m	60 m	80 m	100 m	130 m	150 m	200 m
Excavator	71	69	63	59	57	55	53	51	49
Bulldozer	72	70	64	60	57	56	54	52	50
Loader	61	59	53	49	47	45	43	41	39
Heavy truck	69	67	61	57	55	53	51	49	47
Drilling machine	72	70	64	60	57	56	54	52	50
Concrete-mixer	71	69	63	59	57	55	53	51	49
Applicable Standard	70 (daytime)								
	55 (nighttime)								

125. The noise level during construction for compliance with the PRC Standard of Noise Limits at the Borders of Construction Sites (GB12523-2011) is 70 dB(A) for the day (06:00-22:00) and 50 dB(A) for the night (22:00-06:00) at the borders of the construction site. Construction materials, surplus spoil and construction wastes will be transported to and from the construction sites during the average 10 hour work-day for the construction season of about 250 days per year in the project area for about four years. Construction trucks will be required to reduce speed to 20 km/h when passing through villages. This measure will reduce the noise level by 8-9 dB(A).

126. The predicted noise levels for sensitive receptors in the Anlong county project area during

construction are presented in **Table V-8**. The results show that the predicted noise levels for the sensitive receptors in the Anlong county project areas during construction do not violate the Class II of the PRC Ambient Noise Standards (GB 3096-2008). Noise modelling results for the Nayong county project areas during construction show that the noise levels at 158 m from the construction sites will meet the Class II of the PRC Ambient Noise Standards (GB 3096-2008). The nearest settlement is 300 m away from the construction sites and therefore the noise impact will be insignificant for the Nayong county project area.

Table V-8: Projected Noise Values of Sensitive Receptors during Construction ----Anlong County Project Area

	Sensitive Receptor	Noise Source	Predicted Noise Level (dB(a))		Violation
Pingqiao Dam component					
1	Longxin village	Construction, transport	Day	50.7	0.0
			Night	49.7	0.0
2	Pingqiao village	Construction, transport	Day	53.2	0.0
			Night	50	0.0
Pingshan Dam component					
1	Banbianjie	Construction, workers' camp	Day	51.2	0.0
			Night	44.2	0.0
2	Sanjiazai	Construction, workers' camp	Day	51.4	0.0
			Night	43.6	0.0
3	Limo	Construction, workers' camp	Day	52.7	0.0
			Night	45.4	0.0
4	Dapo	Construction, workers' camp	Day	52.5	0.0
			Night	45.6	0.0
5	Laoqangqing	Construction, workers' camp	Day	52.9	0.0
			Night	45.9	0.0
6	Kazi	Construction, workers' camp	Day	51.4	0.0
			Night	44.3	0.0
7	Naha	Construction, workers' camp	Day	52.7	0.0
			Night	42.8	0.0
8	Zhangjiawan	Construction, workers' camp	Day	51.5	0.0
			Night	44.5	0.0
9	Posong	Construction, workers' camp	Day	55.3	0.0
			Night	47.5	0.0
10	Tianwan	Construction, workers' camp	Day	51.6	0.0
			Night	44.6	0.0
11	Mojiaoshan	Construction, workers' camp	Day	51.3	0.0
			Night	43.9	0.0
12	Longtanpo	Construction, workers' camp	Day	52.6	0.0
			Night	45.7	0.0
13	Qiaolu	Construction, workers' camp	Day	55.4	0.0
			Night	47.9	0.0
14	Tingbi	Construction, workers' camp	Day	55.4	0.0
			Night	47.9	0.0
15	Bakan	Construction, workers' camp	Day	51.2	0.0
			Night	44.2	0.0
16	Poqu	Construction, workers' camp	Day	51.5	0.0
			Night	44.5	0.0
17	Daidong	Construction, workers' camp	Day	52.6	0.0
			Night	45.7	0.0
18	Qiaodong	Construction, workers' camp	Day	57.4	0.0

			Night	49.1	0.0
19	Huoshaozai	Construction, workers' camp	Day	51.5	0.0
			Night	44.5	0.0
20	Midu	Construction, workers' camp	Day	51.1	0.0
			Night	44.1	0.0
21	Zhongjianbao	Construction, workers' camp	Day	48.2	0.0
			Night	42.1	0.0
22	Poge	Construction, workers' camp	Day	47.2	0.0
			Night	41.5	0.0
23	Xiangyangping	Construction, workers' camp	Day	48.2	0.0
			Night	42.1	0.0
24	Puza	Construction, workers' camp	Day	51.1	0.0
			Night	44.1	0.0
25	Nagai	Construction, workers' camp	Day	47.2	0.0
			Night	41.5	0.0
26	Chenyao	Construction, workers' camp	Day	51.4	0.0
			Night	44.4	0.0
27	Pogong	Construction, workers' camp	Day	51.5	0.0
			Night	44.5	0.0
28	Poqing	Construction, workers' camp	Day	51.5	0.0
			Night	44.5	0.0
29	Ranjing	Construction, workers' camp	Day	51.2	0.0
			Night	44.2	0.0
30	Shichong	Construction, workers' camp	Day	52.6	0.0
			Night	45.7	0.0
31	Gezai	Construction, workers' camp	Day	51.5	0.0
			Night	44.5	0.0
32	Duimenpo	Construction, workers' camp	Day	47.6	0.0
			Night	41.7	0.0
33	Nongzai	Construction, workers' camp	Day	47.2	0.0
			Night	41.5	0.0
34	Zongke	Construction, workers' camp	Day	47.5	0.0
			Night	41.6	0.0

Note: Applicable standard: Class II of PRC Ambient Noise Standard (GB 3096-2008); 60 d(BA) for day time and 50 dB(A) for night time.

127. Mitigation measures. The following measures will be implemented to comply with PRC construction site noise limits and to protect sensitive receptors (see **Chapter IV**).

i) Ensure that noise levels from equipment and machinery conform to PRC standard of GB12523-90. Properly maintain construction vehicles and machineries to minimize noise.

ii) Apply noise reduction devices or methods for high noise equipment operating within 200 m of sensitive sites e.g. schools, villages, residential areas.

iii) Locate high-noise activities (e.g. rock crushing, concrete-mixing) > 1 km from sensitive areas.

iv) Prohibit operation of high-noise machinery, and movement of heavy vehicles along urban and village roads, between 21:00 and 07:00, in accordance with provincial regulations.

v) Place temporary hoardings or noise barriers around noise sources during construction.

vi) Mobile sound barriers will be used for sensitive receptors during construction.

vii) When passing through villages, construction trucks will reduce speed to no more than 20 km/h.

viii) Monitor noise at sensitive areas at regular intervals (**Table EMP-4**). If noise standards are exceeded, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation.

ix) Conduct regular interviews with residents adjacent to construction sites to identify noise disturbance. Community feedback will be used to adjust work hours of noisy machinery.

(7) Vibration

128. Vibration impacts are expected during dam and irrigation construction works, including vibrations from excavation, quarrying, and pipeline trench compaction. Mechanical vibration may be sudden and discontinuous, which can cause stress among workers and communities. To address these issues: (i) excavation, stone-crushing 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.

(8) Solid Waste

129. Solid waste will be generated from construction waste and worker camps. Project construction requires 2.404 million worker-days for the two subprojects (see **Table V-5**). With each worker produces an average of 1 kg / d of domestic solid waste, the total domestic solid waste to be generated from the 5-year construction period is estimated at 2.404 tons. Covered garbage bins will be installed in the camps. It will be the responsibility of the construction contractors to provide sufficient garbage bins at proper locations and ensure they are protected from birds and vermin and emptied regularly (using the local MSW collection systems). Construction waste will be regularly transported off-site by the contractor for disposal at disposal sites approved by the local LRBs in compliance with 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.

(9) Ecological Resources

130. **Change in biomass**. The Anlong county subproject will acquire 133.63 ha of forested land, 154.19 ha of shrub land, 213.33 ha of shrub-grass land, 529.15 ha of irrigated land and 196.32 of dryland. This will result in a loss of biomass in the project area. According surveys and estimates of the domestic EIA study, the net biomass loss is approximately 4,977.4 t. The loss in average net biomass productivity is estimated at 0.20 t / ha /a from 6.44 t / ha /a to 6.24 t / ha / a. The loss accounts for 3.1% of the average net biomass productivity in the project area. The project will increase irrigated land by 5,656.7 ha and improve existing irrigated land by 1,408.0 ha, and re-vegetate 1,599 ha of rocky desertified land. The total increase in biomass productivity as a result of the re-vegetation subcomponent is estimated at 19,532.94 t / a, which will fully

offset the biomass loss, with a net biomass increase of 14,555.94 t / a.[13] The results are summarized in **Table V-9**. Furthermore, for the Pingqiao Dam area where the loss of 4,977 t / a of biomass occurs, the loss is estimated to account for approximately 5% of the total biomass in the project area. This loss in productivity is judged not to upset the ecological balance of the existing ecosystems. The local ecosystem can still recover from disturbance and remain stable. If the biomass increase from re-vegetation and sustainable agriculture is included, the total biomass in the project area will witness a net increase of 14,555.94 t / a.

Table V-9: Estimated Biomass Loss in Anlong County Project Area

Vegetation Type	Productivity (t / ha / a)	Project Area Total Before Project		Project Impact		
		Area (ha)	Productivity (t /a)	Acquisition (ha)	Productivity Loss (t / a)	% Loss in Productivity over Areal Total
Forest	5.95	4,258.3	25,337	133.62	795.04	3.14
Shrub	5.38	3,613.3	19,440	154.19	829.54	4.27
Shrub-grass	2.87	4,152.3	11,917	213.33	612.26	5.14
Irrigated land	8.08	9,092.4	73,467	539.15	4,356.33	5.93
Dryland	6.79	4,149.6	28,176	196.32	1,333.01	4.73
Total	**6.27**	**25,265.9**	**158,337**	**1,246.61**	**7,926.18**	5.01

Source: Domestic EIA.

131. The Nayong county subproject will acquire 0.15 ha of forested land, 13.94 ha of shrub land, 8.27 ha of shrub-grass land, and 37.2 of dryland. This will result in a loss of biomass in the project area. According surveys and estimates of the domestic EIA study, the net biomass loss is approximately 777.79 t. The loss accounts for 0.84% of the total biomass in the project area. The project will increase irrigated land by 3,594.7 ha and improve existing irrigated land by 360.6 ha, and revegetate 1,208.5 ha of rocky desertified land. The total increase in biomass productivity as a result of the project is estimated at 18,151.62 t / a, which will fully offset the biomass loss, with a net biomass increase of 17,371.83 t / a.[14] Furthermore, for the Pingshan Dam / reservoir area where the loss of 777.79 t / a of biomass occurs, the loss is estimated to account for approximately 0.84% of the total biomass in the project area. This loss in productivity is judged not to upset the ecological balance of the existing ecosystems. The local ecosystem can still recover from disturbance and remain stable. If the biomass increase from re-vegetation and sustainable agriculture is included, the total biomass in the project area will witness a net increase of 17,371.83 t / a.

[13] i) Assuming an average increase of 30% of biomass by converting 5,656.7-ha dryland and barren land into irrigated land, the resulting biomass increase would be: (5,656.7 ha x 8.08 t / h /a x 20%) = 9,141.23 t / a. ii) Assuming an average increase of 20% of biomass for improving the 1,408.0-ha irrigated land, the resulting biomass increase would be 1,408.0 ha x ((8.08 t / ha / a x 1.2) – 6.79 t / ha /a) = 4,091.65 t / a. iii) Assuming the present average biomass productivity for rocky desertified land to be 50% of the shrub-grass land at (2.87 t /a x 50%) = 1.44 t /a and the average biomass productivity for revegetated rocky desertified land to be the same as the shrub land at 5.38 t /a, the resulting biomass increase would be (1,408.0 ha x (5.38 t / ha /a – 1.44 t / ha /a) = 6,300.06 t / a. iv) We get 14,555.94 t /a by subtracting i) and ii) from iii). That is, the net biomass increase for the project would be 19,532.94 t / a – 4,977.4 t /a = 14,555.94 t /a.

[14] i) Assuming an average increase of 30% of biomass by converting 3,594.7-ha dryland and barren land into irrigated land, the resulting biomass increase would be: (3,594.7 ha x 15.53 t / h /a x 20%) = 11,168.24 t / a. ii) Assuming an average increase of 20% of biomass for improving the 360.6-ha irrigated land, the resulting biomass increase would be 360.6 ha x ((15.53 t / ha / a x 1.2) – 9.07 t / ha /a) = 3,449.50 t / a. iii) Assuming the present average biomass productivity for rocky desertified land to be 50% of the shrub-grass land at (8.27 t /a x 50%) = 4.14 t /a and the average biomass productivity for revegetated rocky desertified land to be the same as the shrub land at 13.94 t /a, the resulting biomass increase would be (360.6 ha x (13.94 t / ha /a – 4.14 t / ha /a) = 3,533.88 t / a. iv) iv) We get 17,371.83 t /a by subtracting i) and ii) from iii). That is, the net biomass increase for the project would be 18,151.62 t / a – 779.79 t /a = 17,371.83 t /a.

Table V-10: Estimated Biomass Loss in Nayong County Project Area

Vegetation Type	Productivity (t / ha / a)	Project Area Total Before Project		Project Impact		
		Area (ha)	Productivity (t /a)	Acquisition (ha)	Productivity Loss (t / a)	% Loss in Productivity over Areal Total
Forest	89.20	118.44	10,565.25	0.15	13.38	0.13
Shrub	26.01	1,182.45	30,755.40	13.94	362.58	1.18
Shrub-grass	7.79	852.97	6,644.61	8.27	64.42	0.97
Irrigated land	15.53	788.93	12,252.01	0.00	0.00	0
Dryland	9.07	3,569.11	32,371.87	37.20	337.40	1.04
Total	**14.22**	**6,511.90**	**92,589.14**	**59.56**	**777.79**	0.84

Source: Domestic EIA.

