Environmental Impact Assessment (DRAFT)

Project number: 51189-001
April 2018

People's Republic of China: Sichuan Ziyang Green Transformation and Development Project

Prepared by the Project Management Office of the Ziyang Municipal Government for the Asian Development Bank

CURRENCY EQUIVALENTS

(as of 19 April 2018)

Currency Unit - yuan (CNY)

CNY1.00 = $0.1594

$1.00 = CNY6.2744

ABBREVIATIONS

ADB	-	Asian Development Bank
CNY	-	Chinese Yuan
CRVA	-	climate risk vulnerability assessment
CS-EMP	-	Construction Site EMP
CSC	-	Construction supervision company
DEIA	-	Domestic Environmental Impact Assessment
EA	-	Executing Agency
EHS	-	Environmental, health and safety
EIA	-	Environment Impact Assessment
EMP	-	Environmental Management Plan
EMS	-	Environmental monitoring station
EPB	-	Environmental Protection Bureau
EPD	-	Environmental protection department
FERM	-	Flood and environmental risk management
FSR	-	Feasibility Study Report
GAP	-	Gender action plan
GDP	-	Gross Domestic Product
GHG	-	Greenhouse Gas
GRM	-	Grievance redress mechanism
IA	-	Implementing Agency
LAR	-	Land Acquisition and Resettlement
LIC	-	Loan implementation consultant
MEP	-	Ministry of Environmental Protection
MSW	-	Municipal Solid Waste
Mu	-	Chinese land unit (1 ha = 15 mu)
NDRC	-	National Development and Reform Commission
OPF	-	Operators of project facility
PIC	-	Project Implementation Consultant
PIU	-	Project Implementation Unit
PMO	-	Project Management Office
PPTA	-	Project Preparatory Technical Assistance
PRC	-	People's Republic of China
REA	-	Rapid environment assessment
SPS	-	Safeguard Policy Statement
SZHTDZ		Sichuan Ziyang High Tech. Development Zone
TOR	-	Terms of Reference
TRTA		Transaction Technical Assistance
TVET		Vocational Education and Training
WSCP	-	Water and soil conservation plan
WSP	-	Water Supply Plant
YREB	-	Yangtze River Economic Belt
ZPMO	-	Ziyang Project Management Office
ZMG	-	Ziyang Municipal Government

WEIGHTS AND MEASURES

^{o}C	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
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
m3/s	cubic meter per second
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 United States dollars.

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PRC (51089): Sichuan Ziyang Green Transformation and Development Project — Government's endorsement of the draft Environmental Impact Assessment and Environmental Management Plan and for upload to the ADB public website

Dear Mr. Fan,

The draft environmental impact assessment (EIA) and environmental management plan (EMP) for the captioned project is currently being reviewed by the Ziyang Municipal Government. This is to advise you that there is no objection to these draft documents being posted on the Asian Development Bank (ADB) public website, following ADB's standard procedures. The Government agrees to implement the final draft EIA and EMP and accepts the coordination and inspection of ADB. In case any public comments are received which affect the content of the EIA and/or EMP, or for any questions the Government has on the draft documents, the Government and ADB will review these together to agree on actions to be taken.

Yours sincerely,

Mr. Wanjun Wang
PMO Director
Director
Ziyang High Technology Development Zone Management Committee
Ziyang Municipal Government

2018. 4. 8

Date:

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I. EXECUTIVE SUMMARY

A. Introduction

1. The Government of the People's Republic of China (the PRC) requested the Asian Development Bank (ADB) to support and strengthen efforts in the environmental protection and rehabilitation, and sustainable social economic development of the Yangtze River. During the country programming mission in 2016, ADB and the PRC agreed to a strategic framework approach with the lending support of $1.8 billion to the Yangtze River Economic Belt (YREB) over 4 years (2017–2020) via a cluster transaction technical assistance (C-TRTA).[1] The YREB is considered as one of the economic growth engines for the future development. The PRC has started focusing on environmental and ecological protection and social inclusiveness as laid out in the YREB development plan.

2. The Ziyang Municipality, a typical small- and medium-sized municipality in the YREB, with a total population of about 3.6 million—of which about 680,000 are urban residents—is in the southeast of Chengdu City, the capital of Sichuan Province; and northwest of Chongqing, one of the PRC's four provincial-level municipalities.[2] The Chengdu–Chongqing Urban Agglomeration in the Yangtze River's upstream area is a major part of the YREB. The Ziyang Municipality is keen to find a smart development approach, making best use of the timing and location to make the municipality both attractive to investors and laborers. ADB is proposing a $200 million loan to the Ziyang Municipality to be used for a development project intended to promote growth that is economically inclusive and environmentally sustainable. The intended project outcome will be improved economic and environmental conditions in the Sichuan Ziyang High Technology Development Zone (SZHTDZ).

3. Based on ADB's Safeguard Policy Statement (SPS, 2009), the project was classified as environmental Category A, requiring the preparation of a project environmental impact assessment (EIA). This project EIA has been prepared in accordance with ADB's SPS requirements and the PRC's related environmental laws, regulations, and standards. It was based on the information and data from the (i) two domestic EIAs (DEIAs) prepared by the China No.2 Railway Engineering Group Co., Ltd.[3] (for the six components of the project output 3) and the Jilin Jilong Environmental Technology Co., Ltd. (for the technical and vocational education and training [TVET] Center), (hereinafter the DEIA institutes); (ii) feasibility study reports (FSRs) of the design institute (DI);[4] (iii) master plans of the Ziyang Municipality and the Sichuan Province; (iv) discussions between the ADB missions, the transaction technical assistance (TRTA) consultants, the SZHTDZ, and the Ziyang Municipal Government (ZMG); and (v) the technical, social, and economic assessments conducted from October 2017 to March 2018 by the TRTA consultants, in cooperation with the DI, the DEIA institutes, and ZMG.

B. Background

4. The PRC experienced an unprecedented economic growth in the past 3 decades, which grew to be the second largest economy in the world and accomplished a significant poverty reduction. The YREB has been earmarked as one of the three key growth engines to ensure the future economic development of the PRC. The Yangtze River is the third longest river in the world, covering more than 2 million square kilometers (km^2) and accounting for one-fifth of the country geographically. Nine provinces and two specially administered cities make

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[1] ADB. 2017. *Framework for the Assistance from the Asian Development Bank for Ecological Conservation and Green Development in the Yangtze River Economic Belt*. Manila.

[2] Beijing, Shanghai, and Tianjin are the other three direct-controlled municipalities.

[3] With the national Grade A EIA study certificate.

[4] The FSR of output 3 components was prepared by the China No.2 Railway Engineering Group Co., Ltd.; and the FSR of the TVET center was drafted by the Guangzhou Kecheng Construction Design Institute.

up the YREB that generates 45% of the total gross domestic product (GDP) of the PRC.

5. Even though the YREB has benefited from extensive development over the last 30 years, the current economic growth is considered below its potential capacity due to (i) limited overall institutional coordination for strategic planning; (ii) significant regional disparity between the highly developed eastern reaches of the YREB and the sub-regions of the central and western reaches; and (iii) increasing environmental pollution and pressure on natural resources.

6. The Ziyang Municipality, an important member of the Chengdu Economic Zone city cluster and the Chengdu–Chongqing city cluster, is in the upper reaches of the Yangtze River; and traditionally an agriculture-based municipality. Like most of the cities in the region, the industrial development of the municipality experienced two stages. The first stage is from 1992 to 2009 that was extensive type of growth with little care about environmental protection. During that time, the municipality expanded towards northeast; and the industry related to the domestic automobile was the most typical industrial type. The second stage is from 2010 to 2018, and the municipality has been trying to transform its industrial structure to a more environment-friendly and sustainable one. The new green industrial park is planned toward the south of the municipality. Currently, the Ziyang Municipality faces the challenges of environmental reparation from previous stages of industrial and urban development; while finding a green and smart approach to develop an enabling environment that will attract investors, businesses, and laborers to move and stay in the municipality.

C. Project Components

7. The project is aligned with the following impact: sustainable economic growth and environmental improvement in the YREB achieved, as envisaged for the YREB development plan.[5] The project will have the following outcome: economic and environmental conditions in the SZHTDZ improved. The SZHTDZ is in the Yanjiang District of the Ziyang Municipality. The expected project outcome aims to promote green development and attract businesses in light industry and service-oriented sectors while creating environment-friendly and attractive living conditions in the municipality. The project included the following three outputs:

8. **Output 1: Urban development planning and management capacity strengthened and applied.** This output will support ZMG by strengthening its capacity to plan and implement the Ziyang Municipalilty's plan to transition to a green and climate-resilient urban area. It will develop a comprehensive urban planning and performance monitoring system for industrial transformation and promote green industry and service-oriented sectors in the SZHTDZ. The project will provide (i) computerized management components (intelligent park platform [SMART systems]); (ii) performance monitoring systems for the SZHTDZ; and (iii) urban green transformation[6] planning study, which is expected to generate an operable approach of the green transformation; and increase the planning, implementation, and innovation capacity of ZMG.

9. **Output 2: Economic sector opportunities broadened.** This output will assist in identifying and promoting the promising economic sectors and diversifying employment opportunities. Initially, the support will focus on the dental sector,[7] for which a priority

[5] Government of the PRC. 2016. *Notice of the Guidelines on Strengthening the Environmental Pollution Prevention and Management in Yangtze River*. Golden Waterway, Beijing.

[6] Green transformation aims to change the traditional development model to a sustainable development model which is harmonious with nature, efficient in use of resources, has distinctive cultural features, and suitable for entrepreneurship and life. Green transformation also aims to address the challenges of rapid urbanization by harmonizing urban development and environmental planning in a comprehensive and planned manner; and serves as a guide to the socioeconomic development in the growth process of the municipality.

[7] The Ziyang Municipality is well positioned to become a modern dental sector hub for the PRC due to the following strategic advantages: (i) cooperation with the globally renowned Huaxi Dental School at the Sichuan University; and (ii) geographical advantage, being located in the Chengdu–Chongqing city cluster in the upper reaches of

development plan has been developed with the support from the Sichuan Provincial Government (SPG) and the Sichuan Huaxi Medical University. The project aims to support ZMG in establishing a better government service system to adjust the market dysfunctional area, including the incubation and research and development (R&D) stages of the dental sector in the SZHTDZ to facilitate the industrial innovation and transformation. This includes three components: (i) establish the R&D incubator for the dental sector; (ii) establish the dental equipment material inspection and examination center; and (iii) construct and equip a TVET center with capacity for 4,000 full-time students. The TVET center would present a comprehensive curriculum to develop workers for a variety of industries. The TVET center is the only component of this output which includes physical construction of 14 buildings in the campus.

10. **Output 3: Ecological systems and environmental infrastructure constructed.** This output will support the improvements in public infrastructure through the rehabilitation and development of an enabling urban environmental infrastructure. Through innovative approaches for green and climate-resilient urban development, this output includes six components: (i) construction of 4.9 kilometers (km) of eco-embankments (total ecological landscape corridor is 6.5 km); (ii) sponge city, including 10 roads (13.95 km); (iii) Yannan Lake wetland restoration at downstream of the SZHTDZ; (iv) landfill closure and conversion to public green area; (v) development of a green wedge as a natural separator between residential and industrial areas; and (vi) preservation of bare hills.

D. Project Benefits and Features

11. The project will contribute to the PRC's sustainable development agenda, as presented during the PRC's National New-Type Urbanization Plan, 2014–2020. It is in line with ADB's Midterm Review of Strategy 2020, which emphasized on the importance of environmental sustainability and inclusive growth.[8] The anticipated interventions will support the implementation of ADB's country partnership strategy for the PRC, 2016–2020.[9] The project will achieve the following significant social, economic, and environmental benefits:

(i) **Beneficiaries.** The project is expected to promote green development and attract businesses in light industry and service-oriented sectors while creating environment-friendly and attractive living conditions for the urban residents in the Ziyang Municipality. The total population of Yanjiang District is 1.103 million, including 0.268 million people who were benefitted directly by the project; and 0.835 million residents in other towns in the district who were benefitted from the project indirectly.

(ii) **Benefits of Output 1.** The procurement of the SMART park system can reduce the costs of data management, energy consumption, and equipment procurement by using the cloud platform. The system will help modernize the SZHTDZ and the industrial park, making it more attractive to industries to locate within it. The system will improve the local government's management efficiency and service capacity.

(iii) **Benefits of Output 2.** The open R&D platform will contribute to the development of the dental industry cluster which is line with ZMG's goals of high

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the Yangtze River, with close proximity to the Chengdu Tianfu International Airport as well as highway and rail transportation networks; and (iii) strong financial and policy support to ZMG by SPG in its emergence as a national dental hub.

[8] ADB. 2013. *Midterm Review of Strategy 2020: Meeting the Challenges of a Transforming Asia and Pacific*. Manila.

[9] ADB. 2016. *Transforming Partnership: People's Republic of China and Asian Development Bank, 2016–2020.* Manila.

technology, and environmentally benign industries. The construction of the TVET center will help to train workers for the industrial park and particularly the newly established dental industry cluster.

(iv) **Benefits of Output 3.** The construction of related six components will facilitate in improving the flood control infrastructure, strengthening flood control management, improving the biological diversity, and protecting the surrounding environment of the landfill site by controlling the landfill gas and leachate; and in improving the water quality and ecosystem of the Yannan Lake and the Kongzi Creek, creating a "green lung" within the center of the Ziyang Industrial Park, reducing soil erosion, enhancing the Ziyang Municipality's ecological resources, and demonstrating the model of sustainable development. Meanwhile, the vegetation coverage of most project areas will be significantly increased from the current 45%–60% to 90%. The major environmental benefits from the components of Output 3 are as follows:

a) The sponge city component, by construction of 18.095 hectares (ha) of sunken green belts, with the width of 3–20 meters (m) along the 10 existing roads (13.95 km in length) will reduce 212,150 cubic meters (m^3) of storm water runoff discharging into the Tuo River annually; and the annual reduction of pollutant loads of the suspended solids (SS), chemical oxygen demand (CODcr), total nitrogen (TN), and total phosphorus (TP) to the Tuo River are 50.92 tons, 27.5 tons, 3.06 tons, and 0.4 tons, respectively.[10]

b) The project, by increasing vegetation coverage rate in the project area, particularly in the areas of eco-embankment of the Tuo River, the landfill closure and conversion to public green area, and the green wedge, about 3,933 tons of soil erosion will be reduced annually; while the annual pollutant loads of CODcr, ammonia nitrogen (NH_3-N), TN, and TP (released from eroded soil) discharging into the Tuo River will be reduced by 7.418 tons, 0.1688 tons, 1.6437 tons, and 0.148 tons, respectively.[11]

c) The Yannan Lake wetland component, after completion of the wetland restoration, will increase flood detention capacity of 0.65 million m^3. The water quality will be improved from current worse than Grade V to Grade III of the PRC's Surface Water Quality Standard (GB3838-2002).[12] Accordingly, the pollution loads (399 kilograms per annum [kg/a] of CODcr, 99.7 kg/a TN, and 17.95 kg/a TP) to the Tuo River will be reduced (footnote 12).

E. Baseline Environment

12. During the DEIA preparation, the environmental baselines of surface water, groundwater, sediment, ambient air, and noise were monitored, which are summarized below.

13. **Surface water quality.** Water quality of the Tuo River mainstream (Ziyang section) is Grade IV–V Surface Water Quality Standard, lower than the Grade III functional target specified by the Sichuan Environment Protection Department (EPD) with the exceeded

[10] The calculation basis of pollutant concentrations in storm water runoff: SS = 300 milligrams per liter (mg/l), COD_{cr} = 162 mg/l, TN = 18 mg/l, and TP = 2.37 mg/l.

[11] Data source: Estimated based on the study report for the Longxi River (another first tributary of the Yangtze River in Chongqing Municipality, 150 km from Ziyang Municipality; the contents of COD_{cr}, NH_3-N, TN, and TP in soil are 1,800.00 mg per kilogram (mg/kg), 42.94 mg/kg, 417.90 mg/kg, and 37.63 mg/kg, respectively.

[12] The water quality improvement targets are divided into two phases: phase I from worse than Grade V to Grade IV by 2022, and phase II to Grade III by 2025.

standard pollutants of NH_3-N, CODcr, and TP, due to domestic wastewater directly discharged into the Tuo River according to the DEIA, even though the sewer collection rate in the urban area has reached 80%. The water qualities of the Yannan Lake (the proposed wetland) and the Kongzi Creek (the 3-km long channel between the Yannan Lake and the upstream Yingjie Reservoir) are Grade V or worse with the pollutants of TN, TP, and NH_3-N; and the reasons for the exceeded standard are wastewater directly discharged from nearby villages and the nonpoint source pollution from nearby farmlands and animal husbandries.

14. **Groundwater quality.** The baseline groundwater qualities on upstream and downstream of the existing landfill were monitored, the monitoring result shows that the groundwater qualities of both upstream and downstream wells exceeded the Grade III of the PRC's Quality Standard for Ground Water (GB14848-93) with the pollutants of NH_3-N, total bacteria, and total coliform, which shows that operation of the landfill leads to degradation of ground water quality to some extent within 1.5-km downstream area.

15. **Sediment quality.** Four sampling points in the Yannan Lake and the Kongzi Creek were selected for the sediment monitoring with the monitoring parameters of 26 (Section IV). Most of monitored sediment quality parameters meet Grade III of the PRC's Soil Quality Standard (GB15618-95). Only mercury (Hg) at 1-in-4 points slightly exceeded the standard (0.523 milligrams per kg [mg/kg] vs. the standard of ≤0.5 mg/kg). The dredged sediment will be transported to the sites of proposed green wedge, the landfill closure and restoration, and other existing green belts for landscaping only. The mitigation measures for preventing the sediment contamination in Section V are as follow: (i) the second round of sampling will be conducted in the engineering design stage; and (ii) after dewatering and prior to disposal, the de-watered sediment will be examined again to ensure compliance with the standard.

16. **Ambient air and noise.** Ambient air quality meets Grade II of the PRC's Ambient Air Quality Standard (GB3095-1996); and noise levels meet both the Grade II of the PRC's Environmental Quality Standard for Noise (GB3096-2008) and the World Bank Group's environment, health, and safety (EHS) guideline values.

F. Potential Environmental Impacts and Mitigation Measures

17. Environmental risks and impacts are anticipated from the construction and operation phases of the project. Key risks and impacts are associated with the soil erosion, odor impacts from the dredged sediment, water quality, and local ecosystem.

18. **Construction phase.** Key impacts anticipated to result from construction are (i) odor impacts during the landfill closure and sediment dredging in the Yannan Lake and the Kongzi Creek; (ii) soil erosion, particularly during the embankment along Tuo River; and the preservation of bare hills; (iii) short-term damage to aquatic habitats in the Tuo River section and the Yannan Lake due to dredging and embankment; (iv) removal of existing vegetation for the constructions of embankment and green wedge; and (iii) short-term alteration of river flow, from the temporary installation of diversion weirs or structures during construction. Other temporary impacts due to construction include noise disturbance to nearby settlements, air pollution (mainly fugitive dust), uncontrolled solid waste disposal, interference with traffic and municipal services due to construction vehicle movements and any works alongside roads, permanent and temporary acquisition of land, involuntary resettlement, and occupational and community health and safety.

19. **Operational phase.** Key operational risks and impacts are more or less altered hydrology and ecology within and downstream of the project construction areas due to dredging and embankment, safe operation of closed landfill (preventing groundwater from pollution by the closed landfill), and energy-saving and environment-friendly operation of the

TVET center. Other operational risks are inadequate maintenance of project vegetation, structures, and facilities, which could contribute to reduced efficiency of the built facilities; or the moved pollution sources returning back to the Yannan Lake wetland again. All project facilities will be under the management of the project implementation agencies (IAs). Each IA will develop operation and maintenance (O&M) program for the built facilities and receive training in maintenance of the facilities, green campus environmental management system (EMS), and wetland restoration.

G. Public Consultation and Grievance Redress Mechanism

20. Two rounds of public consultation were conducted in the Yangjiang District and the SZHTDZ. Feedback from the consulted residents and organizations included both support for the project for improving green economic transformation; environmental preservation and development of the TVET; and concern over potential construction noise, soil erosion, dust, and odor from landfill and dredged sediments. Measures to address these concerns have been incorporated in the updated FSRs, the DEIAs, and mitigation measures (environmental management plan [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 EHS and social concerns associated with the project. The GRM was introduced to residents during the design phase and will be implemented throughout project implementation.

H. Climate Change

21. A climate risk vulnerability assessment (CRVA) was conducted by the TRTA climate change consultant to identify the risk climate change presents to project viability, assuming a design life of 30–40 years. The annual mean temperature has increased 0.15℃/10a in the Ziyang Municipality (Chengdu Plain) during 1961–2015, which was lower than the warming rate for the PRC average (about 0.22℃/10a). Representative concentration pathway (RCP) modeling (RCP4.5) indicates that mean annual temperatures will increase by 0.9℃ during 2020–2030 and 1.2℃ by 2050. The rainfall intensity in the Ziyang Municipality will be changed due to climate change. The frequency analysis suggests that the maximum daily rainfall of 50-year return period will be increased by 4% during 2021–2030. Variability in precipitation will increase, and storm severity may increase. Increasing flood volumes could exceed the flow capacity of embankments, channels, pipelines, and pump stations. To accommodate this, the eco-embankment will be constructed to a flood protection standard of once-in-50-years, and embankments have been designed to be porous for improved infiltration.

22. The project will increase 90.6 ha of greening area, including about 87.6 ha of woody trees and shrubs, which will achieve 290.8 tons of carbon sequestration per year (725 tCO_2e). These reductions will be offset by the emissions generated during project construction and operation, resulting in a net emission of 6,939 tCO_2e per year, i.e., well below the SPS threshold of concern of 100,000 tCO_2e per year.

I. Environmental Management Plan

23. As part of this EIA, a project EMP has been developed (Attachment 1), which describes the project requirements and methods for environmental mitigation measures implementation, monitoring, reporting, roles and responsibilities, budget, and the GRM. The EMP will be the key guiding document for environment-related issues for project construction and operation.

J. Risks and Assurances

24. ZMG's agencies do not have previous experience in ADB's safeguard requirements 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 a full-time environment officer in the project management office (PMO) of the Ziyang Municipality (ZPMO) and one officer respectively in each project implementation unit (PIU); (ii) inclusion of a loan implementation environment consultant (LIEC) in the loan consulting services; (iii) clear roles and responsibilities of all relevant agencies for the EMP implementation, including contractors and construction supervision companies (CSCs); (iv) capacity building for the EMP implementation; and (v) the recruitment of an independent agency to conduct the external environmental monitoring described in the EMP. Environmental assurances have been agreed upon and are included in the loan and project agreements.

K. Conclusion

25. It is concluded that full and effective implementation of the project EMP, 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 project EIA.

II. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

A. Overview

26. The project was classified as environmental 'Category A' under ADB's SPS (2009), requiring the preparation of a project EIA. ADB's country partnership strategy for the PRC (2016–2020) supports the PRC's realizing an 'ecological civilization' through: environmental sustainability, pollution control, and climate change adaptation measures; achieving greenhouse gas (GHG) emissions commitments ahead of its 2030 target; and, the overarching strategic goal of building a well-off society by focusing on the three strategic pillars of inclusive growth, environmentally sustainable development, and urban–rural integration. Under the PRC's EIA regulation, the project was classified as 'Class-1' (equivalent to ADB's Category A) and the preparation of full domestic EIA (DEIA) reports is required.[13] The project is consistent with the PRC's and Sichuan Province's Thirteenth Five-Year Plans.

27. The PRC has a range of laws, regulations, technical guidelines, and standards that govern the way in which environmental protection and the EIA for projects must be implemented, including for pollution prevention and control on air, noise, water, ecology and solid waste; and technical guidelines on assessing ambient air, noise, surface water, groundwater, and ecological impacts. The five DEIA reports, upon which this project EIA is largely based, were prepared in accordance with the PRC's EIA Law (2016 revision); Management Regulation on EIA Categories of Construction Projects (Ministry of Environmental Protection [MEP], 2017); Guidelines on Public Participation in EIA (MEP, 2006); and Technical Guidelines for EIA (HJ/T2-93).

B. Environmental Laws, Regulations, Guidelines, and Standards of the People's Republic of China

28. The primary national laws and regulations that govern the DEIA are in Tables II-1 and II-2. Table II-2 shows the relevant Sichuan provincial laws and regulations.

Table II-1: National Laws and Regulations Relevant to the Project

Law	**Year**
Environmental Protection Law	2015
Urban and Rural Planning Law	2008
Solid Waste Pollution Prevention and Control Law	2016
Environmental Impact Assessment Law	2016
Water Pollution Prevention and Control Law	2018
Air Pollution Prevention and Control Law	2016
Noise Pollution Prevention and Control Law	1997
Land Administration Law	2004
Wild Animal Protection Law	2017
Water and Soil Conservation Law	2011
Regulation	**Year**
Classification of Construction Project Environmental Protection Management (MEP)	2017
Environmental Protection Management for Construction Projects	2017

[13] 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; and (iii) EIA Registration Form—for projects with the least environmental impacts.

Law	Year
Circular on National Ecological Environment Conservation Outline issued by the State Council	2000
Decision on Revision of Category on Industrial Structure Adjustment (2011) (NDRC)	2013
Circular on Questions Related to Implementation of the EIA Procedure for Construction Projects	1999
Decision on Implementing Approach of Scientific Development and Strengthening Environmental Protection	2005
Suggestions on Further Strengthening Ecological Environment Protection	2007
Circular on Action Plan for Air Pollutant Prevention and Control issued by the State Council	2013
Regulation on Implementing the PRC's Land Administration Law	2014
Rules for Implementing the PRC's Water Prevention and Pollution Control	2000
Management Regulation on Urban Construction Wastes	2005
Circular on Implementing Action Plan for Air Pollution Prevention and Control and Making Strict Access Approval of the EIA	2014
Interim Measures on Public Participation in Environmental Impact Assessment	2006
Measures on Public Participation in Environmental Protection	2015

Table II-2: Local Laws, Regulations, and Standard

Laws and Regulations	Year
Environmental Protection Regulations of Sichuan Province	2004
Implementing Measures on the PRC's Water Law in Sichuan Province	2005
Implementing Measures on the PRC's Air Pollution Prevention and Control Law in Sichuan Province	2002
Implementing Measures on the PRC's Land Administration Law in Sichuan Province	2012
Circular on Opinions on Implementing Ecological Protection Redline in Sichuan Province issued by the Sichuan Provincial Government	2016
Circular on Classification of Applicable Area Divisions of Environmental Noise in the Urban Area of Ziyang issued by the Ziyang Municipal Government	2006
Specification of Green Buildings Design in Sichuan Province (DBJ51/T037-2015)	2015

29. The implementation of environmental laws and regulations is supported by associated management and technical guidelines. Those applicable to the project are summarized in Table II-3.

Table II-3: Applicable Environmental Guidelines

Guideline	Code/Year
Technical Guideline on EIA: for Construction Projects	HJ/T 2.1-2016
Technical Guideline on EIA: Surface Water Environment	HJ/T 2.3-1993
Technical Guideline on EIA: Atmospheric Environment	HJ 2.2-2008
Technical Guideline on EIA: Acoustic Environment	HJ 2.4-2009
Technical Guideline on EIA: Ecological Assessment	HJ 19-2011
Technical Guideline on EIA: Ground Water Environment	HJ610-2016
Technical Guideline on Environmental Risk Assessment for Construction Project	HJ/T169-2004
Guideline on EIA Classification of Construction Projects	2017
Methodology on Public Participation in Environmental Protection	2015

30. The national environmental quality standard system that supports and/or evaluates the implementation of the environmental protection laws and regulations in the PRC is classified

into two categories by function, i.e., pollutant emission and/or discharge standards and ambient environmental standards. The standards applicable to this project are in Table II-4.

Table II-4: Applicable Environmental Standards

Standard	Code
Surface Water Quality Standard	GB3838-2002
Urban Ambient Acoustic Quality Standard	GB3096-2008
Ambient Air Quality Standard	GB3095-2012
Groundwater Quality Standard	GB/T14848-1993
Integrated Emission Standard of Air Pollutants	GB16297-1996
Emission Standard for Odor Pollutant	GB 14554-93
Emission Standard for Industrial Enterprises Noise at Boundary	GB12348-2008
Environmental Quality Standard for Soils	GB15618-1995
Integrated Wastewater Discharge Standard	GB8978-1996
Noise Limit for Construction Sites	GB12523-2011
Standard on Pollution Control of Storage and Disposal Location for General Industrial Waste	GB18592-2001
Technical Specification on Landfill Treatment of Municipal Waste	GB50869-2013
Standard on Pollution Control of Municipal Waste Landfill	GB16889-2008
Technical Regulation on Closure of Municipal Waste Landfill	CJJ112-2007
Project Construction Standard on Closure of Municipal Waste Landfill	Construction Standard 140-2010
Environmental Monitoring Requirement on Municipal Waste Landfill	GB/T18772-2008
Technical Specification on Leachate Treatment Project for Municipal Waste Landfill (Trial Implementation)	HJ564-2010
Technical Specification on Landfill Gas Collection, Treatment, and Utilization of Municipal Waste Landfill	CJJ133-2009
Technical Specification on Closure of Municipal Waste Landfill	GB51220-2017
Technical Specification on Water and Soil Conservation for Development and Construction Projects	GB50433-2008
Standard for Prevention and Control of Water and Soil Loss for Development and Construction Projects	GB50434-2008
Emission Standard for Industrial Enterprises Noise at Boundary	GB12348-2008
Standard for Flood Control	GB50201-94
Design Standard for Schools	GB50099-2011
Design Standard for Energy Efficiency of Public Buildings	PGB 50189-2015

C. International Agreements

31. The PRC is signatory to major international environmental agreements relevant to the project (Table II-5), dealing with the biodiversity, wetland protection, and climate change.

Table II-5: Applicable International Agreements

Agreement	Year	Purpose (relevance to the project)
Ramsar Convention on Wetlands of International Importance	1975	Prevent encroachment on and loss of wetlands for now and the future (project includes the reservoir)
Convention on Biological Diversity	1993	Conservation and sustainable use of biological diversity (project includes reforestation)
United Nations (UN) Framework	1994	Achieve stabilization of atmospheric greenhouse gas (GHG)

Agreement	Year	Purpose (relevance to the project)
Convention on Climate Change		concentrations (project involves GHG emission reduction)
Kyoto Protocol to UN Framework Convention on Climate Change	2005	Further reduction of GHG emissions (as above)
Montreal Protocol on Substances That Deplete the Ozone Layer	1989	Protection of the ozone layer (same as above)
UN Convention to Combat Desertification	1996	Combat desertification and mitigate effects of drought (project involves soil erosion control)

D. Applicable ADB Polices and World Bank's EHS Guidelines

32. ADB's SPS (2009) provides the basis for the project EIA. Projects funded by ADB must comply with the SPS. The purpose of the SPS is to establish an environmental review process to ensure that projects funded under the ADB loans are environmentally sound and to be operated in line with applicable regulatory requirements so that significant EHS hazards are not likely to be caused. The SPS promotes a good international practice as reflected in internationally recognized standards such as the World Bank Group's EHS Guidelines.[14] The principles and standards of the EHS guidelines are adopted by the SPS. Some of the relevant EHS sector guidelines for this project cover general guidelines (including both occupational and community health and safety) and industry sector guideline on waste management facilities. The water, air, and noise quality standards in the EHS guidelines provide a reference against project impacts. In general, many of the PRC's standards are the same as, or higher than, the EHS standards.

33. Compared with the PRC's EIA requirements, the SPS requires a number of additional considerations for the EIA preparation, including (i) a project-specific GRM; (ii) definition of the project area of influence; (iii) assessment of direct, indirect, induced, and cumulative impacts; (iv) due diligence of project associated facilities; (v) protection of physical cultural resources; (vi) climate change mitigation and adaptation; (vii) occupational and community health and safety requirements (including emergency preparedness and response); (viii) impacts on livelihoods through environmental media; (ix) biodiversity conservation; and (x) ensuring that the EMP includes an implementation schedule and measurable performance indicators. These requirements are usually weak in the PRC's EIAs. With the assistance of the TRTA consultants, the DEIA has been updated for several times in accordance with the SPS by the DEIA institutes to fill in the above gaps and comply with the SPS requirements.

E. Assessment Standards for Proposed Project Components

a. Surface Water Quality

34. The main water body in the PRC should comply with its related standard which is classified by the local environmental protection bureau (EPB) according to its function. The water bodies relevant to this project involve the implementation of Grade III, IV, and V of the PRC's Environmental Quality Standards for Surface Water (GB3838-2002), (Table III-6).

Table II-6: Environmental Quality Standards for Surface Water (Unit: mg/L, except for pH)

Parameter	pH	COD_{Cr}	COD_{Mn}	BOD_5	TN	NH_3-N	TP	Oil
Grade III Standard	6 ~ 9	20	6	4	1.0	1.0	0.2	0.05

[14] World Bank Group Environmental, Health, and Safety Guidelines, 30 April 2007, Washington, USA. See: http://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/Sustainability-At-IFC/Policies-Standards/EHS-Guidelines#IndustryEHS

Parameter	pH	COD_{Cr}	COD_{Mn}	BOD_5	TN	NH_3-N	TP	Oil
Grade IV Standard	6 ~ 9	30	10	6	1.5	1.5	0.3	0.50
Grade V Standard	6 ~ 9	40	15	10	2.0	2.0	0.4	1.00

BOD_5 = 5-day biochemical oxygen demand, COD_{Cr}/COD_{Mn} = chemical oxygen demand, mg/L = milligram per liter, NH_3-N = ammonia nitrogen, TN = total nitrogen, TP = total phosphorus.

b. Ambient Air Quality

35. Ambient air quality in the environmental sensitive locations, and the areas outside the construction sites meets Grade II of the PRC's Ambient Air Quality Standard GB3095-1996, GB3039-2012 (January 2016), and the World Bank's EHS guidelines (Table II-7).

Table II-7: Ambient Air Quality Standard - Grade II (Unit: mg/m^3).

Pollutant	Time	GB 3096-1996 (Grade II)	GB3095-2012 (Grad II)	EHS
SO_2	Annual average	0.060	0.060	n/a
	Daily average	0.150	0.150	0.125-0.050 (0.020 guideline)
	Hourly average	0.500	0.500	n/a
$PM_{2.5}$	Annual average	---	0.035	0.035
	Daily average	---	0.075	0.075
PM_{10}	Annual average	0.100	0.070	0.070-0.030 (0.020 guideline)
	Daily average	0.150	0.150	0.075-0.150 (0.050 guideline)
NO_2	Annual average	0.080	0.040	0.040 guideline
	Daily average	0.120	0.080	n/a
	Hourly average	0.240	0.200	0.200 guideline
CO	Daily average	4.000	4.000	n/a
	Hourly average	10.000	10.000	n/a

--- = data unavailable; CO = carbon monoxide; EHS = environment, health, and safety; mg/m^3 = milligram per cubic meter; n/a = not applicable; NO_2 = nitrogen dioxide; $PM_{10}/PM_{2.5}$ = particulate matter; SO_2 = sulfuric dioxide.

c. Ambient Acoustic Quality

36. According to the Classification of the Suitable Areas for Environmental Noise of Urban Area in Ziyang, the project areas involve the implementation of Grade II, III, and 4a of the Environmental Quality Standard for Noise (GB3096-2008); and the applicable World Bank EHS guidelines are the noise guidelines for residential and institutional area and for industrial and commercial area (Table II-8).

Table II-8: Environmental Quality Standard and EHS Guideline for Noise Unit: dB(A)

Classification	Daytime	Nighttime	Remarks
Grade II Standard	60	50	Refer to major functions of commercial and market trading use or combination of residential, commercial, and industrial areas which need to maintain the quiet environment for the residential area
Grade III Standard	65	55	Refer to major functions of industrial manufacturing and warehousing logistic use which areas need to avoid the significant negative effect caused by the industrial noise
Grade 4a Standard	70	55	Refer to the areas along the traffic trunk line, except the railway, where need to avoid the significant negative effect caused by the traffic noise
EHS	55	45	for residential annd institutional area
EHS	70	70	for industrial and commercial area

d. Ground Water Quality

37. The groundwater quality in the project area must comply with Grade III of the PRC's Quality Standard for Ground Water (GB 14848-93), (Table II-9).

Table II-9: Quality Standard for Groundwater

(Unit: mg/L, except pH, total bacteria and total coli)

Parameter	Standard Value	Parameter	Standard Value
pH	6.5 ~ 8.5	Hg	0.01
COD_{Mn}	3	Cu	1
Color	15	Zn	1
NH_3-N	0.2	Pb	0.05
NO_2-N	0.02	Cr^{6+}	0.05
NO_3-N	20	Total Bacteria (cfu/L)	100
Cd	0.01	Total Coli. (cfu/L)	3

Cd = Cadmium, Cr = Chromium, Cu = Copper, Hg = Mercury NO_2-N = nitrite nitrogen, NO_3-N = nitrate nitrogen, Pb = Lead, Zn = Zinc.

e. Soil Quality

38. The Grade II of the PRC's Environmental Quality Standard for Soils (GB15618-1995) was adopted to assess the soil and sediment qualities in the project area (Table II-10).

Table II-10: Environmental Quality Standard for Soils Unit: mg/kg

Parameter	Grade II Standard Value	Parameter	Grade II Standard Value
pH	6.5 ~ 7.5	Pb	300
Cd	0.3	Cr (paddy field)	300
Hg	0.5	Zn	250
As (paddy field)	25	$C_6H_6Cl_6$	0.5
Cu (farmland)	100	DDT	0.5

As = Arsenic.

f. Wastewater Discharge Standard

39. Wastewater discharges into the water body, being implemented under Grade III Standard of GB3838-2002, should meet Grade I of the PRC's Integrated Wastewater Discharge Standards (GB8978-1996). In the case of discharging into the municipal sewage pipeline, Grade III Standard of GB8978-1996 is implemented (see Table II-11)

Table II-11: Integrated Wastewater Discharge Standards (Unit: mg/L, except for pH)

Parameter	pH	COD_{Cr}	BOD_5	SS	NH_3-N	Oil
Grade I Standard	6 ~ 9	100	20	70	15	5
Grade III Standard	6 ~ 9	500	300	400	/	20

SS = suspended solids.

g. Air Pollutant Emission

40. During the project construction, the on-site fugitive emission should comply with Grade II of the PRC's Integrated Emission Standards of Air Pollutants (GB16297-1996), (Table II-12).

Table II-12: Integrated Emission Standards of Air Pollutants Unit: mg/m^3

Classification	Parameter	Fugitive Emission Limit at Monitoring Point
Grade II Standard	SO_2	0.40
	NO_x	0.12
	PM	1.00

NOx = nitrogen oxides.

h. Odor Pollutant Emission

41. The waste gas generated by the subcomponent of the Ziyang Landfill Ecological Restoration Project is the landfill gas, mainly including methane (CH_4), ammonia (NH_3), and hydrogen sulfide (H_2S), that is collected before the discharge. The concentration of NH_3 and H_2S at the boundary of the project site should comply with Grade II (existing plant) of the PRC's Emission Standard for Odor Pollutant (GB14554-93), which details are summarized in Table II-13.

Table II-13: Emission Standard for Odor Pollutant Unit: mg/m^3

Parameter	Standard Value (existing plant)	Code of Standard
NH_3	2.0	GB14554-93
H_2S	0.1	

i. Noise Levels During Project Construction

42. Grade II of the PRC's Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008) was adopted to assess the noise at the boundary of existing Ziyang Zhongshan Landfill (Table II-14); while the construction activities must comply with the PRC's Noise Limits for Construction Site standard (GB12523-2011). The applicable World Bank's EHS guidelines for both industrial enterprises and construction site is the noise guideline for industrial and commercial area (Tables II-14 and II-15).

Table II-14: Emission Standard for Industrial Enterprises Noise at Boundary

Daytime, dB(A)	**Nighttime**, dB(A)	Classification
60	50	Grade II Standard
70	70	EHS (for industrial and commercial area)

Table II-15: Emission Standard of Environment Noise for Boundary of Construction Site

Daytime, dB(A)	**Nighttime**, dB(A)	Code of Standard
70	55	GB12523-2011
70	70	EHS (for industrial and commercial area)

j. Standards for Grading of Soil Erosion Intensity

43. Ziyang is located mainly in the “Chinese southwest soil rock area”, which is subject to hydraulic erosion. The applicable standard is the Standard for Grading of Soil Erosion Intensity (SL190-2007; Ministry of Water Resources), (Table II-16.)

Table II-16: Standards for Grading of Soil Erosion Intensity

Grade	**Average erosion modulus** (t/km^2·a)	**Average erosion thickness** (mm/a)
Micro	< 500	< 0.37
Light	500 ~ 2,500	0.37 ~ 1.90
Medium	2,500 ~ 5,000	1.90 ~ 3.70
Strong	5,000 ~ 8,000	3.70 ~ 5.90
Very Strong	8,000 ~ 15,000	5.90 ~ 11.10
Extremely strong	> 15,000	> 11.10

k. Construction-Induced Vibration

44. Construction activities may cause vibration impact and must comply with the PRC’s Standard for Urban Area Environmental Vibration (GB10070–88), (Table II-17).

