PRC: Ziyang Green Transformation and Development Project

Project Preparation Study

Draft Final Report---Supplementary Appendix 1

Technical Report

11 April 2018

Prepared by：

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Preface

This report is part of the Project Preparation Study (PPS) for Ziyang Municipal Government (ZMG) funded by the Cities Development Initiative for Asia (CDIA).

CDIA is an international partnership initiative, established in 2007 by the Asian Development Bank (ADB) and the Government of Germany, with additional funding support from the governments of Austria, Sweden, Switzerland, and the Shanghai Municipal Government. CDIA assists medium-sized Asian cities to bridge the gap between their development plans and the implementation of their infrastructure investments.

CDIA uses a demand driven approach to support the identification and development of urban investment projects in the framework of existing city development plans that emphasize environmental sustainability, pro-poor development, good governance, and climate change mitigation/adaptation. To facilitate these initiatives at city level, CDIA provides a range of international and domestic expertise to cities that can include support for the preparation of pre-feasibility studies for high priority infrastructure investment projects as one of several elements.

ZMG submitted an application to CDIA to conduct a PPS to help support project preparation and ensure compliance with Asian Development Bank (ADB) requirements and incorporation of international best practices in the project design. The application was endorsed by ADB and approved by CDIA on 9 May 2017. The PPS was conducted from October 2017 through April 2018.

This report provides technical details about the infrastructure and capacity building funded by the ADB loan. The report is based on review of Feasibility Study Reports (FSR), interviews, and site visits. The FSR are prepared by Design Institutes (DI) under contract to the Ziyang Project Management Office (PMO) and follow Chinese laws, regulations, standards, and guidelines. The completed FSR are reviewed and approved by the provincial Development and Reform Commission.

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EXECUTIVE SUMMARY

OUTPUT 1: URBAN DEVELOPMENT PLANNING AND MANAGEMENT CAPACITY STRENGTHENED

Improved Management System for SZHTDZ Intelligent Park Platform (SMART Systems)

The component is to provide the Sichuan Ziyang High Technology Development Zone (SZHTDZ) with a modular, web-based, interactive, model-based information and decision support system to support better management and monitoring of the urban environment, including regulatory compliance, public and environmental health, safety, resource efficiency, sustainability and information sharing.

This SMART management support system will provide a platform to develop local industry and promote economic growth; optimize information resources; promote the efficient and transparent distribution of information; provide a unified system for data collection and database development; provide a high-level information collection, data analysis and decision-making tool; provide a user-friendly and widely accessed platform for use by the public; monitor pollution levels to ensure compliance and provide a database of information to demonstrate performance improvements; improve the efficiency and service capability of public administration; enhance transparency; and enable the better management of road traffic, public surveillance, lighting systems, and response systems.

Performance Monitoring System

Consultants will be engaged to work with SZHTDZ and ZMG to develop a performance monitoring system, using data collected and databased though the SMART management support system, to monitor Ziyang's progress in the planning and the implementation of its green Smart City transformation. Terms of reference for consulting services have been prepared to appoint a consultant to develop key performance indicators against which Ziyang's performance in master planning and development processing can be assessed, and a system for data collection, analysis, and reporting.

Urban Green Transformation Study

The Green Transformation Study is to change the traditional development model to a sustainable development model which is harmonious with nature, efficient use of resources, distinctive cultural features and suitable for entrepreneurship and life. Terms of reference for consulting services have been prepared to appoint a consultant to work with SZHTDZ and ZMG to conduct a study that can provide input to Master Plans and associated documents. The study will be done in conjunction with the Performance Monitoring System which is developing a system to measure progress planning and implementing the green transformation.

OUTPUT 2: ECONOMIC SECTOR OPPORTUNITIES BROADENED

Research and Development (R&D) Incubator for Dental Sector

As a high-technology, capital intensive industry, entrants to the dental sector incur large sunk costs, in addition to administration and regulation-related barriers. Moreover, development of a modern dental sector entails substantial investment for research and development (R&D), product development, and human resources. The Dental R&D

Incubator will enable entrepreneurs to take their ideas from mind-to-market by providing services that will reduce the R&D cost for new start-up companies, especially in the preliminary development phase. The component consists of the supply of laboratory instrumentation and equipment; with the construction of a 60,000 m^2 building to house the incubator being funded domestically. This facility will be of great use to international and domestic small and start-up companies and provide a compelling reason to choose to locate in the Ziyang Huaxi Dentistry Industrial Park.

Dental Equipment Material Inspection and Testing Center

Currently, there are 53 medical device inspection and testing centers in China, mostly located in Beijing, Shanghai, and Guangzhou. In Sichuan Province, the Sichuan Medical Equipment Testing Center is responsible for the testing and certification of medical equipment and products including those in the dental sector. However, it does not have enough capacity and lacks certain equipment. This component consists of the supply of laboratory instrumentation and calibration equipment; with the construction of a 16,000 m^2 building being funded domestically. When completed the Center will provide services for product registration, inspection and certification and other requirements to help new products enter into production as well as the domestic dental market.

Technical and Vocational Education and Training (TVET) Center

Under this component, a TVET Center will be redeveloped and commissioned in SZHTDZ to educate people to qualify for work in the zone, and provide continuing educational training for those employed by companies operating there. Ziyang TVET center will offer five specialties: pre-school education, e-commerce, automobile manufacturing and maintenance, leisure sports service and management, aviation services and management. Around 2023, the Center will offer two new additional specialties: tourism service and management, and logistics services and management. The TVET Center is planned to serve 4,000 full time students and 2,000 part-time, with about 170 teachers.

OUTPUT 3: ECOLOGICAL SYSTEMS AND ENVIRONMENTAL INFRASTRUCTURE CONSTRUCTED

Flood Protection Embankment

This sub-component consists of improvements and landscaping to a 6.8 km length of the right bank of the Tuo River, including the raising of the embankment to provide improved flood control and protection along where the river flows through the urban area of Ziyang adjacent to SZHTDZ. The earth embankment will be landscaped to blend into the surroundings, with trees planted on the sloping embankment face to create a green, eco-friendly appearance; with landscaped recreational areas provided along the crest of the embankment allowing for public access for walking, sports, tai chi, etc. This “eco-dike” will be designed to protect SZHTDZ from a flood with a one-in-fifty years’ rate of occurrence, and will rely on the planting (trees and vegetation) on the sloping embankment face to reduce wave action and minimize erosion.

Sponge City Interventions

This sub-component consists of “sponge city” interventions in Ziyang City that will create sunken areas in roadside verges that will act as detention basins where rain water can collect during periods of heavy rainfall. The “green” and landscaped basins will be designed

so that runoff water is “trapped” there, and can gradually seep into the underlying ground strata, and eventually augment the below-surface groundwater aquifer. The detention basins will divert water from entering the urban surface water drainage system, and reduce urban flooding. Detention basins will be constructed along 10 sections of road, totaling 13.95 km, with verge widths varying from 3 to 20 m.

Wetland Area Development Downstream of SZHTDZ

This sub-component comprises the restoration of a series of water bodies and their catchments; and the re-generation of wetland areas. The upstream Yingjie Reservoir, which is used for irrigation, flood control, and aquaculture, flows into the Kongzi Creek, which is a 3 km natural channel, and connects to the downstream Yannan Reservoir, which serves irrigation and flood control functions. Both “lakes” and the creek are badly polluted with water quality worse than Grade V (the lowest category), the pollution being the result of agricultural fertilizer runoff, animal waste, and improper sanitation, e.g. failing septic tanks. The water quality needs to be improved in the near term to Grade IV so the impounded water can be used safely for irrigation and to reduce pollution into the Tuo River. The long term goal is to improve water quality to Grade III. The restoration will provide a clean-up of the existing water bodies and shorelines totaling about 25.7 ha, and include the re-generation of wetland areas for about 20 to 100 m from the shore of the lakes and creek. The works include: the demolition of some buildings and removal of disused septic tanks; removing sources of agricultural pollution (including closing farmsteads and relocating farm animals), dredging & disposal of spoil, and the development of ecological vegetation systems to improve water quality; the construction of subsurface flow wetlands, access tracks and landscape works, and wetland tour and popular science education facilities around the area. When completed the wetlands are planned to be a recreational and educational resource.

Landfill Closure, Restoration, and Afteruse

This sub-component consists of the closure and restoration of the existing and operational Zhongshan sanitary landfill (receiving about 400 tons per day of solid waste from the urban areas of Ziyang City); and the development of a green public open space on the restored landfill and the surrounding rural area (total green public open space area: approximately 37 ha, including 17.5 ha of restored landfill). This landfill is expected to reach its capacity in 2020; and, to provide continuity in solid waste management collection, transport, treatment and disposal, a waste-to-energy (WtE) plant is planned to be commissioned in 2019. (Note: the WtE is not a component under the loan). The restoration of the landfill will include capping of the site (using soil and a geomembrane to prevent the infiltration into the waste of rainwater falling on the site), providing drainage, vegetation, and landscaping; and enhancements to the landfill gas collection and leachate management systems. After closure and restoration, the operation of landfill gas collection and leachate treatment will need to continue, and this may need to continue for 20 to 30 years after closure.

Green Wedge

This sub-component consists of the creation of a “green wedge” to develop an existing undeveloped hilly and gully area as a natural barrier between the residential Ziyang old town and the southern production part of SZHTDZ. This 123 ha area will form an “urban green lung” to improve the urban environment, and will also be accessible to the public as a recreational resource and for the enjoyment of nature. This green wedge will maintain a designated area of open space between urban residential areas to the north, and the industrial area to the south; and is planned to spatially coordinate with the green landscaping of the closed landfill and the re-generation of the Yannan Wetlands to the south.

Ecological Preservation of Bare Hills

This sub-component consists of remedial measures to a series of steep un-vegetated cut and fill slopes located in the urban areas, some in immediate juxtaposition to occupied residential buildings. The slopes were formed as a result of improper excavation for roads, buildings, and borrow pits. These un-vegetated slopes are vulnerable to soil erosion from rain and wind. Increased precipitation and extreme rain storm events as a result of climate change could potentially result in more erosion, with the possibility that parts of these slopes could fail suddenly if the soil becomes saturated and loses strength. The remedial works at nine sites will provide stabilization and ground cover and reduce vulnerability to weather events.

1 OUTPUT 1: URBAN DEVELOPMENT PLANNING AND MANAGEMENT CAPACITY STRENGTHENED AND APPLIED

1.1 Introduction

1. The Sichuan Ziyang High Technology Development Zone (SZHTDZ), formerly known as the Sichuan Ziyang Economic Development Zone, was established in 1992 as a comprehensive development zone. In 1995, the Sichuan provincial government approved an upgrading to a provincial development zone; and subsequently in April 2017, it was designated as a high-tech Industrial Park.

2. This Industrial Park is located at the core of the Chengdu-Chongqing Economic Zone. In 2015, the zone had a developed area of about 21.4 square kilometers; with business revenue reaching about CNY55.2 billion; and providing employment for nearly 5 million people.

3. The Industrial Park focuses on the development of:

(a) modern medical devices, such as the development and sale of dental medical devices;

(b) state-of-the-art service industries such as finance, insurance, consulting, exhibition, information technology and so on;

(c) electric vehicles; and

(d) locomotives and rolling stock for “high-speed” trains.

4. Output 1 will support ZMG with strengthening its capacity to plan and implement Ziyang’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.

5. There are three components:

(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. The study is expected to generate an operable approach of the Ziyang Green Transformation; and to increase the planning, implementation and innovation capacity of the ZMG.

6. As SZHTDZ expands, and Ziyang transforms into a significant industrial and manufacturing center within the Chengdu-Chongqing Economic Zone, there are concerns that environmental impacts will downgrade the quality of life within this community. The Ziyang Municipal Government (ZMG) seeks to develop the SZHTDZ in a green and sustainable manner that does not degrade or endanger adjacent urban and residential areas. ZMG also recognizes the need for energy conservation, the provision of allowances for resilience, the improvement of derelict and degraded areas, the restoration of ecological resources, the reduction of greenhouse gases, and the reduction of industrial pollution by installing pollution control equipment, by changing industrial processes to reduce emissions and the production of waste products, and by developing a circular economy within an industrial area where the “waste” from one process becomes the “resource” of another manufacturing plant.

1.2 Improved Management System for SZHTDZ Intelligent Park Platform (SMART Systems)

7. Problems that have been identified during the development of SZHTDZ include:

(a) The development of Ziyang City is lagging behind other cities in the region because of competition for industries.

(b) Environmental damage is being caused by certain types of industry; and increasing amounts of industrial wastewater, exhaust gas emissions and solid waste are being generated.

(c) SZHTDZ is failing to attract new companies because of a lack of competitiveness, deteriorating environment, and low quality living conditions

(d) The SZHTDZ Management Committee has insufficient staff to manage a zone where 21.37 square kilometers has been occupied (against a total zone area of 64.1 square kilometers). And the working efficiency of the staff is reported to be unsatisfactory.

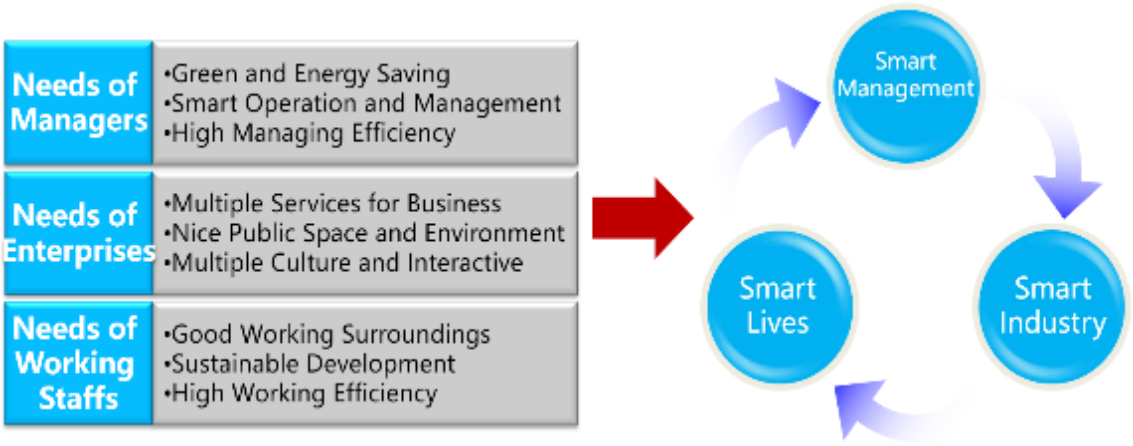
(e) The management style is less effective because of inadequate and untimely reporting and a lack of management relevant data and information

(f) The existing data collection infrastructure is deficient.

(g) The existing management platform is not readily accessible, and the database operates independently between departments. Thus information sharing between departments is limited.

8. SZHTDZ plans to increase its competitiveness and become more attractive to high-technology, high-quality companies to locate in the zone through use of a “Smart solution” that can provide better services for park managers, companies, and staff working in the park, and benefit industry development.

Figure 1: SMART System Satisfying Needs



9. The plan is to procure and install an “Enterprise Public Service Platform” network that utilizes the Ziyang Tianfu (Huawei) Cloud Computing Center. The network will provide information disclosure inquiries, e-commerce, entrepreneurship counseling, human resources, legal rights, technical support, external communication and cooperation, and other multiple service functions for companies. It will also provide data statistics, chart analysis, resource integration, unified management and other service functions for park managers. At the same time, the management of hardware facilities will combine the information technology into the construction of public service platform.

10. Annex 1-1 provides details about the planned management system. The overall design of the Smart Park consists of four levels:

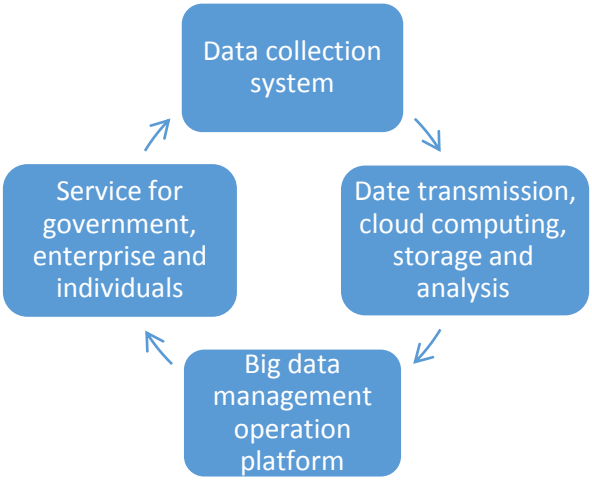
(a) Internet of Things (IoT) used to collect basic information. Through video and sensing to collect all kinds of basic information from the zone.

(b) Information transit through network: Transmit, collect, process and analyze data through network transmission and cloud computing technology. This standardized data output will be the main data sources for the big data management platform.

(c) Big data management and operation platform. The combination and utilization of standardized data sources will be used to create multiple application service models to realize the unified management and operation of the zone.

(d) System application services. This will provide services for the administrator, government staff, companies and individuals in the zone; it also can be used as the data acquisition system to realize the closed loop management of the data flow for the whole Smart application system.

Figure 2: SMART System Data Collection and Usage Cycle



11. The proposed project can be divided into four elements in terms of functions:

(a) ***Smart Government***: The zone's big data management and operation platform, Office Automation (OA) Office System, integrated business service system and conference management system.

The zone's large data management platform consists of data preparation, the construction of a database by collecting data from various departments, the management service platform for the big data center, and the upgrade of GIS. The OA office system will involve the development of an internal cooperated working system and information sharing and disclosure system to realize the automatic working process and the management of documents. The integrated business service system is to provide all kinds of handy services for the public and companies by integrating the service platform for each department and eliminating the isolation of information. The conference

management system is designed for the use of government staff, but also open to the public and companies.

(b) ***Smart Economy***: Cloud Software Park and one-stop Enterprise Park Service Platform

Cloud Software Park: the services of the Cloud software park include cloud enterprise services, industrial applications, incubation innovation center, and providing industry personnel training. It is developed to reduce the cost of using small and local software companies and to increase the competitiveness of high-tech companies.

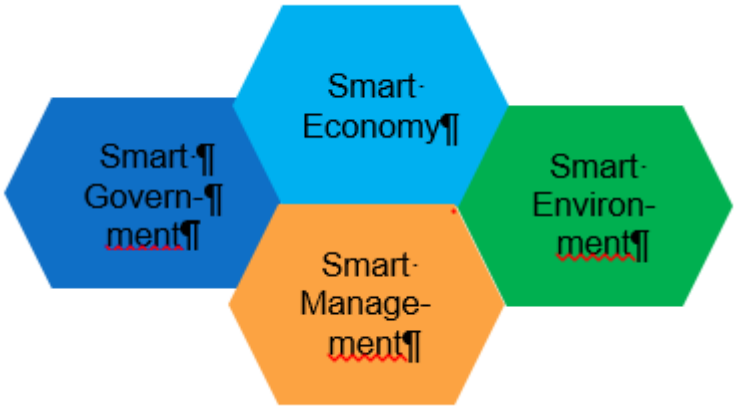
One-stop Enterprise Park Service platform: Platform includes terminal layer, network layer, platform layer, and application layer which includes desk surface cloud, enterprise 3D, animation design desktop cloud, cloud host, cloud storage, call center, fusion communications, video conferencing, business suites and other functions.

(c) ***Smart Management***: Smart transportation, smart lighting, smart security, smart community, and smart emergency response system.

(d) ***Smart Environment***: water quality monitoring, air quality monitoring, noise monitoring and environmental safety emergency systems.

The Smart Environment system includes water quality monitoring, air quality monitoring, noise monitoring, and the establishment of an environmental management system. The environmental management system will be established based on company boundaries and in accordance with the ISO Environmental Management system.