132. Field surveys, local resident interviews and literature review revealed the non-existence of endemic, rare, endangered or threatened floral species in the Anlong and Nayong county project areas. With the implementation of the mitigation measures in the EMP, the residual impact is assessed to be insignificant.

133. **Terrestrial fauna**. The construction activities will result in a number of adverse effect on the wild animal population in the project area, especially the inundation areas for the Pingqiao and Pingshan Dams. First, the use of explosives and construction and transportation machinery, the movement of earth works and the presence of construction workers will produce excessive noise to the animal population. Second, the inundation as a result of the impoundment will reduce the habitat for wild animals. Animal and birds have high degrees of mobility that will allow them to flee to safe surrounding areas and return to the project area once the construction activities are completed, such that the adverse impact on the terrestrial fauna population will be temporary and non-irreversible. The loss of wild animal habitats is irreversible.

134. For the Pingqiao as a medium-sized reservoir, the loss of 2.8 km^2 from inundation represents a very small portion (<0.00005%) of the habitats of the 480,000 km^2 Yunnan-Guizhou plateau bioregion[15]. Field surveys, local resident interviews and literature review revealed the non-existence of endemic, rare, endangered or threatened terrestrial fauna species in the project area. With the implementation of the mitigation measures contained in the EMP, the risk of ecological impacts is assessed to be low.

135. For the Pingshan as a small-sized reservoir, field surveys, local resident interviews and literature review revealed the existence of four nationally-protected bird species (Table V-11). An analysis is undertaken on the potential effect of construction on these protected species, and the results are provided in **Table V-11**. The Nayong County project area is not part of the critical habitats for these species. Moreover, the loss of habitat ranges from a high of 0.00025% to a low of 0.0000015%. In consideration of these factors and with the implementation of the mitigation measures listed in this subsection (see below), project impact is assessed to be minimal.

[15] A bioregion is an ecologically and geographically defined area that is smaller than an ecozone, but larger than an ecoregion or an ecosystem, in WWF classification scheme. There is also an attempt to use the term in a rank-less generalist sense, similar to the terms "biogeographic area" or "biogeographic unit". It may be conceptually similar to an ecoprovince. The Yunnan-Guizhou plateau bioregion covers an area of 480,000 km^2. Source: https://en.wikipedia.org/wiki/Bioregion; https://zhidao.baidu.com/ question/ 124807924.html.

Table V-11: Assessment of Pingshan Reservoir Inundation on Four Protected Birds

Species	Protection Level in PRC	IUCN		Distribution in PRC	% of Habitat Loss over Global / PRC Total
		List	Global Distribution		
Falco tinnunculus	National-II	Least Concerned (LC)	Widely distributed globally in more than 140 countries, with estimated extent of occurrence (EOO) at 37,600,000 km^2 and a global population of 4,000,000-6,500,000 mature individuals	Widely distributed in 29 provinces / territories, non-migratory in Guizhou which is not part of the critical habitat	Global: 0.37 km^2 / 37,600,000 km^2 PRC: 0.37 km^2 / 9,000,000 km^2
Chrysolophus pictus	National-II	Least Concerned (LC)	Widely distributed globally, with estimated extent of occurrence (EOO) at 970,000 km^2 and a global population not approaching the threshold of "Vulnerable"	Native to PRC, distributed in 9 central and south-western provinces, Guizhou is not part of the critical habitat	Global: 0.37 km^2 / 970,000 km^2 PRC: 0.37 km^2 / 800,000 km^2
Milvus migrans	National-II	Least Concerned (LC)	Widely distributed globally, with estimated extent of occurrence (EOO) at 46,700,000 km^2 and a global population not approaching the threshold of "Vulnerable"	Distributed country-wide, Guizhou is not part of the critical habitat	Global: 0.37 km^2 / 46,700,000 PRC: 0.37 km^2 / 8,000,000 km^2
Tyto capensis chinensis	National-II	Least Concerned (LC)	Widely distributed globally, with estimated extent of occurrence (EOO) at 2,420,000 km^2 and a global population not approaching the threshold of "Vulnerable"	Distributed in eight southern and SW provinces, Guizhou Province is not part of the critical habitat	Global: 0.37 km^2 / 2,420,000 km^2 PRC: 0.37 km^2 / 150,000 km^2

PRC = People's Republic of China. Source: http://www.iucnredlist.org; http://baike.niaolei.org.cn, http://baike.baidu.com. Compiled by PPTA consultants.

136. **Aquatic ecosystem**. Potential impacts from project construction were assessed as follows. First, potential disturbance or loss of in-channel habitats, from construction and/or accidental discharge of pollutants from construction materials or wastewater. This risk will be managed through careful control of construction materials and sediment traps, and will be temporary in nature. Second, altered hydrology may change the local ecology. This risk is assessed to be minimal because (i) an ecological flow of 0.37 m^3/s or 10% of the average yearly flow for the Pingqiao Dam and 0.077 m^3/s or 10% of the average yearly flow for the Pingshan Dam has been set, in accordance to the PRC regulatory requirements. The flows will be released through the gates for both dams; (ii) during the construction phase, four pumps (including one backup) will be used to provide the adequate ecological flow for maintaining the functioning of the ecological systems downstream of the dam on the one hand, and on the other hand will provide more stable water supply for downstream villagers especially during the dry season and drought years when the river dries up partially completed such that villagers will have to use groundwater or spring water to be fetched from long distances; and (iii) field surveys, local resident interviews and literature review revealed the non-existence of migratory fish species or endemic, rare, endangered or threatened aquatic species in the project area. Additional risks considered were the introduction of invasive species and/or disease vectors due to new and enhanced water transfer by the project. These risks are low because irrigation has been implemented in the project areas for decades already, the project will provide within-basin transfers only, and the project area is not prone to *Schistosomiasis* or other disease vectors. Overall, with the implementation of the mitigation measures in the EMP, ecological and hydrological impacts are assessed to be minimal.

137. Ecological resource protection measures in the EMP are as follows.

i) The construction of access roads, borrow and spoil sites, material preparation fields, construction camps and management offices will minimize the removal and disturbance to the original vegetation. As far as possible, clearance of vegetation will be avoided.

ii) Removed original soils will be stored for landscaping uses.

iii) Prior to construction, vegetation and habitats will be clearly demarcated, as no-go zones for workers and machinery. Workers will be trained to minimize disturbance to and protect wildlife.

iv) If clearance is required the area will be immediately re-vegetated afterward.

v) All re-vegetation and the reforestation component will use native plant species of local origin, to maintain genetic fitness and reduce the risk of introducing non-local and invasive species.

vi) Reservoir protection zones will be established for the two dams in accordance with PRC regulations.

(10) Social Issues

138. The project will involve permanent and temporary land acquisition, removal of houses, and impacts to around 6,785 people from the two planned dams, including around 6,334 persons from the construction of the Pingqiao Dam and reservoir and around 451 persons from the construction of the Pingshan Dam and reservoir. Land uses in areas to be affected by the project comprise village areas, irrigation ponds and agricultural land, and areas where construction has taken place. Two resettlement plans have been prepared in accordance with PRC and ADB requirements to ensure that all affected residents have been documented and will receive adequate compensation and/or support. Detailed analyses of impacts to livelihoods, resettlement, and economic analysis are included in these plans, and are available in Chinese and English language at the PMO office and ADB website.

(11) Community and Worker Health and Safety

139. Traffic congestion and risk of accidents will increase with construction traffic, causing temporary inconvenience to traffic, residents, commercial operations, and institutions. 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 local traffic management administrations 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.

Three-dimensional detection of underground facilities will be conducted before construction where appropriate.

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 GRM, 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.

140. 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 (**Attachment 1 - Table EMP-2**), 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).

(12) Physical Cultural Resources

141. No officially listed 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. The local cultural heritage bureau, PMO, and PIU 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.

C. Operational Phase

(1) Protection of Reservoir Water Quality

142. Sewage: Pollution of the reservoir water quality may result from the following sources: i) the reservoir management office; and ii) upstream point and non-point sources. The Pingqiao Dam management office will have a staffing level of 28 people. The daily sewage generation is estimated at 4.2 m^3. The Pingshan reservoir management office will have a staffing level of 14 people. The daily sewage generation is estimated at 2.0 m^3. The treatment methods are presented in the following table.

Table V-12: Sewage Treatment for Two Reservoir Management Offices

	Staffing Level	Sewage Volume (m^3/d)	Treatment and Discharge
Pingqiao Dam management office	24	4.2	Sewage treatment unit used during construction will be used to treat the sewage. The effluent will be discharged into river flow downstream river flow, and will not pollute the reservoir.
Pingshan reservoir management office	14	2.0	The sewage will be treated with a septic tank. The septic tank will be inspected and cleared regularly and sent to municipal landfill. There will not be any discharge.
Total	**38**	**6.2**	

143. Solid waste: The daily solid waste generation is estimated at 28 kg for the Pingqiao Dam management office and 14 kg for the Pingshan reservoir management office. A covered mobile garbage container will be placed in the backyard of the reservoir management office and hauled to the local sanitary landfill.

Figure V-2: Covered Mobile Garbage Container for Reservoir Management Offices

144. Reservoir protection zoning: The domestic EIAs and preliminary design reports have recommended the establishment of protection zones for the two dams, in accordance with the *PRC Technical Guidelines on Zoning for Protection of Drinking Water Sources (HJ/T 338-2007)* and *Technical Requirements for Signage for Drinking Water Source Protection Zones (HJ/T 433-2008)*. The zoning plan is provided in **Table V-13**.

Table V-13: Protection Zones for Two Dams

Protection Class and Target	Water Boundary	Terrestrial Boundary
Class I Protection Zone, with Class II of PRC Surface Water Quality Standards (GB3838-2002)	Water surface within a radius of 300 m from the water intake.	Land surface 200 m from the water level of the water intake.
Class II Protection Zone, with Class II of PRC Surface Water Quality Standards (GB3838-2002)	Entire water surface outside a radius of 300 m from the water intake.	Catchment area from dam site to 3000 m from the normal tail water level, except for the land surface of Class I Protection Zone.

Note: Domestic EIAs, Preliminary Design Reports.

145. Prior to the completion of each dam, the Anlong and Nayong County Water Resource Bureaus (WRBs) will each submit a proposal to the respective County Governments for establishment of the drinking water protection zones, as per the above-recommended plan, in accordance with the PRC Technical Guidelines on Zoning for Protection of Drinking Water Sources (HJ/T338-2007). The county government will then engage a certified design institute to prepare a detailed zoning plan and submit to the Guizhou Provincial Government for approval. Once the protection zoning plan is approved, the GPG will publish it for public attention. Warning signs will be placed in the boundaries of the protection zones in accordance with the *PRC Technical Requirements for Signage for Drinking Water Source Protection Zones (HJ/T 433-2008)*. A tentative schedule is presented as follows:

Table V-15: Proposed Schedule for Establishing Protection Zones for Two Dams

	Task	Milestone
1	Engagement of a qualified design institute for protection zoning design	January 2018
2	Submission of zoning design document to county WRB for review and approval	June 2018
3	WRB review and comments	July 2018
4	Revision and resubmission	September 2018
5	Expert panel review organized by county WRB	October 2018
6	Finalization of zoning design	December 2018
7	Procurement of border posts and signs	March 2019
8	Erection of border posts and signs	October 2019

146. Guizhou Wucuimingxiang Circular-Economic Ecological Park. The park was established

in 2011. It consists of a 10,000-mu tea plantation, a 120 t/a tea production line and a 10,000-head pig farm. It is situated about 1 km upstream from the proposed site of the Pingshan Dam. The wastewater production (including manures) is estimated at 148 m^3/d or 47,800 m^3/a. In its approval document, the Nayong County EPA requires zero discharge for the circular-economic park. All production wastes are organic matter, and is used, including the wastewater from the pig farm, to produce organic fertilizers for the tea plantation through a biogas digestion facility. Under normal operating conditions, the liquid and solid organic waste after bio-digestion will be fully applied to the tea plantation and is not expected to cause significant impact on the water quality of the reservoir. An emergency pond, with the capacity to contain three days of wastewater, which is adequate for repair and maintenance of the bio-digestion facilities. The above mitigation measures are included in the assurances.

(2) Maintenance of the Dams and Water Transfer Facilities

147. Without maintenance, the operational efficiency of the dams and water transfer facilities may decline. For the dams, sedimentation is a particular risk, especially Pingshan Dam, where the settled and degraded landscape contributes to soil runoff. Without maintenance, the dead storage volume of the dams could quickly fill with sediment. To offset this risk: i) sediment traps and check dams will be installed 50 to 100 m upstream of the dam water entry points; ii) slope stabilization measures will be undertaken for all erosion-prone slopes in the reservoir area; and iii) reforestation of the upstream watersheds.

148. Potential siltation rates for the two dams were estimated using erosion data. For Pingqiao Dam, the sedimentation coefficient for suspended sediment is 500 t/km^2. The bed load transport rate is estimated at 30%. The sediment content of incoming water is estimated at 1.3 t/m^3. The sedimentation rate is estimated at 80%. Based on these data, the estimated sedimentation in the dam for the first 50 years will be 2.827 million m^3. For Pingshan Dam, the suspended sediment is estimated at 1.38 kg/m^3 or 32,600 t/a. The bed load transport rate is estimated at 20% or 6,520 t/a. The every annual sedimentation is estimated at 39,100 t/a. For both dams, the siltation for the first 50 years will be well below the dead storage level of 1,290 and 1,642 respectively for Pingqiao Dam and Pingshan Dam. The following measures will be taken to offset reduce the siltation rate: i) sediment traps and check dams will be installed 50 to 100 m upstream of the dam water entry points; ii) slope stabilization measures will be undertaken for all erosion-prone slopes in the reservoir area; and iii) reforestation of the upstream watersheds. The above measures are estimated to reduce sedimentation by 20%~30%, further reducing the risk of reservoir siltation.