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

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

F. Domestic EIA Preparation and Approval

45. The DEIA full report for the project Output 3 was prepared by the DEIA institute holding national Grade A certificates in accordance with the Management Guideline on Qualification of EIA Institutes (MEP Ministerial Order No. 36, 2015).[15] The final DEIA has been completed by end-March 2018, and the DEIA approval is expected before the end of April 2018. The tabular EIA for the TVET center has been drafted by the Jilin Jilong Environmental Technology Co., Ltd.; and the approval date is expected before mid-May 2018. The TRTA consultants assisted the finalization of both DEIAs.

[15] China No.2 Railway Engineering Group Co., Ltd.

III. DESCRIPTION OF THE PROJECT

A. Rationale

46. The PRC has identified the YREB as one of the key engines of social and economic development. The YREB consists of nine provinces and two centrally administered municipalities (Chongqing and Shanghai) which comprise about 20% of the PRC's total land area; 40% of its population; and about 45% of its economic output. The PRC envisions the social and economic development to take place around 15 city clusters located in the YREB.[16] Ecological protection and green development are the top priority for social and economic development within the YREB.

47. The PRC's Thirteenth Five-Year Plan (FYP) for National Economic and Social Development (2016–2020) sets "ecological protection and green development" as the top priority for development along the YREB.[17] In this context, "green development" means that areas will be developed in a manner that is socially responsible and environmentally and economically sustainable. This necessitates an industrial transformation in the city clusters from industries that are heavily resource dependent, low technology based, market irresponsive, and environmentally damaging to industries that are equipped by high technology, dynamic, and market responsive; yet environment-friendly. This kind of transformation reduces environmental damage and promotes social inclusiveness by creating local employment opportunities so that local laborers do not need to travel to coastal areas for jobs.

48. The Ziyang Municipality is part of the Chengdu–Chongqing city cluster located in the upper reaches of the YREB. The total area of municipality is 5,747 km^2; and the estimated population was 3.5 million in 2016, of which 19% are urban. The GDP for 2016 was CNY94.34 billion. About 1.8% of the population (65,380) are under the local poverty line.

49. Through industrial upgrading and transformation, the Government of the PRC is promoting a new urban development model: integrated or synchronized city development and industrialization where people will have easy access to clean and high-technology based jobs. The industry will have a livable city nearby its human resource base and service center while the city has a set of dynamic industries to provide jobs for its residents.

50. There is competition among cities for low-polluting and high-value industry. Smaller cities need to improve themselves attractive for industrial relocation or new development. This includes providing better services to businesses and residents, restoring the environment, and planning for a sustainable future. The problems the Ziyang Municipality had to overcome include competition with other cities for the same types of industries, insufficient industrial agglomeration. and less desirable living environment.

51. Typically, the PRC cities focus their interventions for urban development in a fragmented manner for infrastructure, environment, and social inclusiveness. The Ziyang Municipality's transformation requires a new and holistic approach to urban planning and management—an approach that balances economic development with its impacts on the surrounding environment and communities. This change in approach is unlikely to happen on its own; it needs the encouragement and technical support that ADB is providing.

52. ADB helps identify and address development challenges confronting the Ziyang Municipality, specifically its key needs for urban planning, improvement of businesses services to support social economic development, and environmental infrastructure. ADB's Ziyang

[16] National Development and Reform Commission (NDRC). 2014. *National Plan on New Urbanization, 2014–2020*. Beijing.
[17] Government of the PRC. 2016. *Outline of the Thirteenth Five-Year Program for National Economic and Social Development, 2016–2020*. Beijing.

project can add value in the PRC by (i) helping to translate innovative ideas into actual projects and programs for implementation; and (ii) supporting transformative and demonstration projects and programs, which can be replicated and scaled up.

53. ADB is also adding value by (i) introducing an information technology (IT)-based intelligent management system to improve the municipality's urban management, (ii) introducing and developing a performance monitoring system to (a) assess the transformation progress which will serve as feedback system to measure, report, and evaluate the progress made in economic, social, and environmental improvements; and (b) guide in refining and upgrading the transformation planning and implementation process, thus creating a dynamic continuous urban planning and management mechanism for the Ziyang Municipality.

54. ADB's country partnership strategy with the PRC supports the PRC's reform agenda by focusing on strategic priorities of managing climate change and the environment, promoting regional cooperation and integration, supporting inclusive economic growth, fostering knowledge cooperation, and supporting institutional and governance reform (footnote 9). These strategic priorities are aligned with the PRC's and the Sichuan Province's Thirteenth FYPs; ADB's approach to supporting upper middle-income countries; and ADB's Midterm Review of Strategy 2020, which emphasizes the importance of environmentally sustainable and inclusive growth (footnote 8). The interventions will be aligned with and contribute to ADB's main sector plans, e.g., the Urban Operational Plan, 2012–2020; and the Environment Operational Directions, 2013–2020.[18]

B. Impact, Outcome, and Outputs

55. The project is aligned with the sustainable economic growth and environmental improvement in the YREB achieved as envisaged for the YREB Development Plan (footnote 5). The project outcome will be economic and environmental conditions in the SZHTDZ improved. The SZHTDZ is in the Yanjiang District of the Ziyang Municipality. The expected project outcome also aims to promote green development and attract businesses in light industry and service-oriented sectors while creating environment-friendly and attractive living conditions in the Ziyang Municipality. The project has the following three outputs, which are listed in Table III-1; while the locations of the project components are shown in Figure III-1.

Table III-1: Summary of the Project Components

Outputs	Component
Output 1: Urban development planning and management capacity strengthened and applied	(i) Improved management system for the SZHTDZ (intelligent park platform [SMART systems]), including software and hardware (ii) Develop performance monitoring system to assess green transformation progress (iii) Urban green transformation planning study for the SZHTDZ
Output 2: Economic sector opportunities broadened	(i) Open research and development (R&D) platform for the dental sector (ii) Support for testing and inspection facilities for the dental sector (iii) Support for green transformation the echnical and vocational education and training (TVET), including construction of 14 buildings (94,146 square meters [m^2]).

[18] ADB. 2013. *Urban Operational Plan, 2012–2020*. Manila; ADB. 2013. *Environmental Operational Directions, 2013–2020*. Manila.

Outputs	Component
Output 3: Ecological systems and environmental infrastructure constructed	(i) Eco- embankments of the Tuo River (ii) Sponge city (iii) Yannan Lake wetland (iv) Landfill closure and restoring to a green public area (v) Development of a "green wedge" as a natural separator between residential and industrial areas (vi) Ecological preservation of bare hills

Source: Transaction technical assistance draft final report.

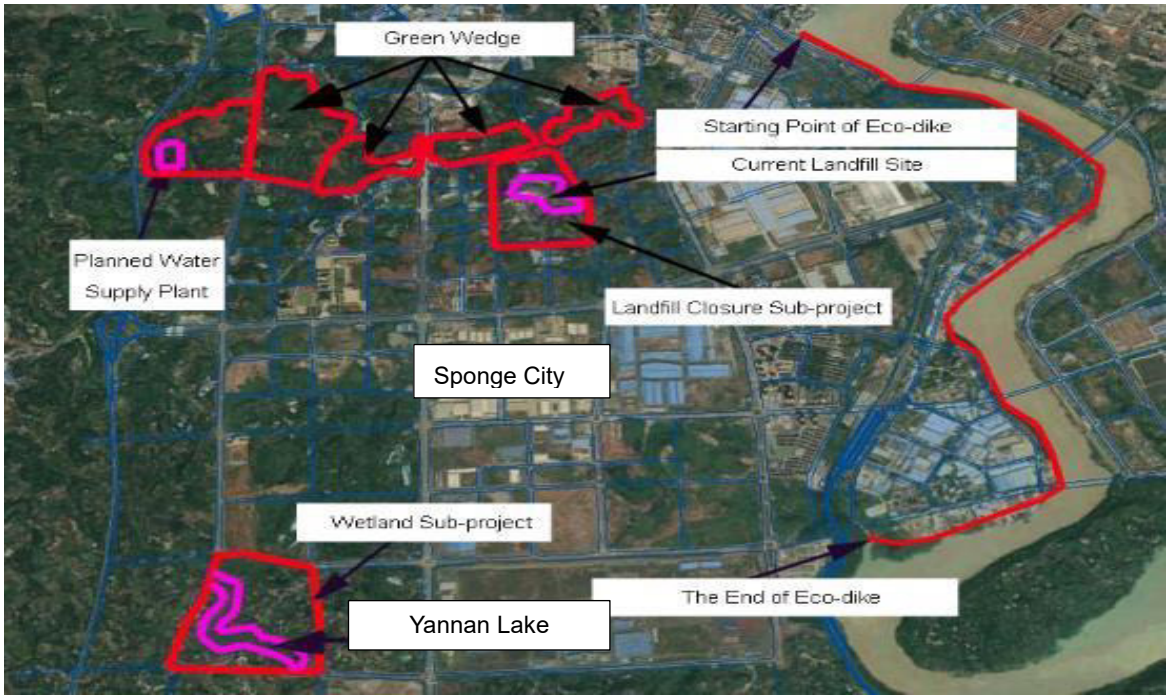


Figure IV.1: Ziyang Component Locations

56. **Output 1: Urban development planning and management capacity strengthened and applied.** Output 1 will support ZMG with strengthening its capacity to plan and implement the Ziyang Municipality's plans to transition to a green and climate-resilient urban area. It will develop a comprehensive urban planning and performance monitoring system for industrial transformation and promote green industry and service-oriented sectors in the SZHTDZ. The project will provide (i) computerized management components (intelligent park platform [SMART systems]); (ii) performance monitoring systems for the SZHTDZ; and (iii) urban green transformation planning study for the SZHTDZ.[19] The study is expected to generate an operable approach of the Ziyang Municipality's green transformation; and increase the planning, implementation, and innovation capacity of ZMG.

57. The demand of energy conservation, emission reduction, ecological restoration, and environment improvement is increasingly urgent in the municipality. The procurement of SMART park aims to (i) help transform and upgrade the industrial zone by reducing the operating costs, improving the working efficiency, and enhancing the service capabilities for all enterprises; (ii) enhance the sharing of resources, data exchange, and collaborative working for various departments or companies; and (iii) improve the government's monitoring capability, response speed, and public service level for the society. It will focus on an area of 21.37 km^2,

[19] Green transformation aims to change the traditional development model to a sustainable development model which is harmonious with nature, efficient in use of resources, has distinctive cultural features, and suitable for entrepreneurship and life. Green transformation also aims to address the challenges of rapid urbanization by harmonizing urban development and environmental planning in a comprehensive and planned manner; and serves as a guide to the socioeconomic development in the growth process of the municipality.

including the core services for the Dental Valley.

58. Green transformation aims to change the traditional development model to a sustainable development model which is harmonious with nature, efficient in use of resources, has distinctive cultural features, and suitable for entrepreneurship and life. The study of green transformation aims to (i) generate an operable approach of the Ziyang Municipality's green transformation; and (ii) increase the planning, implementation, and innovation capacity of ZMG on the urban green transformation process. There are four main items to be procured: (i) SMART government system which includes the procurement of data base management platform, office automation system, integrated business service system, and meeting management system; (ii) SMART economy which includes the procurement of software based on a cloud platform and an integrated enterprise service platform; (iii) SMART management which includes the procurement of smart systems of traffic, street lighting, security, community, and emergency response; and (iv) SMART environment which includes the procurement of monitoring systems for water quality; heating, ventilation, and air conditioning (HVAC); and noise. The combination of performance monitoring and urban planning create a closed loop of urban planning–management–monitoring that supports green transformation by measuring progress and identifying obstacles. The output 1 includes mainly management strengthening, equipment procurement, and training without physical construction.

59. **Output 2: Economic sector opportunities broadened.** Output 2 will assist in identifying and promoting the promising economic sectors and diversifying employment opportunities. Initially, the support will focus on the health (dental) sector, for which a priority development plan has been developed with the support of the SPG and the Sichuan University,.[20] The project aims to support ZMG in establishing a better government service system to adjust the market dysfunctional area, including the incubation and R&D stages of the dental sector in the SZHTDZ, to facilitate the industrial innovation and transformation of ZMG. This includes three components: (i) establish the R&D incubator for the dental sector; (ii) establish the dental equipment and material inspection and testing center; and (iii) construct and equip a TVET center, with capacity for 4,000 full-time students. The TVET would present a comprehensive curriculum to develop workers for a variety of industries. **The TVET center is the only component under Output 2 with physical construction.**

60. The TVET center is envisioned to educate people to work for companies in the industrial park. It will provide specialized training to develop professional skills to work for industries. Also, it will offer teachers' continuing education training and pre-school for children; which provides for needs of the industrial workers' children and serves as the training center in Sichuan Province for pre-school teacher training education. The TVET center includes construction of 14 buildings, with the total land area of 200 *mu* (13.33 ha) and building construction area of 94,146 square meters (m^2), which are summarized in Table III-2 below.

Table III-2: Summary of Buildings in the Technical and Vocational Education and Training Center

No.	Name of Building	Gross Floor Area（m^2）	Number of floor	Height（m）
1	Training Building	9,962.59	6F/-1F	25.90
2	No.1 Practical Training Building	8,121.56	5F	21.30
3	Administration Building and Library	16,497.99	7F/-1F	31.10
4	No.2 Practical Training Building	6,876.36	5F/-1F	21.30
5	Teaching Building	12,738.73	5F	19.80
6	Canteen	4,496.47	2F	10.50
7	No.1 Student's Dormitory	8,699.30	9F	35.40

[20] Ziyang is well positioned to become a modern dental sector hub for the PRC due to strategic advantages as- (i) cooperation with the globally renowned Huaxi Dental School at the Sichuan University; and (ii) geographical advantage, being located in the Chengdu-Chongqing city cluster in the upper reaches of the Yangtze River, with close proximity to the Chengdu Tianfu International Airport as well as highway and rail transportation networks; and (iii) strong financial and policy support to ZMG by SPG in its emergence as a national dental hub.

No.	Name of Building	Gross Floor Area（m^2）	Number of floor	Height（m）
8	No.2 Student's Dormitory	8,699.30	9F	35.40
9	No.3 Student's Dormitory	8,699.30	9F	35.40
10	Equipment Room	453.44	1F/-1F	6.00
11	Teacher's Dormitory	1,165.38	3F	9.30
12	Indoor Sports Ground	3,236.16	2F	12.90
13	No.3 Practical Training Building	4,445.48	3F	12.15
14	Gatehouse	54.00	1	3.50
	Total	**94,146.00**		

Source: Feasibility study report.

Figure III-2: The "Bird's-eye View" of the TVET School

61. To ensure high level of campus EHS, the project buildings of the TVET center will comply with relevant design standards and codes for energy-efficient, environment-friendly, safe, and green public buildings, including GB50189-2005 (Design Standard for Energy Efficiency of Public Buildings); GB50176-1993 (Thermal Design Code for Public Buildings); GB/T50378-2006 (Evaluation Standard for Green Buildings); and GB50099-2011 (Code for design of schools), and the Sichuan Provincial Green Building Design Standard (DBJ51/T037-2015), and the Sichuan Provincial Green Building Assessment Standard (DBJ51T009-2012). Adherence to the PRC's green public procurement policies will be targeted for equipment and appliances procurement.[21] In addition, the project will support the TVET to develop and implement the EMS, aiming at institutionalizing procedures to enhance campus environmental sustainability.

62. **Output 3: Ecological systems and environmental infrastructure constructed.** The output will support improvements in public infrastructure through the rehabilitation and development of enabling urban environmental infrastructure, through innovative approaches for green and climate-resilient urban development. Output 3 includes six components: (i) construction of 4.9 km of eco-embankments; (ii) sponge city, including 10 roads (13.95 km); (iii) Yannan Lake wetland restoration at downstream of the SZHTDZ; (iv) landfill closure and conversion to public green park; (v) development of a green wedge as a natural separator between residential and industrial areas; and (vi) preservation of bare hills. The designs and

[21] A rating weight will be assigned to equipment that meets green procurement standards during bid evaluation.

construction methods are introduced below.

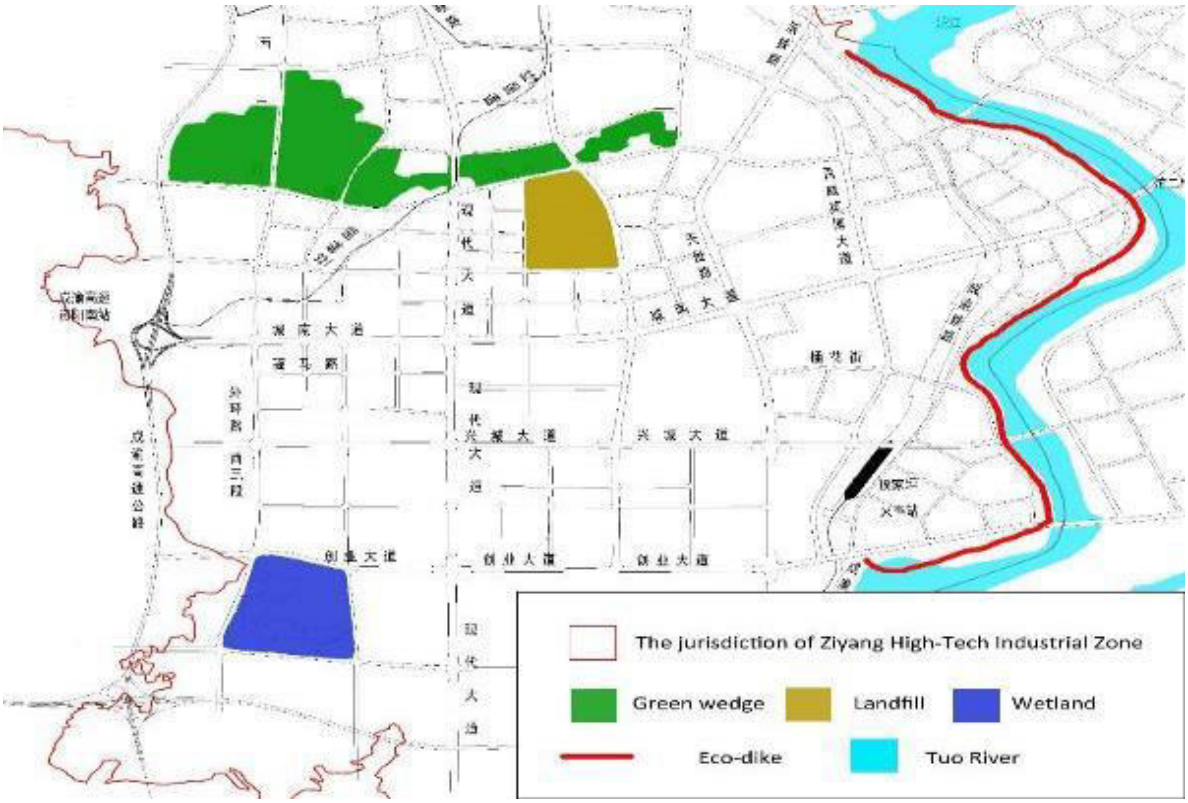


Figure III-3: Infrastructure Locations

1. Component 3-1: Eco-Embankment along the Tuo River (Ziyang Section)

63. An eco-embankment uses landscaping to reduce wave action that might surge over the embankment and to provide soil stability for reducing erosion. The proposed embankment is 4.9 km in length on the left side of the Tuo River, starting at Jiangnan Peninsula and ending at Wangjiaping.[22] It will be designed based on the once-in-50-years flood control standard (i.e., 2% probability of occurrence). The scope of proposed embankment is shown in Figure III-4.

[22] Left side and right side are determined by the direction the river is flowing.

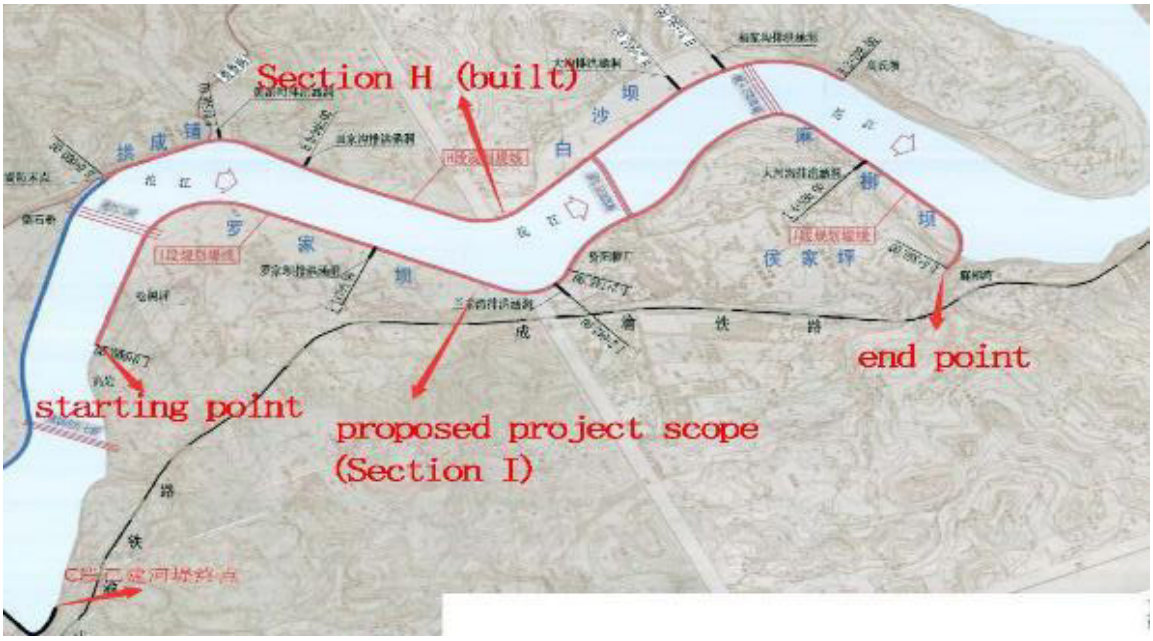


Figure III-4: The Location of Proposed Embankment and Existing Sections in the Tuo River

64. **Existing embankments of the Tuo River (Ziyang section).** The urban area of the Ziyang Municipality is at the middle reaches of the Tuo River with the gently river course, the catchment area is 11,168 km^2 (40% of the whole watershed of the Tuo River). The flow during the flood period is heavy which maximum flow within the urban area achieves 11,300 m^3/s and the flood flow with the 20-year recurrence is also as high as 8,910 m^3/second (s). Due to the incomplete flood control system, the Heping Road, the Jianshe Road, and other roads are located at the zone of mean annual flood level which heavily suffered from the flooding disaster. In addition, the river width at the Tuo River Bridge is only 190 m that makes a bottleneck in flooding, increasing the height of upstream back-water during the flood, and worsening the flooding disaster within the urban area.

65. The total length of the Tuo River embankment in the Ziyang section is 29.8 km. Before 2000, there was no embankment along both sides of the Tuo River. Based on the Tuo River (Ziyang section) Flood Control Planning (revised in 2011),[23] the flood control standard of embankment is once-in-50-years. By the end of 2017, 16.44 km embankment has been constructed (section A-E and H in Table III-3); while the rest of the embankment is 13.36 km, in which 8.0 km is being constructed by domestic funding (sections F and G); and the section I (5.36 km) is the scope of this ADB-financed project component (4.900 km + 0.458 km natural highland, Section I in Table III-3).[24] The proposed cross-section and view sketch are shown in Figure III-5 and Table III-6.

Table III-3: Summary of Embankment in the Ziyang Urban Area

Section	Flood Control Standard (Return Period)	Protected Area	Length (km)	Start - end	Remark
A	50-year	Old Town	1.060	Tuo River Bridge ~ Huangshanxi Bridge	Built
B	50-year	Jiuqu River	3.811	Huangshanxi Bridge ~ Aizi Bridge	Built
C	50-year	Old Town	0.644	Huangshanxi Bridge ~ Zhuanwanzi	Built

[23] The planning was developed by the Sichuan Provincial Hydropower Survey Research Institute (SHSRI) and approved by the Yangtze River Water Conservancy Commission under the PRC's Ministry of Water Resources.
[24] The total length of the proposed project component is 6.5 km of riparian ecological landscaping corridor, including 4.9 km of eco-embankment.

Section	Flood Control Standard (Return Period)	Protected Area	Length (km)	Start - end	Remark
D	50-year	Old Town	2.502	Tangfangwan ~ Tuo River Bridge	Built
E	50-year	East Bank of Tuo River	4.690	Liziyuan ~ Shi Bridge	Built
F	50-year	East Bank of Tuo River	4.464	Ganxigou ~ Liziyuan	To be built
G	50-year	Northern Urban Area	3.543	Huanglianju ~ Sunjia Yuanzi	To be built
H	50-year	East Bank of Tuo River	3.728	Daoshi Bridge ~ Gaoshipo	Built
I	*50-year*	*Southern Urban Area*	*5.358*	*Gaoyan ~ Maliuwan*	*This project*

Source: Domestic environmental impact assessment report.

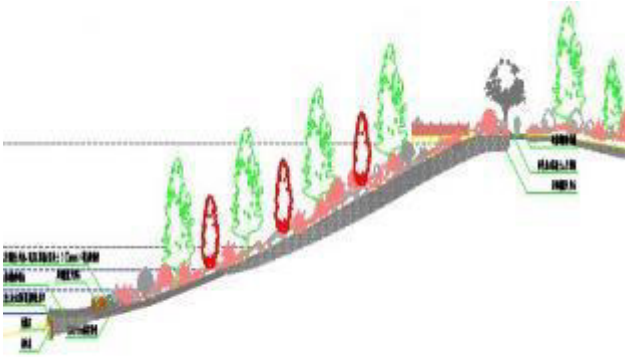


Figure III-5: Cross-section of eco-embankment along Tuo River

Figure III-6: Aerial view sketch of the eco-embankment

Source: Feasibility study report.

66. The three types of embankment were assessed during the TRTA and the FSR preparation: (i) vertical and heavy-weight retaining wall; (ii) slope-type roller compacted sand gravel embankment; and (iii) ecological embankment (i.e., eco-dike). The eco-embankment was selected (Figure III-5, and the alternative analysis was presented in Section VI). The hydraulic analysis calculates an embankment height from 352.87 m to 357.75 m and an additional 0.97 m to 1.24 m for safety. The base of the embankment is hardened and buried to depth of 3 m to prevent scour, and the soil conservation plan has been prepared.

2. Component 3-2: Sponge City

67. The sponge city design absorbs rain water, making rain water available for later use. It does this by replacing impermeable surfaces with porous pavements and by developing landscaping that captures storm water runoff. The storm water runoff can be naturally filtered by the soil as it reaches the groundwater aquifers. The scope of this component includes 10 existing roads with the total length of 13.95 km and the total area of 26 km^2. The component involves constructing sunken greenbelt with a total area of 180,950 m^2. According the updated FSR and DEIA, after completion of the component, about 212,150 m^3 storm water runoff discharging into the Tuo River will be reduced annually, and the annual reduction of pollutant loads of SS, CODcr, TN, and TP to the Tuo River are 50.92 tons, 27.50 tons, 3.06 tons, and 0.40 tons, respectively (Figures III-7–III-9), (footnote 10).

Table III-4: Summary of Sunken Green Belts on Roadsides

No	Road	Length (m)	Width of Green belt (m)	Area of Green belt (m^2)
1	Xiandai Avenue	840	15	12,600
2	No. 1 Section of Tiantai Road	2,000	20	40,000
3	No.2 section of Tiantai Road	1,150	3	3,450
4	No. 3 section of Tiantai Road	500	6	3,000
5	Longma Road	2,000	18	36,000
6	Zhenxing Road	1,000	5	5,000
7	Chaungye Road	260	15	3,900
8	Xingsheng Road	800	5	8,000
9	Xingwang Road	1,300	15	39,000
10	West Section of Xingcheng Road	1,000	15	30,000
	Total	**13,950**		**180,950**

Source: Feasibility study report.

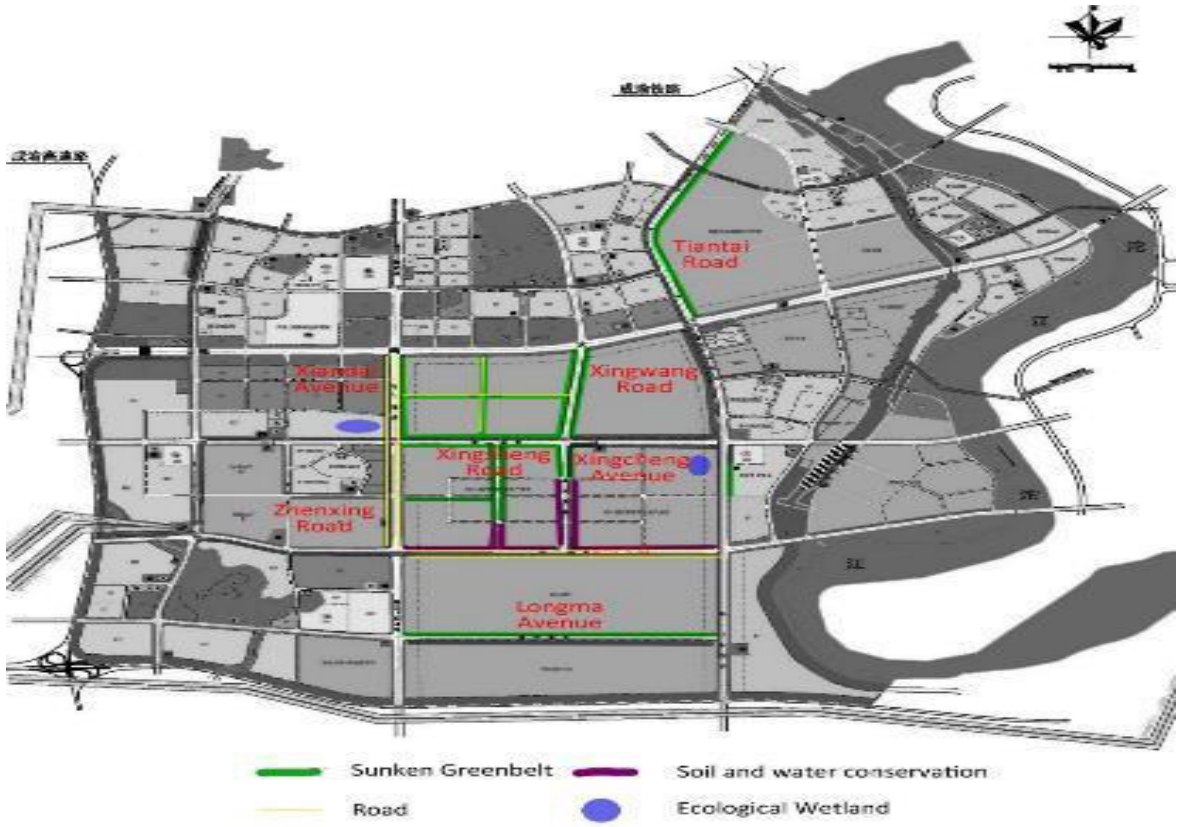
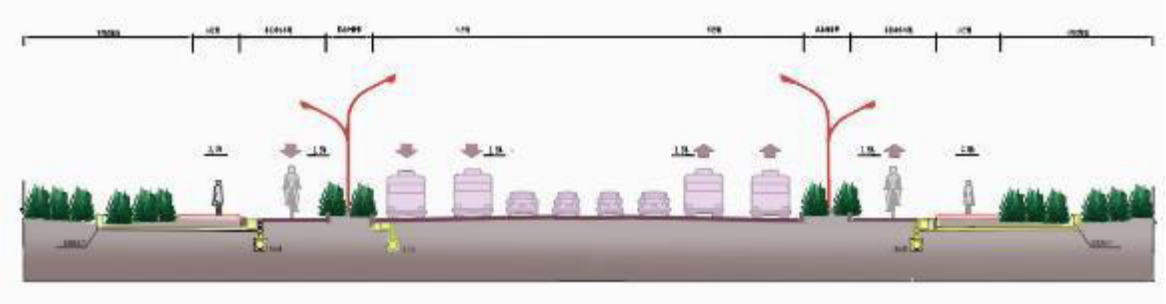
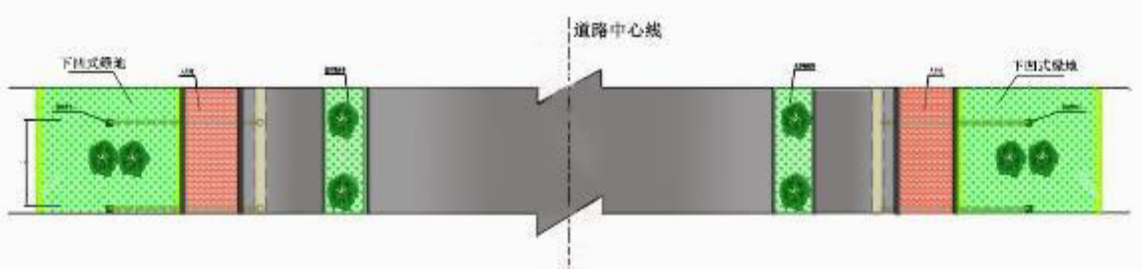


Figure 7: The Scope and Locations of Sponge City Constructions (in green)





Figures 8+9: The Designed Cross Section of the Sponge City Roads with Sunken Green Belt

68. For the 13th FYP period, the PRC will support the development of sponge cities by strengthening flood control, drainage, and temporary reservoirs, as well as ecological infrastructure such as parks and green spaces. The State Council sets objectives requiring that by 2020, over 20% of the area in each of the 658 urban centers will achieve a rainwater absorption and utilization rate of 70%.[25]

3. Component 3-3: Yannan Lake Wetland

69. The component includes the ecological restoration of the Yannan Lake and the Kongzi Creek (the channel between the upstream Yingjie Reservoir and the Yannan Lake). The areas of existing Yannan Lake and Kongzhi Creek are 205 *mu* (13.67 ha) and 91 *mu* (6.07 ha), respectively; the depth of the lake is 1–3 m, and the total catchment area is 4.5 km^2; the length of Kongzi Creek is 3,000 m, with the width of 10–33 m and water depth of 1–2 m. The designed wetland area is from the outlet of the Yingjie Reservoir to the outlet of the Yannan Lake with the total area of 386 *mu* (25.73 ha), including 296 *mu* (19.73 ha) of water surface area. Upon completion of the component, the water quality of the Yannan Lake and the Kongzi Creek will be improved from worse than Grade V to Grade IV of GB3838-2002 in the first phase (2020) and reach to Grade III in the second phase (2025).

70. Yannan Lake gets its water from the upstream Yingjie Reservoir (about 70%) and storm water runoff (30%) within the catchment area. The functions of the associated Yingjie Reservoir are irrigation, flood control, and aquaculture. According to the baseline monitoring, the water quality of the Yingjie Reservoir met the Grade V Standard of GB3838-2002; but that of Yannan Lake and Kongzi Creek both exceeded the Grade V standard, with the major pollutants of NH_3-N and TP, which indicates some pollution sources surrounding the lake and the creek.

71. The major impact factors to the performance of the proposed Yannan Lake wetland restoration include (i) controlling and eliminating pollution sources within the catchment area of the lake, (ii) maintaining and improving the water quality and quality of the upstream Yingjie Reservoir, and (iii) establishing and strengthening the operation and management of the wetland after the construction completion. Based on the site investigation conducted by the DEIA institute from November to December 2017, there were point and nonpoint source pollution from the upstream and surrounding area that were discharged into the Yannan Lake and the Kongzi Creek, which include the following:

(i) Due to the municipal sewer network not being connected yet with the villages of Longdang and Qinglong nearby the lake, the domestic wastewater flowed into the lake and creek without any treatment;

(ii) Agricultural nonpoint source pollution flows into the lake via the surface runoff. The lake is surrounded by 758 *mu* of farmland for planting rape (144 *mu*), fruits

[25] General Office of the State Council. 2015. "*Guiding Opinions of the General Office of the State Council on Promoting the Construction of Sponge Cities*." 16 October 2015. http://www.gov.cn/zhengce/content/2015-10/16/content_10228.htm

(362 *mu*), rice (40 *mu*), corn (100 *mu*), and other vegetables (112 *mu*); and

(iii) Wastewater from livestock and poultry farming were directly discharged into the lake without treatment. According to the investigation, there were 23 livestock and poultry farming households raising 3,730 pigs, 7 sheep, 5,100 chickens, and 3.5 *mu* of fish ponds.

72. Based on the investigation in ADB's fact-finding mission, (i) by the end of March 2018, 13 among the 23 livestock and poultry farming households have be already shut down or relocated along with the development of "China Dental Valley"; and the remaining 10 households will be resettled in 2019; (ii) the 3.5-mu fishponds will be converted to wetland before the end of 2018; (iii) the 758-mu farmland will be converted to forestry by the end of 2019; and (iv) the municipal sewer pipes will be connected to the 41 households in the two villages by the end of 2018, and 41 septic tanks will be constructed for the households by using the government's fund for prevention of fecal contamination to the wetland. ZMG issued the commitment in March 2018 that before the wetland construction, all the pollution sources will be shut down or eliminated to meet the national standard.

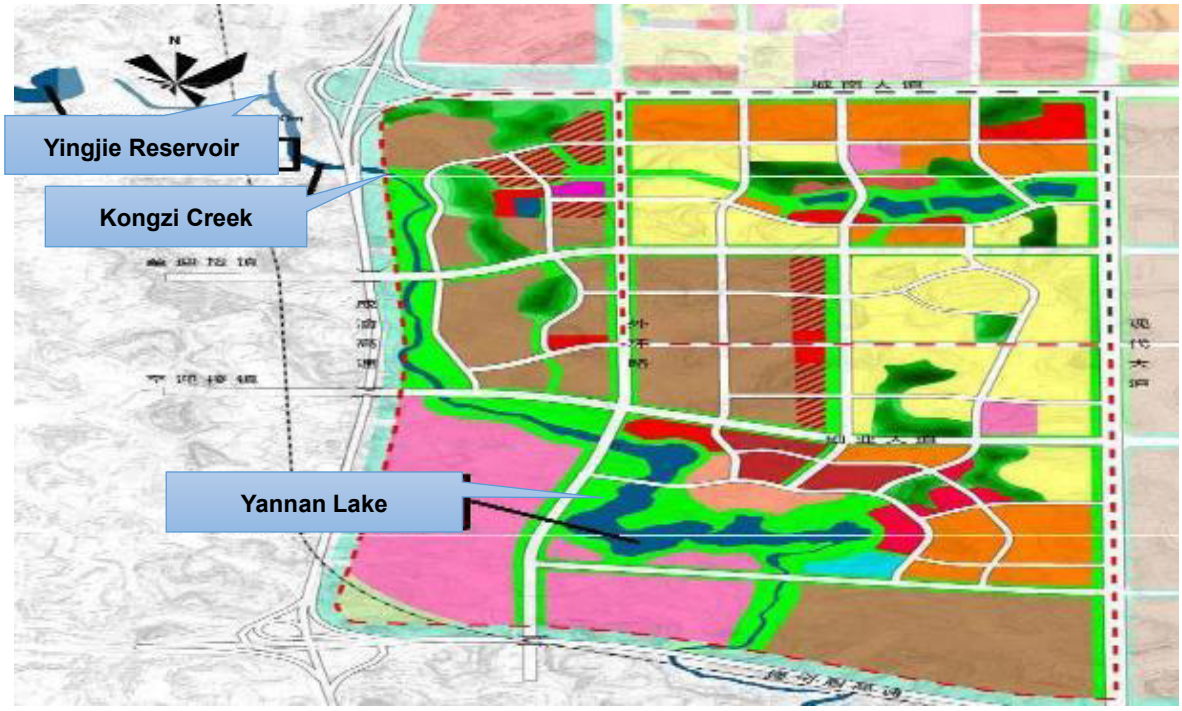


Figure III-10: Location of the Yannan Lake and Associated Yingjie Reservoir

73. For the water quality and quantity of the associated Yingjie Reservoir, ZMG officially confirmed that all the fishponds with the catchment of reservoir will be shut down before the end of 2018. Based on the provincial water source allocation plan, the annual water diversion from the Dujiang Weir in Chengdu City via the Jianzhi Trunk Canal are 2.09 million m^3 by 2020, and 3.35 million m^3 by 2025, respectively. After the completion of the Yannan Lake wetland restoration, an operation team with 10 staff will be formed under the SZHTDZ.

74. **Invasive alien species control.** An invasive alien species, Apple snail (*Pomacea canaliculate*) was discovered in the Yannan Lake and the Kongzi Creek. The status is that the pests are sporadically distributed, and there have not been any outbreaks yet. Apple snails are native to South America and have become widely distributed agricultural and environmental pests in southern and southwestern PRC since their introduction from Argentina in the 1980s. However, only since 2010 have researchers recognized that at least two species, *P. canaliculata* and *P. maculata*, are present in the PRC. Impacts of apple snails have been

extensively documented since 2010, which shows that such snails are harmful to rice growth; have direct and potential effects on aquatic biodiversity; and can even spread human disease. With some successful cases in the PRC's Jiangsu and Zhejiang provinces, the application of duck grazing patterns to control apple snails is an effective and promising biological control method. The stocking density is 20 ducks per hectare.