Figure 3: SMART System Elements



12. Among these four functions, the construction of the big data management and operation platform under the Smart Management and the Cloud Software Park under the Smart Economy will be the most essential and the most urgent items to be constructed. They are the “core” for the whole Smart Park development.

13. The Smart Park can be separated into two main parts, the data service and the application or software service. The data service center is located in the Huawei Cloud computing center which is used for the data storage, update, backup and data maintenance;

and the application service center is located in each section according to its function, such as the customer service application is located in the property management office, the maintenance application center is location in the engineering management office, the security fire control center will be set up in the control room. The data from each separate center will connected to the zone data center to ensure the uniform and comprehensive data collection and to provide convenient service.

14. The project operation agency of the Smart Park project is the Science and Economy Bureau under the SZHTDZ. There are two options for the daily operation and maintenance for the system, self-maintenance or outsourcing. Self-maintenance requires an operation and maintenance group under the SZHTDZ Science and Economy Bureau. While under the outsourcing option a third-party service provider would be engaged to be responsible for the daily operation (and SZHTDZ would pay an annual fee). As at Q1 of 2018, due to the lack of professional staff in SZHTDZ, hiring a third service provider would be the most professional, economical, and practical approach. The ZMG and SZHTDZ management committee would work as the supporting team to assist on the promotion of the project, the collection of basic data sources, the communication and cooperation with each department, etc. Meanwhile, the Science and Economy Bureau would work as the construction supervisor to supervise the maintenance work performed by the third party to ensure the sustainable and smooth operation of the system. At the same time, on the basis of relatively mature products, a third party can provide and create customized services according to the characteristics and specific requirement of the zone as needed during the operation.

15. The major financing source for the operation and maintenance is the Finance Fund from the government in the annual government budget, it would be used to pay the equipment or service rental fee, the data management and update, application maintenance and update and etc. Other source is the service fee charged to enterprises for using Cloud Enterprise Services.

1.3 Performance Monitoring System and Urban Green Transformation Study

16. These are two separate components each with their own scope of work and budget but in this report they are discussed together because they are mutually dependent. Both components will be accomplished through hiring consulting firms and the work is scheduled to complete in sufficient time for results to be incorporated into the ZMG 14th Five Year Plan (2021-2025). Annex 1-2 and Annex 1-3 are the outline terms of reference for each.

Background

17. Typically Chinese cities focus their urban planning on promoting economic development and on creating a city with good living conditions. Traditionally, manufacturing industries have been considered the economic engine for a city to create new jobs for its residents and to generate local revenue to support public service.

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

19. Whether it is heavy manufacturing or light industry[1], it can have an adverse effect on

[1] In China, “light industry” generally refers to the industries that produce final products for daily use by consumers while “heavy industry” generally refers to the industries that produce raw materials or machinery as inputs for other industries.

its surroundings. Thus urban planning needs to focus not only on the economy, but also on people, natural resources, the ecological environment, and the whole of the local society (e.g. with respect to inclusiveness).

20. Ziyang has two options: (i) accept polluting/low-end industries that larger cities no longer want; or (ii) attract high-end, green industries. Ziyang Municipality's goal is to promote green development and attract businesses in light industry and service oriented sectors while creating environmentally friendly and attractive living conditions.

Summary

21. The Green Transformation Study is to change the traditional development model to a sustainable development model which is harmonious with nature, efficient use of resources, distinctive cultural features and suitable for entrepreneurship and life. The study of green transformation is to generate an operable approach of the Ziyang Green Transformation; and to increase the planning, implementation and innovation capacity of the ZMG on the Urban Green Transformation process.

22. The performance monitoring system is to develop a systematic methodology and necessary tools to assess, evaluate, and reflect the progress of Ziyang's green transformation; to guide refining and upgrading the urban transformation planning and implementation process; and to create a dynamic, continual urban green transformation monitoring and management mechanism for Ziyang.

23. The combination of performance monitoring and urban planning create a closed loop feedback system of urban planning—management—monitoring that supports green transformation by measuring progress and identifying obstacles. The performance monitoring system will be linked to the intelligent park platform (component 1 of output 1) which can provide data on current conditions (e.g. environment, energy use) and a platform for data storage and reporting.

Sub-Component Rationale and Objectives

Planning

24. Annex 1-4 describes the master planning process in China. There are several factors requiring a change in the usual way Ziyang prepares its Master Plan and associated plans:

(a) In 2014, the PRC Government issued the National New-type Urbanization Plan[2], 2014– 2020. It promotes people-centered urbanization and ***city clusters*** to support development of small- and medium-sized cities. The plan focuses on migrants, urban spatial layout, urban sustainability and integration of urban and rural development, and is a national effort to promote urbanization while addressing critical quality-of-life issues for urban residents. It recognizes sustainability and coordination between urbanization and environmental protection as key aspects of urban development, and states that urbanization in the PRC must adopt a new development approach.

(b) The PRC has marked the Yangtze River Economic Belt (YREB) as one of the key regional growth engines of economic development and has made a strategic decision to set "ecological protection and green development" as the top priority for development along YREB. This necessitates an industrial transformation in the in-land provinces from industries that are heavily resource dependent, low technology

[2] Government of the PRC, State Council. 2014. *National New-type Urbanization Plan, 2014–2020.* Beijing.

based, market irresponsive, and environmentally damaging to industries that are high tech equipped, dynamic and market responsive, yet environmentally friendly.

(c) In the upper reaches of the YREB development focuses on the Chengdu-Chongqing City Cluster which covers an area of 185,000 square kilometers (km^2), has about 40 million urban residents, and encompasses the Chongqing Municipality and 15 cities in Sichuan Province, including Ziyang.[3] Development within this city cluster will follow national and regional guidance, e.g. item (b) above.

(d) China's economy has been transiting from a phase of rapid growth to a stage of high-quality development. Supply-side structural reform and a modernized economy that features better quality, higher efficiency, and more robust drivers of growth are needed to satisfy the people's desire for a better life. So there is an increase of resources towards a more sustainable model of economic growth.[4]

(e) Within Ziyang's urban area the expansion of the SZHTDZ to include both an industrial area and a residential area requires integrated industrialization and urban development which is not now addressed in the city plans.

25. The ADB Loan is intended to not only provide infrastructure and goods, but also to assist Ziyang make this transition in planning from strictly economic development to a more holistic approach that equally considers ecological protection and social inclusiveness with economic development.

Ziyang's Current Master and Associated Plans

26. Table 1 lists several of Ziyang master and associated plans. Details are in Annex 2 of this report. Three relevant plans are discussed below. See Annex 1-5 for more details about these plans.

Table 1: Ziyang Master and Associated Plans

No.	Name of Planning	Effective date	Planning period	Commissioning Agency
1	Ziyang Oral Equipment Industry Development Action Plan			
2	The "13th five-year" environmental protection plan of Ziyang City	2017.05	2016-2020	The People's Government of Ziyang
3	Municipal Solid Waste (according to the Ziyang Urban Master Plan)		2016-2030	The People's Government of Ziyang

[3] State Council. 2016. *Master Plan for Development of Chengdu–Chongqing City Cluster.* Beijing.

[4] PRC President Xi Jinping in his 18 October 2017 opening session speech to the 19th National Congress of the Communist Party of China, http://www.chinadaily.com.cn/china/2017-10/22/content_33555692.htm

No.	Name of Planning	Effective date	Planning period	Commissioning Agency
4	Ziyang Tuojiang River Flood Control Planning		2010-2030	The People's Government of Ziyang
5	Conceptual planning of the whole area water ecosystem of Ziyang city	-	2017-2025	Ziyang Urban and Rural Planning Bureau
6	Municipal water supply planning of Ziyang City		2010-2020	Ziyang Urban and Rural Planning Bureau
7	Ziyang Comprehensive Transportation Planning	2016.12	2016-2030	Ziyang Urban and Rural Planning Bureau
8	Ziyang Urban Rail Transit Network Planning	2016.12	2016-2030	Ziyang Urban and Rural Planning Bureau
9	The urban development plan of Chengdu-Chongqing economic belts	2014.06	2014-2020	Office of the People's Government of Sichuan
10	"13th five-year" development plan for the Chengdu plain economic zone	2016.09	2016-2020	Office of the People's Government of Sichuan
11	Innovation and Development plan of Sichuan Industrial Park	2016.12	2016-2020	Office of the People's Government of Sichuan

27. Ziyang General Master Plan

Compiled by: China Academy of Urban Planning & Design (Beijing)

Commissioned by: The People's Government of Ziyang

Planning period: 2016 - 2030

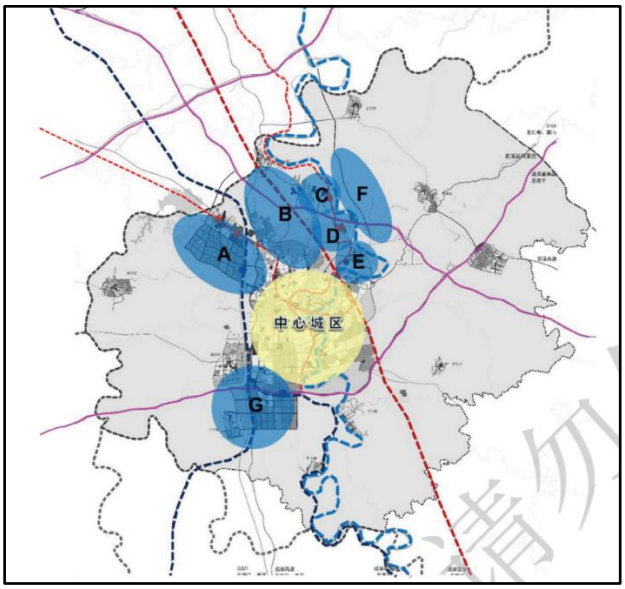
Release date: Unknown (it is approved by the ZMG and submitted to the Sichuan Provincial Government for reviewing)

The Ziyang General Master Plan is designed for the whole area of Ziyang city, and Ziyang High-tech industrial Zone is located in the south-west of Ziyang (marked G in the map). The Ziyang General Master Plan main focus is on the central area of Ziyang (marked in yellow in the map).

The compilation of Master plan starts in 2015. However, there are significant recent changes including transfer out of Jianyang Municipality from Ziyang Municipality

jurisdiction, construction of Chengdu Tianfu Airport, and Construction of Airport Economic Zone near Ziyang. Thus in 2016 and 2017, the Design Institute revised the General Master Plan as per those changes, and submited for approval (still pending at time of this writing). After approval, every five year, there will be a systematic review of the implementation of Master Plan and based on actual conditions and development needs, the general master plan may be adjusted or renewed.

Figure 4: Ziyang Municipality as Shown in the Master Plan



Source: Ziyang General Master Plan

28. Detailed Regulatory Plan for the Ziyang South Central Industrial Development Zone

Compiled by: Planning Bureau of Ziyang

Commissioned by: The People's Government of Ziyang

Period: 2010-2030 Release date: 2012

This regulatory plan is developed by the Ziyang Planning Bureau with the help of Ziyang High-tech Industrial Zone to satisfy the requirement of Ziyang's industrial development.

This detailed regulatory plan is quite out-of-date (complained by the local government staff), since both the city's and the industrial development orientation have changed after 2012. Usually this type of plan is renewed every 20 years unless it cannot satisfy the needs of development.

29. Ziyang Dental Equipment Industry Development Action Plan

The development action for dental equipment industry is released in 2017 for the period from 2017 to 2021. The plan aims to implement the provincial and municipal government decisions to promote industrial development of oral equipment, materials in Ziyang Municipality.

30. Problems in Ziyang's 2016 - 2030 Master Plan include:

a. Less integration between the urban and rural area. In the Master Plan, the

plans for urban area and rural area are described separately, and most likely to be performed separately. There are few integrations between urban and rural areas, including the integrations on transportation system, infrastructure system, industrial layout and etc. The lack of integration may induce the weak communication and mobility between urban and rural area.

b. Limited public participation. The public is more involved during the plan-dissemination stage rather than the plan-making stage. Municipal governments often organize special events to showcase their newest development plans to their local population in order to strengthen the public trust in the success of the project and also in the performance of the city authority. But there is limited consultation during the planning and development stage which can be a risk to local government if there is local resistance due to concerns about health, safety, and the environment.

c. The city orientation: the orientation of Ziyang in national and regional strategic plans is as the national locomotive and automobile manufacturing and export base, green food processing and distribution base, international exhibition, and leisure holiday destination. This orientation does not consider the newly established dental cluster.

d. The Ziyang General Master Plan does not consider the South Central Industrial Development Zone (i.e. the SZHTDZ)

Urban Green Transformation Planning Study

31. The objective of the Urban Green Transformation Planning Study is to address Ziyang's challenges of rapid urbanization with ecological damage by harmonizing urban development and environmental planning in a comprehensive, planned manner. The expected outcome will be to guide ZMG and SZHTDZ to change their traditional planning process and develop a modern, encompassing master plan.

32. The Study will examine and comment on the existing Master Plan and associated plans so that ZMG and SZHTDZ can include these recommendations in the 14th FYP. Including the associated plans helps to assure that the green transformation concepts are included everywhere: water supply, wastewater and drainage, transportation, and energy.

33. Typically these types of associated plans for utility service focus only on infrastructure: population—problem---design and build structures to resolve the problem. Non-structural (green) measures can also be effective, be more harmonious with natural surroundings, and cost less to implement. But there is no incentive to include anything not structural and there may be no knowledge of non-structural interventions by staff of the agency preparing the associated plan. The Study includes workshops and capacity building training that might overcome this knowledge gap and can present examples of how green transformation interventions can be included.

Performance Monitoring

34. The objective of the Performance Monitoring (PM) System is to assist Ziyang measure its progress in preparing and implementing Green Transformation programs and projects, especially those identified in its Master Plan.

35. ZMG already has some existing targets and performance indicators to illustrate the achievement of ZMG for environmental improvement and creating favorable living conditions. For example:

a. Indicators from the “13th Five-Year Environmental Protection Plan”, including the target values in 2020 for indicators on water quality, air quality, air pollutant emission, soil environmental quality, etc.

b. Indicators on creating a “Beautiful, Prosperous, and Liveable Ziyang Plan”, including the target values in 2020 for indicators on green landscaping coverage, waste water treatment, solid waste treatment, air quality, culture scenic zone development, public library maintained.

Table 2: Indicators in the Beautiful, Prosperous, and Liveable Ziyang Plan

Indicator	Target value in 2020
公共交通分担率 Public transportation sharing rate	25%
至成都最快交通时间 The fastest time to Chengdu	30 min
至重庆最快交通时间 The fastest time to Chongqing	90 min
公共供水普及率 Public water supply penetration ratio	90%
地下管网覆盖率 Underground pipe network coverage ratio	95%
家庭宽带接入能力 Home broadband network access	50 M/s
乡村公路覆盖率 Rural road coverage ratio	100%
乡村燃气化比例 Rural gasification ratio	90%
旅游产业占 GDP比重 The proportion of tourism industry in GDP	15%
实际利用外资 Actual usage of foreign capital	300 million us dollar
全国知名品牌数量 The number of famous brands from Ziyang in the country	50
棚户区改造率 Shantytown renovation rate	80%
重大区域建设设施 Major regional construction facilities	100
城市15分钟社区生活圈覆盖率 Urban 15-minute community life circle coverage ratio	80%
城市人均教育设施用地 City per capita educational facilities land	3.5 m2 / person
城市人均医疗床位数 City per capita medical beds	6.5
社区综合服务设施覆盖率 Community comprehensive service facility coverage ratio	100%
森林覆盖率 Forest cover ratio	45%
森林蓄积量 Forest volume	16000 thousand m3

Indicator	Target value in 2020
空气质量优良数 No. of good air quality days	330
水质 3 类以上比例 Water quality grade 3 or above	75%
城镇污水集中处理率 Urban sewage centralized treatment rate	90%
城镇垃圾无害化处理率 The harmless treatment rate of urban garbage	100%
噪声达标区覆盖率 Noise coverage area coverage ratio	80%
农村土壤环境达标率 Soil environment compliance rate in rural area	80%
建成区绿化率 Built-up area greening rate	40%
人均公园绿地面积 Per capita park green area	11 m2
文化遗产保存完好率 Cultural heritage preservation rate	85%
纳入非物质文化遗产名录数量 Including Intangible Cultural Heritage List	30
大型文化主题园数量 Large-scale cultural theme park	50
传统节日主题活动数 Number of traditional festival theme events	30
文化支出占公共财政预算比 Cultural expenditure as a percentage of public budget	3%
博物馆数量 Number of museums per million people	10
文化馆数量 Number of cultural centers per million people	100
公共图书馆数量 Public library number per million people	5
公共体育场馆数量 Number of public stadiums per million people	70
公共文化设施免费开放率 Free open rate of public cultural facilities	90

c. Indicators for the “Construction Plan of Sponge City”, including target values in 2020 and 2030 for indicators on water ecology, water resources, water environment, water safety, water recovery.(as a % of rainfall).

Table 3: Indicators for Construction of Sponge City Interventions

Category	Indicator	Target value in 2020
水生态 Water ecology	年径流总量控制率	75%
	Annual runoff total control rate	
	海绵城市达标面积比例	20%
	Sponge city standard achieved area rate	
	水系生态岸线比例	70%
	Water ecological coastline ratio	
	建成区绿地率	30%
	Built-up area green area rate	
	城市热岛效应	缓解
	Urban heat island effect	Effect eased
水环境 Water Environment	水环境质量	优于 IV 类
	Water environment quality	Better than IV water quality
	水源污染控制	50%
	Water pollution control rate	
	城市污水处理率	50%
	Urban sewage treatment rate	
	雨污分流率	65%
	Rainfall separation rate	
水资源 Water resources	污水再利用率	20%
	Sewage reuse rate	
	雨水资源利用率	1%
	Rainwater utilization rate	
	管网流量控制	15%
	Pipe network flow control rate	
水安全 Water safety	饮用水水源水质达标率	100%
	Drinking water resource quality compliance rate	
	龙头水质达标率	100%
	Faucet water quality compliance rate	
Other Design Elements	防洪堤达标率	100%
	Flood control embankment compliance rate	
	雨水管渠设计标准	2-5年重现期
	Rainwater pipe design standards	Return period 2 – 5 years
	规划建设管控制度	出台
	Planning and construction control system established	published
	技术规范与标准建设	出台
	Technical specifications and standards established	published
Other	投融资机制建立	出台

Indicators	Investment and financing mechanism establishment	published
	绩效考核和奖励机制	出台
	Performance assessment and reward mechanism establishment	published
	连篇示范效应	60% of sponge city built-up area satisfy the standards
	Contiguous Demonstration effect	

36. Although there are various targets/indicators included in the Ziyang plans to illustrate the achievements for a specific project, there is no effective, systematic, and comprehensive performance monitoring system existing to guide the progress of urban green transformation. Those existing indicator systems are developed for specific projects only and for specific municipal departments, and lack detail of precise methodology for data collection, reporting and application of indicators.

37. There are several domestic and international indicator systems developed to evaluate achievement of the green transformation. For example, international green transformation indicators systems were introduced in the UNEP Green Economy Indicators Guideline[5]. China's Green Development Index Report [6], the 12th FYP Urban Environmental Comprehensive Quantitative Assessment Index[7], and China's Low-Carbon City Evaluation Indicator System [8] provide only baseline and target values; no detailed approaches to implementation. Also, these are single subject systems; there is not yet a comprehensive performance monitoring system.

38. To close the gap between Ziyang's current performance indicators and other national and international systems, there is a need to develop indicators relevant to Ziyang and its green transformation process. Indicators shall be selected, eliminated, and optimized through an appropriate process to make sure all are specifically designed for and useful to Ziyang Municipality. A performance monitoring system to collect, calculate, evaluate, and report indicator results shall be developed.