(3) Operation of Pingqiao Pump Station

149. One pump station will be built for transmitting water from the Pingqiao Dam to supply water to downstream communities. The pump station will be built at the end of the main canal. Three pump units of 900 kW each, including two operating units and one backup unit, will be installed. The design flow is 0.686 m^3/s, and the design pumping height is 164.14 m. There are no sensitive receptors within 200 m of the pump station. Nonetheless, to reduce noise, the pump station will install low-noise equipment, submerged pumps, and thick walls. Station operators will maintain the equipment in good working condition as part of standard operating procedures. With these measures, noise levels at the boundaries of the facilities were modeled to be 55 dB(A) in the day time and 47 dB(A) at night: these levels comply with Grade II noise standards [60 dB(A) in the day time and 50 dB(A) at night] of *PRC Noise Standards at the Boundary of Industries and Enterprises (GB 12348-2008)*. For Pingshan Dam, gravity flow will be used for water transmission, and no pump stations are required.

(4) Dam Safety Panel

A dam safety assessment was conducted by the FSR design institute and PPTA team, including structural integrity, existing emergency plans, and potential issues with the project designs. The PPTA and DI dam safety experts reviewed safety issues for the two dams and concluded that: (i) engineering designs for both dams meet PRC regulations for safety and operation and maintenance; (ii) designs have been strengthened for climate change adaptation, specifically, by strengthening the structural integrity in case of increased water volumes which may result from extreme climatic conditions; (ii) the project will include a dam safety monitoring program; and (iii) emergency response plans in the preliminary designs are adequate to respond to the risk of dam failure. PRC law and ADB's SPS also requires that for large projects on dams, designs are reviewed by an independent expert panel. The Guizhou PMO established a dam safety panel in July 2016, for design, construction, and operations of the dams. The panel consists of three national engineers, whom are independent from the GPG, ACG, NCG, and design institutes. The panel will review the detailed engineering designs of the two dams (under preparation in 2016, after approval of the project FSRs) and if necessary, will recommend further measures to strengthen dam safety. During the project construction and operation phases, the panel will convene at least twice a year to assess project progress and any issues. The findings of the panel will be included in the semi-annual environment reports to ADB.

(5) Maintaining Minimum Ecological Flows

150. Minimum ecological flows have been allocated for each dam, in accordance with national guidelines. The minimum ecological flow is 0.37 m^3/s for Pingqiao Dam and 0.077 m^3/s for Pingshan Dam. At both dams, a water discharge pipe and gate will be installed at the end of the main canal specifically for the minimum ecological flows. The gate will be controlled by an automated system to ensure adequate release and accuracy. The following measures are also being taken in the project: (i) during project operation, official flow requirements will be complied with and checked as part of the overall dam panel monitoring and assessment; (ii) the cost of annual assessment is included in the EMP (**Table EMP-7**); and (iii) compliance with official flow guidelines is included as a project-specific assurance (**Section X**).

D. Indirect, Induced and Cumulative Impacts

151. 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.[16]

152. **Indirect impacts.** A potential indirect risk is that the hydrology and ecology of river and channel sections downstream of the dams are negatively affected, either due to the new project facilities, and/or changes in flow regimes which occur after the project. Reduced seasonal water allocation might create risks for downstream environment-related livelihoods e.g. seasonal water requirements for agriculture. For the wet season, the flow regulation by the dams will reduce the risk of flooding and provide a more steady supply of water for residential and agriculture uses. For the dry season, the flow regulation will increase the downstream flow and hence water

[16] ADB. 2011. *Sourcebook for Safeguard Requirement 1: Environment.* ADB, Manila.

supply for residential and agricultural users.

153. **Induced impacts.** Two induced impacts might arise from the increase in surface water availability to be achieved by the project. First, the increased availability of water for communities, agriculture and industry may result in increased wastewater production. This is not considered an issue as the existing and planned WWTPs in the two project counties will have adequate capacity to handle the incremental demand. Second, the two dams will make more water available for agricultural expansion. According to the agricultural development strategies of Guizhou Province and the two project counties, the future direction is to develop "circular and ecological agriculture" with the use of local native crop species and ecological farming technologies and practices. This will not promote clean and green rural communities.

154. **Construction-related cumulative impacts.** The two dams are built on head tributaries for which no further damming or other forms of development are planned. Therefore minimal cumulative impacts are anticipated from multiple developments and construction activities in the project areas. The re-vegetation is not expected to result in any adverse cumulative impacts. The sustainable agriculture components are spread over relative areas in the rural setting where industrial and commercial activities are limited. The availability of farmland is also restricted due to the special topographic conditions. Therefore the cumulative impacts during the construction phase are assessed to be insignificant.

155. **Operational-related cumulative impacts.** Both of the proposed dam sites are along relatively small waterways (flow rate of 3.70 m^3/s for the Pingqiao river on which the Pingshan Dam will be built, and 0.77 m^3/s for the Gantian river on which the Pingshan Dam will be built). There are no plans for building other dams in the catchments of these waterways. The dams are situated in remote mountainous areas where industrial development is not foreseen. The irrigation subcomponents are also located in the rural settings where no intensive development activities are anticipated. Therefore operation-related cumulative impacts are assessed not be an issue of concern.

E. Climate Change and Greenhouse Gas (GHG) Emissions

156. **GHG emissions and carbon sink.** For this project, GHG emissions will be generated during construction from the use of energy, including gasoline, diesel and electricity, by construction machinery and vehicles and by consumption of workers, and during operation from use of energy including energy use at pump station and management offices, and by operational equipment and vehicles. Gasoline and diesel will be purchased from local suppliers. Electricity will be supplied through the local power grids. The inundation by the two reservoir impoundments will reduce vegetated area and therefore reduce the carbon storage and sequestration capacity. The total extent of GHG emissions will be partly offset by carbon sequestration from: (i) the sustainable agriculture sub-components, which will use solar energy to replace traditional fuels, improve the soils, and increase the biomass; and (ii) the revegetation sub-components will also serve the same purposes.

157. Under ADB's SPS, projects which may emit $\geq$100,000 t CO_2e per year are identified as a potential environmental concern. Preliminary estimates of the key project GHG emissions and carbon sequestration were undertaken using project data from domestic preliminary design documents, FSRs, EIAs, GPMO and estimates by PPTA consultants (**Table V-14**). In the 5 year construction phase, annual GHG emissions are estimated at 68,289 tCO_{2e}, which is below ADB's threshold of 100,000 tCO_{2e}. Re-vegetation and sustainable farming practices will offset GHG emissions released over the following 10 years of operations, and capture annually around

6,714.18 tCO_{2e}.

Table V-14: Estimates of GHG Emission and Carbon Sequestration by the Project

		Pingqiao	Pingshan	Total	Conversion Factor	GHG Emission (tCO_2e)	Reference for Conversion Factor
	Construction Phase (5 Years)						
a	Gasoline use (ton)	38.22	3.10	41.32	2.990	123.54	(1)
b	Diesel use (ton)	65,000	24,000	89,000	3.160	281,240	(1)
c	Electricity use ('000 kWh)	13,040	3,338.00	16,378.00	0.997	16,328.87	(1)
d	Workers (worker-days)	1,903,980	500,000	2,403,980	0.018	43,752.44	(2)
	Total (t CO2e)					**341,444.85**	
	Annual Average (t CO2e)					**68,288.97**	
	Operation Phase						
e	Gasoline use (t/a)	5.72	5.11	10.84	2.990	32.41	(1)
f	Diesel use (t/a)	5.00	5.57	10.57	3.160	33.40	(1)
g	Electricity use ('000 kWh/a)	317.95	36.07	354.02	0.997	352.96	(1)
h	Workers (worker-days/a)	8,760.00	5,110.00	13,870.00	0.018	249.66	(2)
i	Biomass loss from inundation (ha)	280.07	45.19	325.26	90.667	29,490.24	(3)
j	Solar power production ('000 kWh/a)	-3.90	-3.88	-7.78	0.997	-7.75	(1)
k	Revegetation (ha)	1,599.00	1,028.80	2,627.80	-13.550	-35,606.69	(4)
l	Sustainable farming (ha)	70.60	72.40	143.00	-8.800	-1,258.40	(5)
	Annual Average Net GHG Emission (t CO2e)					**-6,714.18**	
	Total Net Emission for 5 Years of Construction and 1st Year of Operation (t CO2e) (a+b+c+d+e+f+g+h-j)					**342,113.30**	
	Total Net Carbon Sequestration for 5 Years of Construction and 1st Year of Operation (t CO2e) (k+l-i)					**7,374.85**	

1) National Development and Reform Commission Energy Conservation Information Dissemination Center, NDRC-ECIDC.
2) www.carbonneutral.au. Assuming 0.5 kg/d of meat consumption per worker.
3) Carbon storage of the present land use is assumed to be 1/3 of a mature broad-leaf forest at 271 tCO2e/ha. See 4) below.
4) Assumptions: (a) Mature broad-leaf forest carbon storage is assumed to be 271 tCO2e/ha. (He Ying. 2005. Summary of Estimation Methods of the Carbon Stored in Forests. *World Forestry Research*, 18:1 (22-27)); (b) It is further assumed that the planted tree species will mature within 10 years; (c) Matures will double the existing carbon storage of the existing land use.
5) Haitao Liu, Jing Li, Xiao Li, Yanhai Zhen, Sufei Feng and Gaoming Jiang. 2015. Mitigating greenhouse gas emissions through replacement of chemical fertilizer with organic manure in a temperate farmland. Science China Press and Springer-Verlag Berlin Heidelberg.
6) Project data from domestic preliminary design documents, FSRs, EIAs, GPMO and estimates by PPTA consultants.

158. **Climate change risk for project viability: projections, adaptation and monitoring.** A climate risk and vulnerability assessment (CRVA) was conducted, assuming a project design life of 50 years. The CRVA found that that project infrastructure and the planned activities are at high risk of adverse climate change impacts. For Output 1, projected increases in temperatures[17], increased variability in precipitation relative to the historical baseline, and increasing flood and drought frequency and storm intensity may (i) reduce availability of water for the dams, due to reduced flows and increased evaporation in the upper watersheds; (ii) increased sedimentation due to increased erosion as a result of precipitation/flooding events; and (iii) mechanical damage to the dams, water transfer facilities, water storage structures, and other associated infrastructures, because of more severe storm or flood events, as well as potential subsidence and landslides. These risks have been taken into account in the river basin modeling and the structural design of the dams. These are designed with the highest safety factors granting structural resistance against a 1/2,000 year flood event (0.05%) for Pingqiao Dam and a 1/1,000 year flood event (0.1%) for Pingshan Dam.[18] In addition, operation and maintenance plans, and emergency response plans, for both dams, are included in the preliminary designs and will be confirmed and incorporated in the detailed designs.

[17] Under the RCP4.5 (medium) emission scenario, the annual average temperature in Nayong County is projected to rise by 0.9°C for 2016~2035 over that of the baseline years 1986~2005, by 1.8°C for 2046~2065 and by 2.7°C for 2081~2100.
[18] Domestic preliminary design reports.

159. For Output 2, projected increases in temperature, evapotranspiration, floods, droughts, and storm intensity and increased variability in precipitation may affect the survival and growth of planted vegetation in the re-vegetation component. This risk is mitigated by the selection of climate (drought and flood) resilient plant species. Activities in Output 2, namely re-vegetation and promotion of sustainable farming, will contribute to increased climate adaptation in the project areas, by preventing soil erosion, as well as by increasing carbon sequestration. The initial estimate of project finance that can be attributed to climate change adaptation and mitigation is $12 million. A more refined estimate will be possible during the detailed design phase.

VI. ALTERNATIVE ANALYSIS

160. Alternative methods and designs were identified and compared against technical, economic, social, and environmental criteria for each project component. The primary objective with respect to environmental criteria was to identify options with the least adverse environmental impacts and maximum environmental benefits. Alternative designs, with respect to dam site, dam type, normal storage level, location of diversion tunnel, type of diversion tunnel, use of pump station vs. elevated storage pond for primary water transmission, secondary water transmission, water transmission pipe materials, sewage treatment, so on and so forth, were identified and analyzed. The following environmental and socio-economic factors were fully considered in the analyses: (i) LAR impact; (ii) minimization of village and community disturbance; (iii) adaptation to local context (climatic constraints, rocky desertification, etc.); and (iv) potential impacts on water, air and land. The alternative analyses were done for all subprojects and components. **Table VI-1** provides, as an example, a summary of the alternative analyses performed for the Pingqiao water resource development and irrigation components.