75. The main activities and process before and during the construction include (i) shutting down of all the pollution sources, both point and nonpoint; and wastewater discharge from adjacent village (resettlement); (ii) ecological dredging with the total dredged sediment of 98,000 m^3 (wet sediment with the water content of 90%) for removal of inner pollutants. The sediment drying ground and mitigation measures are described in Section V; and (iii) construction of the pre-tank, sunken green areas and ecological embankment as well as artificial wetland, and ecological buffer strips along the lake and the creek. The major activities and facilities are listed in Table III-5, while the technical process of the ecological restoration is shown in Figure III-10.

Table III-5: Designed Activities and Constructed Facilities for the Wetland Restoration

No.	Activity/Process	Quantity of Construction
1	Shut down point and nonpoint source pollution before June 2019	a) Shutting down and resettlement of the livestock farms, including 3,730 pigs, 7 sheep, 5,100 chickens, and 3.5 *mu* of fishponds (most of them have been completed); b) Restoration of 758 mu of farmland to wetland and grassland and/or forest; and c) Connection of municipal sewer pipe to 41 households in the catchment
2	Removal of inner pollutants	Ecological dredging of 9,8000 m^3 (90% water content).
3	Ecological restoration	a) Construction of 2 pre-tanks (666 m^3) at the Kongzi Creek for inflow water pre-treatment; b) Construction of 1,148 m^2 sunken greenfield; c) Installation of 1215 m^3 ecological rock filled gabion; d) Construction of 9,000 m^2 wetland on lakeside; e) Plantation of 9,855 m^2 emergent aquatic plant, 862 m^2 floating-leaved macrophyte, 162,865 m^2 submerged plants, and 4,250 m^2 emergent aquatic plant; f) Putting in 197,400 m^2 benthos; g) Construction of 1,846 m^2 ecological floating island; and h) Application of duck grazing patterns to control apple snails.

Source: Feasibility study report.

76. The process of pre-tank is shown in Figure III-11 and Table III-12; the technical process of the wetland ecological restoration is in Figure III-13; the profile of wetland, the sunken greenbelt, and the wetland embankment designs, etc. are shown in Figure III-14, Table III-15, and Table III-16; while the ecological dredging sketch are in Figure III-17 and Table III-18.

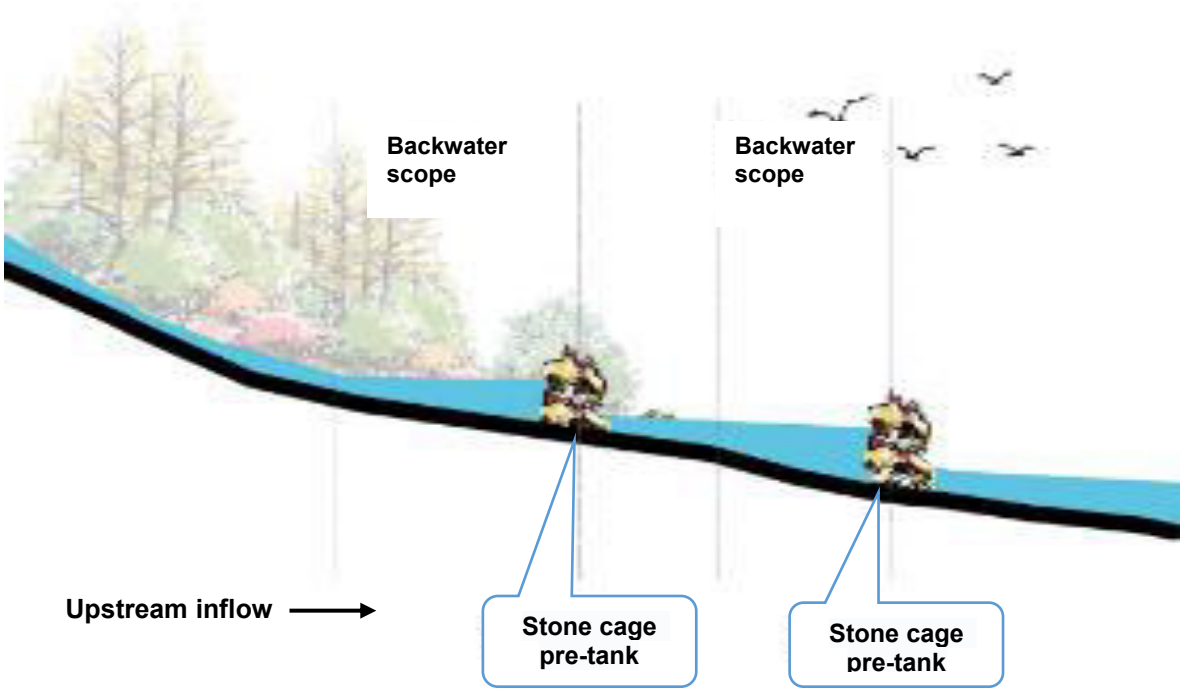


Figure III-11: Sketch of the Pre-tank on the Kongzi Creek

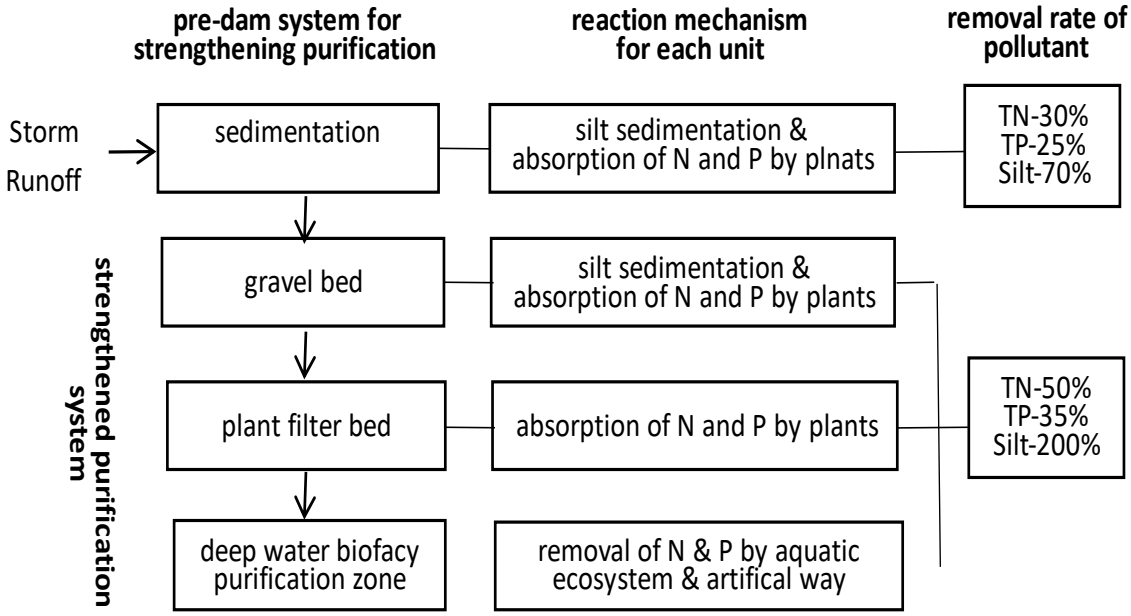


Figure III-12: Technic Process of the Pre-tank on the Kongzi Creek

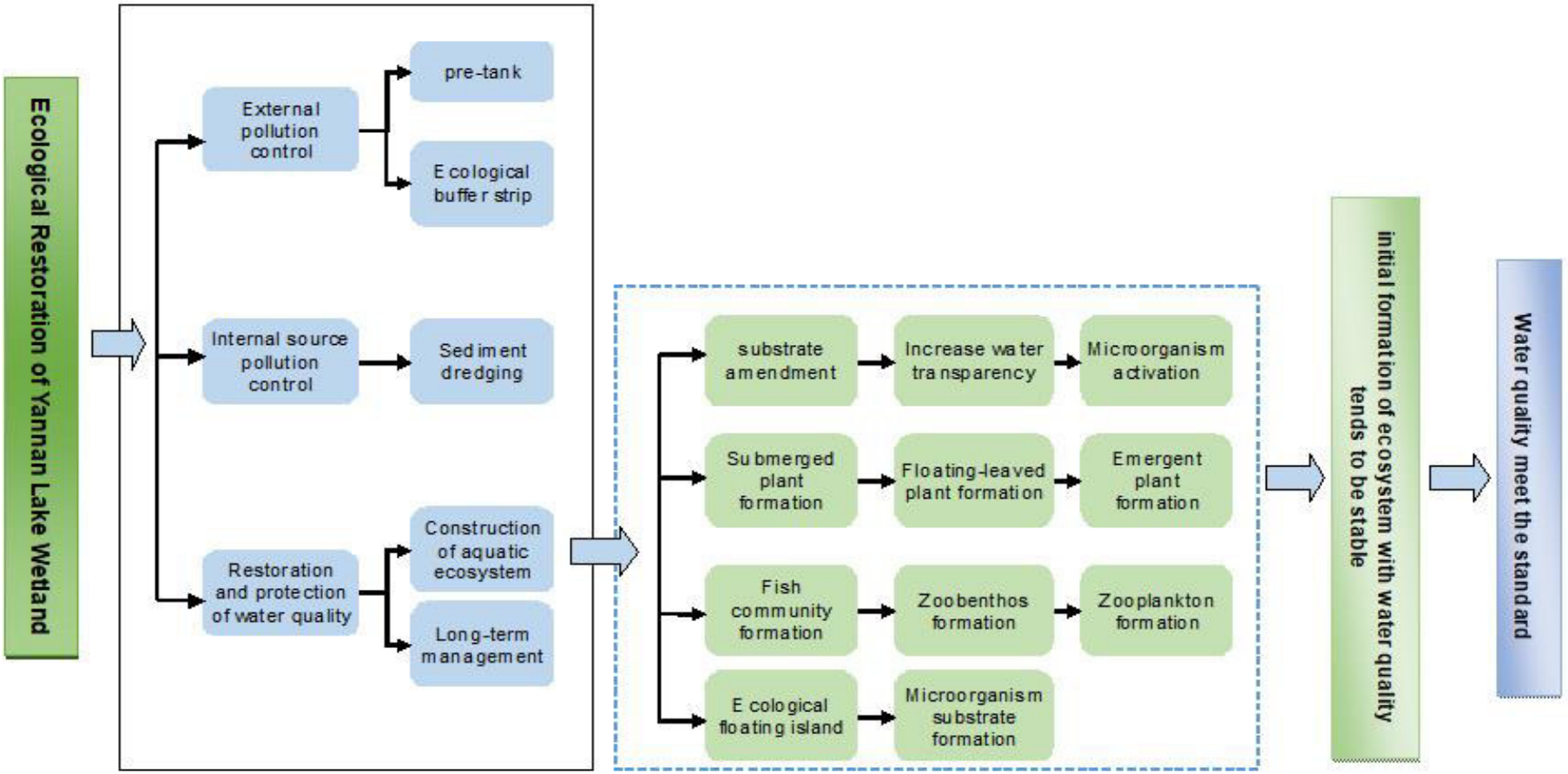
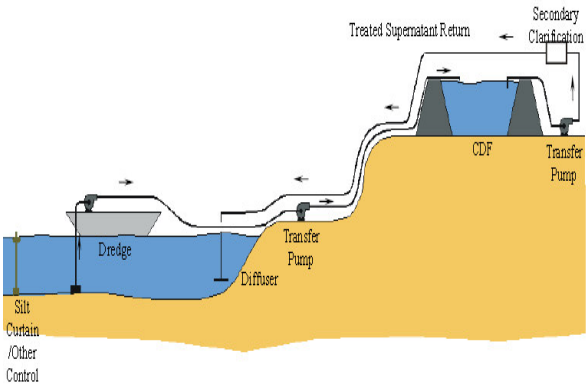


Figure III-13: The Technical Process of the Yannan Lake Wetland Ecological Restoration

Figure III-14: Profile of the Yannan Lake Wetland

Figure III-15: Sunken Greenbelt for Nonpoint Source Pollution Control

Figure III-16: Rendering of Eco-Embankment



Figures III-17 and III-18: Ecological Sediment Dredging

4. Component 3-4: Landfill Closure and Restoration

77. **The existing landfill.** The situations of the existing Ziyang Zhongshan Landfill are (i) the current daily disposal capacity is 400 tons, including the domestic wastes from the Ziyang Municipality's urban area (Yanjiang District) and the towns surrounding the urban area; (ii) the landfill was put into operation in 2003, and the estimated total landfilled rubbish is about 1.4 million tons; (iii) the landfill is planned to be closured in 2020; (iv) landfill leachate is about 180 m^3/day with the CODcr concentration of around 8,000 mg/L, which is being treated by the existing Leachate Treatment Facility (LTF, with the treatment process of anaerobic tank +

nitrifying reactor + microfiltration + RO).[26] To provide continuity in solid waste management collection, transport, treatment, and disposal, a waste-to-energy (WtE) plant is planned to be commissioned in 2020; and the landfill will be closed and restored.

Figure III-19: The Status of Landfill

Figure III-20: The Existing Leachate Treatment Facility

78. According to the groundwater baseline monitoring (Section IV), the groundwater at downstream and surrounding the landfill is more or less polluted by the landfill operation. For ensuring the groundwater safety and preventing leachate leakage, an anti-seepage grouting curtain process (25-m deep, 200-m wide and the 16 m^3/day leachate pumping station) was proposed in the updated FSR.

79. Since in the FSR stage, only one-time (four sampling locations) groundwater quality sampling and monitoring was conducted, without any geological exploration. ZMG has already officially promised that in the detailed engineering design stage, a geological exploration and comprehensive groundwater monitoring surrounding the landfill site shall be conducted, based on which the depth and width of the vertical anti seepage grouting curtain, the pumping station capacity, and treatment method for the landfill leachate shall be properly designed.

80. The activities before and during construction include (i) the specific groundwater quality monitoring to identify if the surrounding groundwater is polluted by the landfill or not, and pollution situation; (ii) the safety inspection and identification for the existing rubbish dam; (iii) landfill area leveling and capping; (iv) landscaping, providing drainage and vegetation on the 37-ha landfill area; and (v) keep ongoing landfill gas extraction and leachate treatment which may need to continue operation for 13–20 years after the landfill closure; and (vi) developing this 37-ha tract of land into a green public open space area involves planting vegetation.[27]

Figure III-21: Scope of Existing Landfill

Figure III-22: Existing Landform of Landfill

[26] Put in operation in 2016.
[27] The FSR estimated after 13 years of the landfill closure.

Figure III-23: Working Sketch of the Landfill Area after Closure and Restoration

5. Subcomponent 3-5: Development of a "Green Wedge" as a Natural Separator between Residential and Industrial Areas

81. The existing mountain and gully area is a natural barrier between residential and industrial areas, forms an "urban green lung", improves the urban environment, and can also be a public place for citizens to enjoy nature.

82. The total area is planned to be 123 ha. The eco-restoration (e.g., return cultivated areas to forest; restore illegal dump sites) is 110 ha (90%) and the promotion development component (roads, parking, service-oriented facilities such as toilets) about 13 ha. The green wedge is planned to spatially coordinate with the green landscaping of the closed landfill and the Yannan Lake wetland to form an area for the construction of new city green space.

83. It is essential to use local vegetation and not foreign species that may become invasive and disrupt or displace local plants and trees. The DI in the detailed engineering design stage will consult with the Provincial and Ziyang Forestry Bureaus to confirm suitability of proposed vegetation.

Figure III-24: Location of "Green Wedge"

Figure III-25: Overview of "Green Wedge"

6. The Subcomponent 3-6 Ecological Preservation of Bare Hills

84. Improper excavation for roads, buildings, and borrow earth have resulted in earth mounds 30–80 m high, with bare, steep slopes that are vulnerable to soil erosion and have potential landslide. Increased precipitation and more extreme storms will result in even more erosion and perhaps sudden subsidence with landslide. The responsibility for the mistakes has been taken by ZMG in writing.

85. The proposed works at nine sites will provide stabilization and ground cover and reduce vulnerability to weather events. The work involves ecological greening restoration, earth shaping as needed, and drainage: (i) conducting slope treatment and ecological restoration for 9 bare hills at the SZHTDZ; (ii) proposed measures, including direct spray-seeding (grass seed or shrub seed) for ecological restoration, spray-seeding after improving the slope stabilization for ecological restoration, and anchoring and shotcreting with covering of vines plants and grass.

Table III-6: Summary of Proposed Bare Hills to be Preserved

No.	Hill	Slope (m)		Type	Repair measures
		length	height		
1	North Huaishu Road exit	100	30	Sandy Mudstone cutting slope	Anchor spray concrete + converting by parasites
2	Tiangong Mountain on Outer Ring Road	200	30	Sandy Mudstone cutting slope	Slop finishing + CF net planting grasses
3	No.10 Group in Zaishan Residential Community	300	30	Heavy weathered mudstone slope	Slop finishing + CF net planting grasses
4	No. 6 Group in Zaishan Residential Community	300	30	Heavy weathered mudstone slope	Slop finishing + CF net planting grasses
5	No. 6 and No.8 Groups in Hongyan Community	800	40	Filling earth by construction excavation	Slop finishing + CF net planting and sowing shrub-grass vegetation
6	No. 11 Group of Wuxian Village	1,500	30	Filling earth by construction	CF net planting and sowing shrub-grass vegetation + 1400

No.	Hill	Slope (m)		Type	Repair measures
		length	height		
				excavation	m drainage ditch
7	North of Chuangye Avenue	1,350	15	Heavy weathered mudstone slope	CF net planting and sowing shrub-grass vegetation
8	Xingwang Road	650	15	Heavy weathered mudstone slope	CF net planting and sowing shrub-grass vegetation
9	Xingsheng Road	460	15	Heavy weathered mudstone slope	CF net planting and sowing shrub-grass vegetation

Source: Feasibility study report.

Figure III-26: Current Situation of Bare Hill at Tiangong Hill Area

Figure III-27: Current Situation of Bare Hill at Xingsheng Road

Figure III-28: Coconut fiber (CF) net for slop protection

Figure III-29: Status after restoration of a bars hill (domestic funded work)

Source: Feasibility study report.

C. Associated Facilities

86. Associated facilities are those which are not funded by the project but whose viability and existence depend exclusively on the project and whose operation and services are essential for successful operation of the project (SPS, 2009). A due diligence for the associated facilities of the project was carried out by the TRTA consultants and the DEIA institute based on the requirement of ADB's SPS (2009). The only identified facility associated to this project is the Yingjie Reservoir, which supplies about 70% of water flowing into the Yannan Lake wetland.

87. **Associated Yingjie Reservoir.** Yingjie Reservoir is located at the Yingjie Town of

Yanjiang District, 3.0 km upstream of the proposed Yannan Lake wetland. The reservoir was built in 1971, and it was majorly maintained and strengthened during 2002–2003. The water quality of reservoir meets Grade V of the Surface Water Quality Standard (GB3838-2002) according to the baseline monitoring in 2017. The reservoir is being managed by the Yanjiang District Water Resources Bureau, with the completed management system including the environmental management regulation. The major parameters of reservoir are listed in Table III-7 below.

Table III-7: The Parameters of the Associated Yingjie Reservoir

No.	Item	Parameter
1	Size of reservoir	Grade Small-1
2	Designed capacity	2.05 million m^3
3	total catchment area	7.4 km2
4	Average annual runoff	2.14 million m^3
5	Function of reservoir	Flood control and agriculture irrigation
6	Year of completion	1974
7	Date for maintenance and strengthening engineering	Sep. 2002 to April 2003
8	Crest elevation	408.4 km ASL
9	Width of dam crest	3.2 m
10	Type of dam	homogeneous earth-filled dam
11	Normal water level	406 m ASL
12	Designed flood level	407.45 m ASL
13	Maximum dam height	13.4 m
14	Length of dam	254 m
15	Maximum discharge flow	46 m^3/s
16	Flood control standard	0nce in 30 years
17	Anti-seepage pattern of dam foundation	Cutoff trench
18	Grade of dam safety	Grade II (basically safe with some weaknesses)
19	Assessment authority of dam safety	Dam safety assessment experts for Sichuan Provencal Water Resource Department
20	Management agency	Yanjiang District Water Resources Bureau

Source: Due diligence by the transaction technical assistance consultants and the domestic environmental impact assessment institute.

IV. DESCRIPTION OF THE ENVIRONMENT (BASELINE)

A. Location and Setting

88. The project area is located in the Yanjiang District of the Ziyang Municipality, Sichuan Province, PRC (Figures V.1). Ziyang Municipality (N29°15'–30°17' E104°21'–105°27'), with the total area of 5,747 km^2, is in the middle-east of Sichuan Province and middle of Sichuan Basin.[28] It borders the Chengdu and Deyang cities in the north, the Meishan City in the west, the Neijiang City in the south, and the Chongqing Municipality and Suining City in the east. The city, about 87 km from Chengdu City and 257 km from Chongqing Municipalilty, is an important member of the Chengdu–Chongqing Economic Belt (Figures V.2) and the Chengdu–Chongqing city clusters, which plays a leading role in a new round of accelerated development and "multi-point multi-pole" support for Sichuan Province.[29] In 2016, the total population and GDP of the municipality was 3.5 million and CNY94.34 billion, respectively.

Figure IV-1: Location of Yanjiang District in Ziyang Municipality

Figure IV-2: Distances from Ziyang to Chengdu and Chongqing

89. Ziyang was designated as a county as early as in the Han Dynasty (135 BC), and it was officially established as a prefecture-level municipality in 2000. The municipality is in the upper reaches of the Yangtze River. About 10 km of the Tuo River, which is a primary tributary of upper Yangtze River, passes through the city. Ziyang is an important part of the Tuo River ecological belt and the YREB.

90. The municipality is rich in historical and cultural remains and beautiful natural scenery. Famous tourist attractions include the Huaxi Valley, Longquan Lake, the Buddha of Banyue Mountain, Wufeng Mountain Forest Park, Huayan Cave, Pilu Cave, and Chen Yi's Former Residence. Because the project area is in the urban area, no cultural heritage or archaeological sites are known within 5 km of the project area.

91. The Yanjiang District (N29°51'–30°17'7", E104°26'7"–105°3'5") is a county-level administrative area located in the southwest of the Ziyang Municipality, with a total area of 1,632 km^2. It borders the Lezhi County in the northeast, the Jianyang City in the north, and the Renshou County in the west. In 2016, the total population and GDP of the Yanjiang District was 1.1 million and CNY44.55 billion, respectively. The district, where ZMG is located, is the political, economic, and cultural center of the municipality. The district administers 4 subdistricts, 19 towns, and 3 villages.

[28] There are four large basins in the PRC, i.e., Junggar, Qaidam, Sichuan, and Tarim basins.
[29] The most important economic belt on the upstream of the Yangze River.

B. Geography, Topography, and Geology

92. The geological structure in the Yanjiang District is neocathaysian tectonic system which belongs to the middle Sichuan fold belt of the Sichuan subsiding belt. Hills form the local morphological character with the elevation between 390 m and 460 m. The geological setting in the area is simple with gentle attitude of rock-formations, and the stability is good due to the fact that there is no deep fault that passed through. The tectonic movement and seismic activity is weak. Based on Guideline on Seismic Design of Building (GB50011-2001) and Seismic Parameters Zoning Map of China (GB18306-2015), the seismic precautionary intensity of the district is 6 degrees; and the value of design basic earthquake acceleration is 0.05 g. In general, the district is in the section in favor of buildings standing against the earthquake with good stability, and no specific unfavorable geological process is found in the area which is suitable for the building construction.

C. Climate

93. Due to south-eastern and south-western monsoon and its topography, the Yanjiang District has a subtropical and humid monsoon climate with plenty of rainfall and four distinct seasons. The spring is dry with little precipitation, while the summer is hot with abundant precipitation. The cloudy days are more often appeared than sunny days, with the high air humidity and low temperature difference between day and night. The average annual precipitation is 950 millimeters (mm), which is distributed unevenly in four seasons. The annual average sunshine and temperature is 1,300 hours and 17°C, respectively. The annual average wind speed is 1.70 meters per second (m/s), with the maximum speed of 22 m/s. The average temperatures in summer (August) and winter (January) are 26.5℃ and 6.5℃, respectively. The annual average humidity of about 80%; and extreme maximum and minimum temperatures are 40.2℃ and -5.4℃, respectively.

94. **Climate change trend—temperature.** The annual mean temperature has increased 0.15℃/10a in the area during 1961–2015, which was lower than the warming rate for the PRC's average of 0.22℃/10a. The annual maximum and minimum temperature have increased at a warming rate larger than annual mean temperature with about 0.08℃/10a (Figure IV-3). The decadal changes showed cold 1980s compared with other decades. The warming during 1990–2015 was successively higher than any previous decades.

95. The highest monthly maximum temperature was 31.4℃ in August during 1961–1990, while it was 31.6℃ in July during 1991–2015. The changes during 1961–1990 and 1991–2015 for monthly mean temperature and monthly minimum temperature show a warmer February, March, and April, especially warming with monthly minimum temperature. However, the changes in the monthly maximum temperature showed a decrease in December and January during 1991–2015. The monthly temperature increase in August was relatively small compared with other months.

96. **Projected temperature change.** Dataset of climate change projection used in the TRTA consultant's report was derived from the simulation based on the Beijing Climate Center Climate System Model version 1.1 (BCC_CSM1.1)–regional climate model (RegCM4.0).[30] Driven by the global model, the BCC_CSM1.1, climate change over the PRC in the 21st century is simulated by a RegCM4.0 under the new emission scenarios of the representative concentration pathways (RCPs)— RCP4.5 and RCP8.5. The dataset is based on a period of transient simulations from 1950 to 2099, with a grid spacing of 50 km.

[30] Gao X-J., Wang. M-L., Filippo. G. 2013. *Climate Change over China in the 21st Century as Simulated by BCC_CSM1.1-RegCM4.0. Atmospheric and Oceanic Science Letters*.

97. In the Ziyang Municipality, projected changes of annual mean temperature under RCP4.5 and RCP8.5 scenarios during 2015–2099 show that there will be substantial warming in the future. The increasing trend during 2015–2099 will be higher than observed warming trend during 1961–2015 with about 0.38℃/10a annual mean temperature, 0.39℃/10a for annual maximum temperature, and 0.36℃/10a for annual minimum temperature. In general, greater temperature rises for the late 21st century, and greater values under RCP8.5 compared to RCP4.5 are found. As shown in the figure, warming follows a similar magnitude prior to 2050 under RCP4.5 and RCP8.5, indicating that the warming is less scenario dependent in the first half of the 21st century. In later half, however, the temperature continues to rise almost linearly under the RCP8.5 scenario; while quasi stabilization is found for RCP4.5 (Table IV-1).

Table IV-1: Projected decadal temperature changes in Ziyang (baseline: 1986–2005)

Decade	Tmean(℃)		Tmax (℃)		Tmin(℃)		PCP (%)	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
2020s	0.7	0.8	0.8	0.8	0.7	0.8	-1	4
2030s	0.8	1.1	0.8	1.2	0.8	1.0	3	-4
2040s	1.0	1.4	1.1	1.5	1.0	1.3	2	-1
2050s	1.1	1.9	1.3	2.0	1.1	1.8	1	-2
2060s	1.4	2.2	1.5	2.3	1.4	2.1	-3	-2
2070s	1.4	2.4	1.6	2.5	1.4	2.4	-1	2
2080s	1.5	2.9	1.6	2.9	1.5	2.8	0	0
2090s	1.4	3.5	1.5	3.7	1.4	3.3	5	-6

Source: Transaction technical assistance climate change consultant.

98. **Climate change trend—precipitation.** The average annual total precipitation fluctuated with a decreasing trend with 40 mm/10a. The changes in decadal precipitation showed that there was one wet period (1960s), (Figure 3a). There is a decreasing trend in annual rainfall day with 8.8 day/10a. The changes in decadal rainfall day shows there are consecutive 3 decades (1980s, 1990s, and 2001–2015) with rainfall days less than the average rainfall days during 1961–1990, and there is 28.8 days less for 1990s (Figure IV-?).

99. The distribution and magnitude of monthly precipitation has changed in the Ziyang Municipality. The largest monthly precipitation was about 220 mm in July during 1961–1990, while it was 176 mm in August during 1991–2015. There was general decrease in monthly precipitation except February, March, and June. The decreases in July and September–November were larger than the others (Figure 4).

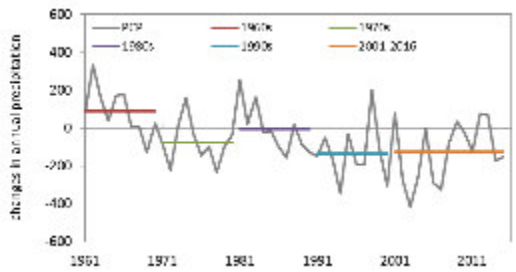


Figure IV-3: Annual and decadal precipitation in Ziyang during 1961-2015

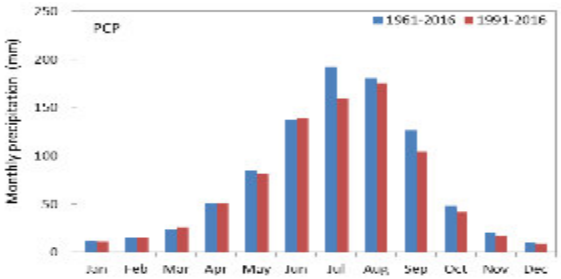


Figure IV-4: Monthly precipitation in 1961-1990 and 1991-2015 in Ziyang

Source: Transaction technical assistance climate change consultant.

100. **Projected precipitation change.** As shown in Table IV-2, the projected decadal precipitation changes for the Ziyang Municipality show an opposite condition under RCP4.5 and RCP8.5. In 2030s, the projected decadal precipitation for RCP 4.5 will increase about 3% but will decrease about 4% for RCP8.5; while in 2090s, the projected decadal precipitation will be increase about 5% for RCP4.5 and will decrease about 6% according to RCP8.5.

101. In the Ziyang Municipality, there is no clear trend under RCP4.5; and a slight decreasing trend under RCP8.5 for annual precipitation toward the end of the century (Figure IV-3 and Table IV-2). Towards the end of 21st century, there will be decreasing trend for annual precipitation under RCP 8.5; while no clear trend under RCP4.5.

Table IV-2: Projected daily rainfall changes in Ziyang during 2021–2050

(baseline: 1986–2005, unit: %)

Probability of Exceedance (%)	Return Period (Year)	RCP4.5			RCP8.5		
		Mean	Max	Min	Mean	Max	Min
1	100	8	25	-5	7	19	0
2	50	7	16	-5	6	12	-1
5	20	2	5	0	2	9	0
10	10	0	3	-2	0	5	-3
20	5	0	2	-2	-1	2	-5
50	2	-2	0	-6	-4	0	-10

Source: Transaction technical assistance consultant.

102. In the Ziyang Municipality, the rainfall intensity during 2021–2050 is expected to change due to climate change. The frequency analysis suggests that the maximum daily rainfall of the 100-year return period will be increased by 8% (ranging from -5% to 25% based on grids) under RCP4.5, and 7% (ranging from 0% to 19%) under RCP8.5. The maximum daily rainfall of the 50-year return period will be increased by 7% (ranging from -5% to 16%) under RCP 4.5 and 6% (ranging from -1% to 12%) under RCP 8.5. The maximum daily rainfall of the 20-year return period will be increased by 2% both under RCP4.5 and RCP8.5 (Table IV-2). The maximum daily rainfall for the 10-, 5-, and 2-year return periods show no clear changes or decrease in general.

103. The projections have shown that future storms will be more extreme. For example, the RCP4.5 daily rainfall of the 100-year return period will be increased by 8% (it is about 150 mm/day for baseline, so it is projected to become 162 mm during 2021–2050). In general, the projected storm will be larger, while the light rainfall will be smaller.

D. Hydrology and Water Resources

104. The Tuo River is the mother river of the Ziyang Municipality, one of the major primary tributaries of the upper Yangtze River, originates from the south of the Jiuding Mountain (also called the Chaping Mountain), and northwest of the Sichuan Basin. The total length of the Tuo River is 712 km with a catchment area of 3.29 km^2. The upper Tuo River, which is from the source to the Zhao Town in Jintang County, has three major tributaries, i.e., Mianyuan River in the east with a total length of 180 km; Shiting River in the middle with a length of 141 km; and Jian River in the west with a length of 139 km. The Mianyuan River is defined as the headstream of the Tuo River, owing to its length. The lower part, which is from the Zhao Town to the river mouth (located in the Luzhou City), is called the Tuo River with a total length of 522 km. The maximal and minimal annual surface runoff of the Tuo River are 10.52 billion and 6.92 billion m^3, respectively. The wet season is from July to September with the average flow rate of 603 m^3/s; while the dry season is from December to March of the following year, with the minimal average flow rate of 9.62 m^3/s in January. The flood hazard is subject to occur during the high flow year; however, a short time break occurred during the extreme dry year.

105. The Yanjiang District is rich in water resources. There are seven rivers with each catchment area over 100 km^2. Moreover, all the local rivers belong to the Tuo River system, and the major surface runoff within the area flows into the Tuo River via the Jiuqu River, which

is the primary tributary of the Tuo River on its right bank and originates from the Lujia Bridge in the Jianyang City. The total catchment area of the Jiuqu River is 368 km^2 and the length of its main stream is 57.5 km, with the gradient of 1.77%. The Jiuqu River is in the hilly area of the basin with a fan-shaped catchment.

106. **Flooding.** The Tuo River flows through the Ziyang Municipality and floods annually. During 2009–2013, the average annual direct economic loss caused by flood disaster was CNY452 million; whereas from 2014 to 2017, flood disasters occurred every year with an annual average direct economic loss CNY153 million. Part of the reduction can be attributed to improved flood protection. However, there are still parts of the city with flood protection less than the national standard for cities of the 50-year recurrence flood.

107. The vegetation coverage rate of the catchment is only 6.1%, which is the lowest in all of rivers in the Sichuan Province. The number of city, county, or district in the total area that is located in the catchment of the Tuo River is 19 and 17 in the case of partial area, including the large and middle cities such as Chengdu, Chongqing, Luzhou, Ziyang, etc. Meanwhile, about a thousand of large- to middle-sized factories are in the area, making the catchment a high-density industry and population. In addition, the catchment is the biggest producing area of the cotton and sugarcane in the Sichuan Province. The water of the Tuo River is polluted due to the discharge of industrial and agricultural wastewater in large amounts along the river sides.

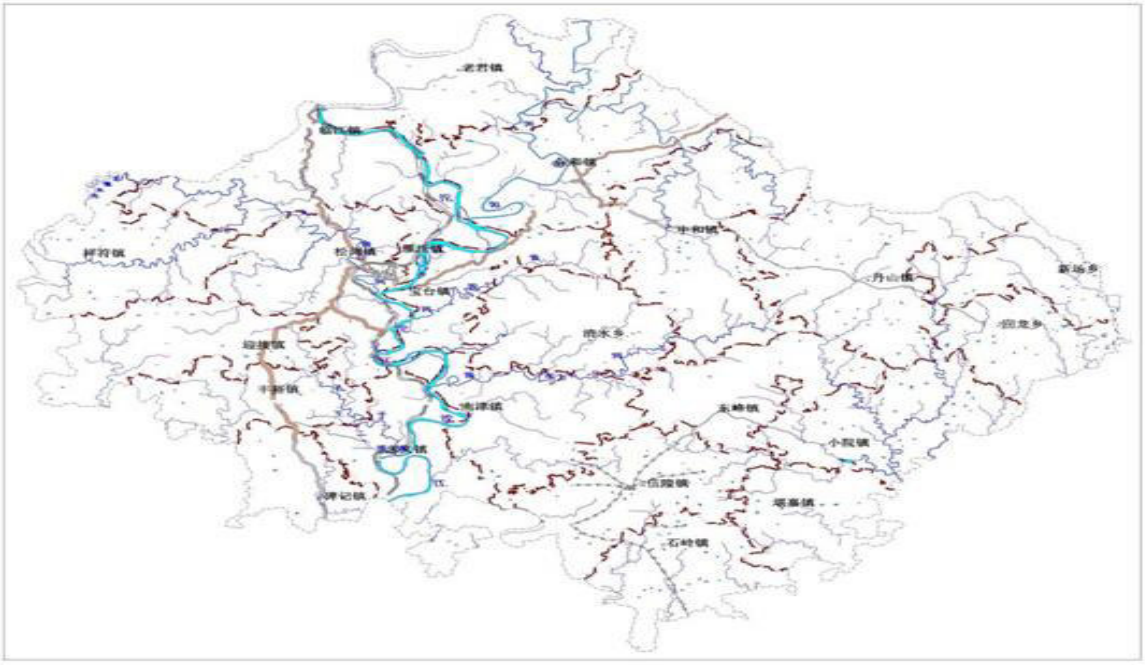


Figure IV-5: Stream Distribution Map of the Yanjiang District

Source: Website of the Land and Resources Bureau of the Ziyang Municipality.

108. The Yanjiang District, the project area, is in the middle reach of the Tuo River, with the river width of 150–300 m and gradient of 0.24%. Based on the hydrological data collected at the Shipantan Hydro Station in the Neijiang City, the annual average flow rate is 375 m^3/s. The maximal water level is 11.6 m that is significantly affected by precipitation. The annual average suspended sediment concentration is 1.27 kg/m^3, and the high suspended sediment concentration mainly occurs between July and October which contributes to 94% of a year.

109. The Tuo River is the wastewater receptor of the Yanjiang District and the Ziyang Municipality as well. Based on the Surface Water Annual Report of the Ziyang Municipality in 2016, the overall water quality in the city was moderately polluted in 2016. Five sampling points (i.e., monitoring section) were set for the regular monitoring, including three points for the Tuo

River (i.e., Linjiang Temple, Xingfu Village, and Gongchengpu Ferry), one point for the Yanghua River (i.e., Xiangzikou) and one point for the Jiuqu River (i.e., Jiuqu River Bridge). None of the five monitoring sections meets the related standard classified by the Ziyang EPB. In general, the main stream of the Tuo River was slightly polluted; and TP was the major parameter exceeding the standard. The overall water qualities of its tributaries were heavily polluted and the major parameters exceeding the standard included NH_3-N, TP, and CODcr. For five monitoring sections, there are (i) three sections that meet Grade IV of the PRC's Environmental Quality Standards for Surface Water (GB3838-2002); (ii) one section that meets Grade V Standard of GB3838-2002; and (iii) one section cannot meet the Grade V Standard of GB3838-2002). The annual report also describes that (i) TN of all monitoring sections exceeded their classified standards; (ii) fecal coli. of the section at the Jiuqu River Bridge exceeded its relevant standard (Grade IV); and (iii) other parameters met their classified standards.

110. **The environmental status of the Yannan Lake.** The proposed subcomponent of the Wetland Development Downstream of the SZHTDZ involves the water environment improvement and wetland ecological restoration of the Yannan Lake, which is a typical water-carrying lake in the Yingjie Town of the Yanjiang District. The sluicing from its upstream (i.e., Yingjie Reservoir) flows through the Yannan Lake via the Kongzi Creek, the downstream overflow weir and the culvert at the Longma Avenue, and finally flows into the Tuo River. The Yingjie Reservoir was built in the end of 1972; and was used for flood control and agricultural irrigation, with a design scale of small (II) type.[31] The total design catchment area is 4.5 km^2, and the average annual flow within the dam site is 2.58×10^5 m^3. The design, dead, and regulating storage capacities of the reservoir is 4.885×10^5 m^3, 1.54×10^4 m^3, and 3.767×10^5 m^3, respectively. The normal water level, design flood level, and dead water level is 385.0 m, 385.53 m, and 381 m ASL, respectively, with the effective irrigation area of 1,000 *mu*. The main water source of the Yannan Lake is the discharged water from the Yingjie Reservoir and the storm runoff within its catchment area.

111. After 45 years of development, especially the rapid development of the SZHTDZ in the recent years, the landforms within the service area of the Yannan Lake have been significantly changed, weakening its functions for flood control and agricultural irrigation. Currently, the Yingjie Reservoir was utilized for artificial farming, leading to the severe eutrophication of the reservoir. Therefore, the water quality does not meet Grade V of GB3838-2002, and large amount of water hyacinth and algae are broken out in every summer.

112. Based on the site investigation conducted by the DEIA institute in November and December 2017, there were point and nonpoint source pollution from the upstream and surrounding area discharged into the Yannan Lake and the Kongzi Creek, which include the following: (i) due to municipal sewer network not being connected with the villages of Longdang and Qinglong nearby the Yannan Lake, the domestic wastewater flowed into the lake and the Kongzi Creek without any treatment; and (ii) agricultural nonpoint source pollution flows into the lake via the surface runoff. The Yannan Llake is surrounded by 758 *mu* of farmlands for planting rape (144 *mu*), fruits (362 *mu*), rice (40 *mu*), corn (100 *mu*), and other vegetables (112 *mu*); and (iii) wastewater from livestock and poultry farming directly discharged into the Yannan Lake without treatment. According to the investigation, there were 23 livestock and poultry farming households raising 3,730 pigs, 7 sheep, 5,100 chickens, and 3.5 *mu* of fish ponds.

113. Based on the investigation in ADB's fact-finding mission, (i) by the end of March 2018, 13 in 23 livestock and poultry farming households have already relocated along with the development of the "China Dental Valley"; and the rest of the 10 households will be resettled in 2019; (ii) the 3.5 *mu* of fishponds will be converted to wetland before the end of 2018, and

[31] In the PRC, the reservoir scale is divided into five types based on the storage capacity, i.e., large (I, II), medium, and small (I, II).

the 758 mu of farmland will be converted to forestry by the end of 2019; and (iii) the municipal sewer pipes will connect to the 41 households in two villages by the end of 2018, and 41 septic tanks will be constructed for the households by using the government's fund for prevention of fecal contamination to the wetland. ZMG issued the commitment that before the wetland construction, all the pollution sources will be shut down or eliminated to meet the national standard.