Design Requirements and Considerations

39. Both components will be done by consulting firms so Terms of Reference (TOR) were prepared. These are in the Ziyang Project Administration Manual (PAM), available as a Linked Document to the Report and Recommendations of the President (RRP). Some details are in the annexes of this report.

40. The first consideration was one TOR or two, i.e. should one contract for both components be awarded? Advantages of one vs. two TOR are summarized in Table 4.

Table 4: Number of TOR for PM and Urban Study Components

Number of TOR	Advantages
One TOR	Improve the working efficiency of consultant and improve the communication efficiency between consultant and ZMG.

[5] United Nations Environment Programme (UNEP), "Green Economy: A Guidance Manual for Green Economy Indicators", 2014. http://www.un-page.org/files/public/content-page/unep_indicators_ge_for_web.pdf
[6] 2014. China Green Development Index Report 2012, Editors: Li, Xiaoxi and Pan Jiancheng, Springer.
[7] 2011. PRC Ministry of Environmental Protection (MEP),
[8] 2015. Reconstruction of China's Low-Carbon City Evaluation Indicator System: A Methodological Guide for Applications, by Jiahua Pan; Guiyang Zhuang; Shouxian Zhu; Ying Zhang, World Scientific, USA.

Number of TOR	Advantages
	Reduce the working load on PMO of procurement and management. Avoid conflicts between these two subjects since they depend on each other. Increase the work efficiency on solving problems encountered during the green transformation process.
Two TOR	Not knowing how to measure could result in important aspects of the study being omitted. Two different consulting firms can stimulate each other to develop solutions. Separate PM TOR enables stronger focus on making linkages with the Industrial Park SMART system
Conclusion	ADB prefers two TOR

41. The second consideration was timing of the TORs: simultaneous or sequential.

Table 5: Sequence of Awarding TOR for PM and Urban Study Components

Sequence	Advantages
Simultaneous	Developing Performance Indicators at the same time as the Urban Green Transformation Study assures that each aspect of the plan can be measured in terms of progress and accomplishment. Links all three components of Output 1 at the same time.
Sequential	PM indicators can inform the Urban Green Transformation Study of aspects on which to focus. OR, the Study can direct the PM as to what planning aspects should have indicators.
Conclusion	Sequential with the PM TOR issued first and the Urban Study TOR to start about one quarter later. It is planned to tender both in early 2019 and complete in year 2020 in order to provide input to Ziyang's 14th FYP, i.e. year 2021

<u>Performance Monitoring TOR</u>

42. The objective of the TOR is to help the ZMG to develop a performance monitoring system that includes a systematic methodology and tools to assess, evaluate, and reflect the progress of Ziyang green transformation; to guide refining and upgrading the urban transformation planning and implementation process; and to create a dynamic, continual urban green transformation monitoring and management mechanism for Ziyang.

43. The proposed performance monitoring system shall be created based on the existing indicators Ziyang city already has; the local characteristics or practice in Ziyang; the national or international indicators system; and coordination with other components of the ADB loan project.

44. The Performance Monitoring TOR includes requirements to:

a. Review Ziyang's current systems on monitoring and reporting performance indicators; and compare it to other systems in China.

b. Establish a Stakeholder Group for the planning and implementation of performance monitoring.

c. Start with a long list of performance including national and international indicators on green transformation; discuss, consolidate, and eliminate to prepare a short list

d. Set up the performance monitoring system to collect, analyze, evaluate, and report indicators including a feedback system of monitor—modify--monitor. Revise the system as needed to support results of the Urban Green Transformation Study.

e. Provide capacity development to planning staff of ZMG and SZHTDZ and assist relevant departments to understand the need and importance of performance monitoring system; and on the operation and updating of performance monitoring system.

f. Provide data to the Urban Green Transformation Study about Ziyang's current condition.

45. Although it comes before the ADB funded Intelligent Park Platform (Output 1, component 1), preparations will be made for the PM system to be connected. For example, collection of environmental data from the Smart Environment module; and use of the Cloud Software Park in the Smart Economy module to distribute PM reports.

Urban Green Transformation Planning Study TOR

46. The Study will close the gap between the current planning model with its focus on economic development to a new model that gives equal consideration to economy, environment, and social concerns.

47. The consultants shall carry out a comprehensive study on the Ziyang Municipality background and its current urban planning system; conduct an assessment of the current plans with respect to incorporating green transformation; assess institutional capacity; develop planning feedback system; increase the capacity of the Ziyang Planning Bureau and the Planning Design Institute, and other relevant municipal and Development Zone bureaus and agencies.

48. The Urban Green Transformation Planning TOR includes requirements to:

a. Research national and international studies and plans relevant to urban green transformation and prepare an outline of the study

b. Establish a Stakeholder Group, perhaps same as the one for PM, to review and comment on the study outline.

c. Draft the study with periodic input from stakeholder interview and discussions.

d. Develop a closed loop feedback system of planning, monitoring, and evaluating that could be used to track progress of green transformation progress.

e. Strengthen the capacity of the Planning Bureau and the Urban Planning and Design Institute to include considerations of green transformation in their planning process.

f. Conduct assessments about services used (e.g. water, wastewater, solid waste disposal, energy), wastes generated and their disposal or reuse; and evaluate

possible applications of industrial waste reuse (i.e. circular economy[9]).

49. There will also be development of methods to enhance the connectivity of green transformation planning and the management system for SZHTDZ Intelligent Park Platform (SMART Systems) as well as support ZMG to enhance its capacity in digital city and information system development.

Project Benefits and Outcomes

50. The benefit of these two components is an improved urban development planning system that includes a system to measure and monitor progress. That is useful because the current method of evaluating master plans is to compare what was forecast and planned five years before. That is too long period to wait to understand the effectiveness of the plan; a system is needed to more quickly identify changing circumstances.

Climate Change Aspects

51. Climate change is expected to see more severe storms and higher rainfall, as well as periods of drought. It is already considered for the ADB funded infrastructure, for example flood control embankment height and stormwater collection and storage through Sponge City interventions. But in addition, expected climate change needs to be a fundamental principle within the master plan and related documents.

Innovative Aspects

52. Linking a performance monitoring system to urban planning that goes beyond physical data of population and density; that provides useful input for planners to monitor progress and modify their plans as needed. Also, making use of existing or planned computerized management systems (e.g. the SMART Management System for SZHTDZ Intelligent Park Platform) and not developing a separate, stand-alone system.

[9] A circular economy is a restorative system in which resource inputs and waste, emission, and energy leakage are minimized through long-lasting design, maintenance, reuse, remanufacturing, refurbishing, and recycling. The circular economy aims to eradicate waste. McKinsey & Company for the Ellen MacArthur Foundation. 2013. “Towards the Circular Economy”, vol. 1 and 2.

2 OUTPUT 2: ECONOMIC SECTOR OPPORTUNITIES BROADENED

2.1 Introduction

53. Output 2 is to enhance government services for diversified economic opportunities. This is to support Ziyang's green transformation to manufacturing and production that is high-technology (and hence higher economic value) but at the same time is less harmful to the environment.

54. There is competition among cities for businesses that are high-technology and environmentally benign. A city must offer something special to make it attractive. One attraction is other companies in the same sector, i.e. "*industrial agglomeration*", where several different companies operating in the same sector are located in close proximity because of services provided, access to materials, and customer contacts; and enabling the cross-fertilization of research and development topics.

55. Output 2 has three components:

(i) Research and Development (R&D) incubator for the dental sector;

(ii) Testing and inspection facilities for the dental sector; and

(iii) Technical and Vocational Education and Training (TVET) Center.

56. The Sichuan Provincial Government has designated SZHTDZ to include a site for the Ziyang Huaxi Dentistry Industrial Park. At present, 23 international and national companies have moved in the Dental Park. These companies manufacture equipment and materials for use by dentists, including diagnostic devices, tools for working on teeth, braces, implants, brackets, etc. This is the start of a dental "*industrial agglomeration*".

57. The development plan is characterized as "One Base, Five Centers" with One Base' being the production base of dental equipment materials industry. The Five Centers are (1) the Research & Development (R&D) entrepreneurial innovation center of dental equipment materials industry, (2) dental integrated vocational training center, (3) national inspection and testing center of dental equipment materials, (4) national dental health big data center, and (5) dental equipment material trading logistics center.

58. The ADB Loan is to provide equipment to Center #1, R&D, and Center #3 the inspection and testing of dental equipment, materials, and products. The loan will fund Technical Assistance and Capacity Building specific for the two dental sector centers: (1) prepare technical specifications for equipment procurement (see Annex 2-3); (2) assist start up (see Annex 2-4); and (3) develop a computerized asset management system with maintenance management and warranty management modules (see Annex 2-5).

59. The dental R&D incubation center will establish the public laboratory and research and development center with supporting platforms of technical, information, management and administration, etc. This benefits small companies and start-up companies, both likely to have insufficient budget for product development, and makes the Ziyang Huaxi Dentistry Industrial Park more attractive than other locations in China.

60. The establishment of Ziyang Dental inspection and Testing Center will provide services for the product registration, inspection and certification and other services to help new products enter production as well as into the dental market. Existing centers are either too distant (e.g. Beijing, Guangzhou) or have low capacity (e.g. Chengdu).

61. Component 3, the TVET Center, can educate people to qualify for work in the Industrial Park, provide continuing educational training for those already employed by companies in the park, and train in new programs, for example leisure sports activities (e.g. manage, support) and aviation services. The TVET Center will provide specialized training

to develop professional skills related to employment by the industries operating within the park. Also, it will offer teacher continuing education training and pre-schooling for children aged 3 to 6 years to provide for the needs of industrial workers' children; and also serve as the training center in Sichuan Province for pre-school teacher training education. The TVET Center is planned to serve 4,000 full time students and 2,000 part-time.

2.2 Research and Development (R&D) Incubator for Dental Sector

Summary

62. The R&D Incubator is at the core of a multi-channel strategy to enable entrepreneurs to shepherd their ideas from mind-to-market by providing whole value-chain services. More specifically, it will foster business development by providing facilities and equipment to selected clients ranging from university labs to businesses at any stage of development to lower the risk and cost of innovative entrepreneurship.

63. The services provided by the incubation center will reduce the R&D cost for new start-up companies, especially in the preliminary development phase. The planned R&D incubation center will not only provide the advanced testing and research facilities, it will also provide dental companies with access for other available supporting facilities and services in the SZHTDZ, such as Tianfu Cloud Innovation Center. In addition to the R & D facilities, the center will also establish a group of experienced dental industrial experts who can serve as mentors and provide guidance to the new enterprises and researchers to transfer their inventions and new products into production for the domestic and international markets.

Sub-Component Rationale and Objectives

64. As a high-technology, capital intensive industry, entrants to the dental sector incur large sunk costs, in addition to administration and regulation-related barriers. Moreover, development of a modern dental sector entails substantial investment for research and development (R&D), product development, and human resources.

65. 80% of high-end dental products in China rely on imports making them affordable only to high income families. This means that a large portion of domestic demand for quality dental devices remains unmet. The PRC thus needs to foster a modern dental industry to meet the immense and fast growing demand for affordable quality dental care.

66. According to Chinese Stomatological Association[10] analysis, the domestic market demand for dental equipment will reach to CNY 39.52 billion in 2020 with a Compound Annual Growth Rate (CAGR) of about 16.65% which is in consistent with average annual growth rate in last four years.

67. The USA National Business Incubation Association defines business incubators as a catalyst tool for regional or national economic development and categorizes incubators by the following five types: academic institutions; non-profit development corporations; for-profit property development ventures; venture capital firms, and combinations of the above. Business incubators focus on startup and early-stage companies.

68. The R&D Incubator for the dental sector in SZHTDZ will provide free or low-price laboratory services, production plants, and equipment, to help the new enterprises or inventors to transfer their inventions and products into production or into the market. The

[10] Stomatology is the branch of medicine concerned with the diagnosis and treatment of diseases of the mouth, i.e. dental related.

objective of establishing the incubation center is to speed up the processing time of the products and technologies transformation and to lower barrier costs in order to meet the fast-growing demands in China for dental products and services.

69. China estimates that science and technology's contribution rate to country's economic growth is currently 57.5%[11]. The R&D Incubation Center can help to commercialize research achievements, i.e. develop potentially profitable ideas into new or improved products.

70. The R&D Center is line with (a) the PRC 863 (计划) or State High-Tech Development Plan (国家高技术研究发展计划) intended to stimulate the development of advanced technologies in a wide range of fields for the purpose of rendering China independent of financial obligations for foreign technologies; and (b) the PRC 973 Program (计划), also known as National Basic Research Program, to achieve technology and strategic edge in various scientific fields.

71. The main objectives of establishing the incubation center include: i) establishment of a public R&D incubation center to provide technical support and assist to the transformation of new patent or technologies into production and serve the market; ii) attracting and introducing expertise and talented researchers to the dental cluster by providing R&D facilities in the incubation center; iii) carry out major research projects by utilizing the resources and facilities in the center; iv) Develop the center to become a dental technology and academic research exchange center through the establishment and development of the various technology and information platforms; and v) help on the regional dental industrial and economic development.

Design Requirements and Considerations

See Annex 2-1 for Technical Analysis of the Dental Sector R&D Incubation Center

Public Testing Laboratories

72. The public testing R&D laboratories are one of the key components in the incubation center. The public labs will be established to meet the needs of dental equipment and material production and scientific research, integrate the research, quality inspection and standardization work, provide technical support, conduct relevant application research and performance evaluation, and develop the patent or proprietary technology for the dental sector. The main task of public labs is to assist in patent and technology transformation, developed by universities or research institutes, solve key technical problems in industrialization process, trial large-scale and commercial production, and to develop and improve the product development standards and process procedures. Five public testing labs are planned:

(i) New Types of Dental Restoration Materials Laboratory - The laboratory is equipped with advanced equipment from both abroad and domestic to provide hardware and technical supports for the development of new dental restoration materials such as dental use metal, dental composite resins, ceramics, nanomaterials, etc.

(ii) Dental Orthodontic Product Research and Development Laboratory – to provide support for the development of orthodontic attachments, brackets, adhesives, arch wires, etc.

[11] China Daily, "More investment in R&D required to create new drivers for growth", 7 March 2018.

(iii) Dental Instruments Research Laboratory – to providing support for research and development of material, instrument and tools for the implantable devices, surgical instruments, pliers, dental instruments, auxiliary products, etc.

(iv) Dental Equipment Research Laboratory – to provide the equipment, materials, technology and support for the development of small, medium and large equipment.

(v) New Medical Consumables Research Laboratory – to provide materials, equipment, technology, and support for the research and development of protection materials, disposable products, X-ray materials, drainage materials, sanitary materials, and auxiliary consumables.

Table 6: R&D Incubation Center Construction Plan

Construction Content	**Tender Period**	**Construction Period**	**Staged Construction Plan**	
Public Laboratories	2019.1.1-2019.3.31	2019.10.1-2021.3.31	2019.10.1-2020.6.30	New Types of Dental Restoration Materials Laboratory
				Dental Orthodontic Product Research and Development Laboratory
				Dental Instruments Research Laboratory
			2020.7.1-2021.3.31	New Medical Consumables Research Laboratory
				Dental Equipment Research Laboratory
Dental Sector Research & Development Incubation Service Platform	2019.1.1-2019.3.31	2019.10.1-2020.6.30	2019.10.1-2020.1.31	Technical Support sub-Platform
				Expertise (Human Services) sub-platform
				Product Transformation sub-platform
			2020.2.1-2020.6.30	Investment and Financing sub-platform
				Industrial Planning sub-platform
				Technical Support Service sub-platform
				Dental Protection Service sub-platform
Dental Digital Engineering Technology Platform	2019.1.1-2019.3.31	2019.10.1-2020.6.30		

Source: FSR, 3 April 2018

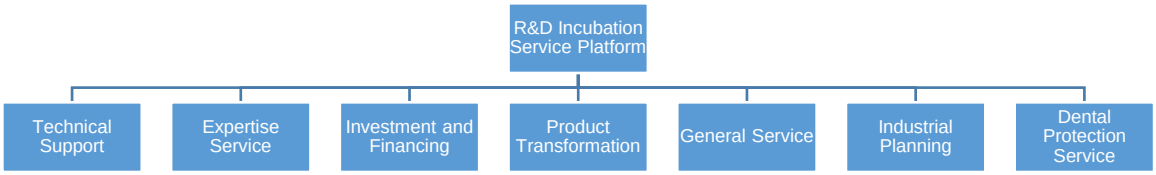
73. The ADB Loan will be used for equipment purchase and installation used by the R&D laboratories. Counterpart funding will pay for Infrastructure (the total floor area of this project is approximately 30,000 m^2). The site is within the Dental Cluster so no land acquisition is required. The Annex to this report provides more details including an equipment list.

74. The Laboratories in the incubation center will be managed by LIMS (Laboratory Information Management System), which consists of the computer hardware and application software. The system will use the advanced computer network technology, database technology and standardized laboratory management process to form a comprehensive and standardized management system and perform the tasks such as data analysis, online scheduling, automatic analysis and data collection, rapid distribution, information sharing, etc. The system will also provide technical support for the implementation of quality assurance system, control of costs, quantitative assessment of personnel, overall laboratory management, etc. The system has an information sharing platform linking laboratories, production plants, quality control departments, customers, etc.

Service Platforms

75. In addition to the laboratories, a service platform shall be established to provide technical support, expertise service, investment and financing services, research transformation, general service, industrial production planning, and dental protection.

Figure 5: Dental R&D Platform Structure



Source: Feasibility Study Report by the IT Electronics Eleventh Design & Research Institute Scientific and Technological Engineering Corporation Limited, Chengdu, March 2018.

Technical Support Platform: will cooperate with different key scientific research institutes, universities, production bases and leading enterprises in dental sector to provide technical support service to meet the development needs of the new enterprises in the incubation center. The platform will establish an external technology resource integration system to support the new product developers, which will reduce enterprise R&D cost as well as the risk and improve the R&D capacity of the new dental companies by sharing software and hardware, large-scale equipment, technical advises scientific and technological data information, etc. It will establish service and resource sharing system aiming to promote technology sharing. A membership management system will be established for the accumulation of innovative resources, the establishment of profiles for outstanding projects as well as the group of experts.

Expertise Service Platform: will assemble an expert group in the dental research, develop and production sector. Initially five positions are planned:

1. Dental health-care specialist
2. Dental repair material specialist
3. Dental equipment specialist
4. Dental implant specialist
5. New medical consumables research specialist

The platform will include the dental researcher and expert database system and the online service system. Focusing on the needs of customers, the researcher service sub-platform will create a database system to collect, sort, and classify the new research resources in the dental development sector, and provide the customers with information of dental medical specialist and researcher information to meet the customer requirement. The platform creates the personalized personnel and company services with the focus on the individual job search as well as the company recruiting needs to process the effective sorting and searching. The platform will enable to setup a dedicated headhunting service for specific researcher, establish a researcher database for dental professionals, publish enterprise recruitment notices, to help the sponsors to locate potential projects for incubation. Meanwhile, the platform will also be able to establish a professional expert database for dental professionals with the member registration system to collect dental expert information. The platform will have the functions for expert service management, individual user administration, enterprise user administration, headhunter administration, advertisement administration, etc.

Investment and Financing Service Platform: will integrate the services and information from relevant government agencies, bank and financial service organizations as well as other financing agencies. Through information collection and processing, the platform will provide investment and financing services such as investment consultation, financing guarantee, venture capital investment, and other financial services. The platform can provide investment and financing-related training services, conduct online consulting services on policies and technical issues involved in corporate financing, and regularly organize training on implementation financing, etc. The system will provide a communication platform between the financial institutions and small and medium-sized enterprises for financial services, build the online financial supermarkets, conduct financial analysis, and other investment and financing services.