Table VI-1: Alternative Analyses for Pingqiao Components

	Options	Selection and Analysis
Dam site	Two options: 1) upper site, and 2) lower site. Upper site is 1,000 m upstream of Pingqiao village, and the lower site is 500 m upstream of the Pingqiao village.	Upper site is selected. The lower site is characterized by karst-type leakage at the left side of the dam base, and strong weathering for the entire dam base. The coffer dam has karst cracks and leakage surrounding the dam, dam base and dam shoulders. The amount of works would be far greater for dam base leakage treatment. Leakage control for the lower dam is more complex, greater in investment and higher in risk. The lower site also has the disadvantage of siting the spillway structures, and of excavation due to high slopes.
Dam type	Two options: 1) concrete-face rockfill dam; and 2) rockfill dam with asphalt-concrete core	Concrete-face and rockfill dam is selected. Concrete-face and rockfill dam has the disadvantages of more stringent requirements for rocks and of greater amount of works. But it has lower amount of works, many successful cases in the PRC, and lower technological risk. In comparison, the asphalt-core wall dam is a newer type with fewer cases in the PRC. There is therefore a technological risk. When the quality of rocks is good and the availability is adequate, the concrete-face and rockfill type is preferred. Moreover, the concrete-face and rockfill type has a lower cost, with a saving of CNY 40.09 million.
Normal storage level	Three options: 1) 1,324 m; 2) 1,326 m; and 3) 1,328 m	Option 2 is selected. The corresponding storage capacity is 65.70 million, 71.41 million and 77.55 million m^3. The respective annual water supply is 84.49 million, 87.36 million and 88.96 million m^3. Inundated farmland is 4,812 mu, 5,024 mu and 5,264 mu. Affected population: 2,408, 2,408 and 2,531. Incremental unit-water investment: CNY 5.08 / m^3 between option 1 and option 2, and CNY 12.39 / m^3. Annual incremental operating cost: CNY 0.14 million between option 1 and 2, and CNY 0.16 million between option 2 and 3. Incremental FIRR: 18.0% between option 1 and 2, and 3.1% between option 2 and 3. In comparison, option 2 has lower number of APs per unit of water supply, lower incremental unit investment, lower incremental unit operating cost and higher incremental FIRR

Location of diversion tunnel	Two options: 1) left bank; and 2) right bank	Left bank is selected. The right bank has many gullies at the dam base. Moreover, the tunnel route has heavily weathered layers which are poor for tunnel construction and require heavy lining. There is safety risk for tunnel construction and operation. It is 592.55 m longer. In comparison, the left bank has fine-sand stone and limestone. The tunnel goes through lightly weathered rocks, the geological conditions are clear to be good for tunneling. Although the right bank has the advantage of shorter distance for irrigation structures and a saving of CNY 4.23 million from the shorter irrigation distance compared to the left bank, its total cost is CNY 2.41 million higher than the left bank, plus construction and operational safety concerns.
Type of diversion tunnel	Two options: 1) pressurized; and 2) non-pressurized	Pressurized tunnel is selected. Non-pressurized tunnel may cause higher vibration of the gates and affect the gates' life and the stability of the vertical well structures. It may also have a higher level of dead water level and thus a smaller usable storage capacity. Investment is also CNY 0.21 million higher.
Water transmission---pump station vs. elevated storage pond	Two options: 1) front-end pump station; 2) elevated water storage pond	Elevated water storage pond is selected. The elevated storage pond has the disadvantages of greater water loss in transfer, greater land occupation and longer construction period. It however has many relative advantages, including use of existing construction roads, gravity-flow pipes, low pipe costs and low O&M costs, low repair costs, etc.
Water transmission----pipeline vs. canal	Two options: 1) single pipeline; and 2) pipeline combined with canal	Single pipeline has the advantage of smaller water loss and interruptions. But a 30-km, 1.2-m diameter pipeline would increase the cost substantially. While the main transmission sections would still use pipelines, the remaining transmission sections could use covered canals that would ensure safety, reliability and sanitation, and meanwhile save construction and O&M cost considerably.
Material for water transmission pipes	Three options: 1) steel pipe; 2) ductile iron pipe; and 3) glass-sand pipe	The left main transmission pipe has irrigation as its main function. It design emphasizes low-cost, reliable performance, convenient construction, operational safety, corrosion resistance, long life and low maintenance cost, which fit the profile of the glass-sand pipe. The right main pipe, reverse siphon and the outlet of the pump station will bear high water head and pressure and therefore fit the profile of ductile iron pipe. Steel pipe is relatively expensive.
Sewage treatment	Two options: 1) septic field; 2) modular treatment units	The option of modular treatment units is selected. The workers' camp at the main dam site is estimated to generate about 100 m^3/d of sewage during peak construction period. One option is to construct a septic field, which is of low cost, but of high risk of overflow during rain storms and downstream water pollution. Modular treatment units are of high initial investment, but more reliable and lower risk of secondary pollution. They are proposed for reuse for the reservoir management station, which will bring about considerable savings.

VII. PUBLIC CONSULTATION, PARTICIPATION AND INFORMATION DISCLOSURE

161. 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 an EIA 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.

162. 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.

163. The sections below describe the public consultations for the environmental assessments for subprojects, undertaken between March and July 2011 (Anlong county) and April 2013 and October 2014 (Nayong county). 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 representatives of the affected public and other concerned stakeholders, including a questionnaire survey after the meeting.

164. A social and poverty analysis was conducted by the PPTA team based on group discussions with key agencies, beneficiaries, and adversely affected communities, with emphasis on poverty villages and potential gender issues. 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

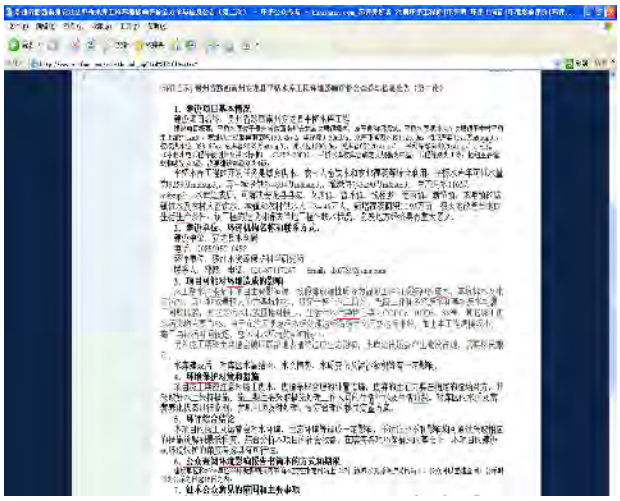
165. Two rounds of information disclosure about the project were conducted by the EIA institutes in each project county. Information was distributed through local government websites and public notice boards in 11 villages and seven towns in the project areas (**Table VII-1, Figure VII-1**).

166. The first round was carried out during early DEIA preparation, and comprised: (i) description of project components; (ii) site locations; (iii) proposed construction measures; (iv) environmental impact assessment procedures; (v) avenues for public feedback; (vi) contact details of the PMO, IAs, EIA Institute and local EPBs; and (vii) procedures and scope of the DEIAs. People from areas where potential impacts might occur were consulted, as well as the appropriate representatives of age, gender, poverty, and occupations. The second round was undertaken after preparation of the FSRs and DEIAs to seek public feedback on the findings, including potential impacts and mitigation measures, and included consultations with communities and businesses in and near project sites. Summary versions of the draft DEIAs were posted online (**Table VII-1**) which included the proposed construction, potential impacts, mitigation measures, and procedures for public requests for the full report.

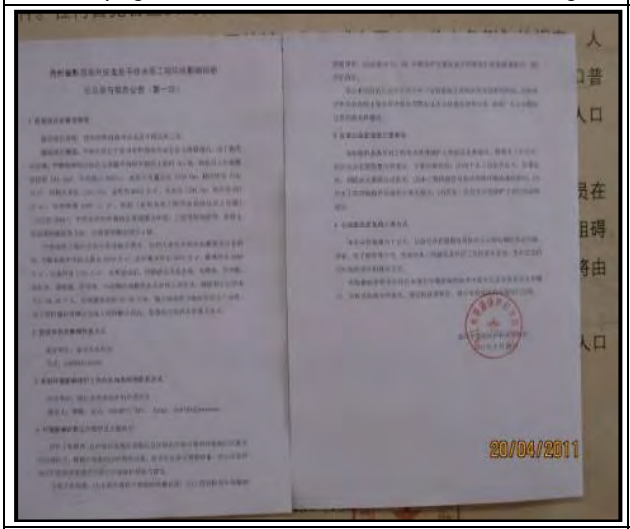
Table VII-1: Summary of Information Disclosure

Component	1st Information Disclosure		2nd Information Disclosure	
	Date	Media Posted	Date	Media Posted
Anlong County	March 2011	Notice boards in 7 towns and 11 villages. Anlong Government website: http://www.gzal.gov.cn/	29 June–12 July 2011	Anlong Government website: http://www.eiafans.com/viewthread.php?tid=212181&extra=
Nayong County	23 April–3 May 2013	Notice boards in 7 towns, 15 villages; Nayong Government website: www.gznayeng.gov.cn	10 Oct. 2014	On bulletin boards in 11 villages

Webpage of 1st Information Disclosure for Anlong



Webpage of 2nd Information Disclosure for Anlong



1st information disclosure – public notices (Anlong sample)

Webpage of Information Disclosure for Nayong

Figure VII-1: Project Information Disclosed on the Websites

167. Future information disclosure. Further disclosure will be as follows:

i) Copies of the DEIAs in Chinese are available for review at the Guizhou Province Environment Protection Department (EPD) and Environment Protection Bureaus

(EPBs) of Anlong and Nayong counties.

ii) This draft project EIA was disclosed on the ADB public website (www.adb.org) on xxx 2016, for 120 days before ADB Board consideration of the loan.

iii) Environment progress and monitoring reports will be prepared on a semi-annual basis and will be disclosed on the ADB public website.

B. Public Consultation

168. Public consultations for the project were conducted in Anlong and Nayong counties between March 2011 and October 2014. The consultation scope comprised villages located within the upper catchment of the tributaries of each dam site and, in the downstream irrigation area, in and near the construction areas. The consultations consisted of villagers/residents from seven villages (three in Anlong and four in Nayong) and 43 government agencies (14 in Anlong and 29 in Nayong). In total for the two project counties, 315 questionnaires (190 and 125 in Anlong and Nayong counties respectively) were distributed by the EIA Institutes to residents, and all (100%) were completed. Respondents were from a range of educational backgrounds, occupations and gender (**Table VII-2**). Survey results are described in **Table VII-3** for Anlong County and **Table VII-4** for Nayong County.

Table VII-2: Respondents of Questionnaire Survey

Information of Consulted APs		Anlong		Nayong	
		# Resp. (total 190)	%	# Resp. (total 125)	%
Gender	Male	179	94.2	102	81.6
	Female	11	5.8	23	18.4
	Not filled	0	0	0	0
Education	Primary school	67	35.3	44	35.2
	Junior high school	81	42.6	36	28.8
	High school	18	9.5	8	6.4
	College and above	24	12.6	17	13.6
	Not filled	0	0	20	16.0
Occupation	Worker	1	0.5	27	21.6
	Peasant	170	89.5	73	58.4
	Civil servant	19	10.0	25	20.0
	Not filled	0	x	0	0
Resettlement	In a household to be resettled?	106	55.8	Yes-71 No-54	Yes-56.8% No-43.2%

Table VII-3: Results of Public Questionnaire Survey – Anlong County

No.	Content	Opinion	# people (N=190)	% of total	# agencies (N=14)	% of total
1	Can the project construction bring more local employment opportunities and income?	Yes	185	97.37	14	100
		No	5	2.63	0	0
2	How will project construction impact local socio-economic conditions?	Promote socio-economic development	190	100	10	71.4
		No directly related	0	0	4	28.6
3	Will the project improve the living conditions of local residents after	Very good improvement	175	92.11	12	85.7
		A little improvement	15	7.89	2	14.3

No.	Content	Opinion	# people (N=190)	% of total	# agencies (N=14)	% of total
	completion?	No improvement	0	0	0	0
4	What is the biggest environmental problem of the project location area?	Water pollution	23	12.11	3	21.4
		Air pollution	10	5.26	2	14.3
		Noise pollution	5	2.63	0	0
		Severely water and soil loss	158	83.16	8	57.1
		Other	6	3.16	1	7.1
5	Which may be the largest impact area of project?	Construction area	163	85.79	11	78.6
		Upstream reach	30	15.79	1	7.1
		Downstream reach	11	5.79	2	14.3
		Other areas	5	2.63	0	0
6	What do you think of the project impact on local water use?	Basic without impact	125	65.79	14	100
		Smaller	8	4.21	0	0
		Larger	58	30.53	0	0
7	Will the project have an adverse impact on the environment?	Excavation and blasting on vegetation and ecology	30	15.79	6	42.9
		Increasing soil and water loss	22	11.58	3	21.4
		Resettlement problems from inundate and land occupation	78	41.05	0	0
		Water, air and sound impact during construction	3	1.58	2	14.3
		Without impact	87	45.79	?	?
8	What impact will the project have on the general trend for the environment and economy?	Some environmental impacts; promote economic development	54	28.42	7	50
		Environmental impacts; little economic benefits	9	4.74	0	0
		Improve the environment and economic development	158	83.16	7	50
9	Do you support project construction?	Approve	170	89.47	14	100
		Conditional approval	0	0	0	0
		Undecided	20	10.53	0	0
		Disapprove	0	0	0	0