Figure IV-6: Current Situation of the Yannan Lake

Figure IV-7: Current Situation of the Kongzi Creek

Figure IV-8+9: Algae Blooms in the Yannan Lake and the Kongzi Creek

114. **Invasive alien species.** An invasive alien species, apple snail (*Pomacea canaliculate*) was discovered in the Yannan Lake and the Kongzi Creek. The status is that the pests are sporadically distributed and there have not yet been outbreaks. Apple snails are native to South America and have become widely distributed agricultural and environmental pests in the southern and southwestern PRC since their introduction from Argentina in the 1980s. However, only since 2010 have researchers recognized that at least two species, *P. canaliculata and P. maculata*, are present in the PRC. Impacts of apple snails have been extensively documented since 2010, which shows that such snails are harmful to rice growth; and have direct and potential effects on aquatic biodiversity, and even spreading human disease. With some successful cases in the PRC's Jiangshu and Zhejiang provinces, application of the duck grazing patterns to control apple snails is an effective and promising biological control method. The stocking density is 20 ducks per hectare of surface water area.

Figure IV-10: Apple snail in Yannan Lake

Figure IV-10: Apple snail eggs in Yannan Lake

E. Ecological Environment

115. The ecological survey in the project area was conducted by the DEIA institute, with the methods of on-site investigation and literature review. Due to frequent human activities, the natural and artificial secondary vegetation communities are developed in the low hilly area of the Ziyang Municipality, which are mainly formed by subtropical evergreen broad-leaved trees, coniferous tress, and deciduous broad-leaved trees. There are more than 2,000 species of plants in the municipality, and the preliminary species are listed in Table IV-3.

Table IV-3: Preliminary Species of Flora in the Ziyang Municipality

Classification	Scientific Name of Vegetation
Evergreen coniferous forest/常绿针叶林	*Cupressus funebris* Endl./柏木, *Pinus massoniana* Lamb./马尾松, Cunninghamia lanceolata （Lamb.）Hook./杉木, Pinus elliottii/湿地松, *Pinus taeda* L./火炬松, *Cedrus deodara (Roxb.) G. Don*/雪松, *Cupressus lusitanica*/墨西哥柏, Cupressus torulosa D.Don/藏柏
Mixed evergreen and deciduous broadleaf forest/常绿落叶和阔叶混交林	Alnus cremastogyne Burk./桤木, Camptotheca acuminata./喜树, *Ulmus pumila* L./榆树, Pterocarya stenoptera C. DC/枫杨, *Robinia pseudoacacia* L./刺槐、*Paulownia./*泡桐、Melia azedarach Linn./苦楝、*Populus nigra*/黑杨、Populus tomentosa Carrière/毛白杨、Ligustrum lucidum Ait./女贞, Pistacia chinensis Bunge/黄连木, Firmiana platanifolia (L. f.) Marsili/梧桐、*Choerospondias axillaris*（Roxb.）Burtt et Hill./南酸枣、Celtis bungeana Bl./黑弹树, Alangium chinense(Lour．)Harms/八角枫, Kalopanax septemlobus (Thunb.)Koidz./刺楸, *Albizzia julibrissin* Durazz./夜合欢, *Platanus acerifolia*/悬铃木, Broussonetia papyrifera (Linn.) L'Hér. ex Vent./构树, *Toona sinensis* (A. Juss.) Roem./香椿, *Ehretia macrophylla* Wall./粗糠树, Platycarya strobilacea Sieb.et Zucc./化香, Koelreuteria paniculata Laxm./栾树、Cinnamomum camphora (L.) Presl./香樟, Phoebe zhennan S. Lee/楠木, *Dalbergia hupeana* Hance/黄檀, Salix babylonica/垂柳, *Ficus microcarpa* Linn. f./榕树, *Bischofia polycarpa* (Levl.) Airy Shaw/重阳木, *Gleditsia sinensis* Lam./皂荚
Shrubbery/灌木林	*Vitex negundo* L./黄荆, *Coriaria nepalensis* Wall./马桑, *Murraya paniculata* (L.) Jack./七里香, Rubus corchorifolius L.f./悬钩子, *Pyracantha fortuneana* (Maxim.) Li/火棘, Vacciniuim mandarinorum Diels/米饭花, *Amorpha fruticosa* Linn./紫穗槐,, *Lonicera japonica* Thunb./忍冬, Elaeagnus pungens Thunb./胡颓子, *Viburnum dilatatum* Thunb./荚蒾, Euscaphis japonica/野垭椿, Rhamnus davurica Pall/鼠李,, *Zanthoxylum simulans* Hance./野花椒, Caulis Fici Tikouae/地瓜藤, Berberis kawakamii Hayata/小檗

Classification	Scientific Name of Vegetation
Bamboo forest/竹林	Neosino calamus affinis/慈竹, *Bambusa rigida*/硬头黄, B.blumeana Schult.f/刺竹, Phyllostachys heteroclada Oliver./水竹, *Phyllostachys sulphurea* (Carr.) A. et C. Riv./金竹, Dendrocalamus latiflorus Munro/麻竹, Pleioblastus amarus (Keng) keng/苦竹

Source: Domestic environmental impact assessment report.

116. In the Yanjiang District, there is no natural large stretch of forest and grassland; and most of the existing woods are man-made forest which are mainly distributed as belt-like on the slope of landslide step at all levels, along the rivers and roads, and around the buildings. According to the forestry statistics, the area of existing woods is 38,400 ha which is 23.5% of the total district area, including 8,700 ha of the timber forest (cypress as the major species); 6,500 ha of the fruit-bearing forest; 6,500 ha of bamboo forest; and 4,900 ha of miscellaneous forests, such as vegetables, shrubs, agroforestry intercropping, etc.

117. **Fauna.** There are 95 species of wild animals in the Ziyang Municipality, including 11 species of mammals, 56 species of birds, 8 species of amphibians, and 20 species of reptiles. Table IV-4 shows the major species.

Table IV-4: Species of Fauna in the Ziyang Municipality

Family	English/Chinese Name of Animal
Mammal/兽类	hog badger/猪獾, yellow weasel/黄鼬, red fox/赤狐, masked civet/果子狸, Sichuan vole/四川田鼠, *Cricetulus longicaudatus*/长尾仓鼠, grass hare/草兔, Cannomys badius/小竹鼠, squirrel/松鼠, hedgehog/刺猬
Bird/鸟类	sparrow/麻雀, chestnut bunting/栗鹀, Eurasian siskin/黄雀, vinaceous rosefinch/酒红朱雀, Eurasian skylark/云雀, Asian short-toed lark/亚洲短趾百灵, ashy-crowned finch lark/灰顶雀百灵, horned lark/角百灵, Sichuan leaf warbler/四川柳莺, /小太平鸟, magpie/喜鹊, Eurasian tree-creeper/旋木雀, Chinese hwamei/画眉鸟, Red-billed Leiothrix/红嘴相思鸟, pheasant/雉鸡, Oriental Turtle Dove/山斑鸠, egret/白鹭, saker falcon/猎隼, crow/乌鸦, eagle/老鹰, starling/八哥, oriental magpie-robin/四喜鸟, tit/山雀
Amphibian/两栖类	giant salamander/大鲵, Gvnther`s frog/沼蛙, terrestrial frog/泽蛙, painted chorus frog/粗皮姬蛙, Microhyla ornate/饰纹姬蛙, :Western Chinese Tree Toad/华西雨蛙
Reptile/爬行类	tortoise/乌龟, turtle/中华鳖, skink/石龙子, brown forest skink/铜蜓蜥, Emei ground lizard/峨嵋地蜥, gecko/壁虎, snake/蛇
Fish/鱼类	Carp, crucian, Grass Carp, spotted silver carp, chub, Small hemp fish, Snakehead

Source: Domestic environmental impact assessment report.

118. In the Yanjiang District, there are more than 30 species of domestic animal which mainly include the buffalo, horse, donkey, mule, cow, pig, goat, rabbit, chicken, duck, pigeon, goose, silkworm, and bee. The project area is in the urban eco-system; and there are no natural forest nor wild, rare, and endangered plants and animals in the area.

F. Social and Economic Condition

119. The Ziyang Municipality consists of one district, Yanjiang; and two counties of Anyue and Lezhi. The population, land area, and density of the Ziyang Municipality are listed in Table IV-5; and the GDP in 2016 is shown in Table IV-6.

Table IV-5: Profile of the Ziyang Municipality

Item	Yanjiang District	Lezhi County	Anyue County	Total
Population	1,105,000	832,524	1,609,516	3,547,040
Land Area (km2)	1633	1424	2690	5747
Density (people/km^2)	676	588	598	---

Source: Ziyang Statistical Yearbook 2017.

Table IV-6: Ziyang Municipality Major Economic Indicators (2016)

Item	CNY Billion	% of GDP
GDP (CNY billion)	95	100%
Primary Industry (agriculture)	16	17%
Secondary Industry (Industry and Construction)	51	54%
Tertiary Industry (service)	28	30%
GDP Per Capita (CNY)	37,308	

Source: Sichuan Statistical Yearbook 2017.

120. The total population of the Yanjiang District (the project area) is 1.105 million, including 0.532 million women (48.14%), 4,088 minorities (0.37%), and 61,383 poor (5.56%).

121. **Urban services.** In general, urban services are satisfactory. Water supply and electricity are available continuously, solid waste is collected and disposed, and major streets are paved and clean; but there has been significant environmental damage to hills in the urban area. Improper excavation for roads, buildings, and earth mining has resulted in earth mounds with bare and steep slopes that are vulnerable to soil erosion from wind and water.

G. Environmental Quality (Baseline Sampling)

122. The environmental monitoring include the baseline qualities of (i) surface water qualities of the Tuo River (for the eco-embankment), the Yannan Lake, and the Kongzi Creek (for the wetland restoration); (ii) sediment quality for the Yannan Lake (for the sediment dredging and disposal), (iii) groundwater quality surrounding the landfill site; (iv) air qualities for odor gases emission from the landfill, and ambient air qualities for the six components of output 3, and the TVET center; (v) acoustic environment, including the baseline noise from the landfill (leachate treatment facility); ambient noise baselines at the component sites of output 3; and the noise baseline for the TVET center; and (vi) soil quality baseline at the landfill site.

(i) Surface Water Quality

123. In the Ziyang Municipality, the major surface water body is the Tuo River. The DEIA institute referenced the monthly monitoring data of the main stream of the Tuo River conducted by the Ziyang EMS during September–November 2017. The referenced data included three monitoring locations, i.e., Linjiang Temple, Xingfu Village, and Gongchengpu Ferry. The applicable water quality function of the Ziyang Section of the Tuo River mainstream identified by the Ziyang Municipal EPB is Grade III of the PRC's Environmental Quality Standards for Surface Water (GB3838-2002). The monitoring results are shown in Table IV-7.

Table IV-7: Baseline Water Quality of the Ziyang Section of the Tuo River

(Unit: mg/L, except Temperature (°C), pH and fecal coli. (cfu/L))

Parameter	Linjiang Temple			Xingfu Village			Gongchengpu Ferry			Grade III Standard
	Sep.	Oct.	Nov.	Sep.	Oct.	Nov.	Sep.	Oct.	Nov.	
Temp.	23.4	21.4	14.0	22.8	21.1	17.4	25.4	20.6	17.2	/
pH	7.99	7.58	8.10	8.07	7.74	7.80	8.24	7.94	7.97	6.00~9.00
DO	7.4	7.9	7.9	7.8	7.8	9.2	8.1	8.4	8.8	≥5.0
COD_{Mn}	2.6	2.1	1.9	3.2	2.1	2.1	2.4	2.0	1.8	≤6.0
BOD_5	1.9	0.6	0.5	2.0	1.4	0.9	1.7	0.9	1.5	≤4.0
NH_3-N	0.32	0.16	0.27	0.16	0.68	0.30	0.31	0.65	0.22	≤1.00
Oil	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	≤0.05
Volatile Phenol	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	≤0.0500
Hg	ND	ND	ND	ND	ND	ND	ND	ND	ND	≤0.0001
Pb	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	≤0.0500
COD_{Cr}	8	10	6	11	6	12	19	6	9	≤20
TN	2.64	2.96	2.46	3.38	2.93	3.01	1.31	2.93	2.57	≤1.00
TP	0.16	0.19	0.17	0.16	0.20	0.18	0.07	0.20	0.16	≤0.20
Cu	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	≤1.000
Zn	0.006	0.006	0.006	0.060	0.006	0.006	0.006	0.006	0.006	≤1.000
Fluoride	0.325	0.284	0.249	0.359	0.323	0.261	0.0381	0.309	0.270	≤1.000
Se	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	≤0.0100
As	0.0017	0.0019	0.0022	0.0025	0.0025	0.0008	0.0037	0.0017	0.0009	≤0.0500
Cd	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	≤0.0050
Cr^{6+}	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	≤0.050
CN^-	0.004	0.004	0.004	0.004	0.070	0.004	0.004	0.004	0.004	≤0.200
LAS	0.050	0.060	0.070	0.050	0.034	0.070	0.070	0.060	0.070	≤0.200
Sulfide	0.038	0.056	0.036	0.043	13,000	0.031	0.054	0.031	0.042	≤0.200
Fecal Coli.	20,500	24,000	17,000	7,900	47.8	11,000	22,000	17,000	14,000	≤10,000

CN = cyanide, DO = dissolved oxygen, LAS = linear alkylbenzene sulfonates, Se = selenium.
Source: Domestic environmental impact assessment report.

124. The baseline monitoring data in Table IV-7 shows that most of the parameters meet the Grade III Standard of GB3838-2002, except TN and fecal coli. which indicates that the main stream of the Tuo River is slightly polluted due to domestic wastewater discharge from nearby residential communities.

125. The baseline water quality of the Yannan Lake was monitored by the Center Testing International (CTI, the certificated environmental monitoring entity) on 7–9 December 2017. Based on the on-site investigation, the seven sampling points were selected by the DEIA institute and the CTI. The selected sampling points are listed in Table IV-8, and the monitoring results are shown in Table IV-9.

Table IV-8: Monitoring Locations for Surface Water and Sediment Qualities—Yannan Lake

No.	Sampling Location	Item	Remarks
W1	in Yingjie Reservoir	Water quality	Upstream reservoir
W2	500 m upstream of Yannan Lake (Kongzi Creek)	Water quality	upstream river
W3	The entrance of Yannan Lake	Water quality, sediment	
W4	in Yannan Lake	Water quality, sediment	
W5	in Yannan Lake	Water quality, sediment	
W6	The outlet of Yannan Lake	Water quality, sediment	
W7	250 m downstream of Yannan Lake	Water quality	downstream river

Source: Domestic environmental impact assessment report.

Table IV-9: Water Quality of Yannan Lake (Unit: mg/L, pH and fecal coli. (cfu/L))

No.	Sampling Date	Parameter								
		pH	SS	COD_{Cr}	BOD_5	NH_3-N	Petro.	TN	TP	Fecal Coli.
W1	7 Dec. 2017	7.24	11	26	6.4	0.811	<0.01	1.89	0.25	2,600
	8 Dec. 2017	7.16	8	26	6.5	0.769	<0.01	1.75	0.24	2,700
	9 Dec. 2017	7.09	10	28	6.5	0.744	<0.01	1.88	0.23	2,200
W2	7 Dec. 2017	7.08	23	21	4.9	0.337	<0.01	0.97	0.20	2,200
	8 Dec. 2017	7.11	26	26	5.2	0.363	<0.01	1.67	0.21	2,700
	9 Dec. 2017	7.28	24	22	5.1	0.377	<0.01	1.75	0.22	2,700
W3	7 Dec. 2017	7.29	27	32	7.8	2.970	<0.01	5.46	0.83	2,600
	8 Dec. 2017	7.38	29	31	7.1	2.990	<0.01	5.25	0.84	1,700
	9 Dec. 2017	7.45	28	29	7.5	2.970	<0.01	5.31	0.85	2,200
W4	7 Dec. 2017	7.34	28	31	7.1	2.870	<0.01	4.95	0.83	1,300
	8 Dec. 2017	7.29	28	31	7.0	3.020	<0.01	5.25	0.85	1,700
	9 Dec. 2017	7.36	29	32	7.3	3.230	<0.01	5.30	0.86	790
W5	7 Dec. 2017	7.26	20	29	7.5	2.930	<0.01	5.25	0.83	2,300
	8 Dec. 2017	7.42	22	29	7.6	2.950	<0.01	6.02	0.82	1,700
	9 Dec. 2017	7.41	21	29	7.4	3.020	<0.01	5.33	0.85	2,200
W6	7 Dec. 2017	7.36	26	29	6.8	2.870	<0.01	5.14	0.84	2,600
	8 Dec. 2017	7.21	21	29	6.6	3.120	<0.01	4.90	0.83	3,300
	9 Dec. 2017	7.25	24	30	6.8	2.990	<0.01	5.10	0.83	3,200
W7	7 Dec. 2017	7.19	13	26	6.5	3.810	<0.01	6.02	0.89	2,700
	8 Dec. 2017	7.31	12	29	6.5	4.010	<0.01	6.16	0.93	4,000
	9 Dec. 2017	7.18	12	28	6.7	4.130	<0.01	6.25	0.95	3,300
Grade V Standard of GB3838-2002		6.00~9.00	-	40	10.0	2.000	1.00	2.00	0.40/0.20 (lake, reservoir)	40,000

W = water sampling point.
Source: Domestic environmental impact assessment report.

126. The monitoring data shown in Table IV-10 demonstrates that the water quality of the Yingjie Reservoir and the upstream of the channel (W1 and W2, the water sources of the

Yannan Lake) exceeded the Grade V Standard of GB3838-2002, with the exceeded parameter of TN (0.20–0.25 mg/L vs. the standard value of 0.20 mg/L for lake and reservoir). The water quality in the Yannan Lake (W3-W7) is obviously degraded and exceeded the Grade V Standard of GB3838-2002; and the concentrations of TN, NH_3-N, and TP were much higher than those in the upstream Yingjie Reservoir. The reasons for the standard exceeding are the wastewater directly discharged from nearby villages and the nonpoint source pollution from nearby farmlands and animal husbandries.

(ii) Baseline Sediment Quality of the Yannan Lake

127. Since sediment dredging will be conducted for the subcomponent of conducted for the Yannan Lake wetland, the sediment was monitored by the CTI on 7 December 2017. Four monitoring points were set in the reservoir that overlap W3, W4, W5, and W6 sampling points for the water quality sampling (Table IV-8 above). The monitoring results are shown in Table IV-10.

Table IV-10: Sediment Quality of the Yannan Lake

(Unit: mg/kg except methylmercury and ethyl mercury (mg/L))

Parameter		S3	S4	S5	S6	Grade II Standard of GB15618-1995
As		6.600	7.770	10.300	6.850	≤25.0
Hg		0.523	0.179	0.245	0.384	≤0.5
Cr		51.000	55.000	56.000	59.000	≤300.0
Cr^{6+}		< 0.160	< 0.160	< 0.160	< 0.160	-
Pb		30.000	23.400	29.400	24.500	≤300.0
Cd		0.190	0.160	0.180	0.180	≤0.3
Cu		32.000	35.000	35.000	33.000	≤100.0
Zn		76.200	72.800	74.200	70.700	≤250.0
SO_4^{2-}		0.400	0.600	0.260	0.110	-
Organic Matter		13.200	9.010	10.500	11.600	-
Organic phosphorus Pesticide	DDVP	< 0.0025	< 0.0025	< 0.0025	< 0.0025	≤15.0
	Rogor	< 0.0023	< 0.0023	< 0.0023	< 0.0023	≤15.0
	Parathion - methyl	< 0.0018	< 0.0018	< 0.0018	< 0.0018	≤0.2
	Malathion	< 0.0021	< 0.0021	< 0.0021	< 0.0021	≤0.2
	Parathion	< 0.0021	< 0.0021	< 0.0021	< 0.0021	≤0.2
Organic chlorine Pesticide	α-$C_6H_6Cl_6$	< 0.0017	< 0.0017	< 0.0017	< 0.0017	-
	β-$C_6H_6Cl_6$	< 0.0011	< 0.0011	< 0.0011	< 0.0011	-
	γ-$C_6H_6Cl_6$	< 0.0013	< 0.0013	< 0.0013	< 0.0013	-
	δ-$C_6H_6Cl_6$	< 0.0013	< 0.0013	< 0.0013	< 0.0013	-
	$C_6H_6Cl_6$	< 0.0054	< 0.0054	< 0.0054	< 0.0054	≤0.5
	p,p'-DDE	< 0.0024	< 0.0024	< 0.0024	< 0.0024	-
	p,p'-DDD	< 0.0017	< 0.0017	< 0.0017	< 0.0017	-
	o,p'-DDT	< 0.0023	< 0.0023	< 0.0023	< 0.0023	≤0.5
	p,p'-DDT	< 0.0030	< 0.0030	< 0.0030	< 0.0030	≤0.5
Alkylmercury	Methylmercury	< 0.00001	< 0.00001	< 0.00001	< 0.00001	-

Parameter		S3	S4	S5	S6	Grade II Standard of GB15618-1995
(immersion)	Ethyl Mercury	< 0.00002	< 0.00002	< 0.00002	< 0.00002	-

S = sediment sampling point; S3(W3) = the entrance section of the reservoir (same as W3); S4(W4) = in the reservoir; S5(W5) = in the reservoir; S6(W6) = the outlet of the reservoir.
Source: Domestic environmental impact assessment report.

128. According to the monitoring results shown in Table IV-10, it is known that the sediment quality of the Yannan Lake met the Grade II Environmental Quality Standard for Soils (GB15618-1995), except that the Hg of No. S3 sampling point, located in the entrance section of the lake, slightly exceeds the standard value. In addition, based on the monitoring data of pesticides, it seems that the sediment has not been polluted by various organophosphorus and organochlorine pesticides.

(iii) Baseline of Air Quality

129. The air quality baseline monitoring include (i) air quality at the boundaries of landfill site with the monitored parameters of H_2S and NH_3 (odor gases), the applicable standard is the PRC's Emission Standards for Odor Pollutant of GB14554-93 (Table IV-11); (ii) the ambient air baseline for the six components of Output 3 (Table IV-12b); and (iii) the ambient air baseline for the TVET center (Table IV-13). The applicable standard for (ii) and (iii) are Grade II of the PRC's Ambient Air Quality Standards (GB3095-2012), and the World Bank's EHS guideline.

130. **Air emission from the landfill.** The baseline air qualities monitoring for the landfill closure component was conducted by the Sichuan Fudechang Environmental Protection Technology Ltd. (SFEPT, the certificated environmental monitoring entity) on 3-4 July 2017. Three sampling points (A1, A2, and A3), located at 10 m downwind of the emission source; and one sampling point (A4), located at 10 m upwind of the emission source, were set for the monitoring. The monitored parameters were H_2S and NH_3, while the sampling frequency was four times per day for 2 days.

Table IV-11: Air Quality at Landfill Site (Unit: mg/m^3)

Date	Sampling Point	Parameter							
		H_2S				NH_3			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th
3 July, 2017	A1	0.050	0.050	0.051	0.050	0.118	0.110	0.115	0.124
	A1	0.049	0.051	0.051	0.050	0.097	0.090	0.083	0.086
	A3	0.050	0.051	0.050	0.050	0.192	0.189	0.201	0.187
	A4	0.049	0.050	0.051	0.050	0.089	0.086	0.081	0.084
4 July, 2017	A1	0.047	0.050	0.050	0.049	0.120	0.116	0.111	0.120
	A1	0.048	0.050	0.051	0.050	0.093	0.090	0.083	0.087
	A3	0.048	0.049	0.050	0.049	0.196	0.195	0.191	0.204
	A4	0.048	0.050	0.050	0.049	0.085	0.080	0.079	0.091
Grade II Standard of GB 14554-93		0.100				2.000			

Source: Domestic environmental impact assessment report.

131. According to the above monitoring data, the concentrations of H_2S and NH_3 at the boundary of the landfill site meet Grade II Standard (in Table 1) of the PRC's Emission Standards for Odor Pollutant (GB 14554-93).

132. **Baseline ambient air quality (for the six components of Output 3).** Since all components of Output 3 are located at the south of the Ziyang Municipality; and there is no air

pollution source, except the landfill, the existing air monitoring data, listed in the Tracking of EIA for the Master Plan of the SZHTDZ prepared by the Sichuan Zhongwang Safety & Environmental Protection Technology Consulting Ltd., are referenced to represent the current baseline of each project site. The information of each sampling point is shown in Figure IV-9 and Table IV-12, and the monitoring data are summarized in Table IV-13.

Table IV-12a: Sampling Locations for Ambient Air Quality—Output 3

Component	Sampling No.	Direction and distance to the site
Eco- embankment along Tuo River	No. A4 (Houjiaping Town)	200 m West of project site
	No. A2 (Yuchai Primary School)	300 m West of project site
Sponge City	No. A3 (Ganjiachang Community)	145 m West of project site
Yannan Lake Wetland	No. A6 (Hetong Village)	2 km Southeast of project site
Landfill Closure and Restoring to Park	No. A1 (Mingde Primary School)	950 m West of project site
Green Wedge		270 m South of project site
Preservation of bare Hills		450 m South of project site
	No. A5 (Ziyang Court)	350 m west of No.3 & No.4 bare hill; 600 m east of No.5 spoil site

Source: Domestic environmental impact assessment report.

Figure IV-9: Air Monitoring Points for Subcomponents of Output 3

Table IV-12b: Baseline Air Monitoring Data—Output 3 (Unit: mg/m^3)

Sampling Point	Date	Monitoring Parameter, time and Result									
		$PM_{2.5}$	PM_{10}	SO_2				NO_2			
		DA	DA	02:00~ 03:00	08:00~ 09:00	14:00~ 15:00	20:00~ 21:00	02:00~ 03:00	08:00~ 09:00	14:00~ 15:00	20:00~ 21:00
A1	25 Oct. 2017	0.023	0.048	0.013	0.016	0.018	0.017	0.054	0.039	0.049	0.052
	26 Oct. 2017	0.035	0.081	0.011	0.014	0.017	0.018	0.076	0.073	0.056	0.059
	27 Oct. 2017	0.031	0.073	0.009	0.013	0.017	0.012	0.051	0.061	0.068	0.074
	28 Oct. 2017	0.040	0.084	0.014	0.016	0.017	0.012	0.060	0.057	0.068	0.064
	29 Oct. 2017	0.042	0.077	0.012	0.016	0.014	0.019	0.035	0.042	0.039	0.034
	30 Oct. 2017	0.020	0.046	0.012	0.015	0.013	0.017	0.053	0.049	0.064	0.043
	31 Oct. 2017	0.024	0..051	0.015	0.017	0.019	0.016	0.077	0.065	0.070	0.073
A2	25 Oct. 2017	0.027	0.055	0.012	0.019	0.015	0.014	0.037	0.044	0.059	0.040
	26 Oct. 2017	0.033	0.076	0.012	0.016	0.014	0.016	0.056	0.064	0.069	0.074
	27 Oct. 2017	0.022	0.068	0.014	0.016	0.020	0.018	0.049	0.060	0.055	0.064

Sampling Point	Date	Monitoring Parameter, time and Result									
		$PM_{2.5}$	PM_{10}	SO_2				NO_2			
		DA	DA	02:00~03:00	08:00~09:00	14:00~15:00	20:00~21:00	02:00~03:00	08:00~09:00	14:00~15:00	20:00~21:00
	28 Oct. 2017	0.041	0.077	0.012	0.017	0.014	0.016	0.050	0.054	0.077	0.072
	29 Oct. 2017	0.039	0.084	0.016	0.015	0.019	0.018	0.036	0.044	0.038	0.042
	30 Oct. 2017	0.025	0.040	0.015	0.014	0.016	0.015	0.046	0.053	0.060	0.055
	31 Oct. 2017	0.026	0.046	0.018	0.017	0.012	0.019	0.075	0.083	0.063	0.065
A3	25 Oct. 2017	0.025	0.057	0.016	0.013	0.015	0.014	0.043	0.052	0.057	0.049
	26 Oct. 2017	0.033	0.086	0.016	0.018	0.013	0.016	0.050	0.057	0.065	0.069
	27 Oct. 2017	0.028	0.071	0.016	0.019	0.013	0.017	0.049	0.065	0.064	0.058
	28 Oct. 2017	0.045	0.084	0.016	0.019	0.016	0.017	0.056	0.075	0.063	0.058
	29 Oct. 2017	0.044	0.079	0.013	0.016	0.013	0.011	0.035	0.032	0.044	0.027
	30 Oct. 2017	0.024	0.042	0.016	0.018	0.017	0.018	0.046	0.043	0.060	0.039
	31 Oct. 2017	0.027	0.056	0.016	0.018	0.016	0.012	0.059	0.069	0.075	0.071
A4	25 Oct. 2017	0.030	0.051	0.016	0.011	0.012	0.019	0.040	0.043	0.047	0.056
	26 Oct. 2017	0.028	0.081	0.014	0.012	0.018	0.016	0.059	0.059	0.057	0.067
	27 Oct. 2017	0.039	0.072	0.019	0.012	0.015	0.013	0.061	0.052	0.040	0.044
	28 Oct. 2017	0.038	0.081	0.014	0.014	0.016	0.013	0.056	0.050	0.063	0.065
	29 Oct. 2017	0.041	0.083	0.016	0.015	0.014	0.017	0.038	0.026	0.035	0.031
	30 Oct. 2017	0.024	0.042	0.021	0.016	0.017	0.014	0.047	0.054	0.047	0.054
	31 Oct. 2017	0.029	0.052	0.014	0.011	0.016	0.017	0.056	0.041	0.066	0.067
A5	25 Oct. 2017	0.025	0.058	0.013	0.017	0.017	0.015	0.050	0.037	0.056	0.052
	26 Oct. 2017	0.028	0.056	0.018	0.017	0.020	0.016	0.070	0.076	0.059	0.063
	27 Oct. 2017	0.030	0.080	0.014	0.016	0.014	0.015	0.046	0.071	0.066	0.060
	28 Oct. 2017	0.043	0.079	0.016	0.015	0.018	0.014	0.036	0.063	0.044	0.057
	29 Oct. 2017	0.040	**0.084**	0.016	0.019	0.015	0.014	0.029	0.032	0.036	0.039
	30 Oct. 2017	0.019	0.045	0.012	0.017	0.013	0.018	0.049	0.065	0.060	0.056
	31 Oct. 2017	0.028	**0.054**	0.016	0.017	0.015	0.016	0.077	0.075	0.071	0.074
A6	25 Oct. 2017	0.028	0.048	0.012	0.017	0.018	0.014	0.049	0.062	0.064	0.056
	26 Oct. 2017	0.030	0.078	0.015	0.016	0.015	0.017	0.064	0.058	0.063	0.072
	27 Oct. 2017	0.026	0.078	0.016	0.016	0.014	0.017	0.050	0.064	0.069	0.063
	28 Oct. 2017	0.048	0.083	0.016	0.012	0.017	0.017	0.043	0.052	0.062	0.059
	29 Oct. 2017	0.044	0.082	0.014	0.019	0.018	0.015	0.036	0.039	0.040	0.030
	30 Oct. 2017	0.021	0.040	0.015	0.019	0.012	0.015	0.040	0.039	0.046	0.049
	31 Oct. 2017	0.025	0.047	0.018	0.013	0.017	0.014	0.061	0.069	0.079	0.082
Grade II Standard Value[a]		0.075	0.150	0.500	0.500	0.500	0.500	0.200	0.200	0.200	0.200
EHS		0.0375-0.075 interim targets, (0.025 guideline)	0.075-0.150 interim targets, (0.050 guideline)	0.050-0.125 (daily average interim targets) and 0.020 guideline				0.200 (hourly average guideline value)			

A = air sampling point, DA = daily average.

[a] Standard for PM10 and PM2.5 are daily average values; and the standard for SO_2 and NO_2 are hourly average values.

Source: Domestic environmental impact assessment report.

133. The monitoring results in Table IV-12 shows that the air quality of all the monitoring met the Grade II of the PRC's Ambient Air Quality Standards (GB3095-2012), but slightly exceeded the World Bank's EHS guideline values on some days.

134. **Baseline ambient air quality for the TVET Center.** Two monitoring points were selected based on the distribution of population and sensitive receptors nearby, i.e., No. A1 center of proposed construction site; and No. A2, 500 m downwind of proposed construction site. The air samples, with the frequency of four times per day for 7 consecutive days, were taken by the Sichuan Zhongzhengyuan Monitoring Technology Ltd. (a certificated environmental monitoring agency) during 2–8 March 2018. The parameters of SO_2, NO_2, and TSP met the Grade II Standard of GB3095-2012, but the SO_2 slightly exceeded the World Bank's EHS guideline value; the PM2.5 at two points exceeded both the Grade II standard and the EHS guideline value.

Table IV-13: Baseline Ambient Air Monitoring Data for the Technical and Vocational Education and Training (Unit: mg/m^3)

Monitoring Date	Daily Average Value							
	SO_2		NO_2		TSP		PM2.5	
	A1	A2	A1	A2	A1	A2	A1	A2
2 March 2018	0.021	0.021	0.031	0.029	0.122	0.124	0.039	**0.079**
3 March 2018	0.021	0.019	0.030	0.028	0.118	0.124	0.032	0.036
4 March 2018	0.021	0.019	0.030	0.031	0.120	0.122	0.031	**0.082**
5 March 2018	0.021	0.019	0.030	0.031	0.121	0.125	**0.092**	**0.080**
6 March 2018	0.019	0.019	0.032	0.029	0.119	0.123	**0.088**	**0.106**
7 March 2018	0.019	0.021	0.031	0.029	0.122	0.129	0.052	0.032
8 March 2018	0.020	0.020	0.031	0.029	0.120	0.131	**0.090**	**0.099**
Grade Ⅱ of GB3095-2012	0.500		0.200		0.300		0.075	
The World Bank EHS Guideline	0.125-0.050 interim targets (0.02 guideline)		n/a (no daily average value)		n/a		0.0375-0.075 interim targets, (0.025 guideline)	

Source: Domestic environmental impact assessment report.

(iv) Baseline of Acoustic Environment

135. The noise baseline monitoring includes the following: (i) for the baseline noise at the boundary of landfill, its applicable standard is Grade II of the PRC's Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008); and the World Bank's EHS guideline for industrial and commercial area (Table IV-14); (ii) the baseline acoustic quality of the components of Output 3 (Table IV-14); and (iii) the baseline acoustic quality of the TVET center (Table IV-15).

136. **Baseline noise at the boundary of landfill.** The landfill is on Dashiwan area of the Yanjiang District, where there is no urban trunk road and centralized residential community nearby. The surrounding area is mainly for commercial and industrial use with the good acoustic environment.

137. The noise sources of the landfill are from various equipment in the wastewater (leachate) treatment facility (LTF), including the pumps and blowers which may achieve noise of 75-85dB(A). The noise monitoring data on 3-4 July 2017 were collected by the SFEPT. The monitoring points, shown in Figure IV-10, were set at 1 m to the boundaries of the LTF (Table IV-14).

Table IV-14: Noise Monitoring Data of Landfill Site Unit: dB(A)

Sampling Location	3 July 2017		4 July 2017	
	Daytime	Nighttime	Daytime	Nighttime
N1 (northern boundary)	62.9	46.8	66.5	48.7
N2 (eastern boundary)	56.9	48.1	56.4	48.2
N3 (southern boundary)	57.9	47.7	56.8	46.8
N4 (western boundary)	61.6	48.8	63.2	47.8
Grade II Standard of GB12348-2008	60.0	50.0	60.0	50.0
EHS (for residential, institutional area	55.0	45.0	55.0	45.0
EHS (for industrial and commercial area	70.0	70.0	70.0	70.0

Source: Domestic environmental impact assessment report.

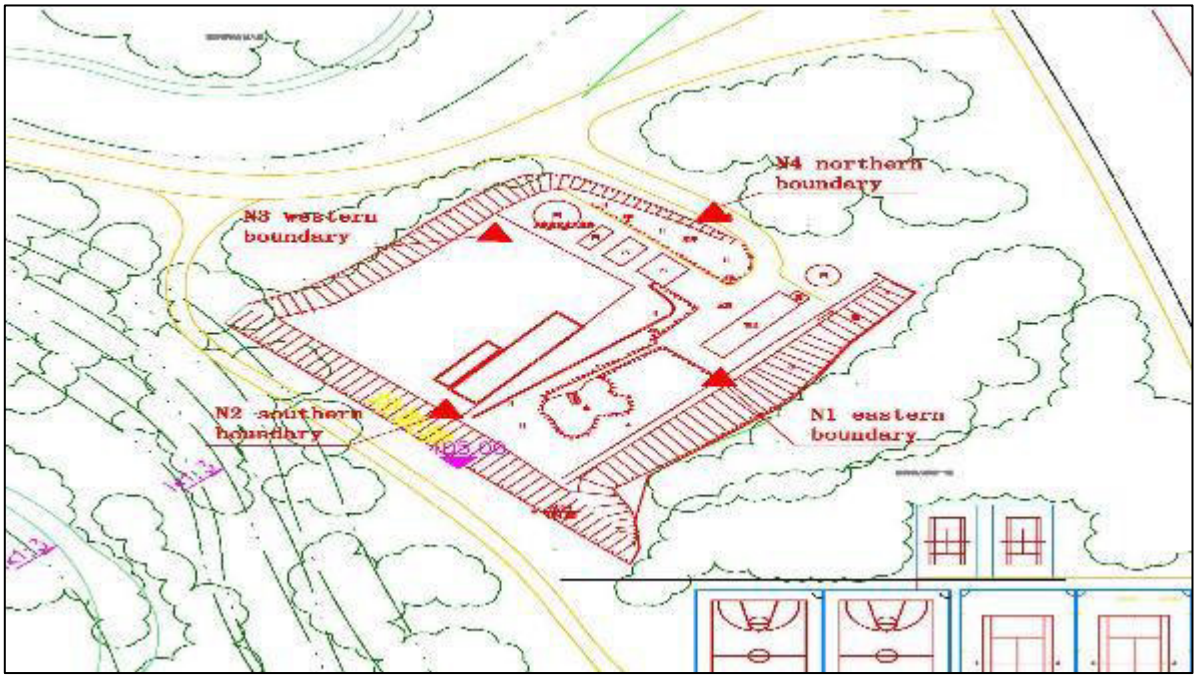


Figure IV-10: Noise Monitoring Points of the Landfill Site

138. Based on the monitoring results in Table IV-14, the daytime noise of northern and western boundary cannot meet Grade II of the PRC's Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008) which exceed the standard value between 1.6 and 6.5 dB(A) due to the N1 and N4 sampling points are close to the LTF. The noise exceedance is contributed by the daily operation of the pumps and blowers in the LTF. Other two monitoring point meet the standard (Table IV-13).

139. **Baseline of noise at other project sites of Output 3.** The sites of other subcomponents of the Output 3 are all located within the CZCDZ where there are several villages except on both sides of the Tiantai Road (the sponge city subcomponent), involving urban residential areas. Since there is no noise source in the areas, the noise monitoring data nearby the area were used to be the noise baseline of the subcomponents. The data source is "Y=Tracking EIA of Master Plan of CZCDZ", the monitoring entity is the Sichuan Province Industrial Environmental Monitoring Research Institute, and the monitoring dates are 25–26 October 2017. The monitoring locations are listed in Table IV-14, and illustrated in Figure IV-?. The monitoring results are shown in Table IV-14.

Table IV-15: Baseline Noise Monitoring Data—Output 3 Unit: dB(A)

Subcomponent	Sampling Point	Location	Monitoring Date				Standard Value	
			25 Oct. 2017		26 Oct. 2017			
			day	night	day	night	day	night
Eco-embankment	N10 Houjiaping Primary School	30 m west of riverbank	53.3	42.9	52.4	42.5	60	50
Sponge City	N3. Mingyuan community in Nanshi Street	30 m west of Tiantai Road	54.5	45.0	53.4	44.6	70	55
	N7 Tongzi Village	20 m east of Tiantai Road	55.2	45.3	54.1	43.9	70	55
	N8 Chahua Community in Songtao Town	140 m East of Tiantai Road	55.2	45.3	54.1	43.9	60	50
Yannan Wetland	N12 Zhujiagou Village	450 m Northeast of project area	51.4	41.1	50.6	41.5	60	50
Green Wedge	N1 Northern border of CICDZ	150 m North of project area	53.8	43.6	52.6	41.8	60	50
	N16 Xiangshui Village	Within the project area	52.7	43.3	52.2	42.6	60	50

N = noise monitoring point.
Source: Domestic environmental impact assessment reports.

140. According to the monitoring data, the daytime and nighttime noise of all monitoring locations met the Grade II Environmental Quality Standard for Noise (GB 3096-2008).