Product Transformation Platform: The platform provides the dental companies the service of product transformation and production service. It will start with the technology sharing, followed by product development, and product production to complete the transformation process. The platform could publish the information on product development, provide professional services related to product transformation such as identifying the scientific and technological aspect of the product, conducting evaluation on the product, transferring the technology property rights, and other required services.

General Service Platform: The sub-platform provides the dental companies with comprehensive services such as human resources management, investment and financing, legal, park service, water delivery, e-commerce, real estate, intellectual property, etc. The system will provide and update new information about implemented policy, dental company advertisements, policy notification, etc. as well as the information of intellectual properties. The enterprises in the park can fill in information and make reservations for information to be online. The platform will have an information exchange interface for government service to publish government service notices and information exchange or share for government information. Overall the platform will provide enterprises with one-stop services such as industry and commerce, taxation, national tax, land tax, etc. The platform provides third-party services, and the third-party service companies can provide services through the certification in the system, and the park enterprises can evaluate the third-party service agencies and make the selection.

Industrial Planning Platform: The main function of industrial planning platform is through the integration of the macro and micro elements of the dental industry to analyze dental

resource, including the major data from dental medical raw material, devices, industry-related data, dental clinics, dental hospitals, dental related technologies, and dental medication, to provide recommendations on the dental industrial planning. The platform will integrate the intellectual resources of the dental medical industry enterprises, research institutes and other sources to establish a dental medical industry planning expert pool, and engage professional researchers to establish a dental industry consultation service system with the medical industry big data analysis system. A large professional expert database in dental health care industry will be established with the experts from government, universities, and business to provide advice for strategic development of enterprises, development planning for the dental enterprise.

Dental Protection Service Platform: The dental protection service platform will establish a system to publish dental care notification, dental industry development trends, oral health protection information, and other dental information about hospital, university and dental medical industry. The service platform will establish a dental protection professional service team and set up a dental consultation service platform to provide the customers with the consultation services in terms of dental protection, dental protection technology, dental protection material and equipment as well as management and utilization. The platform will build a one-stop oral protection service platform integrating with dental protection knowledge, information consultation, health communication, and online expert services to boost the development of dental health care industry.

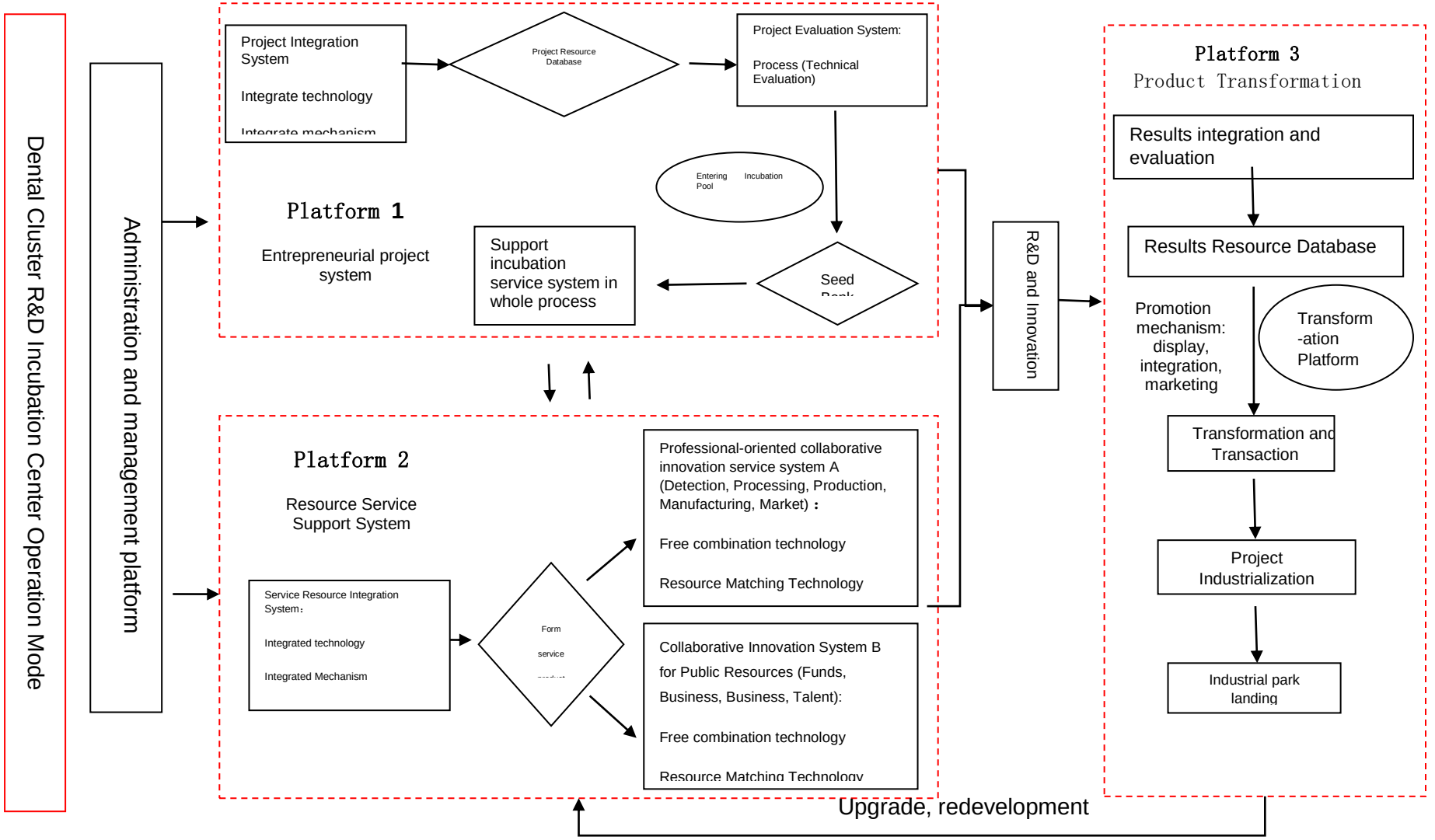
Equipment Selection Strategy

76. The purchase of equipment is for the setup of the R&D labs which are part of the development of the service platforms, specifically (a) technical support and (b) product transformation. The selection of the equipment shall be in accordance with PRC government regulation requirements and ADB procurement guidelines.

77. The establishment of the dental inspection and testing center, also a part of the proposed project and described in the next section of this report, will also have dental inspection and testing equipment. So it is reasonable to ask about sharing equipment. However the equipment uses by the two centers are different. The Inspection and Testing Center is for assuring compliance of existing products with PRC standards. The incubation center is for innovation or improvement of existing products and focuses more on clinical applications.

78. After much discussion about avoiding equipment duplication and sharing the Design Institute decided that all major Inspection and Testing Center equipment duplicated with the incubator has been deleted, except for every-day and inexpensive items (e.g. glassware, hand tools) common to laboratories.

79. The general operation and processing of the incubation center is illustrated in the following diagram.


Dental Cluster R&D Incubation Center Operation Mode
Administration and management platform
Project Integration System
Integrate technology
Project Resource Database
Project Evaluation System:
Process (Technical Evaluation)
Entering Pool
Incubation
Platform 1
Entrepreneurial project system
Support incubation service system in whole process
Seed
Platform 2
Resource Service Support System
Service Resource Integration System:
Integrated technology
Integrated Mechanism
Form
service
Professional-oriented collaborative innovation service system A (Detection, Processing, Production, Manufacturing, Market):
Free combination technology
Resource Matching Technology
Collaborative Innovation System B for Public Resources (Funds, Business, Business, Talent):
Free combination technology
R&D and Innovation
Platform 3
Product Transformation
Results integration and evaluation
Results Resource Database
Promotion mechanism: display, integration, marketing
Transform -ation Platform
Transformation and Transaction
Project Industrialization
Industrial park landing
Upgrade, redevelopment

Application and Acceptance Procedures[12]

(i) Criteria for enterprises to apply to the Incubation Center

1. The scope of business is in line with the orientation and development direction of oral medical industry;
2. the enterprises is small or medium-sized with a certain degree of achievement transformation potential, has a good team, and has a good prospect for development;
3. the company is legally established and without any bad credit or illegal records; however the Incubation Center will accept a company that has not yet been incorporated if it has an adequate business plan and a clear business model;
4. Knowledge property rights are defined clearly and there is no dispute.

(ii) The incubation enterprise approval procedure

1. Customers complete an application that includes the technical level of the enterprise, development, market prospects, future planning, roster of team members and their qualifications, copy of business license, financial monthly report, development plan, internal management system (include finance, personnel, marketing, safety, etc.) and other information.
2. Experts evaluate the enterprise
    (i) Development prospects, project market trends, sustainability, recent development plans and long-term development planning, business strategy, and operating expenses.
    (ii) Financial Situation The financial structure, operating results and cash flow of the project and the financing capacity for sustainable development.
    (iii) Team Status Project management team, technical development team status and development trends, the project has a strong market development capacity and team awareness.
    (iv) System Building whether the underlying management systems within the project are sound and effectively implemented
    (v) Social considerations: employment of university students, female employees, and other categories of personnel in the project.

(iii) Enterprise acceptance

After evaluation, the authorized enterprise or project team and the Incubation Center sign an agreement, and the enterprise or project team settles into the incubation center to start the formal operation.

[12] FSR for the Dental Sector R&D Incubation Center, 3 April 2018

Additional Considerations for Design and Implementation

80. Highly qualified managers and technical staff are needed to successfully operate the R&D Incubation Center. The Center will rely on national, provincial, and municipal level policies for recruitment. For example The PRC Recruitment Program for Innovative Talents (Long Term) targets people under 55 years of age who are willing to work in China on a full-time basis, with full professorships or the equivalent in prestigious foreign universities and R&D institutes, or with senior titles from well-known international companies or financial institutions.[13]

81. Special expertise is needed to equip, start-up, and maintain the R&D Center and the Inspection and Testing Center discussed in the next section of this report. The ADB loan provides funding for technical assistance. Terms of Reference are in annexes to this report.

(a) Prepare technical specifications for equipment procurement

(b) Start-up and publicizing the facilities

(c) Set up an asset management system that includes a maintenance capability and tracking equipment warranty

Alternatives Considered

82. Not establishing a dental R&D Center is likely to result in fewer companies committing to the Ziyang Dental Cluster.

83. Charging for services. The facilities and equipment are public. No fees charged except enterprises to pay a certain fee for usage of expensive, high-precision equipment for special operations especially where the equipment may be damaged.

Project Benefits and Outcomes

84. The incubation center is expected to build up an expert and professional expertise team for product evaluation (e.g. proof of concept), product transformation, investment and financing services, human resource services, and marketing. It is intended to provide one-stop full service for dental product research and development. Establishing the R&D Center will stimulate development of the Dental Cluster and provide a service lacking in China's other two dental clusters: : the Yangtze River Delta (Suzhou High-tech Industrial Park; Changzhou High-tech Park) and the Pearl River Delta (Shenzhen and Foshan Shishan).

Innovative Aspects

85. Establishing a Research and Development Center, including an incubation function, exclusively for the dental sector and establishing cooperative agreements with nearby Stomatology schools and hospitals.

[13] http://www.1000plan.org/en/

2.3 Dental Equipment Material Inspection and Testing Center

Summary

86. The establishment of the Ziyang Dental inspection and Testing Center helps develop the Dental Cluster by providing services to companies for product registration, inspection and certification and other requirements to help new products enter into production as well as the domestic dental market. It is one of the five centers in the Ziyang "One Base, Five Centers" concept for the Dental Cluster.

87. Currently, there are 53 medical device inspection and testing centers in China, and most of them are located in Beijing, Shanghai, and Guangzhou. In Sichuan Province, the Sichuan Medical Equipment Testing Center is responsible for the testing and certification of medical equipment and products including those in the dental sector. However, it does not have enough capacity and lacks certain equipment. The establishment of the new inspection and testing center in Ziyang will supplement the capacity of the existing inspection center.

Sub-Component Rationale and Objectives

88. In the PRC, testing and inspecting institutions for the medical industry are independent legal bodies that are authorized by the China Food & Drug Administration (CFDA) in accordance with the Regulations for Supervision and Administration of Medical Devices and Qualification Determination for Medical Device Inspection. The testing and inspection institutions serve as technical agencies to assess whether the product technical requirement comply with the PRC's national and industrial standards as part of the registration process of a product before commercialization.

89. Dental and other medical equipment, devices, and materials need to go through strict and complex registration processes based on their categorization, before they are licensed for sale. The procedure can be more complicated and time-consuming when it comes to foreign manufacturers.

90. Currently, there are 53 medical device inspection and testing centers in China, and most of them are located in Beijing, Shanghai, and Guangzhou. In Sichuan Province, the Sichuan Food and Drug Inspection and Testing Institute is responsible for food and drug testing and certification, whereas, the Sichuan medical equipment testing center is responsible for the testing and certification of medical equipment and products including those in the dental sector. However, the existing inspection and testing center does not have enough capacity and lacks certain specialized equipment, thus requiring manufacturers to send their products to other locations for testing.

91. The Ziyang dental equipment and material testing center will acquire independent testing certificates and it is expected to be the second provincial testing center within Sichuan Province. It will undertake the quality supervision, random inspection, production registration inspection, operation and the use of dental equipment material inspection, commissioned inspections, as well as to develop the inspection methods, quality standards, and scientific research related to safety standards. It will have equipment and capacity currently lacking in the existing Province Inspection and Testing Center.

Demand Analysis

92. For SZHTDZ, the development of dental cluster has been in progress for several years. By March 2018, there are 37 dental enterprises have established operations in dental cluster. Among them, 27 of them have signed formal contracts, 6 are in contract negotiations, and the remaining are in detailed discussions and negotiations.

93. The PRC classifies dental equipment and materials into stomatological surgical instruments, oral (mouth) medical devices and appliances, and dental medicine materials. Each type of instrument, device, appliance, and material is assigned category in the PRC standards and this determines the type of inspection and testing required. Details are shown in Table 7, Table 8, and Table 9.

94. The types of items to be inspected and tested and the PRC requirements guided the selection of equipment for the Inspection and Testing Center.

Table 7: Stomatological Surgical Instruments

No.	Type	Examples	PRC Category
1	Mouth knife, chisel	Gum knife, watergate knife, sticky powder adjustment knife, silver mercury carving knife, dental bone chisel, cutting teeth bone chisel, tooth glaze chisel	I
2	Oral scissors	Gingival shears, full crown shears	I
3	Oral pliers	Tooth wrench, cutting pliers, alveolar claw clamp, tongue clamp, extended clamp	I
4	Tweezers and clamps for oral use	Residual root tweezers, tooth tweezers, long tweezers, forming clip	I
5	Mouth hooks, needles	Tooth probe, abscess probe, periodontal bag probe	I
6	Other instruments for oral use	The tooth is very, the Ding shape tooth is quite, the root is sharp, the tooth file, the tooth bone Hammer, the tooth scraping spoon, the root canal filling device, the tooth periosteum separator,	I
		Gum separator, cleaning device, scraper, pick-digging device, polishing device, sticky powder filling device, silver amalgam filler, go crown,	
		Mouth mirror, extraction needle handle, water gun head, hot gas gun head, blowing pipe, occlusal device, Impression tray, mercury alloy conveyor, molar belt ring position, ligation rod, belt ring fader, bow wire shaper, measurer	

Table 8: Oral medical equipment and apparatus

No.	Type	Examples	PRC Category
1	Oral Integrated Therapy Equipment	Comprehensive treatment Table (machine)	II

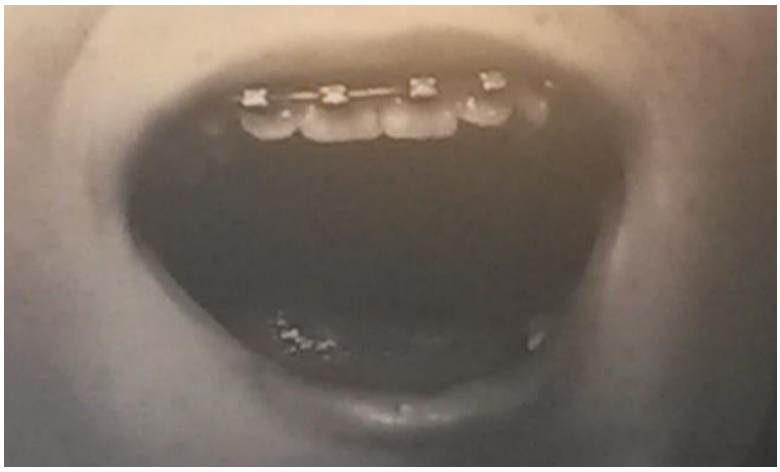
No.	Type	Examples	PRC Category
2	Dental Drills and Accessories	Electric tooth drill, turbine tooth drill	II
3	Dental Chair	Hydraulic Dental chair, Electric Dental Chair	II
		Mechanical Dentistry chair, doctor Chair	
4	Dental Phone	Electric cell phones, turbo phones	II
5	Dental cleaning and filling equipment	Medical teeth cleaning machine, pulp vitality tester, root canal length tester, root canal therapy instrument, light curing machine (device)	II
6	Sewing Needles		
7	Oral Comprehensive Treatment Equipment accessories	Strong Attractor, Three-gun, suction device	II
		Electric suction system, medical air compressor, dental mold tester, silver amalgam mixer	
8	Oral lamp	Oral surgery lamp, oral light	I

Table 9: Dental Medicine Materials

No.	Type	Examples	PRC Category
1	Polymer denture Materials	Synthetic resin teeth, denture base resins, soft denture lining materials, toothpowders and tooth-making water	III
2	Dental Implant Materials	Dental metal and alloy implant materials, dental ceramic implant materials, dental polymer implants, dental carbon implant materials, dental composite implants	III
3	Root canal filling Material	Solid root filling materials, root-filled paste, liquid root filling materials	III
4	Periodontal Plug Treatment agent		III
5	Facial Repair Materials		III
6	Permanent filling materials and related materials	Silver alloy powder, composite resin filling material, cement, dentin adhesive, Hole liner, bottom material, pulp material, whitening adhesive	III
		Enamel adhesive, Pit and fissure sealant	
7	Temporary sealing material and related materials	Temporary sealing fillings, zinc oxide cement	II

No.	Type	Examples	PRC Category
8	Metallic and ceramic Denture materials	Dental Casting alloy, dental forging alloy, porcelain alloy, welded alloy, porcelain powder, metal - Porcelain , porcelain teeth	II
9	Dental Preventive health care materials	Fluoride caries Material	II
10	Filling Auxiliary Materials	Dental acid etching agent, pretreatment agent, color inhibitor	II
11	Orthodontic Materials	Orthodontic wire, appliance, edgewise bow appliance, fine wire appliance, band ring, rubber band	II
12	Impression Material	Impression Paste, zinc oxide printing fuzzy agent, agar impression material, impression plaster, rubber-type impression material, alginate impression material	II
13	Casting embedded Materials	Silicic acid ethyl ester binder embedding material, phosphate binder embedding material, Gypsum binder embedding material, model embedding material	I
14	Model material	Substitute, gypsum model material, model wax, agar copy material	I
15	Dental Auxiliary Materials	Cleaning water, dental separation agent, Alloy flux, occlusal paper	I
16	Abrasive materials		I

Figure 6: Dental Braces (top teeth)



Source: Outdoor Advertising Billboard, Chunxi Road, Chengdu

95. Locating the Inspection and Testing Center in proximity to dental manufacturing companies in the SZHTDZ saves them time getting their products inspected and tested. The delivery time is less than one hour and the new center has higher capacity than the next closer medical device testing center, which is located in Chengdu.