Table VII-4: Results of Public Questionnaire Survey – Nayong County

Question \ Investigation and statistics		# people (N=125)	% of total	# agencies (N=29)	% of total
Are you approval the construction of the project?	Approval	125	100	29	100
	Whatever	0	0.0	0	0
	Disapproval	0	0.0	0	0
Which do you think of the benefits of the project for local:	Development of economic	8	6.4	2	6.9
	Address the water shortage issues of county town	10	8.0	0	0
	Address irrigation and people and livestock water shortage problem in irrigation area	107	85.6	27	93.1
Which environmental factors may restrict this project?	Inundation loss, land occupation	8	6.4	1	3.4
	Resettlement	113	90.4	26	89.7
	Destroy the ecological	4	3.2	2	6.9
What do you think of the environment quality situation in the project area:	Good	50	40.0	19	65.5
	Fair	69	55.2	10	34.5
	Bad	6	4.8	0	0
Which do think is the main environmental problem during construction period?	Water pollution	2	1.6	8	27.6
	Air pollution	3	2.4	1	3.4
	Noise pollution	90	72.0	9	31.0
	Solid waste pollution	10	8.0	4	13.8
	Ecological destruction	20	16.0	7	24.1
Which is the main environmental	Water pollution	4	3.2	2	6.9

impact during the operation period?	Air pollution	3	2.4	1	3.4
	Noise pollution	18	14.4	2	6.9
	Solid waste pollution	10	8.0	2	6.9
	Ecological destruction	90	72.0	22	75.9
Which resettlement program is more acceptable for the local mass?	Adjust cultivated land on the spot	4	3.2	2	6.9
	Relocation	25	20.0	5	17.2
	One-off compensation	96	76.8	22	75.9
Are you agree leaving the present place of residence if you have to remove due to the project affect your house or farmland?	Willing	64	51.2	27	93.1
	Depending on resettlement condition	60	48.0	2	6.9
	Unwillingness	1	0.8	0	0
Are you agreed to compensation and relocation according to state regulations, if the project affects your household or farmland?	Agree	100	80.0	28	96.6
	Whatever	25	20.0	1	3.4
	Disagree	0	0.0	0	0
If you are migrants, what do you like to work on?	Agriculture	3	2.4	0	0
	Work	20	16.0	6	20.7
	Other	102	81.6	23	79.3
If you are migrants, how do you think your living level after relocation	Improving	80	64.0	28	96.6
	Unchanged	45	36.0	1	3.4
	Lowering	0	0.0	0	0
Do you want join in this project?	Yes	90	72.0	28	96.6
	Whatever	35	28.0	1	3.4
	No	0	0.0	0	0
Do you think of the main environmental protection measures operating period should be taken are:	The water environment protection	40	32.0	11	37.9
	Atmospheric environmental protection	1	0.8	0	0
	Acoustic environmental protection	6	4.8	0	0
	Solid waste treatment and disposal	8	6.4	1	3.4
	Ecological environmental Protection	70	56.0	17	58.7
7. What do you think after comprehensive consider the environmental impact?	More good than harm, the environment is feasible.	125	100	29	100
	Good and harm quite, cannot choose.	0	0	0	0
	More harm than good, the environment is infeasible.	0	0	0	0

169. **Results of the public consultation – Pingqiao Dam in Anlong county.** Most or all respondents (90–100%; **Table VII-3**) felt the project will bring more employment opportunities and income for local residents; promote the local economy, and improve local living standards, through improved water supply. For environmental issues, most (81%) respondents felt the key existing issues are limited water supply and soil erosion, and that key construction-related impacts are inundation and land occupation (41%), but that the project will improve the environment and economy (83%). Overall, most (89%) of respondents supported the project (the remainder were undecided) (**Table VII-3**). Feedback by respondents included: (i) the need to ensure a reliable water supply from the dam for downstream communities and agriculture; (ii) minimize vegetation clearance and rehabilitate sites; (iii) compensation and government follow-up support for the residents to be resettled; and, (iv) provision of employment opportunities to residents for dam construction. These considerations were included as mitigation and management measures in the updated FSRs and the DEIAs, through further considerations on ecological and agricultural water flows, construction mitigation measures, design of resettlement plans, and prioritization of local residents for construction jobs.

170. For Anlong county, 14 county government agencies were also consulted, including seven township governments in the project area (county bureaus of development and reform, housing and urban construction, cultural resources, land and resources, agriculture, forestry, hydraulic and hydroelectric engineering immigration office; the town governments of Xingqiao, Getang, Muzan, Punqing, Sayu, and Qianxiang; and, the village committees of Chahe and Longxin). Most

agencies noted the main environmental issue to be limited water supply, and all (100%) supported the project.

171. **Results of the public consultation – Pingshan Dam in Nayong county.** Most public respondents (85%) felt the project will address water shortage issues and all (100%) supported the project (**Table VII-4**). For environmental issues, most (72%) felt that key construction-related issues are noise disturbance and 72% felt the main operational issue for the environment will be ecological damage. Feedback by respondents included the need to ensure a reliable water supply from the dam for downstream communities and agriculture, and operational management to minimize environmental disturbance. These considerations were included as mitigation and management measures in the updated FSRs and the DEIAs, for water environment protection, and solid waste treatment and disposal.

172. A total of 29 county government agencies were also consulted, including eight township governments in the project area and local bureaus. Most (93%) agencies noted the main environmental issue to be limited water supply, and all (100%) supported the project (**Table VII-4**).

C. Future Consultation

173. Dialogue will be maintained with project communities throughout implementation. Future consultation will be undertaken by the PMO, PIU Environment and Social Officers, and implementing agencies, via questionnaire surveys, household visits, workshops, and public hearings during construction.

VIII. GRIEVANCE REDRESS MECHANISM (GRM)

174. 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.

175. Public grievances to be addressed by the GRM might include issues related to interruption of water supply, disturbance of agricultural activities, dust emissions, construction and traffic noise, soil erosion, inappropriate disposal of construction wastes, safety measures for the protection of the general public and construction workers, and/or water quality deterioration. Grievances related to resettlement from the inundation zones 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.

176. Currently in Guizhou 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.

177. The project 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.

178. The GRM will be accessible to diverse members of the villages and community, including more vulnerable groups such as women, minority and poor. Multiple points of entry, including face-to-face meetings, written complaints, telephone conversations, or e-mail, will be available.

179. The details of the GRM, including a time-bound flow chart of procedures, are included in the project EMP (**Attachment 1** of this EIA).

IX. ENVIRONMENTAL MANAGEMENT PLAN

180. A project environmental management plan (EMP) has been prepared (**Attachment 1**). Development of the EMP drew on the domestic environmental impact assessments, discussions with the PMO, PIUs and IAs, Guizhou EPD, local 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.

X. PROJECT ASSURANCES

181. All ADB-funded projects are required to comply with a standard set of loan assurances for environmental safeguards, which focus on compliance with national laws and the project EMP. In addition, the following project-specific assurances are included in the project agreement between the GPG and ADB.

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

(ii) **Re-vegetation.** GPG shall ensure that all planting activities under the project shall only use species which are: (a) native to Anlong and Nayong counties; and (b) sourced from local stock within Anlong and/or Nayong counties (to ensure local genetic provenance). This includes the project re-vegetation components, landscaping, and rehabilitation of construction sites. 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. The only exception to this assurance shall be under Output 2.1, for the project re-vegetation sub-components on lower slopes, which will use fruit trees (for community benefit). No plant species listed on the "PRC Database of Invasive Alien Species" (http://www.chinaias.cn) shall be used for any project activities.

(iii) GPG shall ensure that the re-vegetation activities under Output 2.1 of the project, including fruit trees on lower slopes and native species on upper slopes, will be subject to operation and maintenance procedures after planting, to ensure the planted vegetation is adequately protected and maintained.

(iv) GPG shall ensure that to avoid pollution of the Pingqiao and Pingshan reservoir waters, and streams within the re-vegetation sites, no pesticides and no top dressing fertilizers shall be used for any of the re-vegetation, planting, or landscaping activities under the project.

(v) **Reservoir protection zones and protection of reservoir water quality.** Under PRC law, water source dams are required to have clearly designated and managed protection zones. These have not yet been established for Pingqiao and Pingshan Dams. Elsewhere in the PRC, protection regulations for such zones are frequently not complied with. GPG shall ensure that: (a) reservoir protection zones and management regulations are designed for Pingqiao and Pingshan Dams, in compliance with relevant PRC laws,

before operation of the dams; (b) maps displaying the zones are completed, officially approved, and copies provided to ADB; (c) field markers, public notices, and/or other relevant facilities are installed to clearly demarcate the zones, before operation of the dams; (d) regulations for each protection zone are strictly complied with; (e) any activities in the dam catchment area which pose a pollution risk to the water quality of the dams are strictly prohibited; and (f) any residents or livelihood activities located in the future protection zones will be identified, and affected persons will be adequately compensated for any economic or livelihood losses that may result from the zones.

(vi) GPG shall ensure that the pig farm(s) located upstream of the Pingshan Dam site shall be subject to regular monitoring, by the project external monitoring agency, to ensure compliance with government conditions for operation. The monitoring shall include (a) checking for compliance with environmental safeguard conditions; and (b) water quality sampling, at the farms, and along the waterways between the farms and dam. The monitoring results shall be included in the semi-annual environment progress reports from PMO to ADB.

(vii) **Ecological flows.** During project operation, official ecological flow requirements for Pingqiao and Pingshan Dams will be complied with, especially in the dry season.

(viii) **Dam safety panel.** GPG shall ensure that the dam safety panel established for the project shall convene at least once a year, up to and including at least the first year of operation for each dam, Pingqiao and Pingshan. The panel shall include at least one member from the Guizhou Climate Change Center. The panel shall provide the PMO with at least one annual report each year, which shall include a review with recommendations on the progress of construction and/or operation of the Pingqiao and Pingshan Dams, and identification of any issues, such as preparation and/or revision of the dam operation and maintenance plans, emergency and safety procedures, review of training plans for the dam staff, and/or lessons learned during initial dam operation.

(ix) **Associated facilities.** Associated facilities which contribute to the project viability include four planned water treatment plants, which will be constructed separately by the GPG. GPG shall ensure that: (a) associated facilities will be operational at the same time as, or before, completion of the project facilities, to ensure the timely and effective operation of all structures; and (b) should any changes be made to these facilities which might impact their capacity or functioning, and subsequently the project viability, GPG and ADB shall jointly review and identify follow-up actions.

(x) **Management of wastewater.** The project will result in improved drinking water supply to residents in Anlong and Nayong counties. This may result in increased volumes of wastewater being generated. GPG shall ensure the wastewater generated as a consequence of improved water supply shall be treated by suitable urban and rural wastewater treatment facilities before subsequent discharge into rivers downstream of the Pingqiao and Pingshan Dams.

(xi) **Land conversion.** Some project activities may require the re-zoning of public lands, including (a) delineation of the reservoir protection zones, and (b) conversion of “waste land” to “agricultural land”. GPG shall ensure that prior to any land re-zoning: (a) the existing land use, zoning, and specific area to be converted, is described; (b) official zoning approval is obtained; (c) the documentary evidence is included in the social progress reports from PMO to ADB.

XI. CONCLUSION

182. The project will generate a series of benefits, including improved water supply for domestic and irrigation uses, demonstration of rocky desertification control, and sustainable agriculture. First, the project will supply 89 million m^3/a of safe and reliable water for a beneficiary population of 362,920 in 118,385 households by 2025, and for irrigating 11,020 ha of farmland. By improving the controllability of dam releases, the two dams will also provide more water for agriculture and household use for downstream users in the dry season. The re-vegetation component, as a rocky desertification control pilot program, will reduce rocky desertified areas in the two project counties. Overall, the project will benefit 362,920 people in the direct project areas, of which 42.0% are women, 52.0% ethnic minorities and 20.7% under the poverty line, and over 1.49 million people in the indirect project areas, of which 44.9% are women, 50.3% ethnic minorities and 12.8% under the poverty line.

183. Innovative features are built into the project designs. First, rocky desertification control will be piloted through re-vegetation combined with poverty reduction and eco-compensation. Re-vegetation of the rocky desertification areas will use fruit trees of local species that will not only reduce rocky desertification but also generate income for local farmers. Eco-compensation will be provided to local farmers to retire rocky desertification-prone farmland to fruit forests, therefore reducing the rate of rocky desertification. If successful, this pilot program can be replicated in other parts of the two project counties, other parts of Guizhou Province where 19% of the provincial area and 25% of the total rocky desertification area in the PRC, and other south-western provinces in the PRC. Second, sustainable farming practices will be demonstrated in the two project counties, with the potential for replication nation-wide, through the adoption of high efficiency solar pump, efficient water transfer and irrigation saving technologies, and an integrated “fertigation” (fertilization and irrigation) system. Finally, the project support the formation of water users associations that will solve water use conflicts that are presently common in the project areas.

184. Key construction-related potential impacts are from the proposed construction of two dams and irrigation facilities. Dam and pipeline construction will require excavation, removal of vegetation, transport of borrows, transport and disposal of spoils, and preparation and transport of construction materials. They may cause soil erosion, sediments, dust, vibration and noise to local waterways and communities. Construction camps and machinery and equipment maintenance and repair shops will also produce wastewater and solid wastes. Dam and water pipeline construction will physically alter topography and habitats at the dam site and the impoundment area, and may result in loss of breeding habitat for fish and aquatic invertebrates. Inappropriate transport and disposal may damage roads along transport routes and cause leakage at spoil sites. Other construction risks include interference with traffic and municipal services during pipeline construction across roads and bridges, permanent and temporary acquisition of land, involuntary resettlement, and occupational and community health and safety.

185. Mitigation measures for construction risks have been developed to minimize water and air pollution, noise and vibration, solid waste, soil erosion, ecological impacts, GHG emissions and climate change risks, land acquisition and resettlement, occupational health effects and community disturbance during the construction phase. No critical habitats and rare, endangered or protected wildlife species, or officially listed physical cultural resources, are known in the project areas, except for four bird species under national-level-II protection. An in-depth analysis is undertaken of the potential effect of construction on the four bird species under national-level II protection. The Nayong county project area is not part of the critical habitats for the birds. Moreover, the loss of habitat for the protected bird species ranges from a high of 0.00025% to a

low of 0.0000015%. With the implementation of the mitigation measures contained in the EMP, the impact on the bird species is assessed to be negligible. Public consultations were undertaken during the domestic preparation process and the PPTA. The comments received were used to improve project design and formulate the EMP. A GRM has been developed. An environmental monitoring program has been developed as part of the EMP. Institutional roles and responsibilities have been outlined and a comprehensive training program has been prepared to strengthen the capacities of local partners in implementing the EMP. The costs for EMP implementation have been incorporated into the overall project investment plan. With the implementation of the recommended mitigation measures, the residual impacts are assessed to be temporary, non-irreversible and insignificant.