Figure IV-11: Noise Monitoring Points for Subcomponents of Output 3 except the Landfill

141. **Noise baseline monitoring for the TVET center.** Four monitoring points were set around the boundary of the TVET site to assess the noise baseline, including the eastern (No. N1), southern (No. N2), western (No. N3), and northern (No. N4) boundaries of the TVET center. The noise monitoring was conducted by the SZMT on 2–3 March 2018. According to the above monitoring results, the southern and northern boundary of project area met Grade II standard of GB 3096-2008, and the eastern (near Outer Ring Road) and western (near Chengyu Highway) boundary of project met 4a standard of GB 3096-2008 (Table IV-16).

Table IV-16: Noise Baseline Monitoring Data of the TVET Unit: dB(A)

Monitoring Point	2 March 2018		3 March 2018		Standard Value	
	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime
No. N1	54	37	52	36	70	55
No. N2	56	37	56	37	60	50
No. N3	69	43	63	39	70	55
No. N4	54	40	55	39	60	50

Monitoring Point	2 March 2018		3 March 2018		Standard Value	
	Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime
Grade II Standard	60	50	60	50	60	50
Grade 4a Standard	70	55	70	55	70	55

Source: Domestic environmental impact assessment reports.

(v) Ground Water Quality

142. The landfill leachate may have the potential to contaminate the groundwater nearby the landfill. The groundwater monitoring was conducted by the environmental monitoring entity (SFEPT) on 3–4 July 2017. Three wells, located at 1.0 km (G1), 1.2 km (G2), and 1.5 km (G3) downstream of the landfill site; and one well, located at 1.0 km (G4) upstream of the landfill were selected for the groundwater monitoring. The sampling frequency was four times per day for 2 days.

Table IV-17: Ground Water Quality of Landfill Site

(Unit: mg/L, except pH, total bacteria and total coli. (cfu/L))

Date	Sampling Location	pH	COD_{Mn}	Color	NH_3-N	NO_2-N	NO_3-N	Cd
3 July 2017	G1	6.93	2.97	2	**0.559**	0.020	1.00	0.00085
	G2	6.96	2.69	2	**0.424**	0.019	0.86	0.00074
	G3	6.92	2.03	2	**0.330**	0.016	0.94	0.00066
	G4	6.99	1.75	2	**0.318**	0.016	0.77	0.00052
4 July 2017	G1	6.96	**3.17**	2	**0.542**	0.019	1.00	0.00081
	G2	6.93	2.75	2	**0.401**	0.018	1.08	0.00069
	G3	6.99	2.14	2	**0.336**	0.017	0.94	0.00064
	G4	7.02	1.83	2	**0.312**	0.014	0.85	0.00054
Grade III Standard of GB14848-93		**6.50~8.50**	**3.00**	**15**	**0.200**	**0.020**	**20.00**	**0.01000**
Date	**Sampling Location**	**Hg**	**Cu**	**Zn**	**Pb**	**Cr^{6+}**	**Total Bacteria**	**Total Coli.**
3 July 2017	G1	0.000038	0.05	0.274	0.048	0.014	**328**	＜3
	G2	0.000030	0.05	0.166	0.044	0.009	**271**	＜3
	G3	0.000027	0.05	0.127	0.040	0.009	**580**	**18**
	G4	0.000024	0.05	0.095	0.038	0.005	**410**	**＞230**
4 July 2017	G1	0.000046	0.05	0.241	0.047	0.012	**510**	＜3
	G2	0.000038	0.05	0.133	0.045	0.008	**450**	＜3
	G3	0.000033	0.05	0.098	0.041	0.008	**570**	**18**
	G4	0.000028	0.05	0.082	0.033	0.005	**420**	＞230
Grade III Standard of GB 14848-93		**0.001000**	**1.00**	**1.000**	**0.050**	**0.050**	**100**	**3**

G = groundwater sampling point.

Source: Domestic environmental impact assessment reports.

143. The monitoring results in Table IV-16 demonstrate that (i) NH_3-N, total bacteria, and total coli. of the upstream ground water (G4) exceed Grade III of the Quality Standard for Ground Water (GB14848-93), especially the microbiological parameters which means there are probably some pollution sources nearby discharging of microbiological pollutants; (ii) the water qualities of three downstream wells exceeded the standard with the exceeded parameters of NH_3-N (G1, G2, and G3), total bacteria (G1, G2, and G3) and total coli. (G3), which shows that operation of the landfill leads to degradation of ground water quality to some extent within 1.5 km downstream area; and (iii) the water quality (NH_3-N) of G3 (1.5 km downstream of the landfill site) is gradually improved in comparison with the G1 and G2 points (1.0 km and 1.2 km downstream of the landfill).

(vi) Soil Quality

144. The soil quality of landfill site references the relevant monitoring data in the EIA for the Master Plan of Ziyang South Industrial Area. The monitoring was conducted by the Sichuan Provencal Institute of industrial environmental monitoring on 25 October 2017. The sampling point was at northwest boundary of the existing landfill (200 mm below the ground surface). The monitoring result in Table IV-18 shows that the soil quality on the landfill site meets Grade II Standard of GB15618-1995, and the soil has not been polluted by the landfill operation.

Table IV-18: Soil Quality on Landfill Site

Parameter	Unit	Result	Grade II Standard of GB15618-1995 (pH＞7.5)
Water Content	%	0.270	/
pH	/	9.290	/
Hg	mg/kg	0.134	≤1.0
Cd	mg/kg	0.220	≤0.6
As	mg/kg	5.600	≤40.0
Cu	mg/kg	33.000	≤100.0
Pb	mg/kg	29.900	≤350.0
Cr	mg/kg	96.000	≤250.0
Zn	mg/kg	96.500	≤300.0
Ni	mg/kg	54.000	≤60.0

Ni = nickel.

V. POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Project Area of Influence and Sensitive Receptors

145. To define the geographic scope of the impact assessment, the “project area of influence” and “sensitive receptors” were identified during the TRTA and DEIA preparation. The project area of influence was defined as the total area which might be subject to adverse impacts of the project. This was based on the locations of sensitive receptors, defined as settlements and/or environmental values that might be affected by the project construction and/or operation. The receptors (Tables V-1) comprise (i) villages, communities, and/or public buildings (e.g., schools) potentially subject to construction- or operational-related noise, air pollution, altered water quality or flow; and/or environment-related social impacts; (ii) public service facilities vulnerable to disturbance or pollution, e.g., downstream of the Tuo River and surrounding area of the Yannan Lake and the Kongzi Creek; (iii) vegetation, fauna habitats, and agricultural lands within 200 m of the waterbodies targeted for construction works, including the Tuo River and its riverbank habitats; and (iv) the Yannan Lake–bank habitats.

146. The following distances were applied to identify the sensitive receptors: (i) for construction and/or operational noise—receptors within 200 m of the noise-generating source; (ii) for construction-related air quality impacts (e.g., odor from dredging)—receptors within 200 m of the source; (iii) for local ecological environment, both the surface water area and the land area within 100 m from the edge of embankment section, including 200 m upstream and 2,000 m downstream of the Tuo River; and the entire areas of other subcomponent; and (iv) for potential downstream changes in hydrology or environment-related social impacts on the Tuo River mainstream, 2,000 m downstream from the furthest downstream embankment works. These distances, combined with the direct construction sites, were assumed to encompass the total project area of influence.

147. Based on the characteristics of the proposed subcomponents, the environmental features of each project site were investigated by the DEIA institute. The sensitive receptors related to each subcomponent are identified and summarized in Table V-1.

Table V-1: Environmentally Sensitive Receptors

Impact	Component	Sensitive Receptor	Location and Distance	Impact description/ Household (HH)
Ecological environment	Eco-embankment; Yannan Lake wetland, Green Wedge, Landfill closure and restoration	Forest and other vegetation, soil erosion and habitats of	On and nearby the sites	Construction and land occupation
Surface water	Eco-embankment	Tuo River mainstream	200 m upstream and 2,000 m downstream of Tuo River embankment section	Construction wastewater and domestic wastewater from workers’ camp
	Yanna Lake wetland	Yannan Lake and Kongzi Creek	Waterbodies of Yannan Lake and Kongzi Creek	
Groundwater	Landfill Closure and restoration	40 HH residents in Wuxian Village	400–630 m west of the landfill	Groundwater pollution by landfill leachate
Ambient Air (construction dust, TSP, and exhaust	Eco-embankment	Bintie Jiayuan Residential Community	170 m west of embankment	100 HH (308 person
		Changshou Village	20 m West of embankment	10 HH (32 persons)
		Gaoyan Village	5 m west of embankment	30 HH (96 persons)

Impact	Component	Sensitive Receptor	Location and Distance	Impact description/ Household (HH)
emission from vehicles and machineries, and asphalt fume. (SO2 and NO2 from landfill) Odor from the sediment dredging		Wujia Yuanzi Village	60 m west of embankment	20 HH (67 persons)
		Houjiaping Village	20 m west of embankment	30 HH (94 persons)
		Houjiaping Primary School	30 m west of embankment	School
	Sponge City	Jiangnan Huadu Residential Community	10 m east of Tiantai Road	30 HH (101 persons)
		Tongziyuan Residential Community	20 m east of Tiantai Road	100 HH (320 persons)
		Chahua Residential Community	20 m east of Tiantai Road	100 HH, some buildings are under construction
	Yannan Lake	Longdang Village	30 m north of Yannan Lake	20 HH (64 persons)
		Baima Village	30 m west of Kongzi Creek	20 HH (60 persons)
		Liuma Village	80 m east of Kongzi Creek	20 HH (65 persons)
	Landfill Closure,	Resettlement Housing at Chengnan Avenue	560 m Southwest of the boundary	Under construction
		Sichuan Xiwang Automobile Vocational & Technical College	1,000 m Southwest of the boundary	College with 7 fields of study and 41 professors, 5000 students
		Xiwang Weilaicheng residential Community	1,400 m Southwest of the boundary	Under construction
		Mingde Primary School	1,000 m West of the boundary	400 students
		Ziyang Radio and Television University	1,100 m west of the boundary	Open university with 1,300 professors and specialists as lecturers, 7000 students
		Wuxian Village	800 m west of the boundary	70 HHs (224 persons)
		Xiangshui Village	1,700 m west of the boundary	50 HHs (160 persons)
		Zaishanzui Community	1,500 m northwest of the boundary	30 HHs (95 persons)
		Balengqiao Community	1,100 m northeast of the boundary	100 HHs (295 persons)
		Shutai Village	1,000 m northeast of the boundary	20 HHs (65 persons)
		Baleng Village	720 m Southeast of the boundary	10 HHs (27 persons)
		Tongziyuan Community	1,100 m Southeast of the boundary	100 HHs (310 persons)
		Chahua Community	1,600 m Southeast of the boundary	100 HHs (300 persons)
		Changshou Village	1,400 m East of the boundary	40 HHs (115 persons)
		Chengnan Chuntian Community	1,600 m east of the boundary	300 HHs (865 persons)
		Huaxi Jiayuan Community	1,600m East of the boundary	200 HHs (586 persons)
		Nancheng Duhui Community	1,000 m north of the boundary	Under construction
		Hengdacheng Community	1,500 m north of the boundary	2,000 HHs (6000 persons)
		Shutai Yaju Community	1,800 m northeast of the boundary	300 HHs (880 persons)
		Ganghua Jiayuan Community	1,600 m north of the boundary	Under construction
		Nanshijie Mingyuan	1,600 m northeast of the boundary	300 HHs (850 persons)
		Bintie Jiayuan	1,800 m northeast of the boundary	300 HHs (900 persons)

Impact	Component	Sensitive Receptor	Location and Distance	Impact description/ Household (HH)
		Jiangnan Huadu	1,550 m northeast of the boundary	500 HHs (1450 persons)
	Green Wedge	Wuxian Village	20m South of the boundary	30 HHs (90 persons)
		Xiangshui Village	40 m south of the boundary	20 HHs (58 persons)
		Zaishanzui Community	15 m north of the boundary	30 HHs (88 persons)
Construction Noise	Eco-embankment	Bintie Jiayuan	170 m west of embankment	100 HHs (290 persons)
		Changshou Village	20 m west of embankment	10 HHs (28 persons)
		Gaoyan Village	5 m west of embankment	30 HHs (90 persons)
		Wujia Yuanzi Village	60 m west of embankment	20 HHs (58 persons)
		Houjiaping Village	20m West of embankment	30 HHs (90 persons)
		Houjiaping Primary School	30 m west of of riverbank	300 students
	Sponge City	Jiangnan Huadu Community	10 m east of Tiantai Road	300 HHs (900 persons)
		Tongziyuan Community	20 m east of Tiantai Road	100 HHs (290 persons)
		Chahua Community	20 m east of Tiantai Road	100 HHs (200 persons), partially under construction
	Yannan Wetland	Longdang Village	30 m north of Yannan Lake	30 HHs (88 persons)
		Baima Village	30 m west of Kongzi Creek	20 HHs (60 persons)
		Liuma Village	80 m east of Kongzi Creek	20 HHs (58 persons)
	Green Wedge	Wuxian Village	20 m south of the boundary	30 HHs (90 persons)
	TVET Center	There is no sensitive receipted within the project impact area (500 m from the boundaries of TVET Center. The shortest distance from the site to Tuo River is 1,820 m.		

Source: Domestic environmental impact assessment reports.

B. Assessment of Potential Impacts

148. Potential project impacts, both positive and negative, were assessed during the DEIA and TRTA, through site visits and technical analysis. Environmental risks and impacts are anticipated from the construction and operational phases of the project. Key risks and impacts are associated with the soil erosion, odor impacts from the dredged sediment, water quality, and local ecosystem.

149. **Construction phase.** Key impacts anticipated to result from construction are (i) odor impacts during the landfill closure and sediment dredging in the Yannan Lake and the Kongzi Creek; (ii) soil erosion, particularly during the embankment along the Tuo River and the bare hills preservation; (iii) short-term damage to aquatic habitats in the Tuo River section and the Yannan Lake due to dredging and embankment; (iv) removal of existing vegetation for the constructions of embankment and green wedge; and (iii) short-term alteration of river flow from the temporary installation of diversion weirs or structures during construction. Other temporary impacts due to construction include noise disturbance to nearby settlements, air pollution (mainly fugitive dust), uncontrolled solid waste disposal, interference with traffic and municipal services due to construction vehicle movements and any works alongside roads, permanent and temporary acquisition of land, involuntary resettlement, and occupational and community health and safety.

150. **Operational phase.** Key operational risks and impacts are more or less altered hydrology and ecology within and downstream of the project construction areas due to dredging and embankment, and safe operation of closed landfill (preventing groundwater from pollution by the closed landfill). Other operational risks are inadequate maintenance of project vegetation, structures, and facilities, which could contribute to reduced efficiency of the built facilities; or the moved pollution sources returning back to the Yannan Lake wetland again. All project facilities will be under the management of the project IAs, and each IA will develop O&M program for the built facilities and receive training in maintenance of the facilities and wetland restoration.

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

C. Project Benefits and Features

152. The project will contribute to the PRC's sustainable development agenda, as presented during the PRC's National New-Type Urbanization Plan, 2014–2020. It is in line with ADB's Midterm Review of Strategy 2020, which emphasized the importance of environmentally sustainable and inclusive growth (footnote 8). The anticipated interventions will support the implementation of the ADB's country partnership strategy for the PRC, 2016–2020 (footnote 9). The project will achieve the following significant social, economic, and environmental benefits:

(i) **Beneficiaries.** The project is expected to promote green development and attract businesses in light industry and service-oriented sectors while creating environment-friendly and attractive living conditions for the urban residents in the Yanjiang District of the Ziyang Municipality. The total population of the Yanjiang District is 1.103 million; and the project direct and indirect beneficiaries are 0.268 million and 0.835 million, respectively.

(ii) **Benefits of Output 1.** The procurement of Smart park system can reduce the costs of data management, energy consumption, and equipment procurement by using the cloud platform. The system will help modernize the SZHTDZ and the industrial park, making it more attractive to industries to locate within it. The system will improve the local government's management efficiency and service capacity.

(iii) **Benefits of Output 2.** The open R&D platform will contribute to the development of the dental industry cluster which is line with ZMG's goals of high technology and environmentally benign industries. The construction of the TVET center will help to train workers for the industrial park and particularly the newly established dental industry cluster.

(iv) **Benefits of Output 3.** The construction of related six subcomponents will facilitate (i) improving flood control infrastructures, strengthening flood control management, improving the biological diversity, and protecting the surrounding environment of the landfill site by controlling the landfill gas and leachate; and (ii) improving the water quality and ecosystem of the Yannan Lake and the Kongzi Creek, creating a green lung within the center of the Ziyang Industrial Park, reducing the soil erosion, enhancing the Ziyang Municipality's ecological resources, and demonstrating the model of sustainable development. Meanwhile, the vegetation coverage of most project areas will be significantly

increased from current 45%–60% to 90%. The major environmental benefits from the components of Output 3 are as follows:

(v) The Sponge City component, by construction of 18.095 ha of sunken green belts, with the width of 3–20 m along the 10 existing roads (13.95 km in total length) will reduce 212,150 m^3 of storm water runoff discharged into the Tuo River annually. Accordingly, the annual reduction of pollutant loads of the SS, CODcr, TN, and TP to the Tuo River are 50.92 tons, 27.50 tons, 3.06 tons, and 0.40 tons, respectively. [32]

(vi) The project, by increasing vegetation coverage rate in the project area, particularly in the areas of embankment of the Tuo River, the landfill closure and conversion to public green area, and the Green Wedge, about 3,933 tons of soil erosion will be reduced annually; while the annual pollutant loads of CODcr, NH3-N, TN, and TP (released from eroded soil) discharging into Tuo River will be reduced by 7.418 tons, 0.1688 tons, 1.6437 tons, and 0.148 tons, respectively (Table V-2).[33]

(vii) The Yannan Lake component, after completion of the wetland restoration, will increase flood detention capacity of 0.65 million m^3. The water quality will be improved from current worse than Grade V to Grade III of the PRC's Surface Water Quality Standard (GB3838-2002), accordingly the pollution loads to the Tuo River will be removed (399 kg/a of CODcr, 99.7 kg/a of TN, and 17.95 kg/a of TP), (Table V-2).[34]

Table V-2: Reduction of Soil Erosion and Pollution Load to Tuo River (Unit: tons)

Component	Soil erosion amount without project	Soil erosion amount after project completion	Reduction of soil erosion amount	Reduction of pollution load to the Tuo River			
				CODcr	NH_3-N	TN	TP
Eco- embankment	776.44	149.51	626.94	1.1825	0.0269	0.2620	0.0236
Sponge city	117.65	72.38	45.27	0.0854	0.0019	0.0189	0.0017
Yannan Lake wetland	55.45	44.36	11.09	0.0209	0.0005	0.0046	0.0004
Landfill closure and restoration	207.36	57.59	149.77	0.2825	0.0064	0.0626	0.0056
Green Wedge	2,950.32	417.96	2,532.36	4.7764	0.1087	1.0584	0.0953
Preservation of bare hills	608.40	40.95	567.45	1.0703	0.0244	0.2372	0.0214
Subtotal	**4,715.62**	**782.75**	**3,932.88**	**7.418**	**0.1688**	**1.6437**	**0.148**
Yannan Lake wetland by water quality improvement	-	-	-	0.399		0.0997	0.01795
Total	**4,715.62**	**782.75**	**3,932.88**	**7.817**	**0.1688**	**1.7434**	**0.16595**

Source: Domestic environmental impact assessment institute and transaction technical assistance consultants.

[32] The calculation basis of pollutant concentrations in storm water runoff: SS - 300 mg/l, CODcr - 162 mg/l, TN - 18 mg/l, and TN - 2.37 mg/l.

[33] Data source: Estimated based on the study report for the Longxi River (another first tributary of the Yangtze River in the Chongqing Municipality, 150 km from the Ziyang Municipality (the contents of CODcr, NH3-N, TN, and TP in soil are 1,800 mg/kg, 42.94 mg/kg, 417.9 mg/kg, and 37.63 mg/kg, respectively).

[34] The estimation was based on the baseline monitoring data and the standard values of Grade IV standard of GB3838-2002.

D. Impacts and Mitigation Measures during Pre-Construction Phase

153. The following measures will be implemented in the engineering design and pre-construction phase to ensure the project's environment management readiness.

(i) **Institutional strengthening.** (a) appointment of one qualified environment officer within the ZPMO to coordinate the implementation of the EMP for the project; and (b) under the loan consulting services, the ZPMO will hire the LIEC to provide the external support.

(ii) **Second round of water and sediment monitoring.** During the detailed design, a second round of water and sediment sampling will be conducted, specifically to examine the presence of pesticides, heavy metals, and persistent organic pollutants (POPs, such as PAHs and PCBs) in the Yannan Lake and the Kongzi Creek. If the presence of these pollutants in the sediments is confirmed, the mitigation measures for the dredging (Section V) will be reviewed and updated as needed to minimize the risk of these pollutants.

(iii) **Updating the EMP.** In case of any changes in the project detailed design, the EMP will be updated as needed, including the mitigation measures and monitoring plan, which will be the responsibility of the ZPMO and the LIEC.

(iv) **Training in environmental management.** The LIEC and personnel from the Ziyang EPB will give training on the implementation and supervision of environmental mitigation measures to contractors and the CSCs.

(v) **Geological exploration and comprehensive groundwater monitoring on landfill site.** The detailed engineering designs shall include, based on the approved FSR, conduct of the geological exploration and the comprehensive groundwater quality monitoring (at multi-points and multi-layers of groundwater) based from which the depth and width of the vertical grouting anti seepage curtain will be designed.

(vi) **Shutting down the pollution sources within the catchment area of the Yannan Lake wetland.** Before construction of the Yannan Lake wetland, all the pollution sources within its catchment area will be eliminated or mitigated to ensure the performance of the wetland restoration, which will be the responsibility of the ZPMO and ZMG (the commitment letter for closing the pollution sources and residents' relocation has been signed by ZMG and provided to the ADB fact-finding mission).

(vii) **Grievance redress mechanism.** The ZPMO will implement the project GRM at least 2 months before the start of construction to ensure that the related residential communities, villages, schools, and hospitals, etc. are well informed and have opportunity to discuss any concerns.

(viii) **Bidding documents and contract documents.** The related clauses in the EMP will be included in all 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.

(ix) **Contractor obligations.** All contractors, in their bids, will respond to the environmental clauses in the bidding documents for the EMP requirements. Prior to construction, each contractor will develop a site EMP based on the project EMP (Attachment 1) and assign at least a person responsible for the EHS. The site EMP shall at least include the following: (a) surface water and

ecosystem protection (particularly for protection of water quality of the Tuo River and the Yannan Lake), (b) spill control and management, (c) site drainage and soil erosion protection, (d) temporary traffic management, and (e) construction site access control. The site EMP will be submitted to the environmental officer of the ZPMO for approval, with the support of the SZHTDZ and Ziyang Municipal and Yanjiang District EPBs.

E. Construction Phase

1. Environmental management on construction sites

154. During construction, the assigned environmental management officers of the ZPMO and the PIU, together with environmental supervision engineers from the CSCs, will be responsible for enhancing site supervision, management, and appraisal for timely identification and resolving of any issues. Intermittent follow-up training (following the pre-construction measures; Section D of Chapter V) will be conducted.

2. Soil erosion and earthwork balance

155. Without management, the construction works may cause soil erosion and/or contamination. Soil erosion may be caused by unprotected stockpiles of soil and spoil, and exposed surfaces from the embankment of the Tuo River; sediment dredging in the Yannan Lake; building foundation and land leveling for the TVET center; and landscaping after landfill closure, green wedge, and bare hills preservation construction. Embankment construction may contribute to bank erosion and excessive suspended particles (SS) and sedimentation of the Tuo River. Erosion could also occur after completion of construction where site restoration is inadequate. Soil contamination could result from inappropriate transfer, storage, and/or disposal of dredged sediment, chemicals, (e.g., gasoline, diesel and lubricant), and solid wastes.

156. **Soil erosion.** The project area is in hilly landforms typical of southwest PRC. The natural soil erosion intensity in the project areas is 480 (sponge city)—3,510 (bare hills) tons per square kilometer per year (t/km^2.a) in accordance with the DEIA and the Soil Erosion Conservation Plan. Soil erosion rates are expected to increase during construction when the banks and sites nearby waterbodies are disturbed and surface vegetation and soil are damaged or disturbed. The most vulnerable soil erosion areas for the project are the bare hills, embankment of the Tuo River, and the wetland construction activities along the Yannan Lake, construction sites, spoil sites, temporary construction roads, and other areas where surface soil is disturbed, especially on rainy days (less windy days in Ziyang). Soil erosion amounts during the periods of construction and recovery (generally 1–2 years after the construction completed) were estimated based on the following formula:

$$W = \sum_{j=1}^{2} \sum_{i=1}^{n} (F_{ji} \times M_{ji} \times T_{ji})$$

$$\triangle W = \sum_{j=1}^{2} \sum_{i=1}^{n} (F_{ji} \times \triangle M_{ji} \times T_{ji})$$

Where, W is soil erosion amount (t); ⊿W is newly increased soil erosion amount (t), Fji is the predicted area at certain period and unit (km^2); Mji is the soil erosion intensity at certain period and unit (t/km^2.a); ⊿Mji is newly increased soil erosion intensity at certain period and unit (t/km^2.a); Tji is the prediction period for a certain unit (a); j is the prediction period (j = 1, 2, 3, including the construction and recovery periods; and i is prediction period (i=1, 2, 3, n);

157. **Soil erosion intensity before and after soil disturbance.** Based on the site surveys and the current soil erosion situation, in combination with the factors of rainfall, soil type, landform, physiognomy, and vegetation on the project sites, against the Grading Standard of Soil Erosion Intensity of SL190-2007, the identified baseline soil erosion intensities of the components of embankment, sponge city, the Yannan Lake, landfill closure, green wedge, bare hills, and the TVET center are 2,470 t/(km^2.a), 480 t/(km^2.a), 2,505 t/(km^2.a), 2,605 t/(km^2.a), 1,845 t/(km^2.a), 3,510 t/(km^2.a), and 300 (km^2.a), respectively (Table V-4).

158. Projected soil erosion intensities after disturbance (i.e., during construction) were derived by comparison with a similar construction in the area. Soil erosion factors of the Output 3 and the TVET center were compared and a correction coefficient applied to estimate soil erosion intensities during both the construction and recovery periods were determined (Tables V-2 and V-3).

Table V-2: Estimated Soil Erosion Amount for Each Component of Output 3

Component	Period	Baseline erosion ($t/km^2 \cdot a$)	Erosion after disturbance ($t/km^2 \cdot a$)	Area of soil disturbance (ha)	Erosion period (a)	Baseline erosion amount (t)	Estimated erosion amount (t)	Estimated erosion amount with measures (t)	Increased erosion amount without measures (t)	Increased erosion amount with measures (t)
Eco-embankment	Construction	2,470	7,500	56.51	1.50	2,100	6,400	3,800	4,300	1,700
	Recovery	2,470	3,000	35.51	1.00	900	1,100	/	200	/
Sponge City	Construction	480	6,800	18.10	1.00	100	1,200	800	1,100	700
	Recovery	480	3,000	18.10	1.00	100	500	/	400	/
Yannan Wetland	Construction	2,505	7,500	22.21	1.50	800	2,500	1,500	1,700	700
	Recovery	2,505	3,000	16.03	1.00	400	500	/	100	/
Landfill Closure,	Construction	2,605	7,500	39.38	1.75	1,800	5,200	3,100	3,400	1,300
	Recovery	2,605	3,000	39.14	1.00	1,000	1,200	/	200	/
Green Wedge	Construction	1,845	7,800	124.31	2.00	4,600	19,400	11,200	14,800	6,600
	Recovery	1,845	3,000	114.01	1.00	2,100	3,400	/	1,300	/
Bare Hills	Construction	3,510	7,500	2.31	1.00	100	200	100	100	0
	Recovery	3,510	3,000	2.31	1.00	100	100	/	0	/
Total	**Construction**			**262.82**				**20,500**	**25,400**	**11,000**
	Recovery			**225.10**					**2,200**	**/**
Total									**27,600**	**11,000**

Source: Domestic environmental impact assessment reports.

Table V-3: Estimated Soil Erosion Amount for Construction of the Technical and Vocational Education and Training Center

Period	Component area	Baseline erosion (t/km²·a)	Erosion after disturbance (t/km²·a)	Area of soil disturbance (ha)	Erosion period (a)	Estimated erosion amount without disturbance (t)	Estimated erosion amount after disturbance (t)	Increased erosion amount (t)
Construction	Building area	300	10,000	2.29	3.5	24.05	801.5	777.45
	Road and campus	300	12,000	5.29	3.5	55.55	2221.8	2,166.25
	Landscaping	300	12,000	5.76	3.5	60.48	2,419.2	2,358.72
Recovery	Landscaping	300	1,500	5.76	1.0	17.28	86.4	69.12
Total				**13.34**		**157.36**	**5,528.9**	**5,372.00**

Source: Feasibility study reports.

159. The total soil disturbance area in the project areas during construction is estimated to be 276.16 ha, including 262.82 ha for the six subcomponents of the Output 3 and 13.34 ha for the TVET center. The increased soil erosion amount during the 4–5 years of construction period with mitigation measures will be 16,372 tons (Tables V-2 and V-3), including 11,000 tons from the components of Output 3 and 5,372 tons from the TVET center, which is categorized as a "medium soil erosion impact" in comparison with other similar projects in the Sichuan Province.

160. **Earthworks.** The early draft FSR included a surplus of about 0.9 million m^3 with no clear disposal mechanism. Following discussions among the TRTA team, and the FSR and DEIA institutes, the excavation plans were improved; and the surplus earth was reduced to 0.3653 million m^3 in the updated FSRs (Table V-3). The surplus earth will be reused within the Yanjiang District for filling the roadbed and construction sites. The earth work balanced is shown in Table V-4.

Table V-4: Earth Balance for Each Subcomponent (Unit: 10^4 m^3)

Subcomponent	Excavation Earth	Filling Earth	Borrow earth	Transport out earth	Surpluses earth and spoil
Eco-embankment	12.60	18.90	6.78	---	0.48
Sponge city	4.92	3.35	---	1.57	---
Yannan Lake wetland	9.70	3.20	---	4.87	1.63
Landfill closure	1.03	6.30	5.39	-	0.12
Green wedge	12.97	10.46	---	1.37	1.14
Preservation of bare hills	43.59	9.53	---	4.36	29.70
TVET center	58.48	55.02	3.19	3.19	3.46
Total	**143.29**	**106.76**	**15.36**	**15.36**	**36.53**

Source: Domestic environmental impact assessment reports.

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

(i) During Tuo River embankment construction: (a) maintain slope stability at cut faces by implementing erosion protection measures such as terraces and silt barriers; (b) construct berms or drainage channels around the perimeter of the construction site to capture soil runoff and direct rainwater away; and (c) plan and implement construction in staged sections ($\leqslant$1,000 m), with one section completed and stabilized before beginning the next.
(ii) Stabilize all cut slopes, embankments, and other soil erosion-prone working areas.
(iii) Stabilize all earthwork disturbance areas within 15 days after earthworks are completed.
(iv) Minimize open excavation areas during trenching and pipeline works ($\leq$300 m).
(v) Use appropriate compaction techniques for pipe trench construction (sponge city).
(vi) Provide temporary detention ponds or containment to control silt runoff.
(vii) Construct intercepting channels and drains to prevent runoff entering construction sites and divert runoff from sites to existing drainage or open ground for watering the vegetation.
(viii) Strip and stockpile topsoil, and cover (by geotechnical cloth) or seed temporary soil stockpiles.
(ix) Limit construction and material handling during periods of rains and high winds.
(x) Properly slope or re-vegetate disturbed surfaces e.g. pipeline trenches and cut banks.
(xi) Protect slopes on both sides of embankment.
(xii) All dredged sediment and spoil disposal sites, embankments, and revetments, will be rehabilitated once they are completed (or full in the case of the disposal sites).

(xiii) Landscaping will only use native plant species.
(xiv) Construction camps and storage areas will be properly located to minimize land area required.

162. **Measures for soil contamination.** To reduce the risk of soil contamination from construction machinery, contractors will do the following:

(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 (solid wastes paras. in Section V).
(iii) Establish emergency preparedness and response actions.
(iv) Provide spill clean-up measures and equipment at each construction site.
(v) Train contractors and crews in emergency spill response procedures.

163. **Inspection and monitoring.** Site inspections and monitoring will be conducted by the contractors, the CSCs, the ZPMO, the LIEC, and external monitoring agency; and is described in the EMP (Appendix 1).

3. Water Quality

164. **Water quality and wastewater management.** Embankment and dredging constructions could result in soil runoff to the Tuo River; while inappropriate storage and handling of fuel, accidental spills, domestic wastewater discharge from construction camps, and wash-down water for machinery and vehicles could contaminate the river and lake. Construction wastewater will come from washing aggregates, pouring and curing concrete, cleaning of construction sites, machineries and vehicles, and human wastes.

165. **Construction wastewater.** Construction wastewater will be produced from the maintenance and cleaning of mechanical equipment and vehicles, water from mixing and curing concrete, and lost water and soil during the construction period which is discharged as pollutants. During construction, there will be a total of 10 construction sites (Table V-4) over 4 years. Each site will generate an estimated 8 m^3/d of construction wastewater, with SS (about 300 mg/L) and petroleum (20 mg/L), (based on rates applied in the DEIAs). If discharged in an improper manner, this has the potential to impact the existing water bodies. Construction wastewater will not be discharged onto the surrounding soil or into the Tuo River, the Yannan Lake wetland, and other surface water bodies. Sedimentation tanks will be held on site; and after settling out of solids, the upper clear liquid will be recycled for spraying the construction site for dust control; and the waste residue in the tank will be cleared and transported to the construction spoil disposal sites. Oily wastewater will require the installation of oil-water separators before the sedimentation tank. After site treatment, construction wastewater will comply with the Integrated Wastewater Discharge Standard (GB8978-1996). The standard provides the limit for pollutant concentrations and the total allowed wastewater discharge from industries and construction sites. The indicative pollution parameters are total SS and oil and/or petrochemical residues. These will be monitored as part of the EMP.

166. **Domestic wastewater from construction workers.** Peak work forces are estimated to be 340 workers in the project area (Yanjiang District). Daily domestic wastewater discharge production is estimated as 0.064 m^3 per worker per day. The pollutant concentrations of CODcr, 5-day biological oxygen demand (BOD_5), and NH_3-N in the domestic wastewater from the construction workers are assumed to be 350 mg/L, 200 mg/L, and 25 mg/L, respectively. Estimated volumes of construction and domestic wastewater are shown in Table V-5. About 60% of the workers will live in rented apartments in the district. Therefore, majority of domestic sewage will be discharged and disposed through the existing municipal sewer network. For the 40% of workers that will reside in worker

camps, camp management will include wastewater management system. All the domestic wastewater will be delivered to the wastewater treatment plants (WWTPs) through the municipal sewer network (Table V-6).

Table V-5: Wastewater Generated during Construction

Subcomponent	Eco-embankment	Sponge City	Yannan Lake Wetland	Landfill Closure	Green Wedge	Preservation of Bare Hills	TVET Center	Total
No. of construction sites	2	1	1	2	2	1	1	**10**
Construction wastewater generated (m^3/d)	16	8	8	16	16	8	8	**80**
Pollutant generation from construction wastewater (SS kg/d)	4.8	2.4	2.4	4.8	4.8	2.4	2.4	**24**
Pollutant generation from construction wastewater (petroleum kg/d)	0.32	0.16	0.16	0.32	0.32	0.16	0.16	**1.6**
No. of worker at peak construction	50	40	60	60	50	30	50	**340**
Wastewater discharge（m^3/d）	3.2	2.56	3.84	3.84	3.2	1.92	3.2	**21.76**
Pollutant generation from domestic wastewater (CODcr, kg/d)	1.12	0.896	1.344	1.344	1.12	0.672	1.12	**7.616**
Pollutant generation from domestic wastewater (BOD_5, kg/d)	0.64	0.512	0.768	0.768	0.64	0.384	0.64	**4.352**
Pollutant generation from domestic wastewater (NH3-N, kg/d)	0.08	0.064	0.096	0.096	0.08	0.048	0.08	**0.544**

Sources: Transcation technical assistance consultants and domestic environmental impact assessmen institute.

167. **The existing WWTPs and sewage network in Yanjiang District.** There are three WWTPs in Yanjiang District with the total designed capacity of 85,000 m^3/d and actual treatment load of 60,000 m^3/d. and all the effluents of the WWTPs are discharge into Tuo River. the sewer collection rate in the district is 80%. In the old urban area, the combined sewer and storm system is still used while the separated storm and sewer system is being constructed; the separate drainage networks have been constructed in SZHTDZ, with lengths the sewer pipeline and stormwater pipeline of 70.5 km and 71.87 km, respectively. The No.2 WWTP is under construction and planned to be putting into operation before the end of 2018, and other two WWTPs and their drainage networks are in normal operation. (Table V-5)

Table V-6: Existing Wastewater Treatment Plants in the Yanjiang District of the Ziyang Municipality

WWTP	Treatment process	Effluent standard	Designed capacity（m^3/d）	Status	Length of sewer pipeline (km)	Service population
Tuodong WWTP	Modified Oxidation ditch	Grade I-A	10,000	Normal operation	176.0	30,000
WWTP of Haitian Sewage	A2/O Oxidation	Grade I-B	50,000	Normal operation	16.5	300,000

WWTP	Treatment process	Effluent standard	Designed capacity (m^3/d)	Status	Length of sewer pipeline (km)	Service population
Treatment Co.	ditch					
No. 2 WWTP of Ziyang	A2/O Oxidation ditch	Grade I-A	25,000	Pilot running	Under construction	---

Source: Domestic environmental impact assessment institute.

168. The following measures will be implemented to minimize the water pollution:

(i) During the embankment construction and dredging, contractors will pump the slurry to the shore and properly re-use the embankment excavation soil and dredged sediment, as well as the appropriate disposal of other spoil to reduce the impact to water qualities of the Tuo River and the Yannan Lake.

(ii) Contractors will develop relevant measures on controlling the oil and other chemicals 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 to be washed, will be equipped with water collection basins and sediment traps.

(v) Fuel storage, machinery maintenance workshop, and vehicle cleaning areas must be located at least 500 m away from the surface waterbody.

(vi) Storage facilities for fuels, oil, and other hazardous materials will be within secured areas on impermeable surfaces and provided with sorbent mats and clean-up installations.

(vii) Contractors' fuel suppliers must be properly licensed and shall follow proper protocol for transferring fuel and the PRC standard of JT3145-91 (Transportation, Loading and Unloading of Dangerous or Harmful Goods revised).

(viii) Earthworks along the river and wetland will be accompanied by measures on minimizing the sediment runoff into the water bodies, including sediment traps.

(ix) For landscaping along the riverside and lakeside, the base fertilizer will be fully applied to each plant; and application of top fertilizer is prohibited to avoid the nitrogen (N) and phosphorus (P) pollution to the surface waterbody via surface runoff.

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

(xi) Water quality will be monitored by local environmental monitoring agencies during construction as per the EMP.

(xii) River embankment and lake dredging works shall be conducted in the dry season. Construction during the high-flow season (May to September) is prohibited.

4. Sediment dredging

169. The proposed dredging work will be conducted in the Yannan Lake and the Kongzi Creek, with the total area of 183 *mu* (12.2 ha). The total volume of the sediment to be dredged is estimated to be 98,000 m^3 (the water contents of 90%), and the designed dredging depth is 0.4–0.5 m. The dredging work will be staged for a year. The lake and creek are polluted according to the baseline sediment monitoring: water qualities are Grade V or worse, but sediment qualities meet the PRC's Standards for Pollutants in Sludge and Sediment for Agricultural Use (GB4284-84) and Grade III of the Soil Quality Standard (GB15618-95). The sediment sample with "slight odor" was described in the baseline monitoring report.[35]

[35] In the PRC practice, in the case of concentrations of pollutants (NH3-N, TN, TP, etc.) ≧5 times of the Grade V Surface

170. The dredging will cause short-term and localized disturbance and exposure of sediment. This may cause the following: (i) temporary increases in the levels of nutrients and SS, leading to sediment plumes downstream, reduced water transparency and dissolved oxygen, and algal blooms. Low light, reduced oxygen, and smothering or abrading by silt may reduce plant growth and cause mortality of fish and sediment-dwelling (benthic) organisms; (ii) removal of habitats for fish, invertebrates, and other aquatic fauna; and/or (iii) release of pollutants and/or odor (hydrogen sulfide and ammonia) from the dredged sediments, since some sediments are anoxic with high organic content. Modeling conducted for the project estimated the odor dispersion distances to be 20–50 m around the dredging sites and up to 100 m downwind of the temporary dredge storage and dewatering sites. Based on the FSR and DEIA, all the residents within 200 m of the dredging locations will be relocated before the dredging construction begins; and (iii) inadequate management of dredging procedures and machinery could cause leakage or spill of sediments or fuel into waterbodies, along transport routes, and/or at disposal sites, leading to soil or water pollution. These risks will be minimized as follows:

(i) **Planning.** Base on the approved FSR, the design institutes, in their detailed engineering design, will further develop a detailed dredging plan, emergency preparedness, and response plan prior to commencement of dredging activities to be approved by the Yanjiang District EPB and the Ziyang Municipal Water Resources Bureau (WRB).

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

(iii) **Timing.** Dredging will only be conducted in the dry season (late November to early March), the time of lowest water depth and slow flow; and be completed by late February to allow at least 1 month for the disturbed bottom sediments to settle and stabilize before the wet season (April–October).