Design Requirements and Considerations

96. See Annex 2-2 for Technical Analysis of the Dental Sector Inspection and Testing Center.

97. The Inspection and Testing Center will have the following facilities:

(a) Active Testing Laboratory building, including: electromagnetic compatibility testing laboratories, electrical safety inspection laboratories, active implant medical device testing laboratories, electrical and mechanical medical equipment testing laboratories and other professional testing laboratories

(b) Passive testing laboratory building, including: dental medical devices testing laboratories, passive implantable medical devices testing laboratory, chemical testing room, physical testing room, environmental test laboratory, and biological evaluation laboratory.

(c) Animal Experimental Building, including rabbit, rat, mouse, guinea pig testing laboratories.

(d) Office Building with offices for, personnel, finance, quality control, business development; and reference and conference rooms.

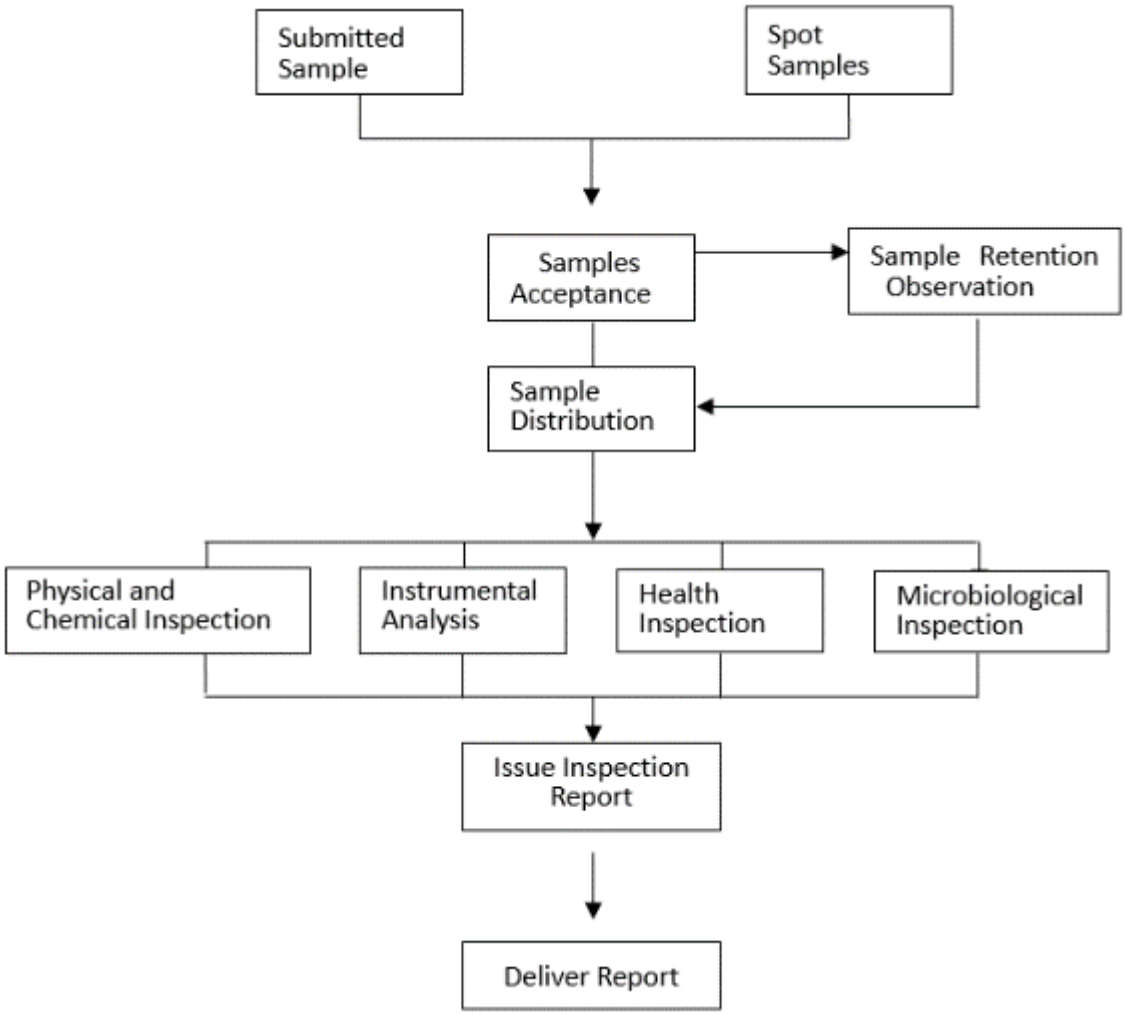
(e) Ancillary facilities: including gas storage room, reagent test room, sample room, sample storage room, storeroom.

98. The civil works will involve the construction of a total floor area of 17,000 square meters for the inspection center, in which 6,000 m2 for the active detection laboratory building, 4,000 m2 for the passive testing laboratory, 2,000 m2 for the office building, 2,000 m2 for the ancillary facilities, and 3,000 m2 for the animal laboratory building.

99. The ADB Loan will be used for equipment purchase and installation. Counterpart funding will pay for civil works. The facility is located inside the Dental Cluster so no land acquisition is required).

100. The Ziyang Dental Equipment Material Inspection and Testing Center will provide services for registration inspection, supervision inspection, commission inspection and quality arbitration inspection of medical equipment and products. It will conduct testing and inspection on medical equipment import and export, and other international certification inspection and testing services. Meanwhile, it will conduct related technical training and business guidance works. Figure 7 illustrates the work flow within the Center.

Figure 7: Work Flow in the Dental Inspection and Testing Center



Recommendations for Operations and Maintenance

101. The operation of the inspection and testing center will be entrusted to the Sichuan Provincial Medical Equipment Inspection & Testing Center, which is certified by the National Credentialing Committee. In view of yearlong successful management and operation experience of the Provincial Inspection Center, it is recommended that the provincial inspection center could conduct personnel management at the initial stage, including later training and assessment, on the basis of no other conflicts. However, it is important to clarify staffing and treatment issues at an early stage.

Staff Recruitment

102. Due to the specialization of inspection and testing centers, researchers with professional backgrounds and practical work experience are required. Initial recruitment should include a "leader" in each field of testing. The main workload at start-up is to establish rules and regulations, set up a working framework, standardize the operational procedures, and make changes according to the specific conditions.

103. All managers will come from the Sichuan Province Testing Center and another 30 employees will be recruited and trained, including related professional technicians in

materials, pharmacy, medicine, etc. The budget comes from municipal financial subsidies.

Alternatives Considered

104. Not establishing an inspection and testing facility for dental materials, products, and equipment is likely to result in fewer companies committing to the Ziyang Dental Cluster.

105. Sharing equipment with the Dental R&D Incubator was considered but subsequently rejected. Among the reasons is that the Inspection and Testing Center is for assuring compliance of manufactured products with PRC standards. This requires a specified level of precision and methodology.

106. Accepting some of the workload from the existing facility in Chengdu will speed the inspection and testing process and improve the Province's competitiveness in the China dental sector.

Innovative Aspects

107. Locating the Inspection and Testing Center within the Dental Cluster can result in faster service and will reduce logistic costs of packaging and shipping to a similar center in another location.

2.4 Technical and Vocational Education and Training (TVET) Center

Summary

108. Under this component, a TVET Center will developed and commissioned in SZHTDZ to educate people to qualify for work in the Industrial Park, and provide continuing educational training for those already employed by companies in the park. The TVET Center will provide specialized training to develop professional skills related to employment by the industries operating within the park. Also, it will offer teacher continuing education training and pre-schooling for children aged 3 to 6 years which will also provide for the needs of industrial workers' children; and also serve as the training center in Sichuan Province for pre-school teacher training education. The TVET Center is planned to serve 4,000 full time students and 2,000 part-time, with about 170 teachers.[14]

Sub-Component Rationale and Objectives

Overview

109. In 2017, there were seven secondary vocational schools in Ziyang Municipality, of which four were public and three private. Three are located in Yanjiang District, two in Anyue County, and two in Lezhi County. Of the 7 schools, 1 is a national key and demonstrative school, 1 is provincial key school, 2 are municipal key schools, and 3 are general schools. The 7 schools offered 24 specialties with pre-school education (for ages 3 to 6 years) having about 25% of total enrollment followed by the tourism service and management programs with about 11%.

110. In 2017, about 85% of the graduates of secondary vocational schools in Ziyang had direct employment with about 74% of the graduates employed outside of Ziyang. Secondary

[14] The exact number of teachers will be based on the PRC's standard for vocational education and determined by the Sichuan Province Education Department.

vocational education is not very effective in serving the local economy. Also in year 2017 98 enterprises signed cooperative agreements with Ziyang secondary vocational schools.

111. In the past five years, the number of enrollments and graduates in secondary vocational education in Ziyang have shown a trend of rapid decline. The number of enrollments dropped from 42,554 to 19,942 and the number of graduates declined continuously since 2015, from 17,682 to 12,239 in 2017.

112. Reasons of this decline in Ziyang include: (1) decline in the school age population. (2) larger percentage of junior secondary school graduates chose to go to general senior secondary school; (3) Secondary VET schools have quality issues, such as out-of-date facilities, VET teachers lack of industrial experiences, and curriculum that does not meet the real needs of enterprises; (4) It is difficult for VET students in Ziyang to get higher Education opportunities; and (5) lack of interest by students in professions such as building construction for which there is large demand but viewed as dirty, noisy, requiring hard physical labor with low pay.

113. Because secondary vocational education in Ziyang does not understand the needs of enterprises and lacks channels to connect enterprises, Ziyang vocational education is oriented by supply, which cannot meet the requirements of Ziyang's economic and social transformation and development.

Ziyang TVET

114. The Ziyang TVET center in Yanjiang is public and classified as key school at provincial level. In 2017, it offered four specialties: pre-school education, primary education, automobile manufacturing and maintenance, and computer. Currently its largest program is pre-education. Unlike other TVET in Ziyang, the Ziyang TVET center has increased entrants, enrollment, and graduates.

Table 10: Students in Ziyang TVET center

Year	Enrollment	Entrants	Graduates
2013	3635	1109	880
2014	3237	1121	845
2015	3520	1290	978
2016	4006	1595	901
2017	4126	1241	985

115. From 2013 to 2016, 100% of the graduates from Ziyang TVET Center got employment. In 2017, except for 24 students who entered higher education, all other graduates were directly employed. About 30% of the graduates were employed locally and the remainder employed outside of Ziyang.

Rationale

116. ZMG wants to improve the Ziyang TVET by building new facilities and re-orienting its curriculum to the needs of enterprises in the High-Technology Development Zone.

117. The total number of enterprises in SZHTDZ is 135 with total number of employees about 39,000 of which 17,284 are college graduates and 21,716 are below college level. There are 36 building industry enterprises, 4 pharmaceutical industry enterprises, 10 food industry, 11 home building materials, and 22 dental related enterprises in the high-tech park.

So there is demand for qualified vocational school graduates.

Objectives

118. To construct a new modern campus with facilities suitable for adequately training vocational students the majority who will be employed within Ziyang Municipality.

Design Requirements and Considerations

119. Facilities to be constructed include: Student Hostel (26097m^2); Practice Room (17557m^2); Teaching Building (13902 m^2)); Underground Buildings (9071m^2); Logistics and Ancillary Rooms (9672m^2). The Design Institute has already prepared drawings for preliminary engineering so the physical facilities are ready for Detailed Engineering Design.

Figure 8: Architectural Drawing of Proposed Ziyang TVET

Source: TVET FSR March 2018

120. The TVET buildings will comply with relevant design standards and codes for energy-efficient, environmentally 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), and Sichuan Provincial Green Building Design Standard (DBJ51/T037-2015), and Sichuan Provincial Green Building Assessment Standard (DBJ51T009-2012).[15]

121. Adherence to PRC green public procurement policies will be targeted for equipment and appliances procurement.[16] In addition, the project will support TVET to develop and implement an environmental monitoring system (EMS) aimed at institutionalizing procedures to enhance campus environmental sustainability.

[15] Ziyang Environmental Impact Assessment prepared by ZMG, April 2018.

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

122. Ziyang TVET center will offer five specialties: pre-school education, e-commerce, automobile manufacturing and maintenance, leisure sports service and management, aviation services and management. Around 2023, Center will offer two new additional specialties: tourism service and management, and logistics services and management. The proportion of students in pre-school education will be reduced from about 90% to about 40% and finally to 25%. Meanwhile, enrollment in other specialties will be increased.

123. Besides financial support for construction and equipment the ADB will provide technical assistance and capacity building.

Table 11: Proposed TVET Technical Assistance and Capacity Building

	Position	**Type**	**Person Months**
1	TVET Specialist	National	5
2	Competency-based curriculum (CBC) Development Specialist	National	10
3	CBC Delivery Specialist	International	4
4	CBC Delivery Specialist	National	10
5	TVET Assessment Specialist	International	4
6	TVET Assessment Specialist	National	10
7	School-Enterprise Partnership Specialist	International	2
8	School-Enterprise Partnership Specialist	National	10
9	Green Skills Development Specialist	International	2
10	Green Skills Development Specialist	National	10
	Total	10	67

124. The consultants for School-Enterprise Partnership will focus on creating a working committee of enterprise leaders and Ziyang TVET administrators to plan and develop a curriculum relevant to the current and future needs of businesses in the Development Zone. The consultants for Competency-Based Curriculum will provide guidance to the TVET faculty on preparing and delivering a relevant curriculum.

Alternatives Considered

125. Not developing a relevant TVET will require enterprises in the Development Zone to recruit elsewhere or develop their own training programs. Both these alternatives will increase their operating costs and make the Ziyang High-Technology Development Zone less attractive.

Innovative Aspects

126. Establishing a school-enterprise partnership so that school leaders develop a curriculum relevant to the needs of businesses in the Development Zone and technical assistance preparing a competency-based curriculum.

3 OUTPUT 3: ECOLOGICAL SYSTEMS AND ENVIRONMENTAL INFRASTRUCTURE CONSTRUCTED

3.1 Introduction

127. Output 3 has two components, each with three sub-components:

(a) Provision of improved flood control and water conservation including:

i. Flood protection embankment (eco-dike),

ii. Sponge city interventions, and

iii. Wetland area development downstream of SZHTDZ

(b) Development of urban green areas, including:

i. Transformation of a landfill into a green public area,

ii. Development of a "green wedge" as a natural separator between residential and industrial areas, and

iii. Ecological preservation of hilly areas.

128. These components are consistent with Chapter 34 of the PRC 13th Five-Year Plan (FYP) titled “Develop Harmonious and Pleasant Cities”, which states that: *“We will transform the way cities develop, improve urban governance capacity, redouble efforts to prevent and control urban defects, continuously improve the quality of the environment, living standards, and the competitiveness of our cities, and work to create cities that are harmonious and pleasant to live in, that are full of vitality, and that have their own unique character*”.

129. Relevant details from the Feasibility Study Report and discussion are in Annex 3-1 for the flood protection embankment; Annex 3-2 for the wetland development; and Annex 3-3 for the landfill closure and transformation. All six sub-components include landscaping and these are discussed collectively in Annex 3-4.

3.2 Flood Protection Embankment

Summary

130. This sub-component consists of improvements and landscaping to a 6.8 km length of the right bank of the Tuo River, including the raising of the embankment to provide improved flood control and protection along where the river flows through the urban area of Ziyang adjacent to SZHTDZ. The earth embankment will be landscaped to blend into the surroundings, with trees planted on the sloping embankment face to create a green, eco-friendly appearance; with landscaped recreational areas provided along the crest of the embankment allowing for public access for walking, sports, tai chi[17], etc. This so-called “eco-dike” will be designed to protect SZHTDZ from a flood with a one-in-fifty years’ rate of occurrence, and will rely on the planting on the sloping embankment face to reduce wave action and minimize erosion. See Annex 3-1 for details.

Sub-Component Rationale and Objectives

131. The 13th national FYP in Chapter 34 states: “We will build green cities by adjusting

[17] Tai chi is an ancient Chinese form of martial arts that, in the 21st century, is practiced as a graceful form of exercise, often as a morning exercise.

the scale of cities in accordance with their resource and environmental carrying capacities, using eco-friendly planning, design, and construction standards, and carry out initiatives to build ecological corridors and restore ecosystems."

132. In line with the 13th FYP, this sub-component will develop an ecological corridor and restore ecosystems associated with the Tuo River, which flows approximately north to south through Ziyang City.

133. The source of the Tuo River, which is one of the major tributaries of the upper Yangtze River, is in the Chengdu Plain in the north-west of the Sichuan Basin, and over 100 km to the north-west of Ziyang. The river flows through a 400 m deep gorge in the Longquan mountain range, which separates Chengdu from Ziyang. Heavy rain falling to the west of the Longquan mountain range in the Chengdu Plan can cause extensive downstream flooding; and this can significantly impact Ziyang. Such floods are characterized by large flows, plus high peaks, with a significant variation of water levels in Ziyang of up to 20 m. The following table shows some extreme rain storm events.

Year	**Maximum water elevation** (m)	**Flood duration** (days)	**Flooded area** (km^2)	**Flood-Hit Population** (10,000)	**Direct estimated economic loss** (10,000CNY)	**Flood return period** (years)
1981	+359.6	10	2.4	2.54	35,984	80
1995	+355.9	3	1.43	2.2	21,000	10
1998	+353.9	2	0.95	1.8	17,000	5

Source: Shaojun Wang, "Discussion on the Necessity of Flood Control Project in Ziyang Urban Area. Water Conservancy in Sichuan Province", 2000 (4).

134. In 1999, the Ziyang Municipal Government (ZMG) engaged a design institute to prepare a Flood Control Plan for the Tuo River between Ziyang and Jianyang (about 100 km upstream). The plan focused on the urban areas of Ziyang and Jianyang, with a proposed embankment in the Ziyang urban area of about 10.59 km length. In this plan the left embankment of the Tuo River was planned to a flood control standard with a 20-year return period, and the right embankment to a flood control standard with a 50-year return period.

135. In subsequent years, there has been rapid urban development in Ziyang, which has expanded the urban area, and the flood control and protection embankments proposed in 1999 are no longer adequate. Consequently the ZMG engaged the Sichuan Provincial Water Resources and Hydroelectric Investigation and Design Institute in 2011 to prepare an updated Flood Control Plan for the Tuo River, where it passes through Ziyang. Under this revised plan an additional 17.093 km length of embankments were proposed.