186. Key operational risks are altered hydrology and ecology within and downstream of the reservoir area due to impoundment, and possible non-point source pollution from irrigation. The formation and operation of the dams will alter the hydrology and ecology within and downstream of the dams. To minimize these risks, the following measures are included in the project design and operation: (i) an ecological flow, equivalent to 10% of the average yearly flow, will be continuously released to maintain the functioning of downstream ecosystems; (ii) Pingqiao Dam is designed to withstand one-in-a-thousand year flood, and Pingshan Dam a one-in-two thousand year flood. A regular maintenance and repair program will be implemented during dam operations. An automated dam safety monitoring system will be installed in each of the two dams; (iii) an independent dam safety panel has been established to review the detailed designs for the dams and convene on a regular basis, once the dams become operational, to review the monitoring results and recommend mitigation measures if necessary; and (iv) for the sustainable agriculture component, efficient water transfer and water-saving irrigation technologies and integrated “fertigation” system will be adopted to ensure the efficient use of water and fertilizers for minimize the risk of salinization and non-point source pollution.

187. Alternative analyses were done for all subprojects and components. Alternative methods and designs were identified and compared against technical, economic, social, and environmental criteria for each project component. The primary objective with respect to environmental criteria was to identify options with the least adverse environmental impacts and maximum environmental benefits. Alternative designs, with respect to dam site, dam type, normal storage level, location of diversion tunnel, type of diversion tunnel, use of pump station vs. elevated storage pond for primary water transmission, secondary water transmission, water transmission pipe materials, sewage treatment, so on and so forth, were identified and analyzed. The following environmental and socio-economic factors were fully considered in the analyses: (i) LAR impact; (ii) minimization of village and community disturbance; (iii) adaptation to local context (climatic constraints, rocky desertification, etc.); and (iv) potential impacts on water, air and land.

188. Climate risks, induced by declining precipitation and rising temperatures, are mitigated throughout the project scope and infrastructure as follows: (i) establishment of two medium-sized dams to improve water storage, strengthening resilience against drought; (ii) selection of climate-resilient plant species for the project re-vegetation and agriculture components, including fruit and crop species and locally-occurring native species with a wide north-south distribution (i.e. along a wide temperature gradient), to provide resilience against rising temperatures; and (iii) training of farmers, to improve water conservation and efficiency for irrigated and un-irrigated areas. In its first 10 years of operations the project will capture GHG emissions estimated at 6,714 tCO_{2e}/year.

189. The largest project components are the construction of two medium-sized dams,

Pingqiao and Pingshan. A review of the construction designs and plans for operation and maintenance (O&M) was conducted by the PPTA dam specialist, including structural integrity and safety. The specialist concluded that: (i) the selected dam locations are the optimal location for geological stability; (ii) all engineering designs meet PRC standards including for safety; (iii) probabilities of dam failure for both dams are low (0.1% for Pingqiao Dam or once-in-one-thousand-year flood, and 0.05% for the Pingshan Dam or once in two-thousand-year flood); and (iv) both dams have well-established emergency response plans. PRC law and ADB's SPS also require that project designs are reviewed by an independent dam expert panel. A panel of three national dam safety experts was convened by the GPG in July 2016. During the project construction and operation phases, the panel will convene at least once a year to assess project progress and any issues. The findings of the panel will be included in the semi-annual environment reports to ADB.

190. Multiple development and construction activities are being planned in the project counties, and construction of some of the projects may coincide with the construction of this project. As and when these other projects begin, and should they overlap closely with the current project, a series of mitigation measures will be implemented to minimize the risk to insignificant level. Two induced impacts might arise from the increase in surface water availability to be achieved by the project. First, the increased availability of water for communities, agriculture and industry may result in increased wastewater production, which can be handled by the existing and planned WWTPs in the two project counties. There are no plans for other dam construction along the two project waterways, as they are relatively small streams (3.70 m^3/s for the Pingqiao river on which the Pingshan Dam will be built, and 0.77 m^3/s for the Gantian river on which the Pingshan Dam will be built). The water supply from the two dams will satisfy the water demand for the residential and agricultural needs for the next few years (up to 2020). Overall, the risk of indirect, induced and cumulative impacts of dam construction is assessed to be low.

191. Two rounds of public consultation were conducted in the project counties, with residents and government agencies. Public feedback comprised support for the project for improving water security, and included concern over potential construction disturbance, resettlement from the dam inundation zones, and the need to ensure water supply for downstream residents and agriculture. Measures to address these concerns have been incorporated in the project design and mitigation measures (EMP; Attachment 1). Public consultation will continue during project construction and operation for early resolution of any grievances. A grievance redress mechanism (GRM) has been developed to address environmental, health, safety, and social concerns associated with the project.

192. Measures to avoid, minimize, and mitigate potential project impacts have been consolidated into an environmental management plan (EMP; **Attachment 1**). The EMP is the key document to manage, monitor and report on environmental impacts of the project. Meaningful public consultation was 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-specific grievance redress mechanism (GRM) has been developed, and will be implemented at the provincial, county, and site levels.

193. In conclusion, based on the information presented in this EIA, and assuming full and effective implementation of the Project EMP (**Attachment 1**), loan assurances, and training, potential adverse environmental impacts are expected to be minimized and/or mitigated to acceptable levels and to within the standards applied in this EIA.

ATTACHMENT 1 - ENVIRONMENTAL MANAGEMENT PLAN

ENVIRONMENT MANAGEMENT PLAN FOR THE GUIZHOU HIGH EFFICIENCY WATER UTILIZATION DEMONSTRATION IN ROCKY DESERTIFICATION AREA PROJECT

People's Republic of China

Prepared by the Guizhou Provincial Government for the Asian Development Bank

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A. Objectives

1. This Environmental Management Plan (EMP) is for the Guizhou High-Efficiency Water Utilization Demonstration in Rocky Desertification Area Project. The EMP is to be implemented in all phases of the project – design, pre-construction, construction, and operation. The EMP is to ensure project compliance with People's Republic of China (PRC) environmental laws and Asian Development Bank (ADB)'s Safeguard Policy Statement (SPS 2009). 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.

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 Guizhou Project Management Office (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 county 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 domestic Environmental Impact Assessments (DEIAs), and project Environmental Impact Assessment (EIA) including updated EMP for compliance.

B. Organizations and Their Responsibilities for EMP Implementation

4. The Guizhou Provincial Government (GPG) will be the executing agency. A project leading group has been established in the GPG. The project leading group is headed by Director General of Guizhou Provincial Water Resources Department (GPWRD) and consists of representatives from relevant GPG agencies, including Guizhou Provincial Development and Reform Commission (GPDRC), (Guizhou Provincial Finance Department (GPFD), GPWRD, Guizhou Provincial Agriculture Committee, and Guizhou Provincial Forestry Department. The PMO has been established under the project leading group in the GPG. The PMO staff includes staff of GPWRD, Guizhou Provincial Agriculture Committee, Guizhou Provincial Forestry Department, and Guizhou Water Investment Co. (GWIC). The PMO staff includes one full-time environmental officer, one full-time resettlement officer, and one full-time interpreter. The GWIC is under GPWRD's jurisdiction and 100% GPG-owned company established in 2011 to invest and administer projects in Guizhou Provincial Master Plan for Water Resources Development, Ecological Development, and Rocky Desertification Management (June 2011).

5. Implementing agencies will be the Anlong County Government (ACG) and Nayong County Government (NCG). In each of the ACG and NCG, (i) a county project leading group, which is headed by Vice Governor of the county government and consists of representatives from relevant county government agencies including the County Development and Reform Committee, Finance Bureau, Water Resources Bureau, Agriculture Bureau, and Forestry Bureau, has been established; and (ii) a PIU has been also established under the county project leading group in the county government. In the ACG, the PIU staff includes staff of the County Water Resources Bureau, County Agriculture Bureau, County Forestry Bureau, and Pingqiao Dam Co., Ltd. that is under County Water Resources Bureau's jurisdiction and 100% ACG-owned company. In the NCG, the PIU staff includes staff of the County Water Resources Bureau, County

Agriculture Bureau, County Forestry Bureau, and Pingshan Reservoir Management Office that belongs to the County Water Resources Bureau. Each PIU includes one full-time Environment Officer and one full-time Resettlement and Social Officer.

6. The EMP implementation arrangements and responsibilities of governmental organizations are summarized in **Table EMP-1**.

Table EMP-1: Institutional Responsibilities for EMP Implementation

Phase	Agency	Environmental Responsibilities
Detailed Design	Design institute	• Pending any design changes, update the EMP if needed, in cooperation with EIA institute. Incorporate mitigation measures in engineering detail designs and contracts; Formulate contractual environmental clauses
	PMO	• Recruit loan implementation consultants, including loan implementation environmental consultant (LIEC)
	PMO, PIUs	• Appoint environment officers
	PIUs	• Engage external environmental monitor
Tendering; Contracting	PMO, PIUs	• Incorporate EMP clauses in RFPs and contracts
Construction	PIUs	• Ensure implementation of mitigation measures, and public consultations • Coordinate Grievance Redress Mechanism • Organize the establishment of water source protection zones
	County WRBs	• Review, approve and supervise the establishment of water source protection zones
	Contractor	• Appoint onsite environmental engineer • Implement all mitigation measures, including those on community and occupational health and safety
	On-site environmental engineer	• Conduct environmental inspection and prepare inspection report
	PMO, County EPB	• Advise and supervise implementation of mitigation measures
	LIEC	• Conduct environmental monitoring and supervision (including public consultations) on behalf of PMO • Prepare semi-annual environmental monitoring report to ADB and EA
	County EMSs	• Conduct compliance monitoring • Conduct ambient monitoring in case of construction related environmental emergency
Test Operation	Licensed environmental institute contracted by PIUs	• Conduct project completion environmental audit, including sampling and lab tests • Prepare project completion environmental audit report
	County EPBs	• Review and approve project completion environmental audit report, and order corrective actions if necessary
Operation	OPFs	• Ensure proper operation of subcomponent facilities according to design standards • Implement mitigation measures and public consultations • Redress grievances
	OPFs	• Conduct and coordinate environmental monitoring and inspections
	County EMSs on behalf of County EPBs	• Conduct regular and unannounced environmental compliance monitoring and inspection of waste transfer station
	County EMSs on behalf of	Conduct ambient monitoring of water, air and noise levels along

Phase	Agency	Environmental Responsibilities
	County EPBs	project roads
	County WRBs	Monitor compliance with water source protection zoning requirements

ACG = Anlong County government, ADB = Asian Development Bank, EMS = environmental monitoring station, EIA = environmental impact assessment, EMP = environmental management plan, EMS = environmental monitoring station, EPB = environmental protection bureau, GEPD = Guizhou provincial environmental protection department, LIC = loan implementation consultancy, LIEC = loan implementation environment consultant, NCG = Nayong County government, OPF = operator of project facilities, PIU = project implementation unit, PMO = (Guizhou) project management office, PPTA = project preparatory technical assistance, PRC = People's Republic of China, RFP = request for proposal, WRB = water resources bureau.

7. **Environment staff within PMO and the implementing agencies.** The PMO will have main EMP coordination responsibility. The PMO has designated two full time PMO environmental officers responsible for EMP implementation. The officers will: (i) coordinate the implementation of mitigation measures during project design, construction, and operation; (ii) ensure that environmental management, monitoring, and mitigation measures are incorporated into bidding documents, construction contracts, and operation management plans; (iii) submit semiannual EMP monitoring and progress reports to ADB; (iv) implement the GRM; and (v) respond to any unforeseen adverse impacts beyond those mentioned in the EMP. The officers will be technically supported by the national individual loan implementation environment consultant (LIEC). At the county level, the PIU of each implementing agency will include one environment officer. This officer will be responsible for daily implementation of the EMP, working closely with the PMO environment officer, and LIEC. TORs for PMO and PIU environment officers are in **Appendix EMP-1**.

8. **Loan implementation environment consultant.** A LIEC will be hired as national individual consultant under the loan implementation consultant services. The LIEC will advise the PMO, PIUs, contractors, and construction supervision companies (CSC) 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) supervise the implementation of the mitigation measures specified in the EMP; (iii) on behalf of the PIUs and PMO, prepare the annual EMP monitoring and progress reports in English and Chinese and submit it to ADB; (iv) provide training to the PMO, local PIUs, and construction supervision companies (CSCs) on the PRC's environmental laws, regulations and policies, ADB's SPS (2009), EMP implementation, and GRM in accordance with the training plan (**Table EMP-5**); (v) identify any environment-related implementation issues, and propose necessary corrective actions; and (vi) undertake site visits for EMP inspection as required. The terms of reference (TOR) for the LIEC can be found in **Appendix EMP-1**.

9. **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. The 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.

10. **Environmental Monitoring Station (EMS)**. The PIUs will appoint the EMS of each

project county to conduct periodic environmental impact monitoring during construction and operation in accordance with the monitoring plan (**Table EMP-4**).