(iv) **Restricted extent of dredging at any one time.** Dredging will be limited to small section ($\leq$0.5 ha for the Yannan Lake and 100 m for the Kongzi Creek) at any one time to minimize disturbance.

(v) **Dredge method.** The “environmental dredging method” will be applied. This method is implemented in specific dredging depth (about 0.4–0.5 m), then sediment will be transferred to geotextile for dewatering by adding flocculants. The geotextile will be stacked in the sediment ground for dewatering. In the ground, there will be sedimentation ponds to stop the polluted water from the dredged sediment flow into the water bodies again. The dredged sediments will be used for landscaping fertilizer as they meet the standard for agriculture use.[36] The equipment used will include a specialized ‘cutter head’, which sucks up sediment and limits dispersion; and therefore, turbidity impacts.

(vi) **On-site storage limited.** Earth berms or drainage channels will be constructed around the perimeter of the dredge sediment storage and disposal sites to prevent

Water. Quality Standard, the bottom sediment is with obvious odor.

[36] The dredged sediment will be used as fertilizer for the landscaping on the landfill closure and restoration and green wedge components of the project.

washing away from rainfall. On-site storage will be limited to de-watering, and the sediment will then be transported to the disposal sites.

(vii) **Treatment and dewatering.** Dewatering sites were proposed in the updated FSR (Figure V-3). Prior to transport, the dredge sediment will be dewatered; and this will reduce spoil volume by up to 70%. Supernatant water from the dredge spoil will be treated to meet the PRC's Integrated Wastewater Discharge Standard (GB 8978-2015, revised).

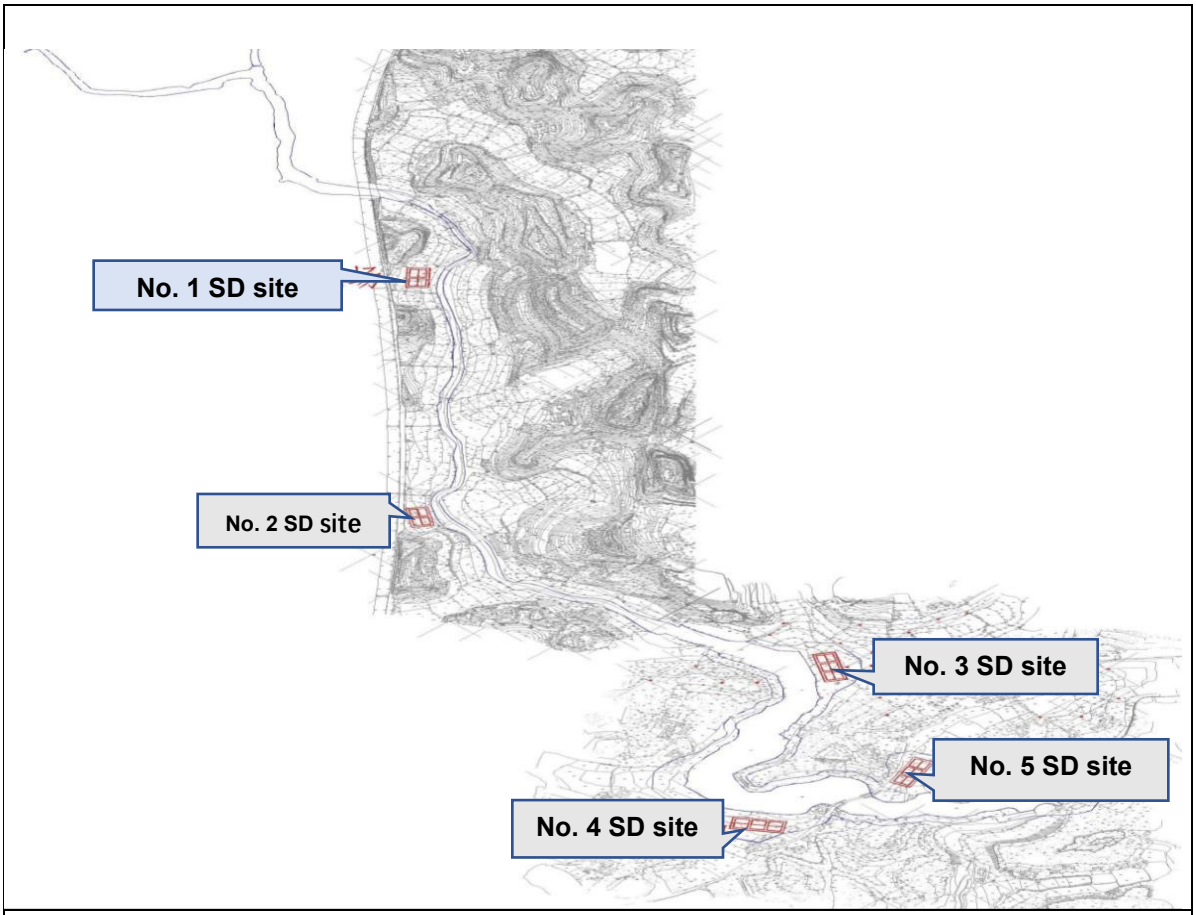


Figure V-3: Layout Sediment Dewatering Sites (SD Site)

(viii) **Managing odor.** Impacts will be minimized by (i) timely community consultation to ensure awareness of the issue prior to dredging in case of some residents surrounding the lake have not been relocated when the dredging begins, (ii) transport in sealed containers to avoid odor impact, (iii) minimizing the release of odors by dredging in short sections (⩽0.5 ha or 100 m) at any one time. Impacts will also be temporary and slight as odor are dispersed.

(ix) **Transport to disposal sites.** Except for any sediment to be used for construction purposes, the de-watered sediment will be transported off-site in sealed containers to prevent leakage and minimize odor.

(x) **Disposal and re-use of the de-watered sediment.** Sediment sampling in the DEIA indicated that pollutant concentrations in the sediments meet the PRC's Control Standards for Pollutants in sludge for Agricultural Use (GB4284-84) and Grade II of

the PRC's Soil Quality Standard (GB15618-2008, revised). This indicates that the dewatered sediment can be re-used as topsoil and fertilizer for landscaping and agriculture. After dewatering and prior to disposal, the de-watered sediment will be examined again to ensure compliance with these standards. Sediment meeting the standards will be transported to the sites of Green Wedge and Landfill Closure and restoration for landscaping according to the DEIA.

(xi) In the event of any spoil exceeding the standards, the spoil would be categorized as a "hazardous waste" and require further assessment and specific disposal methods by a qualified entity, the Ziyang Municipal Hazardous Wastes Disposal Center (under the Sichuan provincial EPB). Such spoil would be disposed at specialized sites in accordance with the PRC's Pollution Control on the Security Landfill—Hazardous Wastes (GB 18598-2013, revised).

171. Overall, the environmental risks of the planned dredging are considered to be very low due to (i) the degraded and polluted condition of the Yannan Lake and the Kongzi Creek (the pollutant concentrations are 2–3 times higher than the Grade V Surface Water Quality Standard, Table IV-9; and the sediment with slight odor as described in the baseline monitoring report); (ii) the nearby residents will be relocated before the dredging begins; and (iii) the safeguard measures will be strictly implemented. The sediment odor disturbance will be minimized by limiting the time that exposed sediments are retained on site (for dewatering only; no extended on-site storage), transported in sealed containers, and disposed in certified sites.

5. Air quality

172. 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). The proposed project components of sponge city and green wedge include small road construction; and 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's Atmospheric Pollutant Emission Standard (GB16297-1996) and the PRC's Ambient Air Quality Standard (GB3095-2012), which limits the concentration of benzopyrene at 0.0025 μg/m^3 (daily average, 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 Section V. Impacts associated with odors from sediment dredging are addressed above.

173. The quantity of dust generated will depend on wind, humidity of the material and earth, and state of site. For the project area, it was estimated that under general on-site conditions (average wind speed 1.7 m/s, and average humidity of 80%) dispersion distance is 80 m downwind. For dust generated by transporting earth and other construction materials, the impact zone may exceed 50 m each side of the route. Based on the locations of sensitive receptors (Section V.A), about six communities (320 households with 1,002 persons) and a school (about 500 students) occur within 50 m of the construction sites; and may be subject to dust-related disturbance.

174. Mitigation measures to reduce impacts on air quality are as follows:

(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, particularly fine material, to avoid spillage or dust generation.
(vi) Ensure vehicle and machinery emissions comply with the PRC's standards of GB18352-2005, GB17691-2005, GB11340-2005, and GB18285-2005.
(vii) Timely monitoring of air quality and inspections during construction, as defined in the project EMP (Tables EMP-6 and EMP-7).

175. The potential impacts of disturbance related to air quality is considered to be low due to (i) the local weather regime, which is generally rainy rather than windy, with high relative humidity (average annual relative humidity of 80%–82%); (ii) the annual average wind speed is only 1.7 m/s due to located on transition zone of the Sichuan Basin and hilly area; (iii) high ground soil moisture and high vegetation coverage, which result in reduction of fugitive dust impact; and (iv) since January 2017, the PRC has implemented increased controls on vehicle and/or machinery emissions to protect the ambient air quality: all vehicles and construction machinery must comply with the PRC's Grade IV or higher emission standard.

6. Noise

176. The project construction phase will result in increased noise levels and sudden and discontinuous vibration impacts. Construction will involve excavators, bulldozers, graders, dredgers, concrete-mixers, rollers, and other heavy machinery. Construction noise will be temporary and localized. Estimated construction noise values (at 5 m distance from the machineries and vehicles) are shown in Table V-7.

Table V-7: 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

177. **Estimation of noise levels.** The construction equipment generates the noise as a point 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 levels at R_i and R_0 respectively. ΔL is additional diffusion attenuation produced by barriers, vegetation and air.

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

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

179. **Prediction results.** Noise levels at different distances were derived after calculating the impact scope of equipment noise during construction. The PRC's Standard of Noise Limits for Construction Sites (GB12523-2011, revised) 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 Table V-8.

Table V-8: Noise Values of Construction Machineries at Different Distances

Unit: dB(A)

	Distance to Machinery								
Machinery Name	**15m**	**20m**	**40m**	**60m**	**80m**	**100m**	**130m**	**150m**	**200m**
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
Grade II of GB12523 − 2011	70 (daytime)								
	55 (nighttime)								
World Bank EHS Guideline	55 (daytime for residential and institutional area); 70 (daytime for industrial and commercial area)								
	45(nighttime for residential and institutional area); 70 (nighttime for industrial and commercial area)								

Source: Transaction technical assistance consultants and the domestic environmental impact assessment institute.

180. These values were compared with the locations of the sensitive receptors (Section V.A) to see which communities would be within 40 m of construction works which exceed daytime noise levels of 70 dB(A), the threshold applied to this project under the PRC's standard GB12523-2011 (Table V-8). To be conservative, no attempt was made to distinguish between noise emissions from different types of construction activity, i.e., any works within 40 m of residences were assumed to generate noise levels exceeding the threshold and so require management. The total which include 243 households, with 747 persons in 6 villages and 3 residential communities; and a primary school with 300 students, are situated within 40 m of planned works (Table V-8a). The maximum construction noise level at 40 m, from the loudest machinery, will be 64 dB(A), i.e., 6 dB(A) lower than the PRC's standard. Although the estimated noise level at 40 m will be below the required standard, the noise may still cause some disturbance.

Table V-8a: Households within 40 meters of Construction Works

Component	Village/ community	Location	Affected household	Affected persons
Eco-embankment	Changshou Village	20 m west of embankment	**3**	**10**
	Gaoyan Village	5 m west of embankment	8	25
	Houjiaping Village	20 m west of embankment	12	40
	Houjiaping Primary School	50 m west of embankment		300 students
Sponge City	Jiangnahuadu Community	10 m east of Tiantai Road	120	360
	Tongziyuan Community	20 m east of Tiantai Road	36	110
	Chahua Community	20 m east of Tiantai Road	40	120
Yannan Lake wetland	Longhan Village	30 m north of Yannan Lake	4	12
	Baima Village	30 m west of Kongzi Creek	8	30
Green Wedge	Wuxian Village	20 m south of the site boundary	5	15
	Zaishanzui Community	15 m north of the site boundary	7	25
Total			**243**	**747 + 300 students**

Source: Domestic environmental impact assessment institute.

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

(i) Ensure that noise levels from equipment and machinery conform to the PRC's standard of GB12523-2011 (revised). Properly maintain construction vehicles and machineries to minimize noise.

(ii) Apply noise reduction devices and methods for high noise equipment operating within 200 m of the sensitive sites, e.g., schools, villages, residential areas (Table V-1).

(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 20:00 and 07:00, in accordance with the Sichuan provincial regulations.

(v) Take special caution at construction sites that are close to such sensitive sites as schools and hospitals. When construction activities are unavoidable during the school seasons, the use of heavy equipment will be restricted to weekends and non-class hours.

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

(vii) Monitor noise at sensitive areas at regular intervals (EMP, Table 5). If noise standards are exceeded, equipment and construction conditions shall be checked; and mitigation measures shall be implemented to rectify the situation.

(viii) Conduct regular interviews with residents and/or villagers adjacent to construction sites to identify noise disturbance. Community feedback will be used to adjust work hours of noisy machinery.

(ix) If needed, discuss with residents the need for other measures: (a) temporary relocation away from the construction; and/or (b) provision of hearing protection equipment, during occasions of short duration high noise.

182. Based on effective implementation of these measures, the net impact of noise disturbance is expected to be mild due to (i) stone material is commercially available, and there will be no on-site stone crushing; (ii) the TVET buildings are 2–9 floor medium and low-rise without using high noise

pile driver, or drilling machine; and also, there is no any community and environment-sensitive receptor; (ii) other project components, such as embankment, sediment dreading, land leveling for landfill closure, and landscaping for the sponge city, green wedge, etc. the maximum noisy machineries are medium-sized excavators, bulldozers, loaders and trucks; (iii) no nighttime construction; and (iv) the extent of noise disturbance to individual communities will be shorter than the total construction time for the project, as the scope of works within individual sites is relatively small compared to the total cumulative works. Overall, noise management will require close attention during the project implementation.

7. Vibration

183. Generally, vibration impact is more or less expected during constructions. Mechanical vibration may be sudden and discontinuous, which can cause stress among workers and communities. To address these issues: (i) high noise activities, such as compaction operations will be prohibited at night; and (ii) communities will be consulted prior to large earthworks to ensure that they are informed and avoid sensitive timing, e.g., exams at nearby schools or festivals. The Japanese Handbook of Environmental Impact Assessment provides measures of vibrations caused by construction machinery (Table V-9).

Table V-9: Vibration Levels of Construction Machinery (Unit: dB)

Equipment	At 5 m	At 10 m	At 20 m	At 30 m
Vibratory hammer	75	67	48	44
Roller	58	53	50	48
Diesel truck	62	58	54	51

184. Table V-9 shows that the requirements for residential and cultural areas as specified in the Environmental Vibration Standard for Urban Areas (GB10070-88) is met at a distance of >10 m from the vibration source. Mitigation measures include prohibition of compaction operations at night, which will effectively reduce the vibration impact. No sensitive receptor site is closer than 20 m from a construction area, although some residential areas are between 20 m and 100 m of construction areas. Overall, same as that for noise impact, the impact of vibration from this project is considered to be very low due to (i) stone material is commercially available, and there will not be any on-site stone crashing; (ii) there is no structure for using pile hammers (high noise and vibration); and (iii) use medium-sized trucks only.

8. Solid waste

185. **Construction spoil.** About 15,000 m^3 of construction spoil cannot be reused as filling earth, this spoil will be regularly transported off-site by the contractor for disposal at designated spoil disposal sites that have been approved by the local authority in compliance with the PRC's Law on Prevention and Control of Environmental Pollution by Solid Waste. The approved construction spoil disposal site is at the Wuxian Village, 11 km southwest of urban center of the Yanjiang District, the approval date is 7 April 2013 by the Ziyang Municipal Housing and Construction Commission and the SZHTDZ committee (the approval No.: ZZTO-［2013］-25. The total area of disposal site is 80 *mu* (5.33 ha) with the total disposal capacity of 1.0 million m^3, the disposal site was put into operation in January 2014; by the end of March 2018, the remaining capacity is more than 0.8 million m^3, which is confirmed adequate capacity to receive the 15,000 m^3 spoil generated during construction. The site has soil erosion protection plan, and it will be environmentally rehabilitated once filled.

186. **Domestic wastewater and rubbish from construction workers.** The peak work forces are estimated at 340 workers in total. Daily domestic solid wastes production is estimated as 0.5 kg per worker per day (170 kg/d in total). About 60% of the workers will live in rented apartments in the Yanjiang District, and 40% will live in worker camps. For the workers living in rented apartments,

their daily rubbish (about 102 kg/d) will be collected and disposed through the existing municipal rubbishes collection systems in the district. For the rubbish from the worker camps (68 kg/d), covered garbage bins will be installed in the camps, which will be the responsibility of the construction contractors to provide sufficient garbage bins at proper locations; and ensure that they are protected from birds and vermin and emptied regularly, and transported to the local sanitation landfills for disposal. The landfill sites are confirmed to have sufficient capacity to receive the waste and have approved soil control plans.

187. Suppose the average construction days in a year is 250. The estimated domestic wastes generated by the project is 75.1 tons in about 4 years construction (Table V-10), in which only 40% (28.6 tons) is generated from the worker camps. The domestic wastes will be transported through the municipal sanitation system to the existing landfill before 2020; and after 2020, the wastes will be transported to the Ziyang Solid Waste Incineration Power Plant (SWIPP) for disposal.

188. The Ziyang SWIPP is being constructed at 2.8 km south of the urban area of the Yanjiang District. The designed capacity (first phase) is 600 tons per day (t/d), (with a 12 megawatt [MW] power generator); and then expansion to 1,000 t/d (12 + 7.5 MW power generator) in the second phase. The Ziyang SWIPP will be operated by the China Environment Protection and Energy Conservation Co., Ltd.; and the service area is 1,632 km, including the whole Yanjiang District and other surrounding towns and villages. The designed flue gas cleaning process is “SNCR Semi-dry mechanical rotating spray deacidification + dry lime spraying + activated carbon injection + bag filler dust removal” for ensuring that the emission will achieve the national “Pollution Control Standard for Municipal Solid Wastes Incineration (GB 18485-2014). The plant is expected to put in operation in August 2019. After the landfill closed in 2020, all the municipal solid wastes will be transported to the Ziyang SWIPP for sanitation disposal.

Table V-10: Estimated Amount of Municipal Solid Waste During Construction

Subcomponent	No. of Workers	Construction Period (year)	Amount of Domestic Waste (t)
Eco-embankment	50	1.50	9.4
Sponge City	40	1.00	5.0
Yannan Lake Wetland	60	1.50	11.3
Landfill Closure and Restoration	60	2.75	20.6
Green Wedge	50	2.00	12.5
Preservation of bare Hills	30	1.00	3.8
TVET Center	50	2.00	12.5
Total	**340**	**---**	**75.1**

Source: Domestic environmental impact assessment reports.

189. The following measures will be undertaken to manage the solid waste:

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

(ii) The construction waste will be re-used as many as possible, and the disposed waste will timely be transported to the site designated by the local authority according to the

Law on the Prevention and Control of Environmental Pollution by Solid Waste of the PRC and the scrap material and demolition waste disposal standards promulgated by the PRC's Ministry of Housing and Urban–Rural Construction.

9. Ecosystem

190. **Ecological resources.** Impacts comprise (i) clearance of some existing vegetation for embankment along the Tuo River and dredging in the Yannan Lake and the Kongzi Creek; and (ii) temporary noise and/or visual disturbance to fauna within and near the construction sites. Ecological impacts are considered low as (i) species richness is low and comprises widespread species because the sites are all located in urban area and the SZHTDZ; (ii) the FSR and DEIA both stipulate, and comments provided by the TRTA consultants and the ADB mission that preservation of the extant landscape and vegetation to the greatest extent in the constructions of landfill closure and restoration, and green wedge; (iii) there are almost no vegetation on the embankment site; (iv) most existing vegetation is secondary, planted, and/or degraded; (iv) there are no rare, threatened, or protected flora or fauna species, critical habitats, or protected areas, in or near the construction sites; and (v) the project will result in a net increase in vegetation from the planned green area of 90.6 ha (Table V-11). In case that some existing vegetation had to be cleared in construction, the compensatory plantings will be required for the cleared sites. In accordance with Sichuan provincial regulations, double the area cleared will be replanted to ensure a minimum survival rate of 80%. The ecological resource protection measures in the EMP are as follows:

(i) Clearance of vegetation will be restricted to specific construction sites.
(ii) Prior to construction, vegetation and habitats will be clearly demarcated as no-go zones for workers and machinery.
(iii) In compliance with the Sichuan Provincial Regulation for Landscaping Management: (a) the area of compensatory plantings will be double that of the area of vegetation that is cleared; and (b) a minimum survival rate of 80% of the planted vegetation is required. The Sichuan regulatory requirement for the area of replanting builds on the PRC's Forestry Law, which states that compensatory planting will be of "an equivalent or larger area of affected trees and vegetation".
(iv) Cleared sites will be immediately re-vegetated afterward.
(v) All re-vegetation will use native plant species of local origin to maintain genetic fitness and reduce the risk of introducing non-local and invasive species.

10. Socioeconomic resources

191. The embankment of the Tuo River, sponge City, and green wedge construction sites are in urban area of the Yanjiang District; and the comprehensive scope of the project works will render some social impacts unavoidable. Construction may cause unexpected interruptions in municipal services and utilities because of damage to pipelines for water supply, drainage, and gas supply. This risk will be managed through (i) frequent inspection of the facilities during construction; and (ii) consultations with nearby communities before and during construction, as part of the ongoing consultation and information disclosure (Section VII). The project will also involve temporary and permanent land acquisition and house demolition. These issues, including resettlement, compensation, and public consultations, are described in the TRTA documents of the Land Acquisition and Resettlement (LAR) Plan and the Poverty and Social Assessment Report (PSAR).

11. Community and worker health and safety

192. Traffic congestion and risk of accidents in the Yanjiang District 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 and drainage, 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 by the contractor, and 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 that disturbances to utility services will be minimized.

(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.

193. **Workers' health and safety.** The construction industry was 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 (Table EMP-2 of Attachment 1), 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 and periodically cleared to prevent outbreak of diseases.

(iv) Provide personal protection equipment to comply with the PRC's 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 Yanjiang District EPB for review and approval. Emergency phone link with hospitals in the project area 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 project gender action plan (GAP).

194. It is expected that these risks can be effectively managed through implementation of the EMP, including the mitigation measures, capacity building, inspection, supervision, and reporting.

12. Physical cultural resource[37]

195. **Physical cultural resources.** No cultural heritage or archaeological sites are known from the project area so far. 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 Ziyang Cultural Heritage Bureau, the ZPMO, and the 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.

F. Operational Phase

196. The components of Outputs 1 and 2 are mainly procurement of hardware and/or software, except the TVET center of Output 2, which includes 14 physical campus building construction. All components of Output 3 are ecological restoration projects with considerable positive environmental benefits.

1. Operation of the Components of Output 3

197. **Local ecosystem.** The project will facilitate improving the biological diversity, protecting the surrounding environment of the landfill site by controlling the landfill gas and leachate; improving the water quality of the Yannan Lake and the Kongzi Creek, creating a green lung within the center of the Ziyang Industrial Park, reducing the soil erosion in the SZHTDZ, enhancing the Ziyang Municipality's ecological resources, and demonstrating the model of sustainable development. Meanwhile, the green coverage of most project areas will be significantly increased which details are summarized in Table V-11.

Table V-11: Vegetation Coverages before and after Project Implementation

Component		Before Construction	After Construction			
		Vegetation Coverage (%)	Increased Vegetation (ha)			Vegetation Coverage (%)
			Arbor	Shrub	Lawn	
Eco- embankment		60	12.1	3.4	1.7	90
Sponge City	Sunken Greenbelt	0	12.6	3.6	1.9	100[a]
	Other Landscaping	5	8.9	2.5	1.3	95
Landfill Closure and Restoration		40	11.8	3.4	1.6	85
Green Wedge		70	18.0	5.2	2.6	91
Subtotal			**63.4**	**18.1**	**9.1**	
Total (vegetation)				**90.6**		

[a] The landscaping area does not include the roads and sidewalks.
Source: Feasibility study report and domestic environmental impact assessment reports.

[37] The Sichun Provincial Government issued the "Regulation for strengthening the management of cultural relics" on 22 October 2016 (SC-Gov-2016-48), which says: The project IA shall report to the Sichuan Provincial Administration of Cultural Relics (ACR) in advance, and the cultural relics discovered during the construction shall be reported to the ACR in a timely manner and effective protection measures shall be taken. The cost for any archaeological survey, exploration, or excavation required for construction shall be included in the project budget.

198. During operation, the 90.6 ha of planted vegetation will be managed by the Ziyang Forestry Bureau. The operation activities and management will include the following: (i) daily maintenance—60 workers will manage the vegetation (mainly including the eco-embankment, green wedge, and the landfill closure and restoration) including regular irrigation, pruning, weeding and replacement of dead plants, etc.; (ii) pest control—the guiding principle will be prevention first followed by integrated treatment; for the Tuo River eco-embankment landscaping, pesticides shall be prohibited to prevent river pollution; (iii) fire prevention—measures for prevention of fire will be put in place, with the emergency response mechanism, and education courses for raising public awareness in fire prevention will be undertaken to staff and residents by ZMG.

199. **Wastewater and storm water runoff.** After the project completion, the sites of eco-embankment, the Yannan Lake wetland, green wedge, and landfill closure and restoration could become recreation areas for local residents and visitors; thus, (i) domestic wastewater will be produced by the residents and visitors, which will be discharged into the municipal sewage network and then, will flow to the existing WWTPs for treatment; (ii) due to the fact that the separate drainage system in the project area (SZHTDZ) are already formed, in addition, most of storm water runoff will infiltrate the ground and replenish the groundwater source through newly planted 90.6 ha vegetation areas; and the rest of surface runoff will be discharged into the rainwater pipeline nearby, eventually flowing into the Tuo River; and (iii) the operation of landfill LTF will last for 13 years or even longer after the landfill closure according to the FSR. The amount of leachate generated after the landfill closure is estimated to be 9,993.3 m^3/a (i.e., 27.4 m^3/d). The treatment capacity of the existing LTF is 180 m^3/d, which can meet the demand of leachate treatment after the landfill closure.

200. **Operation and management of the eco-embankment.** The activities for O&M of the embankment include (i) implementing an annual (as a minimum) inspection of the built embankment for physical integrity; (ii) implementing a repair program immediately if signs of failure are discovered; (iii) integrating routine maintenance activities into existing work program of local WRB team; (iv) implementing monthly maintenance (at least in spring–summer) of re-vegetated embankment—pruning, weeding, and replacement of dead or dying plants; (v) inspecting signs of plant disease and/or pests and implement ecological control measures, as necessary; (vi) at least once a year in April–May (i.e., before the rainy season), removing solid waste and debris to be disposed in the municipal landfill; and (vii) prohibiting or removing any illegal structures which are found, to maintain free water flow.

201. **Operation of the closed landfill.** The waste gas during closed landfill operation mainly from combustion of the landfill gas. The project construction includes replacement and maintenance of landfill gas exhaust pipes and installation of the gas collection and reuse system. After the landfill closure, the landfill gas will be collected via the gas pipes with a collection efficiency of more than 90%, and then be burned in the boiler for the LTG use, the emissions from the boiler chimney include NO_2 and SO_x. Based on the prediction model for single source emission in the DEIA, it is estimated that the maximum ground-level concentrations of NO_2 and SO_2 after combustion are 0.017 mg/m^3 and 0.048 mg/m^3, respectively (at 192 m downwind point from the boiler);[38] which meet the PRC's Emission Standard of Air Pollutants from Boilers of GB13271-2014 (gas-fired boiler).[39] After completion of the project, the landfill will be effectively covered and greened; and the landfill gas will be collected and reuse as fuel for boiler in the LTF, which will greatly reduce the methane, NH_3, and

[38] 192 m is the maximum ground-level concentration point at downwind direction, which was calculated by the model of SCREEN3 in accordance with the PRC'S "EIA Technical Guideline—Atmospheric Environment (HJ2.2-2008)". The calculation was based on point source emission rate, a chimney height and outlet diameter, a chimney flue gas emission velocity at the exit, the exit temperature of flue gas, etc. can be found to the maximum ground concentration and distance.

[39] The emission limits in the standard of GB13271-2014 are SO_2 at 50 mg/m^3, and NOx at 150 mg/m^3 for new gas-fired boilers.

H_2S (odor gases) and other gas emissions. The local environment will be significantly improved.

202. The following activities shall be properly implemented during the operation: (i) landfill gas to be initiatively collected via the gas pipes with a collection efficiency of more than 90%; and to be burned by the boiler in the LTF; (ii) in the LTF, maintenance of the base isolation and equipment room for sound insulation, and the muffler installation for blowers; (iii) conduct regular inspection for the noise impact; (iv) conduct scheduled and non-scheduled check and maintenance of infrastructures and facilities for the landfill closure; (v) establish and practice the emergency response mechanism and team; (vi) leachate to be collected and treatment on-site; (vii) implement regular inspection and monitoring of leachate, landfill gas, underground water, ambient air, and noise; and (viii) prohibit construction of permanent structures before technical evaluation is conducted by the professional institute for the landfill subsidence stability.

203. **Noise.** The noise will be generated by a small amount of traffic entering the landscaping areas of the green wedge, the Yannan Lake wetland, and the landfill closure and restoration; and water pumps for landscaping watering. Since the designed parkways in above components in the updated FSR are mainly for bicycles and pedestrians use, the traffic will be not heavy and mainly on daytime. The noise will be minimized by strengthening the traffic management. In addition, for the 80%–90% vegetation rates after the project completion in the project area, the anticipated noise impact will be slight; and the acoustic environmental quality will meet the Grade II of Ambient Noise Standard of GB3096-2008. The noise during operation of the landfill LTF will be produced by pumps and blowers, which could be minimized by installation of the base isolation, muffling, and soundproofing devices in the facility for ensuring that the noise meets the Grade II Noise Standard at Boundary of Industrial Enterprises (GB12348-2008).

2. Operation of the TVET Center

204. No major environmental impacts are anticipated during the operation of the TVET buildings. The buildings will create emissions and discharges (summarized in Table V-12), but these can be addressed by integrating the buildings into the existing municipal service networks (water supply, municipal solid waste [MSW] disposal, and wastewater collection and discharge). To ensure high level of the TVET campus EMS, the TVET buildings will comply with relevant design standards and codes for energy-efficient, environment-friendly, safe, and green public buildings, including but not limited to, GB50189-2005 (Design Standard for Energy Efficiency of Public Buildings); GB50176-1993 (Thermal Design Code for Public Buildings); GB/T50378-2006 (Evaluation Standard for Green Buildings); and GB50099-2011 (Code for design of schools); the Sichuan Provincial Green Building Design Standard (DBJ51/T037-2015); and the Sichuan Provincial Green Building Assessment Standard (DBJ51T009-2012). Adherence to the PRC's green public procurement policies will be targeted for equipment and appliances procurement.[40] In addition, the project will support the TVET to develop and implement the EMS aiming at institutionalizing procedures to enhance campus environmental sustainability.

Table V-12: Main Emissions and Proposed Abatement Measures

No.	Pollution Source	Pollutant	Anticipated Amount	Disposal/Measures
1	Domestic wastewater	SS, COD, NH_3-N	211 m^3/d during school seasons and 40 m^3/d in vacations	Discharge into the municipal sewer pipeline then to the WWTPs for treatment.
2	Municipal solid wastes	Domestic waste	800 kg/d during school season and 150 kg/d in vacation	Reduce and reuse as possible; collection and transport to the Landfill through municipal sanitation system
3	Noise from fan and air	Ambient noise	---	Low noise equipment and Insulation

[40] A rating weight will be assigned to equipment that meets green procurement standards during bid evaluation.

No.	Pollution Source	Pollutant	Anticipated Amount	Disposal/Measures
	conditioners, etc.			facilities
4	Air pollution caused by cooking oil fumes from the canteens in the campus	Benzopyrene, $PM_{2.5}$, CO	---	High efficient purification equipment and Insulation facilities

Source: Domestic environmental impact assessment reports.

205. **Waste gas emissions from cooking.** Waste gas will be produced in the canteens of the campus. Cooking oil fumes will be emitted through the standpipe chimney leading to the building top. Kitchen cooking oil fume purification devices will be installed for purification of the fumes generated. The emissions will satisfy the requirements of the PRC's national Standard for Cooking Oil Fume Emission Control (GB18483-2001).

206. **Water supply.** It is estimated that the total population of the campus in the first 1–3 years operation will be 1,600, including 1,500 students and 100 faculties. The daily water demand is estimated to be 264 m^3, including the water supply for canteens, class rooms, offices, students' bathrooms, student dorms, laboratories, and firefighting, etc., which will be supplied by the existing Ziyang water supply system.

207. **Storm water.** Storm water from campus roads will be discharged into the municipal storm water drainage network. Storm water detention tanks will be built to collect the rain water from roofs of buildings. After pre-treatment by modular filtering medium, the collected rainwater will be used for landscaping irrigation. The overflow will be discharged into separate municipal storm water drainage.

208. **Wastewater collection and treatment.** The TVET campus will produce 211 m^3/d and 40 m^3/d of domestic wastewater, respectively, in school seasons and vacations. Wastewater from the buildings will be pre-treated by underground septic tanks first before discharging into the campus sewer pipeline, which will be connected to the municipal sewage network; and then, discharging to the existing WWTPs. The effluents from the WWTPs meet the Grade I-B standard of GB18918-2002 (Section III).

209. **Power supply.** The estimated power consumption of the TVET center is 4.18 million kilowatt-hour (kwh) annually. The power supply for the buildings will be provided from the municipal power line near the campus. The 220/380 volts (V) power system will be supplied to the campus by a 0.4 kilowatts (kw) transformer in the campus.

210. **Energy conservation.** The campus will be committed to energy-efficiency and resources conservation. The project will adopt the technologies included in the "Key Technologies promoted in Sichuan Province", such as (i) thermal insulation concrete hollow bricks; and (ii) new waterproof technologies. Electricity consumption will be reduced through using various new materials and equipment, such as (i) solar heating system to provide hot water for student dormitories; (ii) solar street lighting system; (iii) highly efficient light-emitting diode (LED) lights for classroom; and (iv) aerated concrete blocks, polystyrene board and polystyrene insulation mortar for building envelope.

211. **Municipal solid waste management.** During operation, the TVET campus will generate MSW such as paper, cardboard, plastics, and general refuse by routine activities. The amount of MSW to be disposed will be reduced through the application of the 3R (Reduce, Reuse, and Recycle) methods. The Green Campus Policy will identify options to the 3R waste management in the campus. The TVET management will develop and implement a MSW management and minimization strategy. MSW shall be segregated into biodegradable and non-biodegradable wastes, and biodegradable wastes will be used as fertilizers for landscaping and growing vegetables in the campus. Where recycling is feasible, these wastes will be stored in segregated bins and removed as required. Other

solid wastes will be removed by sanitary contractors on a regular basis and disposed to designated municipal landfill site.

212. The following measures and actions shall be carried out by the TVET center under the supervision of the Ziyang Municipal Education Bureau (ZMEB).

(i) Ensure implementation of the EMS to manage the activities in the TVET center to achieve green, safe, and sustainable campus in compliance with the PRC's Green Building Policy;
(ii) Ensure connection of new TVET buildings to on-site pretreatment facilities (septic tanks) and to municipal sewer system;
(iii) Periodically monitor (visual inspection) sludge accumulation in septic tanks; and request licensed company to de-sludge, as needed;
(iv) Provide adequate solid waste collection facilities in all buildings and in the TVET campus;
(v) Promote segregation of solid waste through (i) provision of separate collection bins for paper, biodegradable waste, metallic waste, and other wastes; and (ii) provision of training and awareness raising for the TVET staff and students;
(vi) Reach agreement with local waste collection service provider(s) for different types of waste;
(vii) Regularly clean and disinfect waste collection facilities;
(viii) Ensure compliance with relevant EHS regulations pertaining to ventilation, indoor air quality, lighting, noise, fire escape, etc.;
(ix) Establish preparedness plan and operation plan under emergency conditions, such as fire, flood, earthquake, wind, storm, water contamination, epidemic, air contamination, infestation, explosion, etc., as part of the TVET center's EMS to ensure safe environment for all student, faculty, staff, and visitors;
(x) Prepare safety checklist and reporting forms as procedure control documents of the EMS; and
(xi) Provide guidelines and reference materials to help the TVET center reduce or eliminate potential hazards which may cause injury, illness, or property loss.

G. Indirect, Induced, and Cumulative Impacts

213. Indirect impacts are adverse and/or beneficial environmental impacts which cannot be immediately traced to the 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.[41]

214. **Indirect impacts.** A potential indirect impact is that the hydrology and ecology of river sections downstream of the Tou River are affected, either due to the new embankment, and/or changes in flow allocations which occur after the project. The water quality improvement in the Yannan Lake wetland will positively impact the Tuo River. Reduced seasonal water allocation might create impacts for associated upstream Yingjie Reservoir's environment-related livelihoods, e.g., seasonal water requirements for agriculture. These risks are considered minimal because (i) flow allocations downstream of the 4.9 km of embankment will not be reduced in any seasons; (ii) improved storage capacities of the Yannan Lake wetland will enable improved flood control and reduce the incidence of downstream flooding; and (iii) the Tuo River watershed and the Yannan Lake sub-environment are not isolated ecological systems; and overland flow and water mixing occurs, at

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

least occasionally, during floods.

215. **Induced impacts.** Nowadays, about half of middle school graduates in the Ziyang Municipality go to colleges for their education. Due to the PRC being a big manufacturing country and the Ziyang Municipality a manufacture base, the college graduates have difficulty finding jobs. The TVET center will attract middle school graduates to vocational education, thus reducing the enrollment rate of colleges, which will benefit the Ziyang Municipality's industrial green transformation, development of the "China Dental Valley", and reduction of the local unemployment rate.

216. The project will result in increased water storage capacity of the Yannan Lake wetland by 0.65 m^3, which will increase dry-season surface water availability. This will benefit agriculture and domestic use around the wetland.

217. **Cumulative impacts.** Numerous, separate, and small construction projects are being conducted or planned in the Yanjiang District, in accordance with municipal development plan. Together with the ADB-funded project, cumulatively larger effects of construction and operation will occur, including levels of noise and dust, wastewater discharge, solid waste disposal, and traffic congestion. The exact locations of other planned construction projects over the next several years (2019–2024, during the construction phase of the ADB-funded project) are unknown. However, as and when these other projects begin and should they overlap closely with the proposed project, the following mitigation measures will be implemented to minimize cumulative impacts: (i) coordination between projects to share road access and borrow and disposal sites; (ii) sharing of any associated facilities (e.g., pipelines, easements) to avoid repeated excavation of the same alignments; (iii) coordinated traffic management plans; (iv) participatory planning with local villages and communities; and (v) training of workers to minimize social disturbance.

H. Climate Change and Greenhouse Gas Emissions

218. **Greenhouse gas emissions, carbon sequestration, and net emissions.** Project GHG emissions will be generated during construction (vehicles, machinery, workers) and operation (electricity use at the intelligent park platform, the dental sector R&D center, and the TVET center). Electricity will be supplied through the municipal grid. A course estimate of the project GHG emissions by the TRTA consultants and the DEIA institute was derived using the following assumptions: construction—full-time 4-year schedule (the project is 5 years but peak construction intensity will be less) employing 340 full-time workers, construction vehicles, and generation of construction waste; and operation—electricity use of the intelligent park platform, the dental sector R&D center, and the TVET center, for the first 10 years of operation (Table V-13).[42] This is not a detailed project GHG inventory, and almost certainly underestimates total project GHG emissions. Nonetheless, after 10 years of construction and operation, the total estimated emissions are only one-third of the level defined by ADB as significant ($\geq$100,000 tCO_2e), (SPS, 2009); and are small compared with the annual emission of high-risk projects listed by ADB's *Environmental Safeguards Good Practices Handbook* (ADB 2012, pp.59–62).

Table V-13: Course Estimation of the Greenhouse Gas Emission by the Project

Construction period	**CO_2 equivalent** (tCO_2e)
Workers (290) – consume 1 kg meat/d for 3 years	2,500
Articulated truck (100 t) – total100,000 km	2,000
Light commercial truck (10t) – total100,000 km	100
Construction wastes (15,000 t)	3000

[42] The number of workers was estimated by the FSR and DEIA Institute.