136. However of the various sections of embankment proposed in the 1999 and 2011 plans, not all the recommendations have been implemented. This sub-component, therefore, addresses improvements and landscaping to a 6.8 km length of the right bank of the Tuo River, including the raising of the embankment to provide improved flood control and protection adjacent to SZHTDZ, between Luojiaba and Maoliu (see Figure 2). The actual embankment is 5.0 km but the planned work is along the entire 6.8 km length

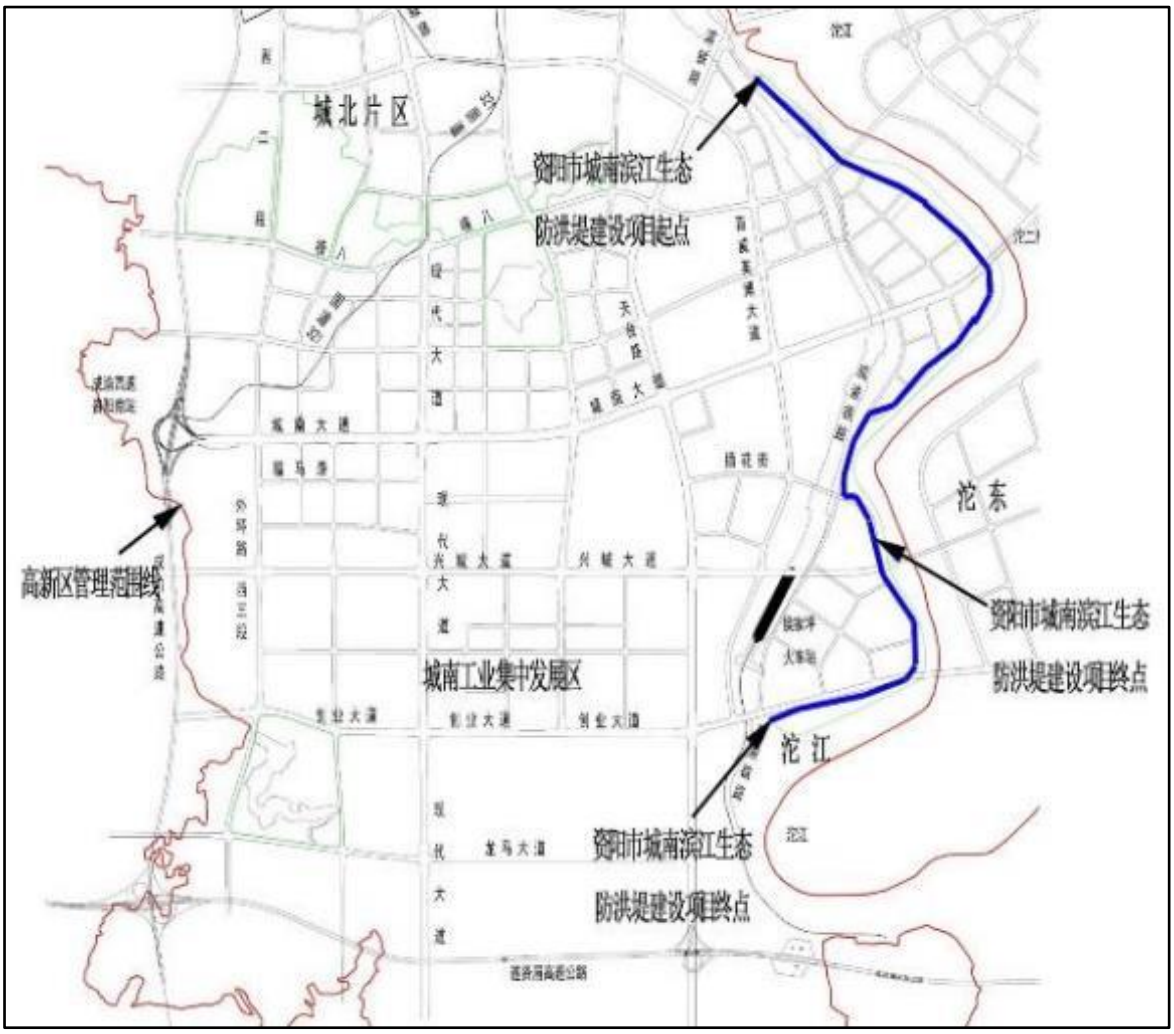
Design Requirements and Considerations

137. The PRC Urban Flood Control Standard (GB50201-94) specifies a 50-year flood

return period for a city of Ziyang's population and importance. Ziyang's goal is to achieve this standard by 2030.

138. The PRC design procedure for calculating the height of the embankment and the free board is specified by the Code for Design of Levee and Embankment Projects (GB50286-2013) ("Freeboard" is an additional height to provide protection from wave action and turbulence in the river). The design procedure for the embankment elevation follows standard engineering practice (volume of design flood; surface roughness coefficient, etc.).

Figure 9: Location of Flood Control Embankment



Source: FSR, March 2018.

Figure 10: Flood Control Embankment on Tuo River Right Bank

Source: Design Institute presentation, 22 January 2018

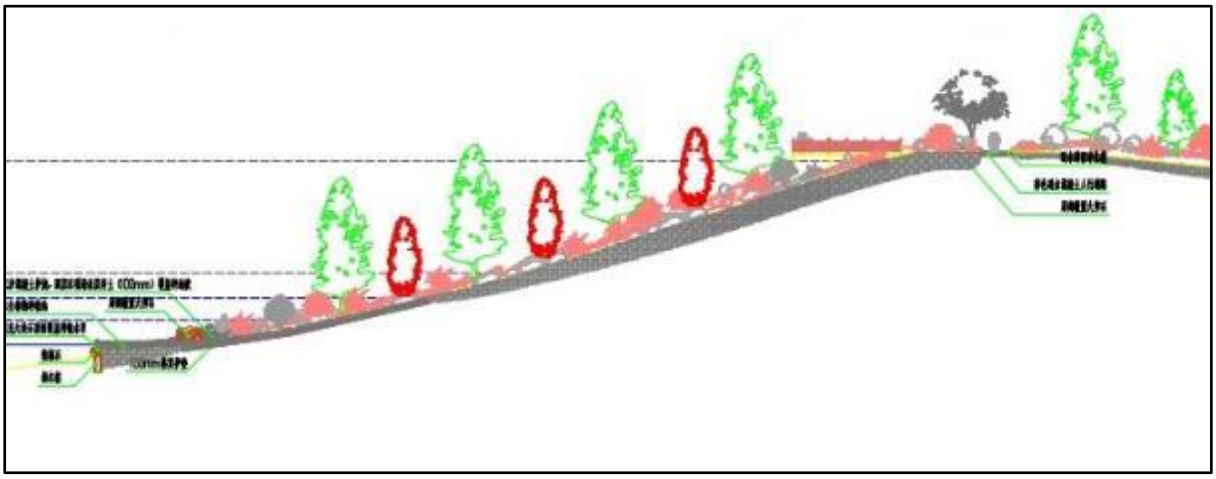
Design Alternatives

139. For cities that have rivers flowing through their urban area, a common approach to provide for flood control and protection is to construct a near vertical concrete river wall, sometimes with a masonry facing and with levees for pedestrian access, using either a mass concrete structure, or a reinforced concrete retaining wall structure. This solution can be appropriate in a densely developed urban area, where there is limited space for construction; and has good anti-scouring properties, and is relatively easy to construct. However, where there is a significant water level rise under flood conditions, a concrete wall can be more complex to construct, and can have an adverse visual impact, especially where massive structures block views, and little landscape planting is provided.

140. An alternative is to provide a compacted earth embankment, with rip-rap protection to prevent scouring, which might have 1 (V) on 1.5 (H) side slopes, and could also include a levee for access. This solution can provide a greater waterway area, and is more appropriate where there is a large water level rise under flood conditions. However, an embankment solution requires a much greater land take, and floating rubbish can easily get trapped in the rip-rap, and can become unsightly. An alternative to rip-rap is concrete paving, but this can be damaged in flood conditions.

141. A compacted earth embankment, with a vegetated surface, is a sustainable alternative to using rip-rap or concrete paving. This type of embankment (referred to as an “eco-dike”) can be landscaped to blend in with the surroundings and create a more harmonious, eco-friendly and attractive appearance, and provide green open space for public use, e.g. walking, sports, etc. (see Figure 11). This solution uses landscaping with trees, shrubs and grass to reduce wave action that might surge over the embankment, and to provide anti-scour protection and soil stability to reduce erosion.

Figure 11: Illustrative Sketch of Vegetated Embankment (Eco-dike)



Source: Draft FSR for Ziyang Project, January 2018: river is to the left in this sketch

142. This type of embankment requires the expert input of engineers, ecologists and landscape architects. Construction can be more complex due to the time and space needed to grow a sufficiently dense tree cover (3-4 years). In addition trees and other vegetation add to operation and maintenance costs, because of the need to prune and remove dead and decaying material, and to maintain the desired plant communities on the embankment.

143. Alternative embankment types were considered in the FSR[18] taking account of flood control requirements and ecological rehabilitation aspects, together with the planning requirements of ZMG, and the vegetated embankment (eco-dike) was that recommended.

Project Benefits and Outcomes

144. The implementation of this sub-component will provide improved flood control and protection for about 200,000 people in the communities of Songtao and Shizishan in the Yanjiang District of Ziyang.

Climate Change Aspects

145. The height of the flood control embankment along the Tuo River is the sum of the height required to protect from the 50-year flood recurrence and freeboard.

146. The PRC Code for Design of Levee and Embankment projects (GB50286-2013) specifies the method for calculating the height of free board; and the average freeboard along the embankment was calculated at 1.1 m. Increasing the design flood by 15% to address the effects of climate change resulted in an increase in elevation of 1.2 m. The DI set the height of the freeboard at 1.3 m, an increase of 0.2 m.

Innovative Aspects

147. This sub-component advances the use of a vegetated embankment (eco-dike) to provide improved flood control and protection in the urban area of Ziyang. The embankment not only improves the landscape appearance of this eastern boundary of SZHTDZ, as part of

[18] FSR prepared by China Railway Eryuan Engineering Group Co. Ltd, located in Chengdu.

the green transformation of Ziyang, but also provides a resource for passive recreational activities. Although embankments, with levees to increase the waterway area, are used for flood control along major rivers in the PRC, this eco-dike is significant in its extensive use of vegetation on the sloping embankment faces, and along levees, to reduce wave action and minimize erosion; and also to be designed with soft landscaping as a recreational resource.

3.3 Sponge City Interventions

Summary

148. This sub-component consists of “sponge city” interventions that will create sunken areas in roadside verges that will act as detention basins where rain water can collect during periods of heavy rainfall. The “green” and landscaped basins will be designed so that runoff water is “trapped” there, and can gradually seep into the underlying ground strata, and eventually augment the below-surface groundwater aquifer. The detention basins will divert water from entering the urban surface water drainage system, and reduce urban flooding. Detention basins will be constructed along 10 sections of road, totaling 13.95 km, with verge widths varying from 3 to 20 m.

Sub-Component Rationale and Objectives

149. The concept of a “sponge city” is based on diverting rainwater from storm water drains, or delaying its discharge into the city drainage system, with the rainfall in the urban environment being detained and allowed to “soak” into the ground (with the ground acting like a sponge). Ultimately the water that percolates into the underlying ground strata should contribute to replenishing the groundwater aquifer. In concept therefore, a “sponge city” helps to reduce rainwater runoff from hard surfaces during storm conditions, with the water being available as a groundwater resource during periods of drought.

150. The approach adopted in the PRC for sponge city interventions includes:

(a) Infiltration (seepage) e.g. parking lots with a “perforated” hard surfacing to allow for rainwater infiltration into the ground;

(b) Detention;

(c) Storage e.g. retention basins where storm flows can be captured and allowed to discharge after the storm peak has passed (the natural flood plains alongside river systems are a form of retention system;

(d) Purification (e.g. filtration through vegetation and overflow stormwater inlet);

(e) Utilization (e.g. vegetation irrigation), and

(f) Discharge.

151. Typical sponge city inventions include:

(a) Permeable pavements that allow for rainwater infiltration into the ground

(b) Green roofs - rooftops covered by plants

(c) Wetlands used for rainwater storage

(d) Detention basins (sometimes referred to as "retarding basins"). A detention basin is typically an excavated area, constructed adjacent to a road, a stream, or a river, to protect against flooding and, in some cases, downstream erosion by storing excess water for a limited period of time; and can allow for water loss by evaporation.

(e) For the 13th FYP period, the PRC is supporting the development of sponge cities by strengthening flood control, drainage, and temporary reservoirs, as well as ecological infrastructure such as parks and green spaces.

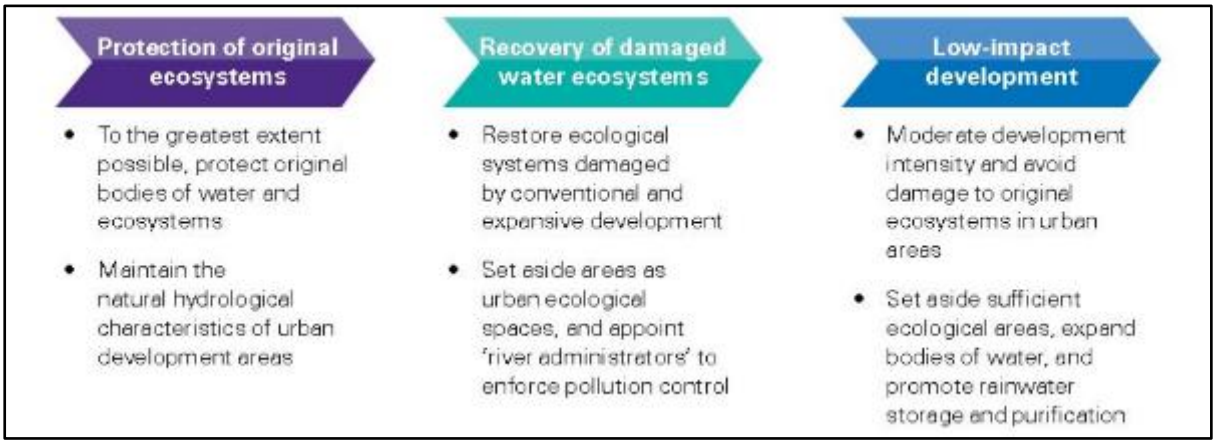
152. The 13th FYP states: "We will strengthen the development of facilities to prevent flooding and waterlogging, and manage water flow as well as the development of parks, green spaces, and other such facilities to support urban ecosystems, support the development of sponge cities, and improve urban public facilities."

153. And in Chapter 36: "[We will] support the development of sponge-like buildings, residential areas, roads, squares, parks, and green spaces by improving drainage and rainwater control and regulation facilities in urban areas and taking measures to enable rainwater to be absorbed, retained, stored, purified, used, or drained."

154. The State Council of the PRC has set objectives[19] requiring that by 2020 over 20% of the area in each of 658 urban centers should achieve a rainwater absorption and utilization rate of 70%.[20] Ziyang is not one of these 658 centers, however this utilization rate can serve as a goal.

155. Figure 12 shows a proposed road map for Sponge City development.

Figure 12: Road Map for Development of Sponge Cities



Source: 2016. KPMG, "The 13th Five-Year Plan – China's Transformation and Integration with the World Economy", October 2016, kpmg.com/cn

156. As the urban development of Ziyang has expanded, many impermeable surfaces have been created as a result of new building developments, roads, footpaths, and car parking areas. Rain, which previously was falling on agricultural land, woodland and other open areas, is able to flow rapidly across impermeable areas and then is channeled into

[19] Asit K Biswas and Kris Hartley. 2017. "*China's 'sponge cities' aim to re-use 70% of rainwater*", September 18, 2017, http://edition.cnn.com/2017/09/17/asia/china-sponge-cities/index.html

[20] 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

storm water drains, and ultimately reaches the Tao River. Whereas rainfall was previously being trapped in low-lying areas in these undeveloped tracts of land, and being allowed to soak into the ground, the newly paved surfaces are accelerating the passage of water into the Tao River, exacerbating peak flows and flood events.

157. The objective therefore of the sponge city interventions included under this sub-component is to divert rainwater from reaching storm water drains, or delay its discharge into the city drainage system, with the rainwater being detained and allowed to permeate into the ground.

Design Requirements and Considerations

158. The PRC has promulgated a new approach to the design of urban storm water drainage systems, which incorporates sponge city concepts, and requires designers to make full use of the infiltration, absorption, retention and purification functions of urban water bodies, green areas, roadside verges, and residential areas. Engineering and ecological measures should be combined to minimize the impact of rainfall on urban developments, with sponge city concepts being used to enhance the effectiveness and capacity of urban drainage systems, and to minimize flooding; whilst in parallel promoting the effective utilization of rainwater resources and ensuring sound and healthy urban aquatic ecosystems.

159. From 2015, all newly planned urban districts in the PRC, all types of industrial parks, development zones and community developments should follow these new requirements. At the same time, the renovation of "old town" communities should focus on solving problems of poor and defective urban storm water drainage systems (and the clogging of drains), the waterlogging of low-lying areas, the treatment of polluted water bodies, and the collection/reuse of rainwater. Another issue in some older developments is the discharge of both storm water and foul water drainage in one collection system, and the use of septic tanks, which can lead to unsanitary and unhygienic conditions. Such sources of pollution can however impact groundwater aquifers, and reduce the benefit of aquifer recharge where a sponge city intervention using detention basins is implemented.

160. By itself, sponge city infrastructure cannot avert water logging[21] caused by heavy rainfall and storms, as traditional pipe, culvert, and channel drainage systems are still needed. However the two concepts need to be integrated in planning urban developments.

161. In Ziyang, the design of these sponge city interventions was based on the following plans:

(a) Ziyang Specialized Sponge City Plan (2016 - 2030)

(b) Ziyang Conceptual Planning of the Whole Area Water Ecosystem (2017 - 2025)

162. For this sub-component the DI[22] proposed a variety of interventions in the FSR including:

(a) porous and permeable pavements in car parking areas and for footways

(b) changing the falls on footways to slope towards the verge rather than drain to the street

(c) rain gardens; and

(d) detention basins to capture rainwater and make it available for later use.

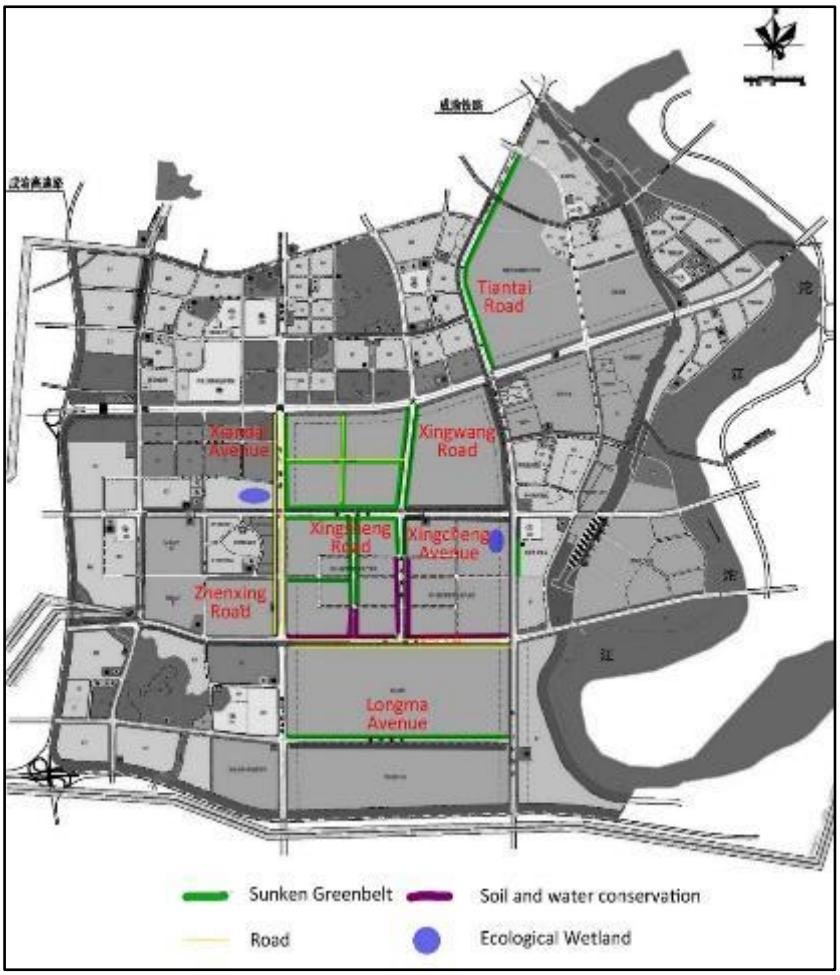
[21] China terminology for urban street flooding caused by stormwater

[22] China Railway Eryuan Engineering Group Co. Ltd, located in Chengdu

163. During the initial FSR review, the TRTA consultant suggested that no work should be done to modify existing pavements to include porous and permeable surfaces or to re-lay paving to different grades. This was recommended as many of the pavements to be reconstructed were relatively new, and undamaged and still had many years of useful life. Any such reconstruction would have been disruptive, an unnecessary expense, and in contravention of the principles of sustainable development. Therefore the final FSR is based on the development of a series of detention basins in roadside verges.