C. Potential Impacts and Mitigation Measures

11. **Tables EMP-2** lists the potential impacts of the project components during project preparation, implementation and operation, and mitigation measures. The mitigation measures will be incorporated into 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-2: Potential Impacts and Mitigation Measures during Pre-construction, Construction, and Operation Phases

Item	Potential impacts / issues	Mitigation measures	Implement	Supervise
A. DESIGN PHASE				
Detailed design stage	Institutional strengthening for EMP Implementation and supervision	• Within at least 60 days of project effectiveness: (i) appoint PMO Environment Officer to coordinate EMP implementation; (ii) appoint at least 1 Environment Officer in each of the two PIUs; (iii) engage LIEC. • The draft terms of reference for these positions are in Appendix 1. • Train PMO and PIU staff for EMP implementation.	PMO, PIUs, LIEC	EA
	Updating EMP	• Update mitigation measures defined in this EMP based on final detailed design. • In the event of any changes to the EMP, submit the updated EMP to ADB for review. • In case of major changes of project location and/or additional physical component, form an EIA team to conduct additional EIA and public consultation. The revised EIA should be submitted to EPD and ADB for approval and disclosure. To determine whether the change is minor or major under assistance of LIEC, PMO and PIUs should consult with ADB.	PMO, LIEC	EPD, LEPBs,
Construction Preparation	Environmental monitoring plan	• Prior to construction, each PIU hires local EMS to conduct environment monitoring in accordance with the monitoring plan defined in this EMP. • Prepare detailed monitoring plan in accordance with the monitoring plan in this EMP.	PIUs, EMSs	PMO
	Bidding and contract documents	• Mitigation measures in the EMP are incorporated in all bidding documents. • Bidding documents are sent to ADB for review. • Prepare environmental contract clauses for contractors.	DIs, PMO, PIUs	LIEC, EPD, LEPBs
	EMP training	• LIEC, or invited environment specialists and/or officials from EPD and EPBs, provide EMP training to contractors and CSCs, in accordance with the training plan in this EMP	LIEC, PMO	EPD
	Establish GRM	• Responsibility for GRM implementation is assigned to the PMO and PIU environmental officers and resettlement and social officers (Appendix 1). • PMO and PIU personnel trained in the GRM and support the environmental and social officers when necessary. • Contact details for the GRM (phone number, fax, address, email) will be provided on the PMO, PIU and/or EPB public websites and information boards at construction sites.	PIUs	PMO, LIEC
B. CONSTRUCTION PHASE				
Soils and earthworks	Earthwork, soil erosion, soil contamination.	• In the tender documents, specify the approved project spoil disposal sites and borrow pit locations. • 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, borrow and spoil sites, 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	Contractor CSCs	PIUs, EPBs, WRBs, LIEC

Item	Potential impacts / issues	Mitigation measures	Implement	Supervise
		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.		
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. • Cover materials during truck transport. • Purchase pre-mixed asphalt for road surface paving; if asphalt is heated and mixed onsite, asphalt mixers must be located ≥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. • Provide high-horsepower equipment with tail gas purifiers.	Contractor CSCs	PIUs, LIEC
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 spots. • 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
Water pollution	Impact of wastewater pollution	• Construction wastewater collected in retention ponds and filter tanks to remove silts and 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 licensed and follow protocol for fuel transfer and PRC 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. • Labor camps will be located ≥500 m from rivers. • 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 (8 Table EMP-4).	Contractor CSCs	PIUs, LIEC

Item	Potential impacts / issues	Mitigation measures	Implement	Supervise
Solid Waste	Solid waste generated by construction activities and from workers' camps	• Provide waste collection and storage containers at locations away from surface water or sensitive receivers. • Solid wastes will be transported to local landfills on a regular basis by the construction contractors. • 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
Socio-economic resources	Impact on physical cultural resources	• If a new site is unearthed during construction, work shall be stopped immediately and Anlong and Nayong cultural relics bureaus (CRBs) and the PIUs promptly notified.	Contractor, CSCs	PIUs, LIEC, cultural relic bureaus
	Temporary interruption to water supply from pipeline 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. damage of a pipeline), immediately inform affected communities and assist with water supply until the issue is resolved.	Contractor, CSCs,	PIUs, county EPBs
	Community health and safety	• Prepare and implement a traffic control plan, for approval by the county traffic management administration before construction. To include scheduling or diverting construction traffic to avoid peak hours, regulating traffic at road crossings, selecting routes to reduce disturbance, reinstating roads, and opening them to traffic when construction is completed; • Plan pipeline construction 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; and • Signs will be placed at construction sites informing people of the project GRM, potential dangers (e.g. moving vehicles, hazardous materials, excavations) 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 bureaus
	Occupational health and safety	• Prepare environmental, health and safety plan, which will include: • Clean and sufficient supply of fresh water for construction sites, camps, offices; • Sufficient latrines and garage receptacles at construction sites and work camps; • Provide safety clothing to workers as necessary (e.g. boots, helmets, gloves, goggles, ear protection) in accordance with health and safety regulations for workers; • Emergency response plan for accidents. 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	Contractors	CSCs, PIUs, LBs, EPBs, LIEC

Item	Potential impacts / issues	Mitigation measures	Implement	Supervise
		degree of publicity to all persons on-site. Display posters prominently; and • Train workers in basic sanitation, health, safety, and work hazards. Implement awareness and prevention program for HIV/AIDS and other diseases – target community and workers.		
C. OPERATION PHASE				
Dam safety	Monitoring	• Implement the automated 24-hr dam safety monitoring system. If signs of fault or failure are discovered, implement a repair program immediately. • Conduct visual inspections on a weekly basis, and prepare weekly dam safety inspection report. • Convene dam safety panel twice a year and review the automated 24-hr dam safety monitoring system report and weekly dam safety inspection reports, and based on the review, the dam safety panel will recommend necessary corrective measures. • Inspect the safety of the check dams and sediment traps on a monthly basis during the raining season (May-October). Repair any faults of the check dams and sediment traps when necessary, and remove sediments if and when the sediment traps are full.	WRBs	IAs, PMO
Dam maintenance and repair	Routine maintenance and repair	• Integrate routine maintenance activities into existing work program of the county WRB teams. • Monthly maintenance (at least in summer) of re-vegetated banks – pruning, weeding and replacement of dead or dying plants. • Inspect for signs of plant disease and/or pests and implement control measures as necessary. • At least once a year in May-June (i.e. before the rainy season) remove solid waste and debris – dispose in municipal landfill. • Prohibit or remove any illegal structures which are found, to maintain free water flow.	WRBs	IAs, PMO
Dams- flow management	Water allocations and ecological flows	• Comply with the ecological flow requirements for Pingqiao river (0.37 m^3/s) (from Pingqiao Dam) and Gantian river (0.077 m^3/s) (from Pingshan Dam). • Control flush spills. • Maintain safe and sustainable dam levels during dry and wet seasons.	Reservoir management authority	IAs, PMO
Noise	From operation of pumping stations	• Maintain acoustic barriers and sound absorbing materials. • Consult nearby residents in first 3 months of operation and assess any noise impacts.	EMSs	EPB
EMP implementation	Insufficient capacity for EMP	• Conduct comprehensive training for EMP implementation.	PMO, LIEC, EMSs, EPD, EPB	PMO

CSC = construction supervision company, EA = executing agency, EPB = environment protection bureau, EMS = Environmental Monitoring Station (of the two project counties), EPD = environment protection department of Guizhou Province, IA = implementing agency, LARP = Land acquisition and resettlement plan, LARO = Land Acquisition and Resettlement Office (in each of the project counties), LIEC = loan implementation environment consultant, PIU = project implementation unit, PMO = project management unit, WRB = water resource bureau.

D. Environmental Monitoring, Inspection and Reporting

12. Three types of project monitoring will be conducted under the EMP: (i) internal monitoring and supervision and reporting by CSCs; (ii) EMP implementation monitoring and progress reporting; and (iii) environmental compliance monitoring by local EMS.

13. The project monitoring program focuses on the environment in the project areas of influence in the two counties (**Table EMP-4**). The program covers the scope of monitoring, monitoring parameters, time and frequency, implementing and supervising agencies, and estimated costs. The monitoring shall comply with the methodology provided in the relevant national environmental monitoring standards. Other associated standards to be followed are the national environmental quality standards of air, surface water, groundwater and noise, and the pollutant discharge standards.

14. **Internal monitoring and supervision and reporting by CSCs.** During construction, the CSCs will be responsible for conducting internal environmental monitoring in accordance with the monitoring plan (**Tables EMP-4**). Supervision results will be reported through the CSC reports to the PIUs.

15. **EMP implementation monitoring 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 LIEC will be reported to ADB through the semiannual 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 LIEC will help PMO prepare the reports and submit the English report to ADB for appraisal and disclosure.

16. **Environmental compliance monitoring by local EMSs.** The PIUs in each county will contract the county EMS to conduct environmental monitoring in accordance with the monitoring program (**Tables EMP-4**). A detailed cost breakdown will be provided by the county 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 PCR is issued. Semiannual monitoring reports will be prepared by the EMSs and submitted to PMO and the PIUs.

17. **Project completion environmental audits.** Upon completion of each subproject, environmental acceptance monitoring and audit reports shall be (i) prepared by a licensed environmental monitoring institute in accordance with the PRC's 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 semiannual EMP monitoring and progress reporting process. These subproject completion reports shall be finalized within 3 months after each subproject completion, or no later than 1 year with permission of the local environment protection bureaus.

18. **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.

iii) QA/QC Manual for Environmental Air Monitoring published by the State Environmental Monitoring Centre in 2001.

Table EMP-3: Environmental Reporting Plan

Report	From	To	Frequency of Reporting
A. Construction Phase			
Internal progress reports	CSCs	PIUs	Monthly
External reports	Local EMSs	PMO, PIUs	Semi-annual
Environmental acceptance monitoring and audit reports	Licensed institute	EPBs, PMO, PIUs	Within three months after component completion
Compliance monitoring with EMP – progress reports	PMO	ADB	Semi-annual (through semi-annual project progress reports)
B. Operation Phase			
EMP progress reports	PMO	ADB	Semi-annual

Table EMP-4: Environmental Monitoring Program

Subject	Parameter	Location	Frequency	Implement	Supervise
1. Pre-construction					
Environmental audit of the Circular-Economic-Ecological Park, including monitoring of the water quality of the Gantian river	i) CODcr, BOD_5, SS, NH_3-N, TN, TP, fecal coliforms; ii) Compliance with conditions for EIA approval by Nayong EPB	(i) Immediately downstream of the Park; and, (ii) 500 m downstream from the Park (i.e. upstream of Pingshan Dam)	Three times before construction (March, April and May 2017)	EMS contracted by PIU	PMO
2. Construction					
Internal monitoring (contractors, CSCs, PIU environmental officer)					
Ambient air quality	Dust mitigation measures in EMP; equipment maintenance	Visual inspection at all construction sites	1 time / week	Contractor, CSC	PMO, PIU, LIEC, EPB
Solid waste	Garbage and construction waste	Visual inspection at all construction sites and work-camps	Daily	Contractor, CSC	PMO, PIU, EPB, sanitation bureau
Wastewater	Provision and operation of domestic and construction wastewater	Visual inspection at all construction sites and work-camps	Daily	Contractor, CSC	PMO, PIU, 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, wetlands	1 time / week; and immediately after heavy rainfall	Contractor, CSC	PMO, PIU, LIEC, WRB
	Re-vegetation of borrow and 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	PMO, PIU
External monitoring (Environment monitoring station)					
Circular-Economic-Ecological	i) CODcr,	(i) Immediately	Twice per	EMS	PIU, PMO

Park, including monitoring of the water quality of the Gantian river	BOD_5, SS, NH_3-N, TN, TP, fecal coliforms ii) Compliance with conditions for EIA approval by Nayong EPB	downstream of the Park; and, (ii) 500 m downstream from the Park (i.e. upstream of Pingshan Dam)	year		
Quality of sewage and discharge channels at work camps	pH, SS, NH3-N, CODCr, BOD5 oil, fecal coliforms	Domestic wastewater discharge at work-camps	4 times /year during construction	EMA	PMO, EPB, PIU
Construction wastewater	SS, oil, pH	at wastewater discharge points of all construction sites	4 times /year during construction	EMA	PMO, EPB, PIU
Surface water quality	pH, SS, NH_3-N, CODCr, oil, As, Cd	200 m upstream and 500 m downstream of the construction site of the two rivers;	2 times / year during construction	EMA	PMO, EPB, PIU
Ambient air quality	TSP, PM_{10}, NOx	All construction sites (at least 1 point upwind, 1 point downwind) and nearby sensitive receivers (Section IV of EIA)	4 times / year during construction	EMA	PMO, EPB, PIU , 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)	EMA	EPB, PIU, LIEC
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, PMO
Soil erosion and re-vegetation	Soil erosion intensity	Visual inspection at borrow and spoil sites and construction sites	Twice a year, and 1 after completion of construction	LIEC	EPB, PIU, PMO
	Re-vegetation of borrow and 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, PMO
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, PMO
3. Operation Phase					
Circular-Economic-Ecological Park, including monitoring of the water quality of the Gantian river	i) CODcr, BOD_5, SS, NH_3-N, TN, TP, fecal coliforms; ii) Compliance with conditions	(i) Immediately downstream of the Park; and, (ii) 500 m downstream from the Park (i.e. upstream of Pingshan Dam)	Twice per year	EMS	PIU, PMO

	for EIA approval by Nayong EPB				
Wastewater discharge from reservoir management station	pH, SS, NH_3-N, oil, CODcr, BOD_5, TN, TP, fecal coliforms	Outlets of septic tanks / wastewater treatment facilities	4 times during the first year of operation	EMS	EPB, reservoir management authorities, GWRIC
Surface water quality	COD, BOD, DO, NH_3-N, TN, TP, SS	Head, center, tail of inflowing and outflowing river(s)	4 times during the first year of operation	EMS	EPB, reservoir management authorities, GWRIC
Noise	LAeq	Nearby sensitive receivers along access roads	4 times during the first year of operation	EMS	EPB, reservoir management authorities, GWRIC
Soil and vegetation	Plant survival and coverage	All re-vegetated sites	Spot check, twice a year	OPF	WRB, reservoir management authorities, GWRIC
Dam safety	Safety monitoring	Dam	Continuous through the automated system	OPF	WRB, reservoir management authorities, GWRIC

BOD_5 = 5-day biochemical oxygen demand; CODcr = chemical oxygen demand; CSC = construction supervision company; EMS = environmental monitoring station; EPB = environmental protection bureau; FB = county forestry bureau, GWRIC = Guizhou Water Resources Investment Co., IA = implementation agency; LAeq = equivalent continuous A-weighted sound pressure level; NH_3-N = ammonia nitrogen; NOx = nitrogen oxides; OPF = operators of project facilities; PIU = project implementation unit, PM_{10} = particles measuring ≤10μm; PMO = Project Management Office; SO_2 = sulfur dioxide; SS = suspended solids; TSP = total suspended particle, WRB = water resources bureau,

E. Training and Capacity Building

19. The two project counties 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) dam safety and climate change; (iii) sustainable agriculture; and (iv) sustainable integrated watershed management. Training will be conducted by the LIEC, Guizhou EPD, Guizhou Agriculture Department and county EPBs. Trainees will include the PMO, IAs, PIUs, contractors, CSCs, county water resource bureaus and county agriculture committees. The PMO will arrange and support the training programs, supported by the loan implementation consultants.