Construction period	CO_2 equivalent (tCO_2e)
Subtotal	**7,600**
Operation (first 10 years)	
Operation of intelligent park platform	500
Operation of R&D platform for the dental sector	1,000
Operation of green wedge (989,880 kwh/year)	8640
Operation of landfill closure and restoring to public park (73,000 kwh/year)	640
Operation of the eco-embankment (762,120 kwh/year)	6650
Operation of the Yannan Lake wetland (57,300 kwh/year)	500
Operation of the TVET (4.1837 million kwh/year)	36,500
Total GHG emissions for 10 years	54,430
Total GHG emissions per year	5,443 **(2,183 t carbon)**

Note: Estimated using the online greenhouse gas calculator (www.carbonneutral.au).[44]

219. Due to domestic rubbishes are mainly organic matters, an existing landfill releases landfill gas, mainly methane (CH_4) and carbon dioxide (CO_2). Methane is 21 times more effective than CO_2 as GHG. The amount of the GHG emission from a landfill depends on kind of rubbishes, the temperature, and the years for rubbishes buried, etc. According to the data from a similar landfill (Tianjingwa landfill in Nanjing, the capital city of the PRC's Jiangsu Province), in 2011, the total methane emission from the landfill was 852.352 tons of methane annually, which is equivalent to 17,899.4 tons of CO_2.[45] The data from the Tianjingwa landfill was calculated by modeling and examination. After completion of the project, the Ziyang landfill will be effectively covered and greened; and the landfill gas will be collected and reuse as fuel for a boiler in the LTF, which will greatly reduce the GHG emission. The local environment will be significantly improved, which is the added value from the ADB project.

220. **Carbon sequestration and net project GHG emissions.** The total proposed afforestation and re-vegetation area in the project area is about 99.7 ha, comprising about 87.6 ha of trees and shrubs. National estimates are not available for carbon sequestration by grasslands and aquatic vegetation; and for the current calculation, only the planting area for woody plants (i.e., trees and shrubs) was used, which is 87.6 ha (Table V-18). In the PRC, annual carbon sequestration capacity of forest is estimated to be 0.3–12.0 tons of carbon per hectare (tC/ha) depending on forest type, species, and age, as well as soil, water, and weather (average annual sunshine hours, rainfall and temperature).[46] Considering the weather conditions of the Ziyang Municipality, the value of 3.32 t/ha.a was applied for the calculation of carbon sequestration for the project.[47] It is estimated the project tree and shrub planting will achieve 290.8 tCO_2e (Table V-14). Assuming project GHG emissions of 5,443 tCO_2e (2,183 tC) per year, the project will result in net GHG emissions of 6,939 tCO_2e per year, i.e., (2,183.3-290.8) x CO_2(44)/C(12). This is a coarse estimate and the subtraction of carbon sequestration does not account for other, more harmful GHG emissions from construction and operation. Nonetheless, these figures are magnitudes of scale much lower than the SPS threshold of concern of 100,000 tCO_2e per year.

[43] Estimated based on the annual power consumption in the updated FSRs, unit electricity coal consumption = 1 kwh electricity = 350 g standard coal, 1 ton standard coal emits 2.493 tons of CO_2.
[44] Estimated based on the annual power consumption in the updated FSRs, unit electricity coal consumption = 1 kwh electricity = 350 g standard coal, 1 ton standard coal emits 2.493 tons of CO_2.
[45] http://www.xny365.com/xueshu/article-148962.html
[46] Carbon sequestration capacity comparison. May 2011. http://www.carbontree.com.cn/News show asp ?bid=5725
[47] C-D. Huang, J. Zhang, et al. 2008. Dynamics on forest carbon stock in Sichuan Province and Chongqing City. *Acta Ecologica Sinica*. 28(3):0966-0975.

Table 14: Preliminary Calculation of Carbon Sink from Vegetation

Component		**Area of trees** (ha)	**Area of shrubs** (ha)	**Total area** (ha)	**Carbon Sink factor** (t/ha.a)	**Carbon Sequestration Potential** (ta)
Eco- embankment		12.1	3.4	15.5	3.32	51.5
Sponge City	12.6	3.6	16.2	19.8		65.7
	8.9	2.5	11.4	13.9		46.1
Landfill Closure and Restoration		11.8	3.4	15.2		50.5
Green Wedge		18	5.2	23.2		77.0
Total		**63.4**	**18.1**	**87.6**		**290.8**

Source: Transaction technical assistance consultants and the domestic environmental impact assessment institute.

221. **Climate change adaptation.** A CRVA was conducted by the TRTA consultant to identify the risk climate change presents to project viability, assuming a design life of 30–40 years. The Modeling (RCP4.5) indicates that mean annual temperatures will increase by 0.8℃ during 2020–2030 and 1.1℃ by 2050. In the Ziyang Municipality, the rainfall intensity will be changed due to climate change. In 2030s, the projected decadal precipitation for RCP 4.5 will increase about 3%; while in 2090s, the projected decadal precipitation will be increase about 5% for RCP4.5. Variability in precipitation will increase, and storm severity may increase. To accommodate this, the embankment of the Tuo River will be constructed to a flood protection standard of once-in-50-years, which has been designed to be porous for improved infiltration. Overall, the existing project design, which is focused on environmental conservation and management, is strongly oriented to achieve resilience to climate impacts. Increased reforestation and storm water retention will strengthen water security and reduce flood risk; increased water storage in the Yannan Lake wetland will increase resilience to drought; and training will be given under the project in flood control, energy saving, and the GHG emission reduction.

VI. ALTERNATIVE ANALYSIS

222. The major construction contents of the proposed project are eco-embankment of the Tuo River, polluted sediment dredging in the Yannan Lake wetland and the Kongzi Creek, landfill closure and restoration, sponge city, greening and building construction for the TRTA center, etc. During the TRTA and preparation of the FSRs and DEIAs, alternative designs and construction methods were assessed and compared against technical, economic, environmental, and social criteria for each project component. The primary objective with respect to environmental criteria were to identify options with the least adverse environmental impacts and maximum environmental benefits. The following environmental and socioeconomic factors were used in the analysis: (i) balanced flood control and water quality improvement; (ii) impacts related to the LAR; (iii) minimization of village and community disturbance; and (iv) adaptation to local context (flood control, ecological preservation, water quality improvement for the Yannan Lake, and climatic constraints. Alternative analyses for embankment designs, pipe materials for sponge city, methods for sediment dredging, and dredged sediment dewatering process and disposal are described below.

A. Without-Project Alternative

223. Without the project output 3 (ecological systems and environmental infrastructure constructed), the urban residents of the Yanjiang District of the Ziyang Municipality will continue to suffer from flood disasters and serious pollution situation in the Yannan Lake and the Kongzi Creek. Without the project output 1 (urban development planning and management capacity strengthened and applied), the Ziyang Municipality will keep the outdated style for management of the municipality and the SZHTDZ. Without the project output 2 (economic sector opportunities broadened), the Ziyang Municipality will lack trained workers for its new dental industry and other sectors, resulting in low competitiveness of the municipality.

B. River Embankment

224. Three embankment designs were assessed for the Tuo River embankment constructions in the updated FSR: (i) vertical and heavy-weight retaining wall; (ii) slope-type roller compacted sand gravel embankment; and (iii) ecological embankment. The options (i) and (ii) are in fact a traditional concrete embankment, which used to be widely constructed in the PRC for flood control; but has high ecological impacts. The ecological embankment method reduces such impacts due to the use of permeable structures and materials and plantings with native species. For the embankment of the Tuo River, the ecological embankment method will be adopted (Section III).

C. River Sediment Dredging Method

225. Two options were assessed for sediment dredging: conventional and ecological dredging. Conventional dredging was conducted in the PRC for many years, which focuses on speed and cost effectiveness; while ecological dredging is the environment-friendly method for precise removal of pollutants in sediment, which takes removal of contaminated sediments as the primary purpose and considers a lake environmental restoration as first factor. Environmental dredging aims to remove the upper layer of polluted sediment, while maintaining the lower substrate to retain aquatic organisms and microbes. Environmental dredging can reduce 40%–70% of inner pollutants in sediment.[48] For the sediment dredging in the Yannan Lake and the Kongzi Creek, the ecological dredging was proposed.

[48] Dredging and silt treatment technology for small and medium rivers: channelshttp://www.360doc.com/content/15/0515/20/20625683_470752063.shtml

D. Dewatering Processes for Dredge Sediment

226. Three alternatives of dredged sediment dewatering were assessed: natural drying, geotextile tube bag process, and mechanical dewatering (Table VII-1). Natural drying requires a relatively larger area of space, longer time for dewatering, and release of odor from the drying sediments; but does not require any power and is the least-cost option. Considering enough space available around the lake and creek, the natural dying was selected.

Table VI-1: Dewatering Process for Dredged Sediment

Option	Option I - Natural Drying	Option II - Geotextile Tube	Option III - Mechanical dewatering
Advantage	• No power consumption • Low cost	• Low power consumption; • Medium dewatering efficiency in comparison with the natural drying; • Low cost	• High water content reduction (35%) • Short dewatering period; • Less land occupation; • Less odor impact
Disadvantage	• Low dewatering efficiency • Long drying period • High water content • Large land occupation • Odor impact	• Low dewatering efficiency; • Long drying period; • High water content • Large land occupation	• High power consumption; • Need flocculant dosage

Source: Feasibility study reports.

E. Disposal of Dredged Sediment

227. The disposal of dewatered dredged sediment can be used as topsoil and fertilizer for landscaping and agriculture. Based on the sediment baseline quality monitoring (Section IV), all the sediment qualities meet the PRC's Standards for Pollutants in Sludge and Sediment for Agricultural Use (GB4284-84) and Grade II of the PRC's Soil Quality Standard (GB15618-95); and so, the dewatered sediment will be transported to the urban area of the Yanjiang District for landscaping.

F. Closure of the Landfill

228. Three alternative options for closing and restoring the landfill were assessed during the TRTA, which include (i) do nothing; (ii) remove all the waste from the site; and (iii) closure and restoration of the landfill. Under the "do nothing" option, it would not be sustainable nor responsible to leave the landfill discharging pollutants without any proper closure and restoration; and it would be breach of the requirements of the Specifications for Closure of Sanitation Landfill (GB51220-2017). Removing all the waste from the site is expensive, dangerous, and increases air pollution and sanitation problem during the removal and transportation. However, options (i) and (ii) would not be appropriate. Option (iii) on landfill closure and restoration is proposed, which comprises two major elements: (i) closure and restoration of the sanitary landfill, and (ii) development of the green public open space area (Section III).

VII. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

229. **Legislative framework.** Meaningful public and stakeholder participation and consultations during project planning, feasibility study, design, and implementation are important and necessary safeguard requirements that will directly reflect the public's perceptions or expectations on the environmental quality within the proposed project area. Decision on Revising the Regulations on the Administration of Construction Project Environmental Protection (No. 682 Order of the PRC's State Council, 2017) requires that during a DEIA preparation, the opinions of related organizations and residents within and nearby the project sites should be solicited according to the relevant laws and regulations. Moreover, in August 2012, the PRC's National Development and Reform Commission (NDRC) issued a new requirement for "Interim Procedure of Social Risk Assessment on Large Investment Project for Fixed Assets", which emphasizes the importance of public consultations in an effective manner and requires that the results of public consultation should be clearly summarized in an independent chapter of the project proposal and the FSR.

230. ADB's SPS (2009) also requires meaningful public participation, consultation, and information disclosure. The consultation process of this project was in line with both the PRC's laws and ADB's SPS.

231. **Public consultation and information disclosure**. The public consultation and information disclosure were conducted during the preparation of the project FSRs, the DEIAs, and the project EIA which involved information disclosure via internet, newspaper, and posters in the communities; the consultation includes questionnaire survey and hearing meeting with the relevant stakeholders, including villagers, village committees, urban residents, and other potential affected persons, and related local organizations.

A. Information Disclosure

232. The first-round information disclosure was conducted by the DEIA institute together with the IAs and the ZPMO, which was posted on the website of the SZHTDZ on 31 January 2018. (http://www.zygxq.gov.cn/details/689.aspx, Figure VII-1) during the preparation of the DEIA report. The main content included the description of the proposed project components, major working procedures, construction measures and scope of the DEIA, main purpose, and method of public consultation, as well as contact details of the ZPMO, the IAs, and the DEIA institute.

233. After the completion of draft DEIA, the second round of information disclosure was posted on the website of the SZHTDZ (http://zygxq.gov.cn/index.aspx) and the Ziyang Daily on 21 March 2018 (Figure VII-2 and Figure VII-3), with the summary of the DEIA report and brief project description attached. In addition, the posters, including the project description, related environmental impacts, proposed mitigation measures, and contact information of the DEIA institute, the IAs, and the ZPMO were posted on bulletin boards at the affected communities and towns for further public participation. It is a way for the public, who do not have chance to fill out the questionnaire, to make their comments on the project construction. During the information disclosure (31 January–15 February 2018), no written comments from the public, including the e-mails, letters, and fax, were received.

234. **Information disclosure by posters and/or notices.** A total 20 notices were posted at the villages and communities, including four for the first-round disclosure and 16 for the second-round, which were listed in Table VII-1.

Table VII-1 The Villages and Communities Disclosed by Posters and/or Notices

Disclosure	Village / Community
First-round	4 villages: Longhan Village, Qinglong Village, Shutai Village, Tongzi Village
Second-	16 villages/communities: Tongziyuan Community, Chahua Community, Liuma Village, Balengqiao

round	Community, Shutai Village, Baleng Village, Chengnan-Chuntian Community, Huaxi-jiayuan Community, Hengdacheng Community, Shutai-yanju Community, Bintie-jiayuan Community, Wuxian Village, Xiangshui Village, Zaishanzui Village, Longhan Village, and Baima Village.

Source: Domestic environmental impact assessment reports.

Figure VII-1: 1st Round of Public Disclosure - Website

Figure VII-2: 2nd Round of Public Disclosure - Website

Figure VII-3: 2nd Round of Public Disclosure - Newspaper

Figure VII-4: 2nd Round of Public Disclosure – Notice on bulletin board

B. First Round of Public Consultation

235. The first round of public consultation, including the questionnaire survey and public hearing, was carried out by the DEIA institute with the assistance of the ZPMO by means of questionnaire survey during 1–7 February 2018, which covered the residents of the Longdang Village, the Qinglong Village, the Shutai Community, and the Tongzi Community that will be directly affected by the proposed project. There were 73 questionnaires distributed; and 100% were returned and effective, including 20 copies from the Qinglong Village, 10 copies from the Tongzi Community, 20 copies from Longdang Village, and 23 copies from Shutai Community. The basic information of 73 respondents, including their age, educational background, gender, ethnicity, and occupation, are summarized in

Table VII-2. The results of 1st round of questionnaire survey are shown in Table VII-3, which indicate that (i) most of the local residents have known the project and support the project construction; (ii) the project is expected to promote the local economic development, accelerate the tourism development, increase employment opportunities, and improve the ecological environment; (iii) the major public concern during the construction includes the vibration, destruction of eco-landscape, and noise; (iv) the major public concern during the project operation includes the noise and water pollution; and (v) the negative environmental impacts caused by the project construction and operation are understandable to most of respondents, except 2.82% of the respondents who do not support the project construction without the explanation of specific reasons.

Table VII-2 Basic Information of Respondents (1st Round)

Item	**Age**			**Education**			
	21～40	41～60	⩾61	Middle School or Below	High School & Polytechnic School	College and Above	Not Completed & Other
Percentage (%)	24.66	54.79	20.55	73.97	16.44	2.74	6.85
Item	**Gender**			**Ethnicity**			
	Male	Female	Not Completed	Han	Other	Not Completed	
Percentage (%)	61.64	38.36	0.00	100.00	0.00	0.0	
Item	**Occupation**						
	Farmer	Migrant Laborer	Self - employed	Employee	Retiree	Other	Not Completed
Percentage (%)	57.53	6.85	1.37	4.11	1.37	9.59	19.18

Source: Domestic environmental impact assessment reports.

Table VII-3 Results of 1st Round of Questionnaire Survey

No.	**Question**	**Option**	**Percentage** (%)
1	In what way do you know this project?	A. Internet	10.17
		B. TV	31.36
		C. Newspaper	7.63
		D. Handout	26.27
		E. Hearing from other people	24.58
		F. Do not know	0.00
2	What do you think about the major contribution of the project construction?	A. Promoting economic development	31.31
		B. Accelerating tourism development	18.18
		C. Increasing employment opportunities	21.21
		D. Improving ecological environment	29.29
3	What do you think about the current environmental quality?	A. Very good	42.47
		B. Good	32.88
		C. Fair	19.18
		D. Poor	5.48
4	What do you think the major impact produced during the project construction?	A. Land occupation	14.40
		B. Destroying eco-landscape	18.40
		C. Water pollution	4.80
		D. Vibration	36.00
		E. Noise	17.60
		F. Traffic block	0.80
		G. Others	8.00
5	What do you think the major impact produced during the project operation?	A. Noise	37.17
		B. Vibration	8.85
		C. Water pollution	29.20
		D. Odor	5.31

No.	Question	Option	Percentage (%)
		E. Solid waste	10.62
		F. Other	8.85
6	What is your opinion on the negative environment impacts caused by the project?	A. Understanding	85.71
		B. Understanding and the mitigation measures need to be implemented	14.29
		C. No comment	0.00
7	What is your opinion on the project construction in the case of civilized construction achieved and pollution discharge meeting the related standard?	A. Agree	91.55
		B. Be indifferent	5.63
		C. Not Agree	2.82

Source: Domestic environmental impact assessment reports.

C. Second Round of Public Consultation

236. **Public hearing.** The public hearing was conducted by the DEIA institute and the ZPMO on 23 March 2018, with participants from the residential community of Nanshijie Mingyuan; and the villages of Gaoyan and Houjiaping. The effective communication between the DEIA institute and the public was carried out by means of on-site introduction; and questions and answers, which offers a reference for the project design, construction, and operation. During the public hearing, the DEIA institute provided (i) a brief introduction of the proposed project components; (ii) detailed explanation of positive (i.e., ecological environment improvement) and negative impacts (such as noise and dust pollution during the project construction and operation) of the project and the proposed mitigation measures; and (iii) answers to public concerns. The participants (i) supported the project construction; (ii) showed their understanding for the environmental impacts caused by the construction; and (iii) hoped that the civilized construction should be conducted and mitigation measures should be strengthened during construction to minimize the noise and dust.

Figure VII-5: Public Hearing in Houjiaping Village

Figure VII-5: Public Hearing in Gaoyan Village

237. **Questionnaire survey.** After the second round of information disclosure, the second round of questionnaire survey was carried out during 23–26 March 2018. The survey aimed at the directly and indirectly affected persons, including 21 communities, such as Balengqiao Community, Chahua Community, Liuma Village, Shutai Village, Xiangshui Village, and Zaishanzui Village, etc. For personal opinions, there were 340 questionnaires distributed; and 333 were returned, with a rate of 97.9%. The information of 333 respondents, including their age, education, gender, ethnicity, and occupation, are summarized in Table VII-4. The results of questionnaire survey are shown in Table VII-5.

Table VII-4: Information of Respondents (2nd Round) for Output 3

Item	Age					Education			
	≤20	21～40	41～60	≥61	Not Completed	Middle School or Below	High School & Polytechnic School	College and Above	Not Completed
Percentage (%)	2.42	26.89	45.62	23.87	1.21	64.76	21.39	5.42	8.43

Item	Gender			Ethnicity		
	Male	Female	Not Completed	Han	Other	Not Completed
Percentage (%)	52.85	47.15	0.00	90.99	0.00	9.01

Item	Occupation			
	Farmer	Worker	Other	Not Completed
Percentage (%)	29.52	3.61	42.47	24.40

Source: Domestic environmental impact assessment reports.

Table VII-5: Results of 2nd Round of Questionnaire Survey for Output 3

No.	Question	Option	Percentage (%)
1	In what way do you know this project?	A. Internet	38.10
		B. TV	9.52
		C. Newspaper	14.29
		D. Handout	33.33
		E. Hearing from other people	4.76
		F. Do not know	0.00
2	What do you think about the major contribution of the project construction?	A. Promoting economic development	26.32
		B. Accelerating tourism development	15.79
		C. Increasing employment opportunities	15.79
		D. Improving ecological environment	42.11
3	What do you think about the current environmental quality?	A. Very good	12.50
		B. Good	62.50
		C. Fair	12.50
		D. Poor	12.50
4	What do you think the major impact produced during the project construction?	A. Land occupation	0.00
		B. Destroying eco-landscape	38.46
		C. Water pollution	0.00
		D. Vibration	46.15
		E. Noise	7.69
		F. Traffic block	7.69
		G. Others	0.00
5	What do you think the major impact produced during the project operation?	A. Noise	25.00
		B. Vibration	8.33

No.	Question	Option	Percentage (%)
		C. Water pollution	25.00
		D. Odor	0.00
		E. Solid waste	25.00
		F. Other	16.67
6	What is your opinion on the negative environment impacts caused by the project?	A. Understanding	87.50
		B. Understanding and the mitigation measures need to be implemented	12.50
		C. No comment	0.00
7	What is your opinion on the project construction in the case of civilized construction achieved and pollution discharge meeting the related standard?	A. Agree	100.00
		B. Be indifferent	0.00
		C. Not Agree	0.00

Source: Domestic environmental impact assessment reports.

238. **Results of the second round of public consultation.** (i) 26.32% of the respondents (N=333) believed that the project will benefit the local economic development, 15.79% expressed that the project will promote local tourism development, another 15.79% thought that the project will increase job opportunities, and 42.11% believed that the project will improve the local ecological environment; (ii) for the local environmental situation, 12.5% of the respondents considered that it was very good; 62.5% believed that it was good; while 5.48% of the respondents expressed that the local environment quality is fair and poor; (iii) for the major impacts during construction, the public concerns are impact to ecosystem (38.46%), vibration (46.15%), noise (7.69%), and traffic (7.69%); (iv) 87.5% of the respondents expressed their understanding of the project impacts, while 12.5% expressed their understanding but emphasized on strictly implementing effective mitigation measures proposed in the DEIA; and (v) 100% of the respondents showed their support to the project.

239. **Results of the local organization consultation.** For consultation of opinions from various local organizations, there were 12 questionnaires distributed; and 8 were returned. All the consulted organizations supported the project and believed that the project implementation will significantly benefit the local social economic development.

Table VII-6: Information of Consulted Organization (2nd Round) for Output 3

No.	Organization	Name of Representative	Telephone no.	Attitude to the project
1	SZHTDZ management committee	Kou Hanjin	18096389255	Support
2	Government of Yanjiang District	Zou Wenming	18708277525	Support
3	Government of Songtao Town	Zhang Hui	18381583303	Support
4	Government of Yingjie Town	Deng Yougou	15183247998	Support
5	Ziyang Radio and TV University	Chen Huajiu	13982981222	Support
6	Houjiaping Primary School (Songtao Town)	Liu Zhongjun	18982987858	Support
7	Mingde Primary School	Liu Zhirong	18080539906	Support
8	Investment Co. of Ziyang Development Zone	Zhou Jingyu	18111108256	Support

240. All the concerns and suggestions expressed during the public consultation have been reflected in the FSR revisions; and appropriate mitigation measures were defined in the DEIA, this project EIA, and the EMP.

241. **The public consultation for the TVET center.** The public hearing meeting with questionnaire survey were conducted by the EIA institute together with the staff from the ZMEB on 16 March 2018. Fifty-two residents participated the meeting, 52 questionnaires were distributed to the public, and 100% were returned and effective. The respondents included peasants (26.9%), urban residents (44.2%), cadres (17.3%), retired persons (7.7%), and unfilled (3.8%); while the gender ratio is 63.5% (male) and 36.5% (female).

242. The consultation results shown in Table VII-7 are as follows: (i) 30.8% of the respondents are satisfied with the local environmental situation, and 69.2% are basically satisfied; (ii) 96.2% of the respondents believed that the project construction will not have impact on their living and working conditions and studies; while 3.8% believed that the construction will have some negative impact, but it is acceptable; (iii) 100% of the respondents believed that the project will have positive impact to the local economic development; (iv) 86.5% of the respondents believed that the TVET center will bring significant benefit to the Ziyang Municipality's social and economic development, while 13.5% considered that the project will have some benefit; (v) 100% of the respondents believed that the site for the TVET center is correct; and (vi) 100% of the respondents expressed their support to the project component.

243. All the respondents believed that the project construction will (i) significantly contribute to the local economic development; and (ii) not have negative impact on the natural and ecological environment.

Table VII-7: Questionnaire Survey Results for the Component of Technical and Vocational Education and Training

No.	Question	Option	Percentage (%)
1	Are you satisfied with the surrounding environmental quality?	A. Satisfied	30.8
		B. Basically satisfied	69.2
		C. Not satisfied	0.0
2	What kind of impact caused by the projection construction will be brought to your living, working and studying?	A. Positive	0.0
		B. Negative	0.0
		C. Negative but acceptive	3.8
		D. None	96.2
3	What kind of impact caused by the projection construction will be brought to the local economic development?	A. Positive	100.0
		B. Negative	0.0
		C. Negative but acceptive	0.0
		D. None	0.0
4	What about your understanding and attitude towards the environmental impact caused by the project construction?	A. Positive	0.0
		B. Negative	0.0
		C. Negative but acceptable	5.8
		D. None	94.2
5	What is your opinion on the projection construction?	A. Support	100.0
		B. Not support	0.0
		C. Be indifferent	0.0
6	Do you believe the TVET will benefit the local social and economic development	A. Yes, significantly	86.5
		B. Some benefit	13.5
		C. No benefit	0.0
6	What is your opinion on the site selection for the project?	A. Support	100.0
		B. Not support	0.0

No.	Question	Option	Percentage (%)
		C. Be indifferent	0.0

Source: Domestic environmental impact assessment reports.

244. The main suggestions from the consulted public include increased majors and curriculum provisions of the TVET in the fields of electronic business, logistics, and pension services for adapting to the development of current market-oriented economy.

D. Future Consultation

245. Dialogue will be maintained with project communities throughout implementation. Future consultation will be undertaken by the ZPMO and the PIU environment and social officers, via questionnaire surveys, household visits, workshops, and public hearings (EMP, Attachment 1).

VIII. GRIEVANCE REDRESS MECHANISM

246. During the DEIA and project EIA preparation, the GRM was developed in the Yanjiang District and the SZHTDZ in compliance with ADB's SPS (2009) requirement to address environmental, health, safety, and social concerns associated with project construction, operation, and land acquisition. The GRM is designed to achieve the following objectives: (i) provide channels of communication for local villages and communities to raise concerns about environmental and social-related grievances which might result from the project; (ii) prevent and mitigate adverse environmental and social impacts to villages and 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 villages and communities; and (iv) build village and community acceptance of the project. The GRM is accessible to all members of the villages and communities, including women, youth, minorities, and poverty-stricken villagers and residents. Multiple points of entry are available, including face-to-face meetings, written complaints, telephone conversations, e-mails, and social media.

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

248. Currently in the Ziyang Municipality (and generally in the PRC), when residents or organizations are negatively affected by a construction or development, they may complain, by themselves or through their village or community committee, to the contractors, developers, the local EPBs, 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. This project GRM addresses these weaknesses.

249. The GRM meets the regulatory standards of the PRC that protect the rights of citizens from construction-related environmental and/or social impacts. Decree No. 431 Regulation on Letters and Visits, issued by the State Council of the PRC in 2005, codifies a complaint acceptance mechanism at all levels of government and protects the complainants from retaliation. Based on the regulation, MEP published the updated Measures on Environmental Letters and Visits (Decree No. 15) in December 2010.

250. 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-mails, will be available.

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

IX. ENVIRONMENTAL MANAGEMENT PLAN

252. A project EMP has been prepared (Attachment 1). Development of the EMP drew on the DEIA reports, discussions with the ZPMO and the IAs, and consultations with the local EPB, 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 the PRC's environmental laws, standards, and regulations and ADB's SPS (2009). The EMP specifies major environmental impacts and mitigation measures, roles and responsibilities, inspection, monitoring, and reporting arrangements, training, and the GRM. The EMP will be updated after detailed design, as needed.

X. CONCLUSION

253. The project is expected to promote green development and attract businesses in light industry and service-oriented sectors while creating environment-friendly and attractive living conditions in the Ziyang Municipality. The project will directly bring benefit to about 0.268 million residents in the Yanjiang District of the Ziyang Municipality, while indirectly benefit 0.835 million residents on other towns of the municipality.

254. The proposed Smart park system will reduce the costs for data management, energy and equipment by using the cloud platform. The system will help modernize the industrial park, making it more attractive to industries to relocate within it. The system improves the local government's management efficiency and service capacity. The open R&D platform will contribute to the development of the dental industry cluster which is line with ZMG's goals of high technology and environmentally benign industries. The construction of the TVET center will help to train workers for the industrial park and particularly for the newly established dental industry cluster.

255. The construction of related six components of Output 3 will facilitate improving flood control infrastructures, strengthening flood control management, improving the biological diversity, protecting the surrounding environment of the landfill site by controlling the landfill gas and leachate; improving the water quality and ecosystem of the Yannan Lake wetland, creating a green lung within the center of the SZHTDZ, reducing the soil erosion, enhancing the Ziyang Municipality's ecological resources, and demonstrating the model of sustainable development.

256. Key impacts anticipated to result from construction are (i) odor impacts during the landfill closure and sediment dredging in the Yannan Lake and the Kongzi Creek; (ii) soil erosion, particularly during the embankment along the Tuo River and the bare hills preservation; (iii) short-term damage to aquatic habitats in the Tuo River section and the Yannan Lake due to dredging and embankment; and (iv) short-term alteration of river flow from the temporary installation of diversion weirs or structures during construction. Key operational risks and impacts are the safe operation of the closed landfill (preventing groundwater from pollution by the closed landfill); inadequate maintenance of project vegetation, structures, and facilities, which could contribute to reduced efficiency of the built facilities; failures of the TVET center's EMS operation; or the moved pollution sources returning back to the Yannan Lake wetland again.

257. Measures to avoid, minimize, and mitigate potential project impacts have been developed within the EMP (Attachment 1), which is the key document to manage, monitor, and report on the environmental impacts of the project.

258. A project-specific GRM has been developed and will be implemented at the provincial, county, and site levels. Two rounds of public consultation were conducted in the Yangjiang District and the SZHTDZ. Feedback from the consulted residents included both support for the project for improving green economic transformation, environmental preservation, and development of the TVET; and their concern over the potential construction noise, soil erosion, dust, and odor from landfill and dredged sediments. Measures to address these concerns have been incorporated in the updated FSRs, the DEIA, and mitigation measures (EMP, Attachment 1).

259. Project assurances have been developed to strengthen confidence in the implementation of key measures in the project EMP; and address potential issues that may affect project viability, which are beyond the project scope. The assurances have been discussed and agreed between ZMG and ADB, which are described below.

260. ZMG shall ensure that all the pollution sources within the catchment area of the Yannan Lake

wetland will be eliminated or mitigated before the Yannan Lake wetland construction; the water quality and quantity of the Yingjie Reservoir upstream of the Yannan Lake shall be maintained and improved; and before completion of the wetland construction, the team for operation and management of the built wetland will be established and its capacity in wetland restoration and preservation shall be strengthened by sufficient training.

261. ZMG shall ensure that in the detailed engineering design stage, for the groundwater safety and prevention of leachate leakage, a geological exploration and a comprehensive groundwater monitoring surrounding the landfill site shall be conducted, based on which the depth and width of the vertical anti seepage grouting curtain, the pumping station capacity, and landfill leachate treatment method shall be properly designed.

262. ZMG shall ensure that the buildings of the TVET center shall be designed in accordance with the PRC's and the Sichuan Province's Green Building Design, the PRC's Design Standard for Energy Efficiency of Public Buildings, and the PRC's Design Standard for Schools.

263. ZMG shall ensure that all planting activities under the project, including green wedge, embankment construction, wetlands, landscaping, and rehabilitation of construction sites, shall only use plant species which are (i) native (i.e., naturally occurring) to the Ziyang Municipality; and (ii) sourced from the local stock within the Sichuan Province.

264. ZMG shall ensure that all re-vegetation activities under the project, including for the wetland, landscaping, and embankment, will be subject to O&M procedures after planting to ensure that the planted vegetation is adequately protected and maintained.

265. ZMG shall ensure that at least one full-time and qualified ZPMO environment officer is assigned for the entire duration of the project. This officer will be responsible for coordinating the implementation of the project EMP. Terms of reference for this position are described in the project EMP.

266. As part of the loan implementation consultant support, ZMG shall engage one national wetland specialist (at least 6 person-months) and one national plantation specialist (at least 2 person-months) to support the design and monitoring of the project component on wetland restoration.

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

ATTACHMENT 1: ENVIRONMENTAL MANAGEMENT PLAN

TABLE OF CONTENTS

A. Objectives

1. This environmental management plan (EMP) is for the Sichuan Ziyang Green Transformation and Development Project (the project). The EMP will be implemented in all phases of the project—design, pre-construction, construction, and operation. The EMP will ensure the project compliance with the environmental laws of the People's Republic of China (PRC) and the Safeguard Policy Statement (SPS, 2009) of the Asian Development Bank (ADB). The EMP describes the (i) roles and responsibilities of all project agencies that will implement this EMP; (ii) anticipated impacts and mitigation measures; (iii) inspection, monitoring, and reporting arrangements; (iv) training and institutional strengthening; (v) grievance redress mechanism (GRM); and (vi) future public consultation.

2. In the detailed design stage, the project management office (PMO) of the Ziyang Municipality (ZPMO) will pass this EMP to the design institutes for incorporating mitigation measures into the detailed engineering 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 ZPMO and the project implementation units (PIUs) under the project implementation agencies (IAs) will prepare and provide the specification clauses for incorporation into the bidding documents: (i) a list of environmental management requirements to be budgeted by the bidders in their bids, (ii) environmental clauses for contractual terms and conditions, and (iii) the two component domestic environmental impact assessments (DEIAs); and project environmental impact assessment (EIA), including the updated EMP for compliance.

B. Organizations and Their Responsibilities for Environmental Management Plan Implementation

3. The Ziyang Municipal Government (ZMG) is the executive agency (EA) of the project. ZMG has established the Ziyang Project Leading Group (ZPLG) to provide policy guidance and coordination; and the ZPMO to manage, supervise, and coordinate the overall project implementation. The ZPMO comprises representatives from the Sichuan Ziyang High Technology Development Zone (SZHTDZ) Administrative Committee, the Ziyang Finance Department (ZFD), the Ziyang Development and Reform Commission (ZDRC), the Ziyang Water Resources Bureau (ZWRB), the Ziyang Forestry Bureau (ZFB), and other relevant agencies.

4. The SZHTDZ Administrative Committee will serve as the IA for Output 1: Urban development planning and management capacity strengthened and applied and Output 3: Ecological systems and environmental infrastructure constructed, as well as Subcomponent 1 (i.e., Testing and Inspection Center) and Subcomponent 2 (i.e., Open Public Research and Development [R&D] Platform) of Output 2. The Ziyang Education Bureau (ZEB) will serve as the IA to manage Subcomponent 3 (i.e., Upgrade and Development of the Ziyang TVET Center) of Output 2. The EMP implementation arrangements and responsibilities of governmental organizations are summarized in Table EMP-1.

Table EMP-1: Institutional Responsibilities for the Environmental Management Plan Implementation

Agency	Environmental Management Roles and Responsibilities
Executing Agency (EA)—Ziyang Municipal Government (ZMG) and Ziyang Municipal Project Leading Group (ZPLG)	• Coordinate with ZMG and the Sichuan Ziyang High Technology Development Zone (SZHTDZ) Administrative Committee; • Coordinate on project preparation and implementation; • Facilitate the inter-agency coordination; and • Liaison with the Asian Development Bank (ADB).

Agency	Environmental Management Roles and Responsibilities
Ziyang Project Management Office (ZPMO)	• Supervise and manage the project implementation; • Manage the daily activities during project preparation and implementation; • Assign the ZPMO environment and social officers; • Coordinate with ADB on the project progress and monitoring reports; • Submit the bidding documents, bid evaluation reports, and other necessary documentations to ADB for necessary approval; • Procure the project implementation consulting services (PIC), including the loan implementation environment consultant (LIEC); • Consolidate the environmental monitoring reports prepared by the LIEC and the environmental monitoring agency, and submit them to ADB for disclosure; and • Engage a procurement agency which supports the IAs and the PIUs.
Implementing Agencies (IAs)—SZHTDZ Administrative Committee and Ziyang Education Bureau	Implement the project components in their jurisdiction, including finance and administration, technical and procurement matters, monitoring and evaluation, as well as safeguard compliance.
Project Implementation Units (PIUs)	• Coordinate with the ZPMO for project management and implementation; • Assign the PIU environment officer as the EMP coordinator; • Incorporate the EMP into the bidding documents; • Establish and implement the GRM; • Supervise and monitor the EMP implementation and annual reporting to the ZPMO (with support of the LIEC); • Participate in capacity building and training programs; • On behalf of the IAs, submit the bidding documents, bid evaluation reports, and other necessary documentations to the ZPMO and ADB for approval; • Submit the withdrawal applications to the Ziyang Finance Bureau; • Engage a design institute to complete engineering designs; • Tender contractors and equipment with assistance of the international tendering agency; • Administer and monitor the contractors and suppliers; • Construction supervision and quality control; • Contract local EMA to conduct environmental monitoring; • Procure and manage the construction supervision companies (CSC) for subcomponent implementation; and • Commission the constructed facilities.
Built Project Facility Operators: SZHTDZ, Ziyang Forestry Bureau, Ziyang Water Resources Bureau, Ziyang Landscape Management Department, Ziyang Urban Appearance and Environmental Sanitation Management Department	• With the ZPMO and the PIUs, commission the constructed facilities; and • Operate and maintain the completed facilities, including environmental management, monitoring and reporting responsibilities.

5. **Environment officers within ZPMO and PIUs.** The ZPMO has main EMP coordination responsibility. The ZPMO has designated an Environmental Officer to be responsible for the environmental issues during the project implementation. The officer will take charge of (i) coordinating the implementation of the EMP and developing implementation details; (ii) supervising the implementation of mitigation measures during project design, construction and operation; (iii) ensuring that environmental management, monitoring, and mitigation measures are incorporated into bidding documents, construction contracts and operation manuals; (iv) submitting semi-annual EMP monitoring and progress reports to ADB; (v) coordinating the GRM; and (vi) responding to any unforeseen adverse impacts beyond those mentioned in this EMP. The ZPMO Environmental Officer will be technically supported by the loan implementation environment consultant (LIEC). Each of the two PIUs will nominate one environmental officer and one social officer to check the overall implementation of environmental management provisions of this EMP, and to work in close coordination with ZPMO Environmental Officer.

6. In March 2018, two environmental officers were appointed by ZPMO and the IA of TVET Center: the Environmental Officer of ZPMO is Mr. Yuling Tang (email: 599148145 @qq.com); and the that of TVET PIU is Ms. Guilan Zhang (137481983@qq.com). At least six months before any construction: ZPMO shall reconfirm or reappointed the two qualified environment officers to coordinate the EMP implementation

7. **Loan Implementation Environment Consultant (LIEC).** A LIEC will be hired under the loan implementation consultant services. The LIEC will advise the ZPMO, PIUs, contractors and CSCs on all aspects of environmental management and monitoring for the project. The LIEC will (i) assist in updating the EMP and environmental monitoring program, as needed; (ii) supervise the implementation of the mitigation measures specified in the EMP; (iii) on behalf of the PIUs and ZPMO, prepare the annual EMP monitoring and progress reports in English and submit it to ADB; (iv) provide training to the ZPMO, PIUs, CSCs, on the PRC's environmental laws, regulations and policies, ADB SPS 2009, EMP implementation, and GRM in accordance with the training plan defined in Table EMP-9; (v) identify any environment-related implementation issues, and propose necessary corrective actions; (vi) undertake site visits for EMP inspection as required.

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

9. **External Environmental Monitoring Agency**. External environmental monitoring is required by ADB for projects which are Category "A" for environment. The external environmental monitoring (Table EMP-8 in Section D) will be conducted by a certified environmental monitoring agency (EMA), that will be engaged through a public tendering process. The agency will report the results of the monitoring to the PIU, ZPMO, local EPB and ADB.

10. The ZPMO will appoint the EMA to conduct periodic environmental monitoring during construction and operation in accordance with the monitoring plan (Table EMP-7 and Table EMP-8).

C. Potential Impacts and Mitigation Measures

11. **Tables EMP-2 and EMP-3** list the potential impacts of the project components during the 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.

12. The applicable standards and guideline during construction and operation for surface water, groundwater, sediment, ambient air and gas emission, noise and soil are as follows.

(i) **The surface water:** the applicable standard/target for surface water quality is PRC Environmental Quality Standards for Surface Water (GB3838-2002), in which the

Grade III Standard is applicable for Tuo River mainstream; the Grade IV Standard for Yannan Lake wetland after 2020 (the Phase I target), while the Grade III Standard for the wetland after 2025 (the Phase II target), (Table II-6 of the EIA)

(ii) **The groundwater:** the applicable standard for groundwater in the landfill area is Grade III of Quality Standard for Ground Water (GB 14848-93) (Table II-9);

(iii) **Wastewater Discharge Standard.** For wastewater discharges directly into Tuo River, its applicable standard is the Grade I of PRC Integrated Wastewater Discharge Standards (GB8978-1996); In the case of discharging into the municipal sewage network (the construction wastewater and domestic wastewater from workers' camps), the Grade III Standard of GB8978-1996 is applicable. (Table II-11)

(iv) **Ambient air quality:** The air quality in the environmental sensitive locations, and the areas outside the construction sites, the Grade II of PRC Ambient Air Quality Standard (GB3039-2012), and World Bank EHS guidelines (for ambient air) are applicable (Table II-7).

(v) **Air Pollutant Emission.** During the project construction, the on-site fugitive emission should comply with Grade II of Integrated Emission Standards of Air Pollutants (GB16297-1996) (Table II-12).