164. For this sub-component 10 sections of road were identified (see Figure 13), totaling 13.95 km, both in the existing urban area and within the industrial area, where road side areas of open space (with verge widths varying from 3 to 20 m) can be excavated to create "green" detention basins for the collection of storm water. The total area for development of detention basins is 18.09 ha.

Figure 13: Location of Sponge City Interventions



Project Benefits and Outcomes

165. The prime benefit of this sub-component is to minimize flooding, with a secondary benefit of augmenting the groundwater aquifer, in Yanjiang District of Ziyang City.

Climate Change Aspects

166. Providing detention basins where rainwater can collect has the benefit of reducing peak flows in the storm water drainage system, and minimizing flooding. If sufficient rainwater is diverted from the drainage system, the potential exists to reduce the pipe and culvert sizes.

167. The PRC has set an objective that over 20% of the area of selected urban centers should achieve a rainwater absorption and utilization rate of 70% by 2020. Notwithstanding that this is an ambitious target, the achievement of this reduction could be the basis for reducing the design standards for piped drainage systems, i.e. using smaller pipe sizes. In turn there would be a reduction in the "embedded energy", because of the production of smaller pipe diameters.

168. However for this sub-component, as the sponge city interventions are being retrofitted into an existing urban infrastructure, no measurable climate change benefits have been identified.

Innovative Aspects

169. This sub-component using sponge city concepts is designed to "detain" rainwater, and make it available for later use; or slow down its passage into the drainage system. These concepts are not new, in fact the construction of detention basins and porous paving is just re-creating a natural system that was already in place before rapid urbanization paved over large tracts of rural land. And in the PRC, sponge city concepts are a well-recognized element in the design of modern urban developments. What is however innovative in Ziyang is retrofitting these design concepts in a sustainable and cost-effective manner within an already developed urban infrastructure. One output from these Ziyang interventions should be a design manual that illustrates how sponge city concepts can be retrofitted within an existing city environment.

170. An interesting development, which was incorporated into a sponge city development in Xiamen, was to promote the sponge city concept in primary school "nature courses", with specially developed notebooks and display boards.[23]

3.4 Wetland Area Development Downstream of SZHTDZ

Summary

171. This sub-component comprises the restoration of a series of water bodies and their catchments; and the re-generation of wetland areas, collectively referred to as Yannan Wetlands. Details are in Annex 3-2.

172. The Yannan Reservoir receives about 70% of its inflow from the upstream Yingjie Reservoir through the Kongzi Creek, which is a 3 km natural channel, connected to the downstream Yannan Reservoir. See Figure 14. Water from the Yannan Reservoir flows into the Tuo River.

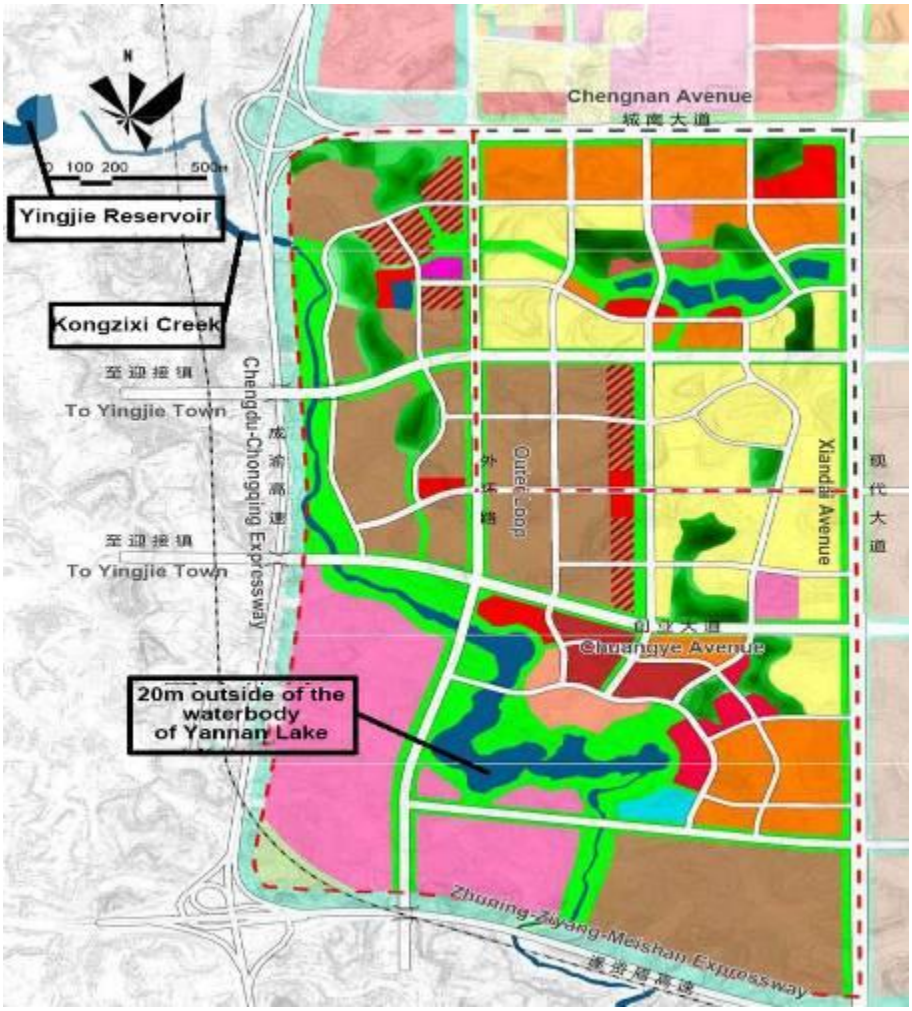
173. The project includes structural and non-structural improvements to the Yannan Reservoir and Kongzi Creek, both located within the boundary of SZHTDZ. Only non-structural activities are planned for the Yingjie Reservoir which is located outside the development zone.

[23] http://usa.chinadaily.com.cn/china/2016-08/04/content_26345067.htm

174. Both the Yingjie and Yannan Reservoirs serve irrigation and flood control functions. And in both there is aquaculture. Both reservoirs and the connecting creek are badly polluted with water quality worse than Grade V (the lowest category), the pollution being the result of agricultural fertilizer runoff, animal waste, and improper sanitation, e.g. failing septic tanks. The water quality needs to be improved so the impounded water can be used safely for irrigation and to reduce pollution flowing into the Tuo River. The immediate goal is to reach water quality Grade IV and eventually Grade III.

175. The restoration will provide a clean-up of the existing water bodies and shorelines totaling about 25.7 ha, and include the re-generation of wetland areas for about 20 to 100 m from the shore of the lakes and creek. The works include: the demolition of some buildings and removal of disused septic tanks; removing sources of agricultural pollution (including closing farmsteads and relocating farm animals), dredging & disposal of spoil, and the development of ecological vegetation systems to improve water quality; the construction of subsurface flow wetlands, access tracks and landscape works, and wetland tour and popular science education facilities around the area. When completed the wetlands are planned to be a recreational and educational resource.

Figure 14 Proposed Location and Scope of Yannan Wetland Restoration



Sub-Component Rationale and Objectives

176. The 13th PRC FYP in Chapter 45 states: “Affording high priority to environmental

protection and letting nature restore itself, we will ensure the protection and restoration of ecosystems, build ecosystem service corridors and biodiversity protection networks, and work to make natural ecosystems more stable and better able to provide services, thereby building robust ecological security barriers." And "We will strengthen protection of scenic areas, forest parks, wetland parks…".

177. "[We will] strengthen the protection of natural wetlands on the middle and upper reaches of the Yangtze…take integrated steps to improve the environment of wetlands with degraded ecological functions and low levels of biodiversity; carry out demonstrations of sustainable wetland utilization; [and] work to ensure that the total area of wetlands stays above 53.33 million hectares nationwide."

178. And in Chapter 47 states: "We will regulate the use of ecological spaces, define and strictly observe ecological redlines, and ensure that the functions of ecosystem service zones are not degraded, that their total area is not cut, and that they are not used for other purposes. We will establish a system for managing the total area of forests, grasslands, and wetlands…."

179. In line with the 13th FYP, this sub-component will develop an ecological corridor and restore ecosystems associated with the Yingjie and Yannan Reservoirs and the Kongzi Creek.

180. The upstream "lake" (the Yingjie Reservoir used for irrigation, flood control, and aquaculture), the Kongzi Creek connecting channel with a length of 3 km, and the downstream "lake" (the Yannan Reservoir used for irrigation and flood control) are badly polluted.

181. In December 2017, the Chengdu Huace Detection Technology Co Ltd carried out sampling and testing of surface water in the Yannan Reservoir and upstream in the Kongzi Creek and the Yingjie Reservoir; and sampling and testing of the sediment from the Yannan Reservoir. Test data was provided for chemical oxygen demand (COD), total phosphorus (TP), ammonia nitrogen (NH_3-N) and total nitrogen (TN), and has been compared against the "Environmental Quality Standard for Surface Water (GB 3838-2002)". [24] Based on this testing, the following observations were made:

(a) Yingjie Reservoir: The main water quality indicators meet the Class IV standard under GB 3838-2002, except for total nitrogen.

(b) Kongzi Creek: COD, TN, TP meet the Class V standard, with NH_3-N reaching the Class III standard.

(c) Yannan Reservoir: COD meets the Class V standard, but NH_3-N, TN and TP are "worse" than the Class V standard.

182. The major factors impacting 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; (iii) establishing and strengthening operation and management of the wetland after the construction completion. Based on the site investigation conducted by the DEIA Institute in November to December 2017, there were point and non-point pollution sources from the upstream and surrounding area discharging into Yannan Lake and Kongzi Creek, which include:

[24] "Environmental Quality Standard for Surface Water", GB3838-2002 http://english.mep.gov.cn/standards_reports/standards/water_environment/quality_standard/200710/t20071024_111792.htm

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

(ii) Agricultural non-point pollution flows into the lake via the surface runoff. The lake is surrounded by 758 mu farmlands for planting rape (144 mu), fruit (362 mu), rice (40 mu), corn (100 mu) and other vegetables (112 mu);

(iii) Wastewater from livestock and poultry farming 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 fish ponds.

183. Based on the investigation in the ADB fact finding mission, by the end of March 2018, 13 of 23 livestock and poultry farming households have been shut down or relocated along with the development of "China Dental Cluster", and the remaining 10 households will be resettled in 2019; the 3.5 mu fishponds will be converted to wetland before the end of 2018, and the 758 mu farmland will be converted to forestry by the end of 2019; and 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 government's fund for prevention of fecal contamination to the wetland. The 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 15: View Across the Yannan Reservoir

184. The Yannan Reservoir is a popular place for urban inhabitants to use for outdoor activities, including fishing.

185. The Kongzi Creek is adjacent to Ziyang's dental cluster within SZHTDZ and, according to the Ziyang Green City Master Plan (2012-2020), the Kongzi Creek and Yannan Reservoir are to be restored as a green corridor, and a recreational resource, and would complement the landscape setting and amenity of the dental cluster. The Master Plan also includes the closure, clearance and removal of livestock farms and farming homesteads in this area.

186. Therefore, in order to restore these water bodies, this sub-component assumes point source of pollution (i.e. from farms and domestic dwellings) within the catchment has been eliminated, and mainly focusses on the control of exogenous pollution sources, namely

runoff and inflow water.

187. In summary the objectives of this sub-component for the restoration and development of this wetland include:

(d) to improve water quality in the Yingjie Reservoir – Kongzi Creek – Yannan Reservoir ecological corridor in line with the national policy of water pollution prevention and control; and to reduce pollution flowing into the Tuo River

(e) to improve the landscape setting and amenity of this corridor where it adjoins the Ziyang dental cluster, and develop a wetland eco-resource center focused on the Yannan Reservoir

(f) as a step to improve water quality, point sources of pollution in the entire catchment to be removed, including farms and domestic dwellings (and including areas outside SZHTDZ)

(g) to set up a management organization for the future operation, management and maintenance of this ecological corridor.

Design Requirements and Considerations

188. The works include:

(a) The clearance of domestic dwellings, and demolition of buildings within the catchment, including the removal of disused septic tanks.

(b) The closing and clearance of farmsteads, and the relocation of farm animals, within the catchment, in order to remove sources of agricultural pollution.

(c) The dredging and disposal of contaminated sediment from the water bodies.

(d) The development of a water pollution improvement scheme, including ecological vegetation systems, to improve water quality to Grade IV so it can be used safely for irrigation and to reduce pollution flowing into the Tuo River

(e) The construction of subsurface flow wetlands

(f) The development of access tracks and landscape works.

(g) The development of wetland tour and popular science education facilities around the area (when completed the wetlands are planned to be a recreational and educational resource).

Table 12: Proposed Activities and Constructed Facilities for the Wetland Restoration

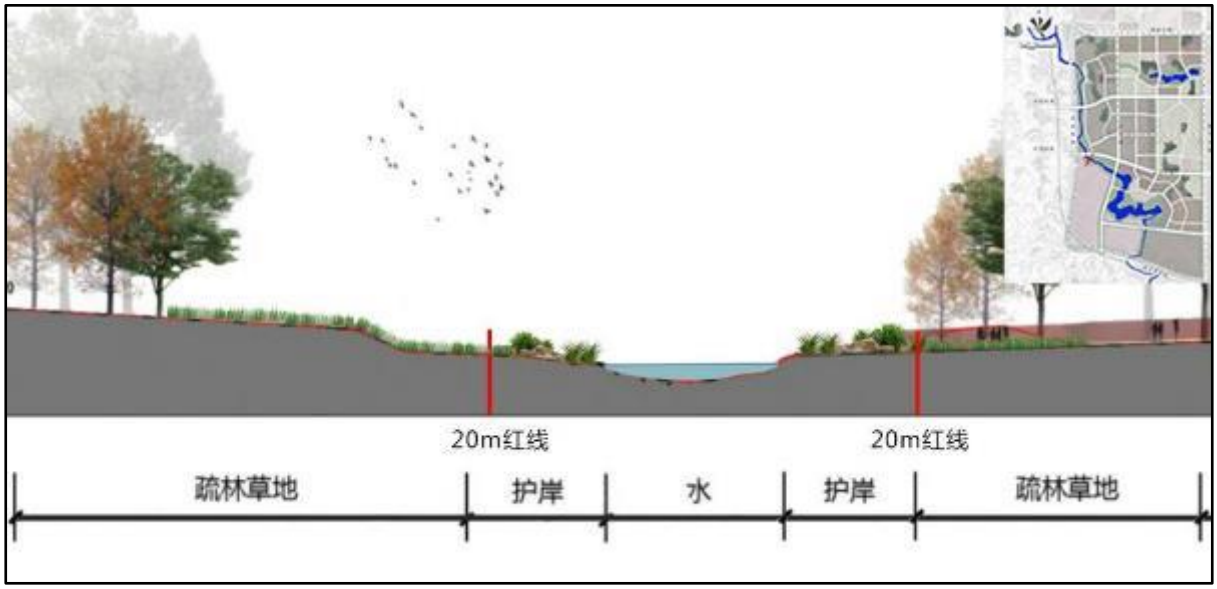
No.	Activity/process	Quantity of construction
1	Shut down point and non-point pollution source before June 2019	a) Shut down and resettle the livestock farms including 3,730 pigs, 7 sheep, 5,100 chickens, and 3.5 mu fishponds (most of them have been completed). b) Restore 758 mu farmland to wetland and grassland/forest c) Connect municipal sewer pipe to 41 households in the catchment.
2	Removal of inner pollutants	d) Ecological dredging of 9,8000 m^3 (90% water content)
3	Ecological Restoration	e) Construction of 2 pre-tanks (666 m^3) at Kongzi Creek for inflow water pre-treatment;

		f) Construction of 1,148 m^2 sunken greenfield; g) Installation of 1215 m^3 ecological rock filled gabion; h) Construction of 9,000 m^2 wetland on lakeside; i) Plantation of 9,855 m^2 emergent aquatic plant, 862 m^2 floating-leaved macrophyte, 162,865 m^2 submerged plants, and 4,250 m2 emergent aquatic plant; j) Putting in 197,400 m^2 benthos; and k) Construction of 1,846 m^2 ecological floating island l) Application of duck grazing patterns to control apple snails

Source: the FSR

Figure 16: Cross Section through Kongzi Creek showing Landscaping

(h)



Project Benefits and Outcomes

189. The prime benefit of this sub-component is to reduce water pollution and restore a degraded resource into a sustainable and attractive ecosystem, which has the secondary benefit of providing a recreational resource for public education and enjoyment.

Climate Change Aspects

190. This sub-component promotes the use of ecological vegetation systems to improve water quality, rather than using energy-intensive mechanical or biological water treatment interventions to reduce pollutant levels, i.e. minimizing carbon emissions from power generation.

191. This sub-component includes the restoration and extension of existing wetland areas, and tree planting and other soft landscaping along the shoreline of this ecological corridor. Such planting and wetland development has a climate change benefit through carbon sequestration, i.e. the natural capture of carbon dioxide from the atmosphere through biological, chemical, and physical processes, thereby slowing the atmospheric accumulation of greenhouse gases, which are released by the burning of fossil fuels.

Innovative Aspects

192. Urban development in the PRC often focuses on complete clearance, demolition, and flattening of hills, and backfilling of valleys to create a "platform" on which a new city or industrial estate is developed. Roads are laid out in a grid pattern with little regard to the existing terrain or natural features. The result is a featureless cityscape, which is little different from the next city.

193. This sub-component is a demonstration of a greener, more sustainable, public-oriented approach. Two existing reservoirs, which were used for irrigation purposes, and their connecting creek, have been "saved" and can be re-badged as "lakes". Their function will be enhanced by the restoration and development of wetland areas, which creates a development "no-go" area, and provides a recreational and attractive resource for public education and enjoyment. This ecological corridor will provide a featured landscape, and adds character to this south eastern corner of SZHTDZ.

3.5 Landfill Closure, Restoration, and Afteruse

Summary

194. This sub-component consists of the closure and restoration of the existing and operational Zhongshan sanitary landfill (receiving about 400 tons per day of solid waste from the urban areas of Ziyang City); and the development of a green public open space on the restored landfill and the surrounding rural area (total green public open space area: approximately 37 ha, including 17.5 ha of restored landfill). This landfill is expected to reach its capacity in 2020; and, to provide continuity in solid waste management collection, transport, treatment and disposal, a waste-to-energy (WtE) plant is planned to be commissioned in 2019. (Note: the WtE is not a component under the loan). The restoration of the landfill will include capping of the site (using soil and a geomembrane to prevent the infiltration into the waste of rainwater falling on the site), providing drainage, vegetation, and landscaping; and enhancements to the landfill gas collection and leachate management systems. After closure and restoration, the operation of landfill gas collection and leachate treatment will need to continue, and this may need to continue for 20 to 30 years after closure. See Annex 3-3 for details.

Sub-Component Rationale and Objectives

195. The existing Zhongshan sanitary landfill, which opened in 2003, is expected to reach its capacity in 2020. This landfill receives municipal solid waste (MSW) from the urban area of Ziyang City and other communities surrounding the main city conurbation. To provide continuity in solid waste management collection, transport, treatment and disposal, a 1,000 t/d waste-to-energy (WtE) plant is planned to be commissioned in 2020, and the Zhongshan landfill will be closed and restored.[25]

196. When the landfill opened in 2003 it was located at the southern suburban area of the Ziyang City. With the rapid urbanization of the city, the landfill is now located within the city urban area, between the northern residential area and southern SZHTDZ. In the near future, under the new urban planning, it will be in the central area of the city but by that time it will have been closed, capped, and landscaped.