Table EMP-5: Project Environment Training Program

Training program	Scope of Training	Trainer	Trainee	Time	Days	Persons
Procurement and contract management (emphasize EMP implementation)	• ADB procurement guidelines • Bidding document and contract preparation, including EMP clauses • Risk of improper procurement and mitigation measures, and handling variation orders and contract management	LIC	PMO, PIUs, FBs, contractors, CSCs	2	2	50
Implementation of EMP	• Roles, responsibilities, monitoring, inspection, reporting • Environment monitoring program • Public consultation and participation; • GRM – implementation, coordination,	LIC	PMO, PIUs, EPBs, CABs, other local agencies	2	2	50

Training program	Scope of Training	Trainer	Trainee	Time	Days	Persons
	reporting, working with the general public; • Environment, health and safety during project construction and operation for workers and the community; • Prevention and control of transmissible diseases and HIV/AIDS					
Integrated water resources management	• Principles of IWRM; • Surface water management and water conservation; • Point source and non-point source pollution control; • International and national best practices	LIC	PMO, PIUs, EPBs, CABs, other local agencies	1	1	50
Sustainable agriculture	• Ecological farming; • Water saving irrigation; • Integrated pest management	EPD	PIUs, OPFs, WRBs	1	1	50
Dam safety and climate change resilience	• Climate change, risks and vulnerability; • International and national best practices in dam and reservoir operations for dam safety; • Energy saving and GHG emission reduction in water, agriculture and forestry sectors	LIC, Guizhou climate change center	PIUs, OPFs, WRBs, reservoir management authorities	1	1	50
Emergency preparedness and response planning	• Response mechanism e.g. for spills; • Mitigation measures for hydraulic sectors; • Emergency response team, procedure and actions	PIC	PIUs, OPFs, other bureaus	1	1	50
Total				**8**	**8**	**300**

ADB = Asian Development Bank, CAB = civil affairs bureau, EMP = environment management plan, EPB = environment protection bureau, FB = finance bureau, GHG = greenhouse gas, GRM = grievance redress mechanism, LIC = loan implementation consultant, OPF = operator of project facilities, PIU = project implementing unit, PMO = project management office, WRB = water resource bureau.

F. Grievance Redress Mechanism

20. The PMO and PIU environment officers and social officers will be the lead coordinators for GRM implementation. 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.

21. At the PMO level, the PMO environment officer and social officer 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 officers 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).

22. The contact persons for different GRM entry points, such as the PMO and PIU Environmental and Social Officers, contractors, operators of project facilities, 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.

23. 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 working 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 working 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 working 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.

24. 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.

25. 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.

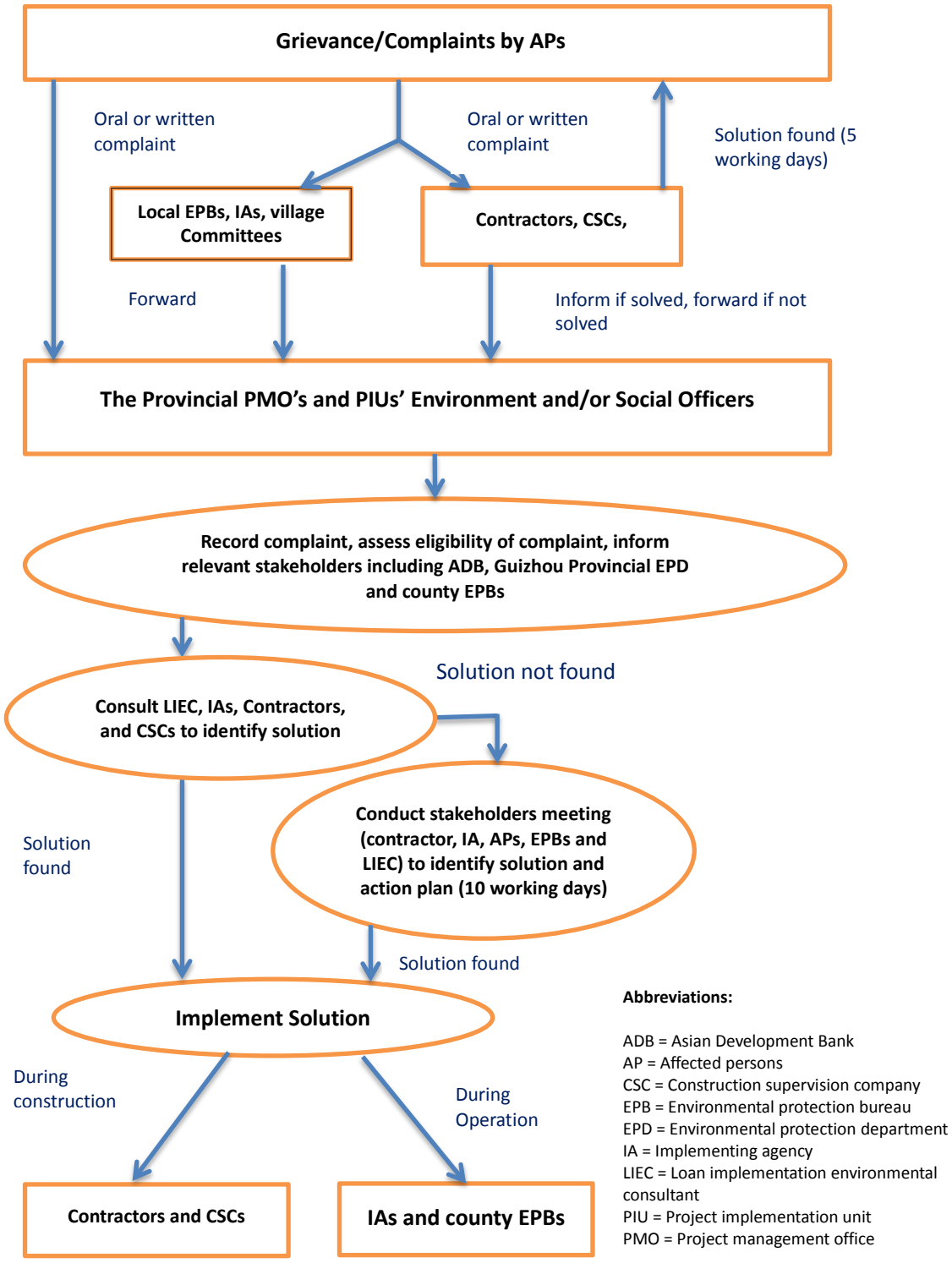

Figure EMP-1: Operation Chart of the GRM

G. Public Consultation and Awareness Raising

26. Two rounds of public consultation were conducted during project preparation (**Section VII 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. A public consultation plan is in **Table EMP-6**, 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-6: 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, PIUs, 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 survey	At least once after one year of operation	Comments and suggestions	Project beneficiaries

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

H. Cost Estimates

27. This section provides an estimate of the cost of EMP implementation. The cost comprises three categories: mitigation measures (**Tables EMP-2**); monitoring (**Table EMP-4**); and training (**Table EMP-5**). 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 five DEIAs and/or the experience of the PPTA team from other projects. All costs were discussed with the EIA Institute, PMO and IAs.

28. The total estimated cost is CNY66.66 million ($9.99 million) for five years of construction phase and the first year of operation, including CNY 32.14 million ($4.82 million) for the Pingqiao subproject and CNY 32.54 million ($5.18 million) for the Pingshan subproject (**Table EMP-7**). All EMP costs are incorporated into the overall project budget.

Table EMP-7. Estimated Cost for EMP Implementation

	Estimated Cost (CNY 10,000)			
	Pingqiao	Pingshan	Total	Funding Source
Construction				
Water pollution control	231.49	123.46	354.95	Contractors
Air pollution control	48.00	83.25	131.25	Contractors
Noise	25.00	20.50	45.50	Contractors
Solid waste management	96.90	28.58	125.48	Contractors
Ecological flow	330.00	30.00	360.00	Contractors
Protection of floral and fauna	34.00	19.30	53.30	Contractors
Water and soil erosion control	695.76	1,794.58	2,490.34	Contractors
Reservoir bottom clearing	104.10	7.39	111.49	Contractors

Workers' and community health and sanitation	87.20	48.27	135.47	Contractors
Establishment of water supply source protection zones	30.00	20.00	50.00	PIUs
Subtotal	***1,682.45***	***2,175.33***	***3,857.78***	
Operation				
Water pollution control (first year)	24.00	12.00	36.00	OPFs
Solid waste management (first year)	7.10	4.00	11.10	OPFs
Ecological flow (first year)	60.00	30.00	90.00	OPFs
Subtotal	***91.10***	***46.00***	***137.10***	
Environmental Monitoring				
Construction phase-environmental monitoring	322.86	52.80	375.66	PIUs
Construction phase-automated dam safety monitoring system	754.28	850.88	1,605.16	Contractors
Operation phase-environmental monitoring (first year)	96.86	73.50	170.36	PIUs
Operation phase-dam safety monitoring (first year)	67.89	76.58	144.46	PIUs
Project completion acceptance environmental audit	40.00	24.00	64.00	PIUs
Subtotal	***1,281.88***	***1,077.76***	***2,359.64***	
Capacity Building and Public Consultations				
LIEC (10 person-months)	25.00	25.00	50.00	ADB Loan
EMP training costs	25.00	25.00	50.00	ADB Loan
GRM	5.00	5.00	10.00	PIUs/PMO
Public consultations	20.00	15.00	35.00	PIUs/PMO
Regional climate change monitoring center	83.38	83.38	166.75	ADB Grant
Subtotal	***158.38***	***153.38***	***311.75***	
TOTAL (CNY)	**3,213.81**	**3,452.46**	**6,666.27**	
TOTAL ($)	**481.83**	**517.61**	**999.44**	

Note: i) For five-year construction phase and first 2-year operation (in CNY 10,000); ii) costs for construction phase are paid for as part of the construction contracts, except for establishment of the water source protection zones; iii) costs for the operation phases and environmental monitoring and audit for the responsibility of the OPFs; iv) LIEC and EMP training costs are paid for as part of the loan implementation consulting services; v) exchange rate, $1 = CNY 6.67.

Source: Preliminary design reports, domestic EIAs, domestic water and soil erosion control plan, and PPTA consultant estimates.

Abbreviations: ADB = Asian Development Bank, CNY = Chinese yuan, EIA = environmental impact assessment, EMP = environmental management plan, GRM = grievance redress mechanism, LIEC = loan implementation environmental consultant, OPF = operator of project facilities, PIU = project implementation unit, PPTA = project preparatory technical assistance.

I. Mechanisms for Feedback and Adjustment

29. 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.

30. 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

1. PMO Environment Officer

A. 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 include 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.

B. 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 (6 years).

C. Qualifications

3. The officer will have: (i) a bachelor's degree or higher in environmental management or related field; (ii) at least 5 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.

D. 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 environmental impact assessment (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, and provincial and municipal agencies for environment protection. This should occur at least 3 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 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 2 months before construction begins, establish and implement the project grievance redress mechanism (GRM) described in the EMP. This will include: (a) preparation of 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) preparation of 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 the implementation agencies 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 the loan implementation environment consultant (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 implementation agencies, 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 semiannual environment progress reports.

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

E. Reporting Requirements

5. Semiannual environment monitoring reports using the template provided by ADB or a domestic format reviewed and approved by ADB.

F. Logistical Support Provided by the 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 semiannual monitoring reports, and final responsibility for submission of the monitoring reports to ADB.

2. Project Implementation Unit Environment Officer

A. Background

6. The project will be coordinated by a PMO. Overall coordination of the project EMP is the responsibility of the PMO environment officer. At the field level, implementation of the

EMP will be undertaken by the project implementation unit (PIU) in each of the two project counties. For this purpose, the PIU requires a PIU environment officer.

B. Scope and Duration of Work

7. 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 (6 years).

C. Qualifications

8. The officer will have: (i) a bachelor's degree or higher in environmental management or related field; (ii) at least 5 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.

D. Detailed Tasks

9. 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, 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 3 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 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 environment officer in all of their tasks.

E. Reporting Requirements

10. Monthly reports to the PIU and PMO environment officer.

3. Loan Implementation Environmental Consultant

A. Background

11. The project will be coordinated by a PMO, whose overall responsibility includes implementation of the project EMP. At the field level, the project will be implemented by a PIU

in each of the two project counties. 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.

B. Scope and Duration of Work

12. This position could be a firm or an individual engaged by the PMO. It is an independent position. It is not part of the PMO in-house environmental team or the implementing agencies. The specialist will report directly to the PMO. The position is for the entire project duration (6 years). The LIEC should be recruited as soon as possible after loan effectiveness, as the first task is to confirm project environmental readiness.

C. Qualifications

13. The specialist will have: (i) a bachelor's degree or higher in environmental management or related field; (ii) at least 8 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.

D. Tasks

14. Working closely with the PMO and PIU environmental officers, the LIEC will do the following.

15. 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 semiannual environmental monitoring reports to ADB (to continue until project completion report).
(iv) Undertake training of project agencies as required by the EMP training plan.
(v) Provide hands-on support and on-the-job training to the PMO, implementing agencies, and contractors on the specific requirements of the EMP as required.

16. During project implementation:

(i) Undertake site visits to all implementing agencies 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 the PMO to prepare semiannual environmental monitoring progress reports for submission to ADB.