(vi) **Odor Pollutant Emission.** The waste gas generated by the Landfill Closures and Restoration is the landfill gas, including odor gases of ammonia (NH_3) and hydrogen sulfide (H_2S), the concentrations of NH_3 and H_2S at the boundary of the existing landfill site including the leachate treatment facility should comply with the Grade II of Emission Standard for Odor Pollutant (GB14554-93) (Table II-13).

(vii) **Sediment and soil qualities:** The Grade II of Environmental Quality Standard for Soils (GB15618-1995) was adopted to assess the soil quality on landfill site and sediment quality in Yannan Lake and Kongzi Creek (Table II-10).

(viii) **Ambient Acoustic Quality:** According to Classification of the Areas for Environmental Noise of Urban Area in Ziyang, the project areas involve the implementation of Grade II [60 dB(A) for daytime, and 50 dB(A) for nighttime, for residential and institutional areas], and 4a [70 dB(A) for daytime, and 55 dB(A) for nighttime, areas along the traffic road]of Environmental Quality Standard for Noise （GB3096-2008）; and the applicable World Bank EHS Guideline are noise for residential, institutional area [55 dB(A) for daytime, and 45 dB(A) for nighttime] (Table II-8).

(ix) **Noise Levels during Construction:** Grade II of Noise Standard at Boundary of Industrial Enterprises (GB12348-2008) was adopted to assess the noise at the boundary of existing Landfill and the leachate treatment facility (Table II-14); and the applicable standard during construction is the PRC Noise Limits for Construction Site standard (GB12523-2011) (Table II-15). The applicable World Bank EHS Guideline is Noise Guideline for industrial and commercial area [70 dB(A) for daytime, and 70 dB(A) for nighttime] (Table II-14 and Table II-15).

Table EMP-2: Potential Impacts and Mitigation Measures during Pre-construction and Construction Phases

Item	Potential impacts / issues	Mitigation measures	Who implement	Who supervise	Budget (CNY 10^4)
A. DESIGN AND PRE-CONSTRUCTION PHASES					
Detailed Design Stage	Institutional strengthening for EMP implementation and supervision	• At least six months before any construction: ZPMO and PIU each appoints (or reconfirms) a qualified Environment Officer to coordinate the EMP implementation; • At least three months before any construction, ZPMO engages LIEC; • At least three months before any construction, ZPMO organizes and conducts training on the project EMP for appropriate staffs of the ZPMO, IAs, PIU, contractors, and CSCs.	ZPMO	EA, ADB	Included in the ZPMO operation budget
	Updating EMP	• Update mitigation measures defined in this EMP based on final detailed design; • Submit the updated EMP to ADB for review; • In case of major changes of project location and/or additional physical component, form an DEIA team to conduct additional DEIA and public consultation. The revised DEIA should be submitted to Ziyang municipal EPB and ADB for approval and disclosure. To determine whether the change is minor or major under assistance of LIEC, ZPMO should consult with ADB.	ZPMO, LIEC	EPD, EPB, ADB	
Construction Preparation	Environmental monitoring plan	• At least two months before any construction, ZPMO signs contractual agreement with local EMS or other certified environmental monitoring agency (EMA) to conduct the environmental monitoring described in the EMP. (EMS is qualified environmental monitoring agency which is part of municipal level of EPB); • The EMS or EMA prepares detailed monitoring program including monitoring locations, monitoring parameters, and frequencies based on the monitoring plan in the EMP; • **Second round of water and sediment monitoring.** During the detailed design stage, a second round of water and sediment sampling will be conducted, specifically to examine pesticides, heavy metals and persistent organic pollutants (POPs) in Yannan Lake and Kongzi Creek. If the presence of these pollutants in the sediments is confirmed, the mitigation measures for the dredging (Section V) will be reviewed and updated as needed to minimize the risk of these pollutants.	ZPMO, EMS	ZPMO, ADB	
	Detailed design	• In the aspect of engineering design, the ecological dredging and embankment will be designed and identified in details, to avoid negative impacts to local and downstream ecosystems; • **Geological exploration and comprehensive groundwater monitoring on Landfill site.** The detailed engineering designs shall include: (a) based on the approved FSR, the geological exploration and the comprehensive groundwater quality monitoring (at multi points and multi layers) shall be conducted, based on which to design the depth and width of the vertical grouting anti seepage curtain. • **Shutting down the pollution sources within the catchment area of Yannan Lake wetland.** Before construction of Yannan Lake wetland, all the pollution sources within its catchment area will be eliminated or mitigated for ensuring the performance of the wetland restoration, which will be the responsibility of the ZPMO and ZMG (the commitment letter for closing the pollution sources and residents'			Included in detailed design contract.

Item	Potential impacts / issues	Mitigation measures	Who implement	Who supervise	Budget (CNY 10^4)
		relocation has been signed by ZMG and provided to the ADB Fact-finding Mission in March 2018); • Second round of water and sediment monitoring. During the detailed design, a second round of water and sediment sampling will be conducted.			
	Bidding and contract documents	• Mitigation measures in the EMP are incorporated into all bidding documents; • Bidding documents are submitted to ADB for review; • Prepare environmental contract clauses for contractors.	DIs, ZPMO	LIEC, EPB, ADB	
	EMP training	• LIEC, or invited environment specialists and/or officials from EPBs provide training on construction environmental management, implementation, supervision, to contractors and CSCs, in accordance with the training plan in this EMP	LIEC, ZPMO	EPB, ADB	Included in the loan implementation consulting contract
	Establish GRM	• Responsibility for GRM implementation is assigned to the Environmental and Social Officers of ZPMO, and is included in their terms of reference; • The ZPMO personnel will be aware of and trained in the GRM, and will help support the environmental and social officers when necessary; • Key contact details for the GRM (phone and fax number, address, email address) will be provided on the ZPMO and/or local EPB public websites and information boards on construction sites.	ZPMO	LIEC, ADB	
	Land acquisition and resettlement	• Update LARP after detailed design • Establish resettlement office and assign government officials to manage LARP; • Conduct information dissemination and community consultation programs in accordance with the PRC Land Administration Law (1999) and ADB SPS; • Ensure that all resettlement activities are reasonably completed before construction starts on any subcomponent.	ZPMO, LARO	Ziyang Civil Affairs Bureau, Ziyang Land Resources Bureau	Include in the LAR budget
B. CONSTRUCTION PHASE					
Topography and Soils	Earthwork, soil erosion and contamination, and groundwater pollution.	• Define spoil disposal sites and borrow pit locations in the construction tender documents; • Construct intercepting channels to prevent surface runoff of construction sites entering nearby waterways; • Divert runoff from sites to sedimentation ponds or existing drainage; • Limit construction and material handling area in case of the heavy rain and strong wind; • Stabilize embankments and other areas susceptible to the soil erosion during works; • Minimize open excavation areas on construction sites; • 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 storage areas to minimize land area required; • Remove construction wastes from the site to the approved disposal sites; • Establish emergency preparedness and response plan for spills including cleanup equipment on each construction site and provide training in emergency spill response procedures;	Contractors, CSCs	ZPMO, EPB, WRB, LIEC	1,716.3

Item	Potential impacts / issues	Mitigation measures	Who implement	Who supervise	Budget (CNY 10^4)
		• Stabilize earthwork areas within 30 days after earthworks have ceased on the sites.			
Ambient Air	Dust generated by construction activities, gaseous air pollution (CO, CH, NOx and PM_{10}) from construction machinery and vehicles	• Equip material stockpiles with dust shrouds; • Spray water on construction sites and earth/material handling areas/routes; • Use premixed mortar and purchase commercial concrete. Prohibit concrete mixing on the construction site; • Cover materials during truck transport; • Store petroleum or other harmful materials in appropriate places; • Ensure emissions from construction vehicles and machinery comply with PRC standards of GB18352-2005, GB17691-2005, GB11340-2005, and GB18285-2005; • Provide high-horsepower equipment with tail gas purifiers; and • Conduct regular ambient air monitoring including H_2S caused by sediment dredging.	Contractors, CSCs	ZPMO, LIEC	120
Noise	Noise generated from construction activities	• Ensure construction machinery conform to PRC standard of GB12523-2011; • Properly maintain vehicles and machinery to minimize noise; • Apply noise reduction devices or methods (such as sound insulation) for high noise equipment operating within 200m away from various sensitive areas e.g. schools, villages, and residential areas; • Locate high-noise activities (e.g. rock crushing) more than 1 km from sensitive areas; • Prohibit operation of machinery generating high levels of noise, such as piling, and movement of heavy vehicles along urban and village roads between 20:00 and 06:00; • Place temporary hoardings or noise barriers around noise sources during construction; • Monitor noise at sensitive areas and consult residents at regular intervals (see monitoring plan in this EMP). If noise standards are exceeded, equipment and construction conditions shall be checked, and mitigation measures shall be implemented to rectify the situation; • Conduct interviews with residents adjacent to construction sites to identify and resolve issues, including adjustment of work hours of noise-generating machinery.	Contractors, CSCs	ZPMO, LIEC	180
Surface water pollution and dredging	Impact of embankment and dredging construction on river hydrology	• A dredging plan will be prepared in advance to be approved by local EPB and WRB; • Technical requirements and mitigation measures for dredging will be included in the bidding documents and construction contracts; • The contractor' site EMP will included dredge machinery maintenance, de-watering	Contractors, CSCs, EMA	ZPMO, LIEC, EPB, WRB	70

Item	Potential impacts / issues	Mitigation measures	Who implement	Who supervise	Budget (CNY 10^4)
		arrangements, emergency preparedness and response mechanism; • Dredging will only be conducted in the dry season (September to March); • Dredging should be conducted in a shorter section (say 300 m) to minimize extent of the disturbance at any one time; • Environmental dredging method will be applied; however, for some narrow sections of Yannan Lake Reservoir, conventional dredging or dry excavation methods can be used; • Earth berms or drainage channels will be constructed around storage sites of the dredged sediment to prevent washing away from rainfall; • Supernatant of the dredged sediment will be treated to meet PRC Integrated Wastewater Discharge Standard (GB 8978-2002) before discharge; • Odor impacts will be minimized by: (i) timely community consultations to ensure awareness of the issue prior to dredging; (ii) rapid on-site treatment of dredged sediment to minimize time near communities; (iii) minimizing the release of odors by dredging in shorter sections (say 300 m) at any one time. Impacts will also be temporary as odors are dispersed; • The dewatered sediment will be re-used on-site for landscaping to minimize the pollution caused during the transportation.			
	Impact of wastewater pollution	• For embankment construction and dredging, slurry will be pumped to shore for treatment; • Earthworks along the river, reservoir and wetland will be accompanied by measures on minimizing the sediment runoff into the water bodies, including sediment traps; • Construction wastewater will be 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 $\geq$500 m from waterways; • Storage facilities for fuels, oil, and other hazardous materials will be within secured areas on impermeable surfaces, and provided with sorbent mats and cleanup installations; • Contractors' fuel suppliers must be properly licensed. They shall follow proper protocol for transferring fuel and the PRC standard of JT3145-1991 (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. • The labor camp will not be set up on construction sites, and workers will rent the temporary accommodation; • Portable toilets and on-site wastewater pre-treatment systems will be installed at construction camps along with proper maintenance protocols; • For landscaping along the riverside, the base fertilizer will be fully applied to each plant, and the application of top fertilizer is prohibited to avoid the N and P pollution to the surface waterbody via surface runoff;	Contractors, CSCs, EMA	ZPMO, LIEC, EPB, WRB	30

Item	Potential impacts / issues	Mitigation measures	Who implement	Who supervise	Budget (CNY 10^4)
		• Water quality (for pollutants such as SS, COD_{cr}, NH_3-N and oil) in the project waterways will be monitored by certified environmental monitoring agency during construction (Table EMP-5).			
Solid waste	Solid waste generated from construction activities and on-site workers	• Provide appropriate waste collection and storage containers at locations away from surface waterbody or sensitive spots; • Arrange with local municipal waste collection service for regular collection of waste; • Properly remove and dispose residual materials, wastes and contaminated soils. Paving or vegetating shall be done timely when materials are removed to stabilize the soil; • Burning of waste on construction sites is strictly prohibited; • Provide sufficient garbage bins at strategic locations and ensure that they are protected from birds and vermin, and emptied regularly by local municipal waste collection system.	Contractors, CSCs	ZPMO, LIEC	90
Biological resources	Protection of flora and fauna around construction sites	• Prior to construction, the vegetation and habitats will be clearly demarcated as no-go zones for workers and machinery; • As far as possible avoid clearance of any vegetation; • After construction, immediately replant vegetation in any sites subject to soil erosion; • In compliance with PRC Forestry Law, the compensatory planting must be the same as, or larger than the area cleared; • Use only native plant species of local provenance for all re-vegetation and landscaping.	Contractors, CSCs	ZPMO, LIEC	900
Socio-economic resources	Impact on physical cultural resources	• Establish chance-find procedures for physical cultural resources; • If a new site is unearthed, construction shall be stopped immediately, and local cultural relic bureau and ZPMO shall be promptly notified. Procedures for management of the chance find shall follow the *Regulation for strengthening the management of cultural relics* (Sichuan Government 2016: SC-Gov-2016-48): • (a) IA shall report to Sichuan Provincial Administration of Cultural Relics (ACR) in advance; • (b) Cultural relics discovered during the construction shall be reported to the ACR in a timely manner and effective protection measures shall be taken; • (c) The cost for any archaeological survey, exploration or excavation required for construction shall be included in the project budget.	Contractors, CSCs	ZPMO LIEC, cultural relic bureau	-
	Temporary interruption to water flow from embankment construction	• Use coffer dams and temporary diversion channels to maintain continued water flow while works are conducted; • Prior to works, re-confirm the planned construction schedule and site EMP actions; • Inform residents at least two days before any planned water interruptions; • Assist residents if requested with community water storage during the interruption period; • Interruptions to water supply should not be longer than one (1) day;	Contractors, CSCs,	ZPMO, LIEC,	Include in contractor's budget

Item	Potential impacts / issues	Mitigation measures	Who implement	Who supervise	Budget (CNY 10^4)
		• In case of accidental interruption (e.g. unintended damage of an existing pipeline), immediately inform affected communities and assist with water supply until the issue is resolved.			
Health and safety	Community health and safety	• Prepare and implement a traffic control and operation plan approved by the district traffic management authority before construction，including 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; • Underground facilities survey and protection. Construction activities will be planned to minimize disturbances to utility services. • Residents and businesses will be informed in advance via media and information boards of the construction activities, dates and duration of expected disruption; • Signs will be placed at construction sites informing people of the project GRM, potential dangers (e.g. moving vehicles, hazardous materials, excavations) and safety issues; • Heavy machinery will not be used at night; • All sites will be secured from unauthorized public access.	Contractors, CSCs	ZPMO, LIEC	
	Occupational health and safety	• Prepare environmental, health and safety plan, including: i) clean and sufficient supply of fresh water for construction sites and offices; ii) sufficient latrines and other sanitary arrangements at construction sites; iii) garbage receptacles and regular emptying; and iv) provide sufficient personal protective equipment to workers as necessary (e.g. boots, helmets, gloves, goggles, ear protection) in accordance with relevant regulations of occupational health and safety; • Prepare emergency response plan for accidents approved by ZPMO and administration of work safety. Establish emergency phone link with local hospitals and maintain a first-aid base on each construction site; • Establish a records management system for occupational accidents, diseases, incidents. The records will be reviewed during compliance monitoring and audits; • Safety communication. Ensure that occupational health and safety matters are given a high degree of publicity to all persons on-site. Display posters prominently in relevant areas of the site; • Training, awareness and competence. Train all workers in basic sanitation, health and safety matters, as well as work hazards. Implement awareness and prevention program for HIV/AIDS and other diseases which aims at the local community and construction workers.	Contractors	CSCs, Labor's bureau, ZPMO, LIEC	
Total					**3,106.3**

ADB = Asian Development Bank; CH =hydrocarbon, CO = carbon monoxide, COD_{cr} = chemical oxygen demand, CSC = construction supervision company, EA = executing agency, EMA = environmental monitoring agency, EMS = environmental monitoring station, EPB = environment protection bureau, GRM = grievance redress mechanism, H_2S = hydrogen sulfide, IA = implementing agency, LARP = Land acquisition and resettlement plan, LARO = Land Acquisition and Resettlement Office, LIEC = loan implementation environment consultant, NH_3-N=ammonia nitrogen, NO_x=nitric oxide, PIU = project implementation unit, PM_{10} = particles measuring ≤10μm; SS = suspended solid, WRB = water resources bureau, ZPMO = Ziyang project management office.

Table EMP-3: Potential Impacts and Mitigation Measures during Operation

Potential Issues	Mitigation Measures and/or Safeguards	Who Implement	Who Supervise	Budget (CNY 10^4)
Management of 90.6 ha of planted vegetation	• **Daily maintenance** - 60 workers will manage the vegetation (mainly including the Eco-embankment, Green wedge, and the Landfill closure and restoration) including regular irrigation, pruning, weeding and replacement of dead plants, etc.; • **Pest control** - The guiding principle will be prevention first followed by integrated treatment, for the eco-embankment landscaping, pesticides shall be prohibited to prevent river pollution; • **Fire prevention** - Measures for prevention of fire will be put in place, with the emergency response mechanism, and education courses about fire prevention will be undertaken to staff and residents by the ZMG.	ZFB	ZPMO, SZHTDZ	500/a
Domestic wastewater, storm water and landfill leachate (Green wedge, landfill closure and restoration and eco-embankment	• Domestic wastewater produced by the residents and visitors will be discharge to the municipal sewage network and then flow to the existing WWTPs for treatment; • Because the separated drainage system in the project area (SZHTDZ) are already formed, except for the most of storm water runoff will infiltrate the ground and replenishes groundwater source through newly planted 90.6 ha vegetation areas, and the rest of surface runoff will be discharged into the rainwater pipeline nearby, eventually flows into Tuo River; and • Continue operation of landfill leachate treatment facility will last for 13 years or even longer after the landfill closure according to the FSR.	Sanitation Bureau, WRB	ZPMO, IAs	40/a
Operation of landfill closure and restoration	• Landfill gas to be initiatively collected via the gas pipes with a collection efficiency of more than 90%; and to be burned by the boiler in the leachate treatment facility; • In the leachate treatment facility, maintenance of the base isolation and equipment room for sound insulation, and the muffler installation for blowers; and conduct regular inspection for the noise impact; • Conduct scheduled and non-scheduled check and maintenance of built infrastructures and facilities for the landfill closure; • Establish and practice the emergency response mechanism and team; • Leachate to be collected and treatment on-site for meeting the national standard; • Implement regular inspection and monitoring of leachate, landfill gas, underground water, ambient air, noise; and • Prohibit construction of permanent structures before technical evaluation is conducted by the professional institute for the landfill subsidence stability.	Sanitation Bureau, EMA	ZPMO, IA	80/a
Noise – from operation of watering pumps in landscaping areas	• Set up equipment rooms for vegetation watering pumps to obstruct the noise; • Use low noise pumps.	FB	ZPMO, IA	10/a
Embankment – Stability	• Implement annual (as a minimum) inspection for the built embankment for physical integrity; • Implement a repair program immediately if signs of failure are discovered.	WRB	ZPMO, IA,	20/a
Embankment – Routine maintenance of embankment and landscaping	• Integrate routine maintenance activities into existing work program of local WRB team; • Monthly maintenance (at least in summer) of re-vegetated embankment – 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	WRB, FB	ZPMO, IA	100/a

	season) remove solid waste and debris to dispose in municipal landfill; • Prohibit or remove any illegal structures which are found, to maintain free water flow.			
Operation of TVET Center	• Ensure implementation of the EMS to manage the activities in TVET campus to achieve green, safe and sustainable campus in compliance with the Green Building Policy; • Ensure connection of new TVET buildings to on-site pretreatment facilities (septic tanks) and to municipal sewer system; • Periodically monitor (visual inspection) sludge accumulation in septic tanks and request licensed company to de-sludge as needed. • Provide adequate solid waste collection facilities in all buildings and on the TVET campus; • Promote segregation of solid waste through (i) provision of separate collection bins for paper, biodegradable waste, metallic waste, and other wastes; and (ii) provision of training and awareness raising for TVET staff and students; • Reach agreement with local waste collection service provider(s) for different types of waste; • Regularly clean and disinfect waste collection facilities. • Ensure compliance with relevant EHS regulations pertaining to ventilation, indoor air quality, lighting, noise, fire escape, etc.; • Establish preparedness plan and operation plan under emergency conditions, such as fire, flood, earthquake, wind, storm, water contamination, epidemic, air contamination, infestation, explosion etc., as part of the TVET Center EMS to ensure safe environment for all student, faculty, staff and visitors. • Prepare safety checklist and reporting forms as procedure control documents of EMS; and • Provide guidelines and reference materials to help the TVET reduce or eliminate potential hazards which may cause injury, illness or property loss.	TVET, Ziyang Education Bureau	ZPMO, ADB	900/a
Total				**1,650/a**

D. Environmental Monitoring, Inspection, and Reporting

13. Three types of project monitoring will be conducted under the EMP: (i) internal monitoring – to be conducted by the PIUs and the CSCs; (ii) external monitoring of air, water, and noise and soil standards – to be conducted by the local EMA; and (iii) compliance monitoring – to be conducted by both the EMA and LIEC, to ensure the EMP is being implemented.

14. The project monitoring program focuses on the environment in the project areas of influence (Table EMP-5). 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 ambient air, surface water, groundwater and noise, and the pollutant discharge standards.

15. **Internal monitoring.** During construction, the PIUs and CSCs will be responsible for conducting internal environmental monitoring in accordance with the monitoring plan (Tables EMP-4 and EMP-5). Results will be reported through the CSC monthly reports to the ZPMO.

16. **External monitoring.** The PMOs will contract the EMA to conduct environmental monitoring in accordance with the monitoring program (Table EMP-4, Table EMP-5). A detailed cost breakdown will be provided by the EMA when the environmental monitoring program is updated at the start of each component implementation. Monitoring will be conducted during construction and operation period, until a project completion report (PCR) is issued. Semiannual monitoring reports will be prepared by the EMA and submitted to ZPMO and the PIUs.

17. **Compliance monitoring for EMP and progress reporting.** The LIEC will review project progress and compliance with the EMP based on field visits, the review of contractors and CSCs' monthly report and EMA's environmental monitoring report. 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 the ZPMO prepare the reports and submit the English report to ADB for disclosure.

18. **Project completion environmental audit.** Within 3 months after each subcomponent completion, or no later than a half year with permission of the local EPB, environmental acceptance monitoring and audit report of each subcomponent completion shall be (i) prepared by a licensed environmental monitoring institute in accordance with the PRC Guideline on Project Completion Environmental Audit (2001), (ii) reviewed for approval of the official commencement of individual subcomponent operation by environmental authority, and (iii) finally reported to ADB through the semiannual EMP monitoring and progress reporting process.

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

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

Table EMP-4: Environmental Reporting Plan

Report	From	To	Frequency of Reporting
A. Construction Phase			
Internal progress reports	CSCs	PIUs	Monthly
External reports	certificated EMA	ZPMO, PIUs	Semiannually
Environmental acceptance monitoring and audit reports	Licensed institute	EPB, ZPMO, PIUs	Within three months after subcomponent completion
Compliance monitoring with EMP – progress reports	ZPMO/LIEC	ADB	Semiannually (through semiannual project progress reports)
B. Operation Phase			
EMP progress reports	ZPMO	ADB	Semiannually

Table EMP-5: Environmental Monitoring Program

Subject	Parameter	Location	Frequency	Who Implement	Who Supervise	Budget (CNY 10^4)
1. **Construction**						
Internal monitoring (contractors, CSCs, ZPMO and PIUs' Environment Officers)						
Ambient air	Dust mitigation measures in EMP; equipment maintenance	Visual inspection on all construction sites	Once per week	Contractor, CSC	PIU	Included in Contractor and CSC's budget
Solid waste	Garbage and construction waste	Visual inspection on all construction sites	Daily	Contractor, CSC	PIU, EPB, sanitation department	
Soil erosion and re-vegetation	Soil erosion intensity	Visual inspection on spoil sites and all construction sites, especially embankment section of Tuo River and Yannan Lake wetland	Once per week; and immediately after heavy rainfall	Contractor, CSC	PIU	
	Re-vegetation of embankments, spoil disposal sites, and construction sites	Visual inspection on all sites	At least 4 times per year	Contractor, CSC	PIU	
Occupational health and safety	Allocation of PPE, posting of safety sign, availability of clean water, and emergency response plan	Inspection on all construction sites	Once per month	Contractor, CSC	PIU	
External monitoring (certified environment monitoring agency)						
Construction wastewater	pH, COD_{Cr}, SS, NH_3-N, oil,	(i) 100 m upstream and 500 m downstream of construction sites; (ii) at wastewater discharge points of all construction sites	Twice per year	EMA	EPB, ZPMO, LIEC	15
Surface Water	pH, SS, NH_3-N, BOD_5, COD_{Cr}, oil	(i) 500 m downstream of the Tou River (embankment section); (ii) inlet and outlet of Yannan Lake and (iii) inlet of Kongzi Creek	Twice per year	EMA	EPB, ZPMO, LIEC	20
Ambient air	PM_{10}, $PM_{2.5}$, SO_2, CO, NO_2	All construction sites (at least 1 point upwind, 1 point downwind) and nearby sensitive receivers (see Chapter IV of EIA)	Twice per year	EMA	EPB, ZPMO, LIEC	8
Odor gas	H_2S, NH_3	Four boundaries of the leachate treatment facility	Four times per year	EMA	EPB, ZPMO, LIEC	7
Noise	LAeq	Boundaries of all construction sites and nearby sensitive receivers (Section G, Chapter IV of EIA)	Twice per year (twice a day: once in day time and once at night time, for 2 consecutive days)	EMA	EPB, ZPMO, LIEC	10
Solid Waste (garbage,	Construction waste on	Visual inspection at all construction sites	twice per year	LIEC	ZPMO, ADB	Included in TA

Subject	Parameter	Location	Frequency	Who Implement	Who Supervise	Budget (CNY 10^4)
construction waste)	construction sites					consultant's budget
Soil erosion and re-vegetation	Soil erosion intensity	Visual inspection on spoil sites and construction sites, especially the embankment of Tuo River, Yannan Wetland, landfill closure, green wedge, and preservation of bare hills.	At least once per year, and once after completion of construction	LIEC	EPB, ZPMO, ADB	50
	Re-vegetation of embankments, spoil disposal sites and construction sites	Visual inspection at sites, and temporary occupied lands	At least once per year, and once after completion of construction	LIEC	ZPMO, ADB	50
Occupational health and safety	Allocation of PPE, posting of safety sign, availability of clean water, and emergency response plan	Inspection on all construction sites	At least once per year	LIEC	ZPMO, LB, ADB	Included in TA consultant's budget
Subtotal						**160**
2. Operation phase						
Surface Water - Tuo River	pH, SS, NH_3-N, BOD_5, COD_{Cr}, oil	500 m upstream and 500 m downstream of the embankment section	Twice per year	EMA, WRB	EPB, ZPMO, ADB	2.0/a
Surface water – Yannan Lake wetland and Kongzi Creek	pH, SS, NH_3-N, BOD_5, COD_{Cr}, oil	(i) inflow to constructed Yannan Lake wetland; (ii) outflow from the wetland; (iii) in the middle of wetland; and (iv) Kongzi Creek	Twice per year	EMA, WRB	EPB, ZPMO, ADB	2.0/a
Leachate	pH, SS, NH_3-N, BOD_5, COD_{Cr}, fecal coliform, oil, TN, TP	Outlet of leachate treatment station on the closed landfill site	Twice per year	EMA, sanitation department	EPB, ZPMO, ADB	2.0/a
Ambient air - Green wedge	PM_{10}, $PM_{2.5}$, SO_2, CO, NO_2	Monitoring points at the fast traffic lane of built "green wedge"	Twice per year	EMA, facility operator	EPB, ZPMO, ADB	1.5/a
Ambient air - closed landfill	TSP, SO_2, CO, NO_x, H_2S, NH_3, odor, CH_4	1 point upwind and 1point downwind of closed landfill site, and at least 2 points within the site	Twice per year	EMA, facility operator	EPB, ZPMO, ADB	2.5/a
Waste gas	PM_{10}, $PM_{2.5}$, SO_2, CO, NO_2, H_2S, NH_3	Waste gas discharged from the closed landfill site	Twice per year	EMA, sanitation department	EPB, ZPMO, ADB	2.5/a
Noise	LAeq	Boundary of leachate treatment station on the closed landfill site	Twice per year (twice a day: once in day time and once at night time for 2 consecutive days)	EMA, sanitation department	EPB, ZPMO, ADB	0.8/a
Ground water	pH, COD_{Mn}, NH_3-N, NO_2^-, SO_4^{2-}, HCO_3^-, Cl^-, Na, K, Mg,	(i) 1 km upstream of closed landfill site; and (ii) 1 km, 1.2 km and 1.5 km downstream of	Twice per year	EMA, sanitation department	EPB, ZPMO, ADB	3.0/a

Subject	Parameter	Location	Frequency	Who Implement	Who Supervise	Budget (CNY 10^4)
	Ca, Fe, Mn	closed landfill site				
Soil	pH, water content, organic matter, Hg, Cd, As, Cu, Pb, Cr, Zn, Ni	Monitoring points at top soil and deep soil within the closed landfill site	Once per year	EMA, sanitation department	EPB, ZPMO, ADB	3.5/a
Vegetation	Plant survival and coverage	All landscaping sites	Spot check, twice per year	PIUs, ZFB	ZPMO, ADB	3.0/a
Stability of waste body	Settlement and displacement of waste body	Monitoring points at the waste body of closed landfill site	Four times per year	Certified monitoring agency, sanitation Bureau	Ziyang Administrate of Work Safety, EPB, ZPMO, ADB	2.0/a
Total						**24.8/a**

As = arsenic, BOD_5 = 5-day biochemical oxygen demand; Ca = calcium, Cd = cadmium, CH_4 = methane; COD_{cr}/COD_{Mn} = chemical oxygen demand; Cr = chromium, Cu = copper, Fe = ferro, HCO_3^- = carbonate ion; Hg = mercury, K = potassium, LAeq = equivalent continuous A-weighted sound pressure level; Mg = magnesium, Na = sodium, Mn = manganese; NH_3-N = ammonia nitrogen; Ni = nickel, NO_2 = nitrogen dioxide; NO_2^- = nitrite ion; NO_x = nitrogen oxide; OPF = operators of built project facilities; Pb = lead, $PM_{2.5}$ = particles measuring $\leq$2.5μm; SO_2 = sulfur dioxide; SO_4^{2-} = sulfate ion; TN =total nitrogen; TP = total phosphorous; TSP = total suspended solids; Zn = zinc.

E. Training and Capacity Building

20. The ZPMO, IAs, and PIUs have no previous experience with ADB-funded projects or safeguard requirements. During the project engineering design phase, two trainings on EMP implementation will be conducted, including roles and responsibilities of contractors and CSCs for EMP implementation, the project impacts and mitigation measures. During implementation, a capacity building program will be implemented on: (i) the EMP, including the mitigation measures, monitoring, and reporting; (ii) ecological management of eco-embankment of Tuo River, and Yannan lake wetland; (iii) surface water quality protection and improvement; and (iv) sustainable integrated ecosystem management. Training will be provided by the Ziyang Municipal EPB, and LIEC. Trainees will be the ZPMO, IAs, PIUs, contractors, CSCs, and local WRB and forestry bureaus. The ZPMO will arrange the training programs, supported by the LIC, and LIEC.

Table EMP-6: Project Environment Training Program

Training program	Scope of Training	Trainer	Trainee	Time	Day	No. of Person	Budget (CNY 10^4)
Procurement and contract management (emphasis on 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	ZPMO, PIUs, FB	2	1.5	25	
Implementation of EMP	• Introduction of roles, responsibilities, monitoring, inspection and reporting; • Environment monitoring program; • Public consultation and participation; • GRM – implementation, coordination, reporting and working with the general public;	LIEC	ZPMO, PIUs, EPB, contractors, CSCs	2	1.0	30	

Training program	Scope of Training	Trainer	Trainee	Time	Day	No. of Person	Budget (CNY 10^4)
	• Environment, health and safety during project construction and operation for workers and the community; • Prevention and control of transmissible diseases and HIV/AIDS.						
Wetland ecosystem and restoration	• Principles of wetland restoration; • Wetland ecosystem and biodiversity; • Management of constructed wetland.	Experts from EPB and ADB	ZPMO, PIU, other relevant units	1	1.0	10	0.30
Landfill closure management	• Environmentally friendly landfill closure and land reuse; • Landfill closure maintenance and groundwater pollution prevention	Experts from EPB and ADB	ZPMO, PIU, other relevant units	1	1.0	10	0.30
Ecological management	• Maintenance of planted vegetation and habitats of the project embankments; • Point and non-point pollution control.	Experts from EPB and ADB	PIU, OPF WRB	1	1.0	15	0.45
Climate change resilience	• Energy saving and GHG emission reduction; • Landscaping and carbon sink.	LIC	PIUs, OPF WRB	1	1.0	15	0.45
Emergency preparedness and response planning	• Response mechanism e.g. for spills; • Mitigation measures for hydraulic sectors; • Emergency response team, procedure and actions.	LIC	ZPMO, PIUs, OPF, contractors, CSCs	2	2.0	20	1.20
Total				**6**	**6.0**	**75**	**2.70**

CO = carbon monoxide; CSC = construction supervision company, EMP = environment management plan, EPB = environment protection bureau, FB = finance bureau, GHG = greenhouse gas, LIC = loan implementation consultant, OPF = operator of built project facilities, PIU = project implementing unit, ZPMO = Ziyang project management office, WRB = water resources bureau.

F. Grievance Redress Mechanism

21. The Environmental and Social Officers of the ZPMO and project PIUs will be the lead coordinators for GRM implementation. However, all project agencies and staff will be trained in the GRM and will take an active role in supporting these staff as and when necessary.

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

23. The contact persons for different GRM entry points, such as the ZPMO and PIU Environmental and Social Officers, contractors, operators of project facilities (OPFs), and local 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 local EPBs.

24. Once a complaint is received and filed, the ZPMO 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.

(i) **Stage 1**: 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.

(ii) **Stage 2**: If the issue cannot be resolved in Stage 1, after five days, the PIU and/or ZPMO 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 (in operation) will implement the solution within seven (7) calendar days. Written records will be made of all stages and outcomes.

(iii) **Stage 3**: If no solution can be identified by the ZPMO and/or PIU, and/or the complainant is not satisfied with the proposed solution, the ZPMO and/or PIU will organize, within ten (10) calendar days, a stakeholder meeting (including the complainant, contractor and/or operator of the facility, local EPB, PIU, ZPMO). 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.

25. 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, ZPMO, PIU, ZMG, and/or ADB.

26. The ZPMO 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.

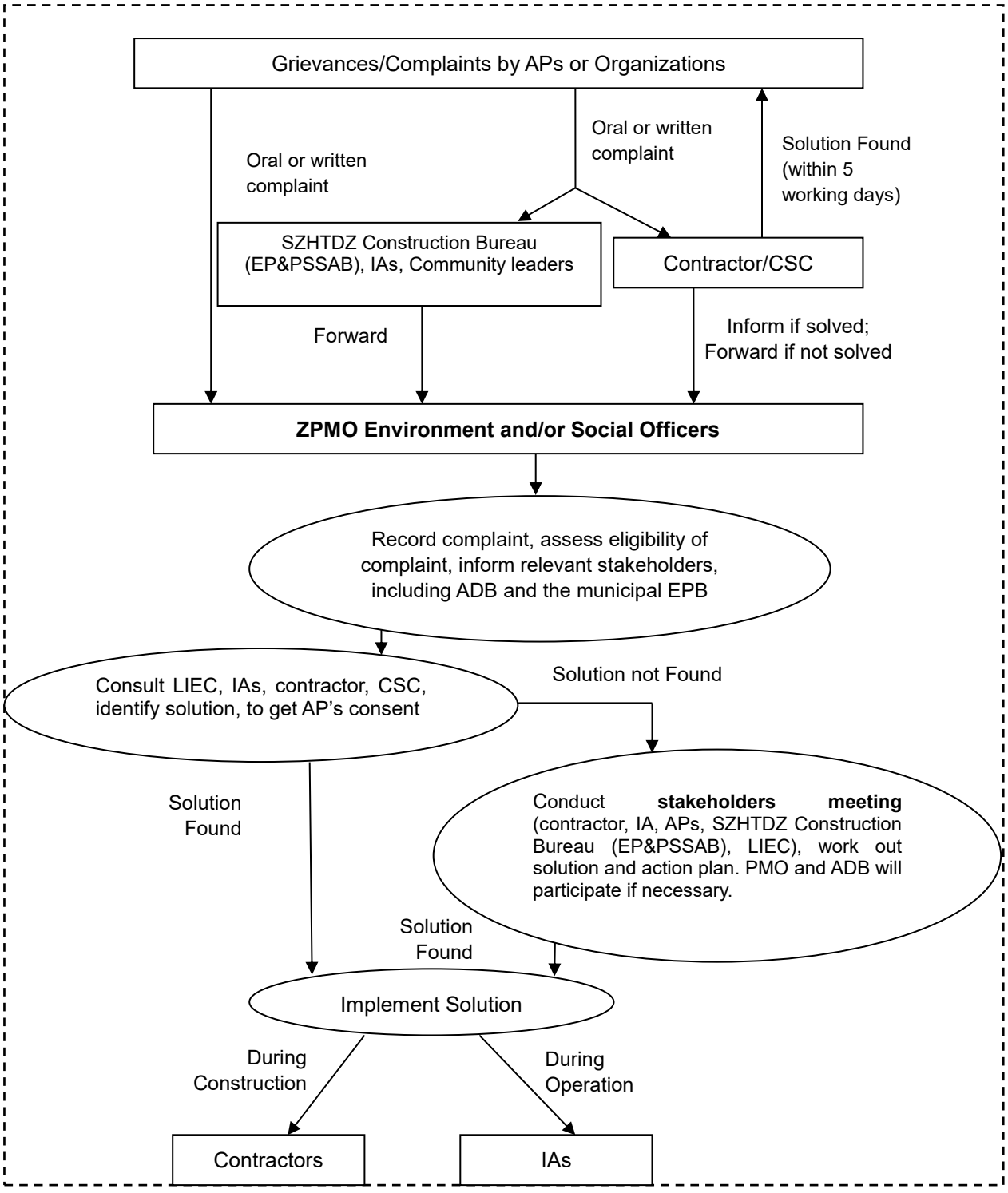


Figure EMP-1: Operation Chart of the GRM

AP = affected person, CSC = construction supervision company, EPB = environmental protection bureau, EP&PSSAB = environmental protection and production safety supervision administration bureau, IA = implementing agency, LIEC = loan implementation environmental consultant, PMO = project management office, SZHTDZ = Sichuan Ziyang High Technology Development Zone.

G. Public Consultation and Awareness Raising

27. Two rounds of public consultation were conducted during TRTA 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, dust or odor from dredged sediment. A public consultation plan is in Table EMP-7, and it 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 ZPMO Environment and Social Officers and the LIEC.

Table EMP-7: Public Consultation and Participation Plan

Organizer	Approach	Frequency	Subject	Participant	Budget (CNY 10^4)
Construction					
ZPMO, PIUs, LIEC	Questionnaire survey, site visit, informal interview	Once a year during peak construction	Construction impacts; adjusting mitigation measures if necessary; and feedback	Workers, residents nearby construction areas	3.0
	Public workshops	At least once during peak construction period.	EMP implementation progress; construction impacts; adjusting mitigation measures if necessary; and feedback	Local residents, affected persons, social sectors	4.0
Operation					
ZPMO, 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, and feedback	Local residents, affected persons adjacent to project facilities	1.0
	Public workshop	As needed based on public consultation	Effects of mitigation measures, impacts of operation, and feedback	Local residents, affected persons, social sectors	1.5
	Public satisfaction survey	At least once after one year of operation	Comments and suggestions	Project beneficiaries	1.0
Total					**10.5**

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

H. Cost Estimates

28. This section provides an estimate of the cost of EMP implementation. The cost comprises three categories: mitigation measures (Tables EMP-2; EMP-3); monitoring (Table EMP-4); and training (Table EMP-6). Costs are presented for the construction phase of five years and the first year of operation, i.e., a total of 6 years. The costs do not include: (i) detailed design revisions and adjustments; (ii) internal monitoring/inspection of solid wastes disposal, occupational health and safety during construction, as this will be included in the construction supervision contracts; and (iii) salaries of ZPMO and PIU staff. Costs for mitigation measures and training are based on estimates in the DEIAs and/or the experience of the TRTA consultants from other projects. All costs were discussed with the DEIA Institute, ZPMO and IAs.

29. The total estimated cost for implementation of the EMP is CNY42.613 million ($6.556 million) for 5 years construction and the first-year operation (Table EMP-2 and 3). Construction-phase costs will be paid by the contractors (as part of their contracts). Operational-phase costs will be paid by each IA.

I. Mechanisms for Feedback and Adjustment

30. Based on environmental inspection and monitoring reports, the ZPMO 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 ZPMO Environmental Officers will play a critical role in the feedback and adjustment mechanism.

31. 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 ZPMO 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 DEIAs 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.