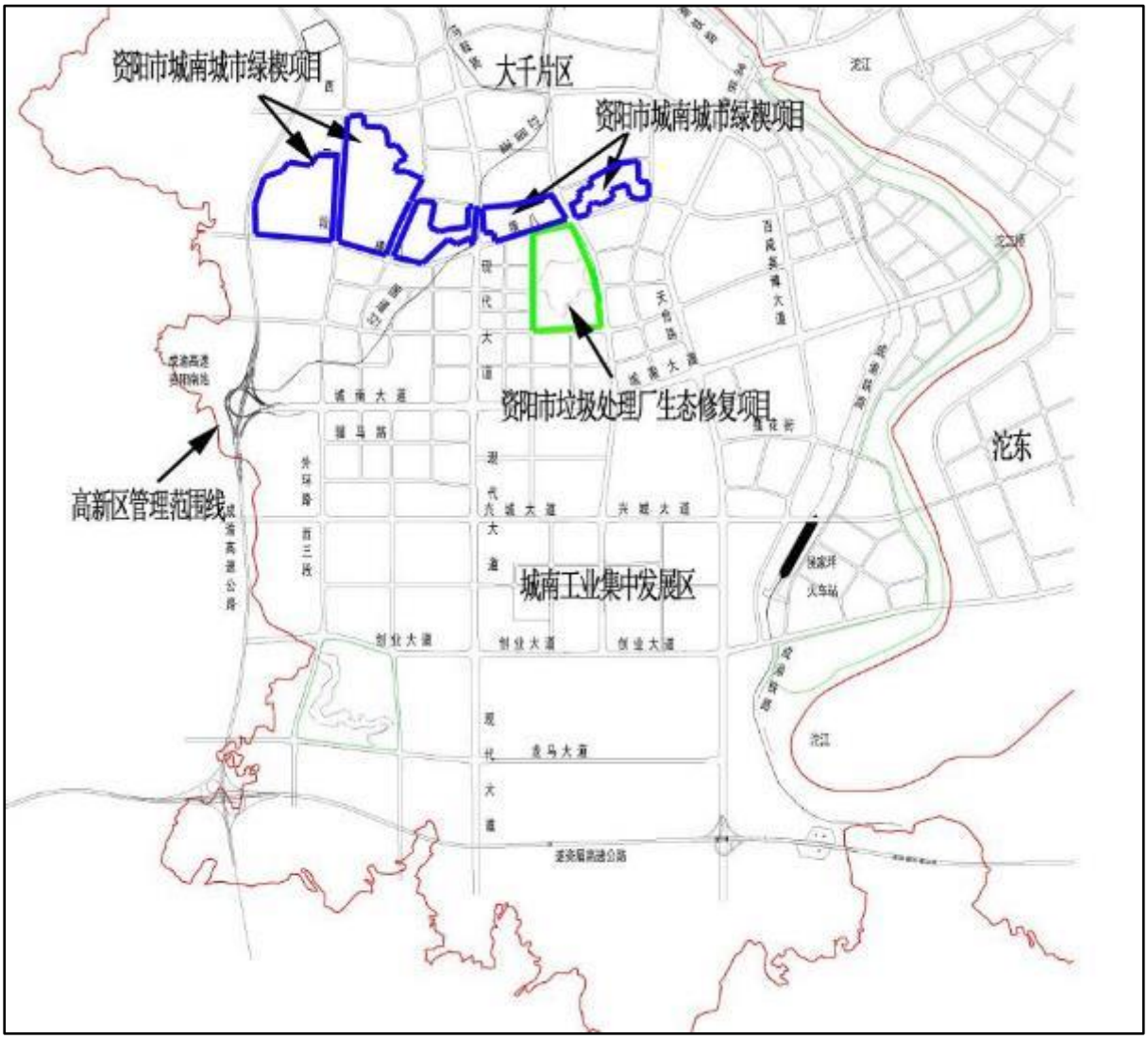
[25] Landfill restoration involves the capping of the site, with vegetation and landscaping of the completed site. However landfill gas extraction and leachate treatment would need to continue possibly for 20 to 30 years after closure.

197. The closure of the landfill and the treatment of MSW in a WtE plant is consistent with the National 13th FYP for Municipal Solid Waste Management that encourages the switch from landfill disposal of MSW to treatment using WtE, with the generation of electricity from this renewable energy source. This FYP plan sets 2020 as the target for 50% or more of the PRC's MSW to be treated by WtE incineration technologies.

198. The landfill, which covers an area of about 17.5 ha, is surrounded by wooded areas, and agricultural land, together with some dwellings and farm buildings. On the Ziyang Master Development Plan the landfill lies in the middle of a roughly rectangular tract of land bounded by the proposed Hengba Road (which runs west to east) to the north. Proposed roads will bound the rectangular area around the landfill, which in total area (including the landfill) would cover about 37 ha.

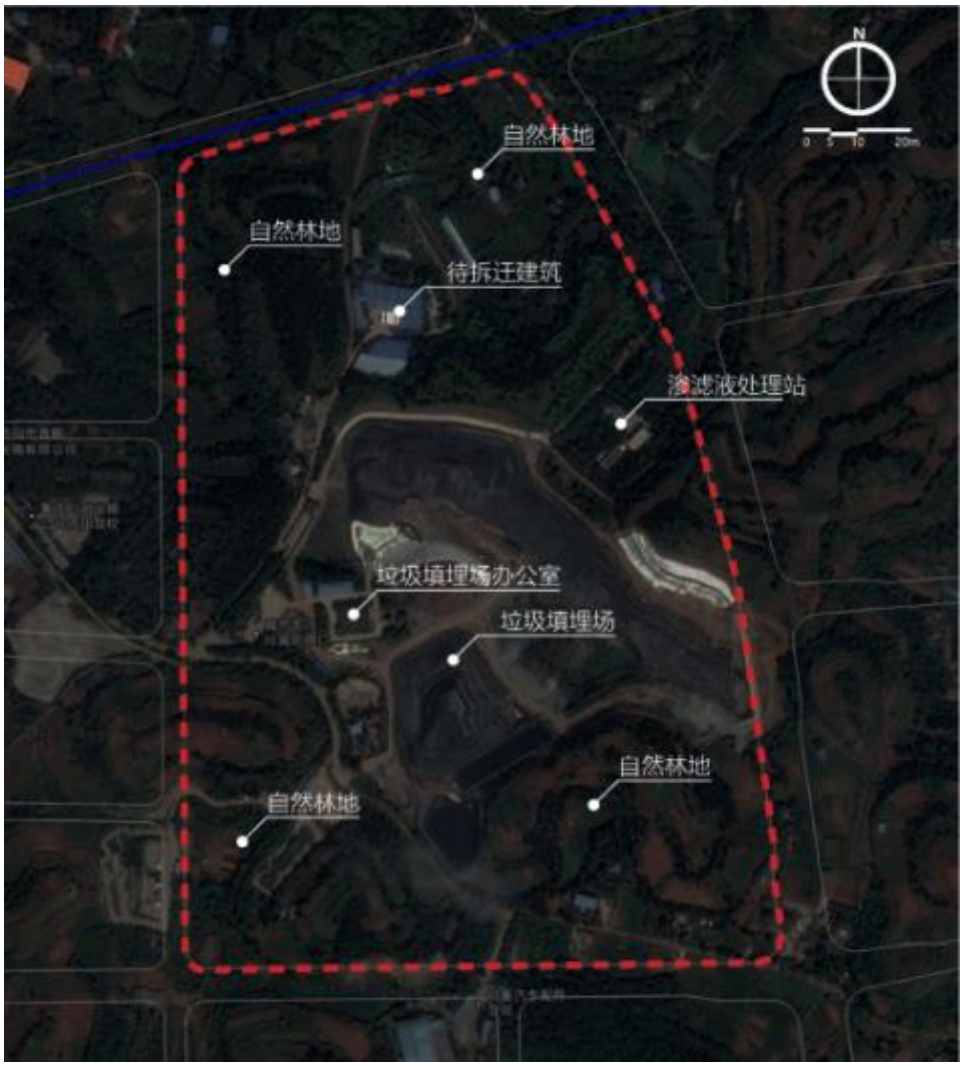
199. The Sichuan Ziyang High Technology Development Zone (SZHTDZ) Administrative Committee has a long-term plan to develop this 37 ha tract of land into a green public open space area to enhance Ziyang's ecological resource, create a green lung within the center of SZHTDZ, and as a demonstration of sustainable development. This open space area would be integrated into the city's overall planning, and be contiguous, and share a consistent theme, with the proposed "green wedge" that runs approximately west to east on the north of Hengba Road. Both the open space area and the green wedge would have linkages into adjacent residential and industrial areas.

Figure 17: Location of Zhongshan Landfill



(Landfill boundary shown in green; Green Wedge boundary shown in blue)

Figure 18: Zhongshan Landfill Boundary



200. Therefore this component comprises two major elements:

(a) The closure and restoration of the Zhongshan sanitary landfill
(b) The development of the green public open space area

201. In terms of the green public open space area, the planning intent (as set out in the FSR) is to create an urban park that displays Ziyang's historical heritage in harmony with nature, including sightseeing opportunities, with space for leisure and entertainment activities.

202. The development of this area of green public open space is consistent with the 13th FYP that sets out the following: "We will strengthen the development of facilities for preventing flooding and waterlogging and managing water flow as well as the development of parks, green spaces, and other such facilities for supporting urban ecosystems, support the development of sponge cities, and improve urban public facilities."

Design Requirements and Considerations

203. When a landfill is full and does not receive any more waste, the site should be closed and "restoration" carried out; where "restoration" is defined as the installation of long-term

measures to control and manage landfill gas and leachate, and cap the surface of the waste to stop the ingress of water (which would otherwise produce leachate), and landscape and vegetate the site. After a site is restored, the landfill owner still needs to continue operating landfill gas extraction systems with flaring (as a minimum), and leachate treatment, which could continue for up to 20 years or more after closure. PRC design standard, GB51220-2017[26], sets out the design requirements for closure and restoration.

204. The scheme for closure and restoration of the sanitary landfill includes the following aspects:

(a) Carrying out detailed geotechnical investigations, including hydro-geological investigations

(b) Assessing the stability of the so-called "garbage dam" at the toe of the landfill, which overlooks the leachate treatment plant; and remedial measures to improve geotechnical stability, if required.

(c) Installation of an active landfill gas extraction system.

(d) Decommissioning of the temporary leachate storage lagoons.

(e) Stabilization of sludge pit.

(f) Closure and capping of landfill, including compacting the surface of the waste mound, and applying a capping system, which includes a drainage layer and a geomembrane to minimize the infiltration of rain water falling on the site. The top layer of the capping system should be soil, which is sufficiently thick to allow for the landscaping of the site, and to avoid damage to the geomembrane by tree roots. Where open space afteruse infrastructure is to be developed on certain sections of the site, the final soil layer should allow for the construction of drainage channels and the installation of utilities etc.

(g) Landscaping and vegetating the capped area

(h) Construction of a competent cut-off drain around the landfill site, which should:

i. prevent rain water flowing into the site

ii. separate uncontaminated storm water flowing from the site, without mixing with any leachate discharge; and

iii. allow such uncontaminated storm water to discharge into an adjacent water course or drainage system.

(i) Providing an appropriate surface water drainage system on the capped surface of the landfill.

(j) Addressing any leakage of leachate from the site, particularly any leachate that is not contained by, or bypasses, the garbage dam.

(k) Upgrading the leachate collection system to ensure leachate is collected, and piped to the leachate treatment plant.

(l) Developing and establishing measures for the disposal of leachate concentrate (the sludge-like material which is a residue after leachate treatment).

(m) Installation of appropriate monitoring wells and points around the closed landfill for

[26] Ministry of Environmental Protection, PRC. 2017. *GB52210-2017: Technical Code for Municipal Solid Waste Sanitary Landfill Closure.*

the analysis of surface water quality, landfill gas emissions and groundwater.

(n) Continuing with the operation of the leachate treatment plant.

(o) Operating the landfill gas management system.

(p) Inspecting and carrying out maintenance work on the landfill cap and associated landfill infrastructure.

(q) Monitoring around the site to detect any landfill gas migration, and water quality variations. A regular monitoring regime should be set up that includes downstream groundwater and water course monitoring, with monitoring data being compared with base-line measurements taken before closure was carried out. A Key Performance Indicator for landfill closure and restoration should aim to demonstrate improvement in groundwater quality, though depending on the hydro-geology of the site, and any other adjacent polluting sources, there may only be some improvement in the long term.

Project Benefits and Outcomes

205. The uncontrolled release of landfill gas can impact on the environmental condition and the health of the local community, and lead to risks of explosions in the surrounding area. By managing and collecting landfill gas in a controlled manner, the environmental impacts, health risks and potential for explosions are greatly reduced.

206. A landfill typically blights the surrounding area, with local residents siting NIMBY concerns, and complaining about odor (actual or imagined), nuisance, dust, additional traffic, health impacts etc. As soon as the landfill is closed and restored, the complaints often reduce with the perceived removal of the “blight”; and the community benefits as property values rise. If, for example, a golf course were to be developed on an old landfill, this additional amenity could further boost property values.

207. Closing and restoring a landfill for community recreational purposes, provides an opportunity to enhance leisure amenities for the public. The creation of community recreational space provides benefits by: providing desirable green space, often in heavily urbanized areas; expanding the availability of nature trails for use by ramblers, and sports activities to promote community health and wellness; and restoring natural habitats and providing areas where wildlife populations can be conserved.

208. An indirect benefit of closing a landfill and diverting the waste to a WtE plant, is the generation of electricity from renewable energy resources (ie MSW) that substitute for fossil-fuel energy sources.

Climate Change Aspects

209. Landfills reduce GHG emissions where landfill gas is collected and either flared off, or utilized beneficially as a source of energy; with a climate change benefit resulting from the reduction in GHG emissions. It is estimated that simple flaring costs from US$6 to $25 to remove one ton of carbon dioxide equivalent (CO_{2e}) from dispersing into the atmosphere.

Innovative Aspects

210. The Zhongshan sanitary landfill is due to be filled to completion in 2020, at which time it will be closed and restoration works carried. Already an afteruse scheme has been developed, and as a consequence the remaining placing of waste within the landfill can be designed such that the profile of the capped waste is complementary to the open space

layout. As a result the excavation of waste (and associated costs) to "sculpture" the site to the necessary profile can be minimized. It should also be possible to adapt the existing access roads and landfill management office to be incorporated into the open space development – this would be an example of sustainable development, and a cost-effective approach to restoring the site for a beneficial afteruse.

3.6 Green Wedge

Summary

211. This sub-component consists of the creation of a "green wedge" to develop an existing undeveloped hilly and gully area as a natural barrier between the residential Ziyang old town and the northern production part of SZHTDZ. This 123 ha area will form an "urban green lung" to improve the urban environment, and will also be accessible to the public as a recreational resource and for the enjoyment of nature. This green wedge will maintain a designated area of open space between urban residential areas to the north, and the industrial area to the south; and is planned to spatially coordinate with the green landscaping of the closed landfill and the re-generation of the Yannan Wetlands to the south.

Sub-Component Rationale and Objectives

212. The 13th FYP in Chapter 34 states: "We will build green cities by adjusting the scale of cities in accordance with their resource and environmental carrying capacities, using eco-friendly planning, design, and construction standards, and carry out initiatives to build ecological corridors and restore ecosystems."

213. And in Chapter 45 states: "Affording high priority to environmental protection and letting nature restore itself, we will ensure the protection and restoration of ecosystems, build ecosystem service corridors and biodiversity protection networks, and work to make natural ecosystems more stable and better able to provide services, thereby building robust ecological security barriers." and

214. "We will strengthen protection of scenic areas, forest parks, wetland parks, and desert parks, improve roads and other infrastructure in forest areas, and promote the appropriately scaled development of goods and services for leisure activities, tourism, and health activities. We will accelerate the development of urban-rural ecological infrastructure such as greenways and country parks, and promote the development of forest towns and cities. We will launch high-quality eco- tourism routes and open up more ecological spaces."

215. The SZHTDZ Administrative Committee has a long-term plan[27] to develop a 123 ha tract of land into a green public open space area (the green wedge) to enhance Ziyang's ecological resource, create a green lung within the center of the SZHTDZ, and as a demonstration of sustainable development. This open space area would be integrated into the city's overall planning, and be contiguous, and share a consistent theme, with the proposed "open space area" on the restored Zhongshan landfill that lies to the south of the green wedge. Both the open space area and the green wedge would have linkages into adjacent residential and industrial areas.

216. The concept of a green wedge is an adaption of the green belt concept that was first introduced in the United Kingdom, where a green belt around an urban area is used as a policy approach for controlling urban growth. The idea is for a ring of countryside, where urbanization would be resisted for the foreseeable future, to be maintained, with agriculture, forestry and outdoor leisure being prevailing activities. The fundamental aim of the green belt

[27] Ziyang Green City Master Plan (2012-2020)

policy is to prevent urban sprawl by keeping land permanently open, and consequently the most important attribute of green belts is their openness.

217. However after many years of implementation the green belt is seen in the 21st century to be a constraint, creating an area that is often inaccessible and irrelevant to many people; and damaged from uncontrolled public access and unauthorized trash dumping. [28] Complaints against green belt include:

(a) it isn't always scenically attractive or accessible to the general public;

(b) it increases property prices and constrains economic development by constraining urban areas and the availability of developable land;

(c) it increases commuting distances for those forced to live beyond its outer edges, which reduces urban sustainability; and

(d) it reinforces inequality between those lucky or wealthy to live within the green belt and those who do not.

218. An alternative to the green belt is the green wedge, which has a similar purpose to prevent the coalescence of settlements and maintain open spaces within settlement boundaries. A green wedge can contain a mix of agriculture and low-density activities:

(a) recreation (e.g. walking)

(b) infrastructure that supports urban areas, for example water treatment facilities

(c) restored sites previously used as quarries for the production of construction materials for the building industry

(d) cultural heritage sites

(e) biodiversity (flora and fauna) conservation areas

(f) water catchments.

219. The green wedge concept overcomes several of the inherent constraints of the green belt:

(a) wedges can be carefully allocated to protect and proactively manage in the long term the cherished landscape and cultural assets that society wishes to retain

(b) permanence encourages long-term investment and community support

(c) wedges do not encircle urban areas, but provide for intervening development growth and for public transport corridors

(d) wedges ensure continued local access to green space services

(e) wedge management and enhancement can be funded from associated adjoining developments, and caters directly for the needs of that population

220. Green wedges "protect the integrity and setting of communities, neighborhoods and settlements, manage urban form through controlled expansion of urban areas, and assist in the safeguarding of the countryside from encroachment and assist in urban regeneration by encouraging the recycling of derelict and other urban land".[29]

[28] Ian Lindley. 2017. "*Green belt vs. green wedge*" Landscape Institute, UK, 30 January 2017 https://www.landscapeinstitute.org/blog/green-belt-vs-green-wedge/

[29] Planning Policy Wales, 2002

Design Requirements and Considerations

221. According to the Standard for Basic Terminology of Urban Planning in China, urban green space is a green space improving the urban ecology, protecting the urban environment, providing recreational sites for the urban residents, and beautifying the urban landscape.

222. Types of green spaces according to the "Standard for Classification of Urban Green Space (CJJ/T85-2002)" include:

(a) parks;

(b) productive green space, such as plant nurseries;

(c) protective green space including isolation strip, roadside green buffer, urban high voltage line greenbelt corridor, windbreak, city cluster isolation strip;

(d) attached green space, all kinds of attached green space in urban construction land in addition to green space such as green spaces in residential areas, green spaces in industry land use, green spaces for traffic or electric infrastructure;

(e) other green spaces including scenic spots, water source protected areas, country parks, forest parks, nature reserves, scenic forests, urban greenbelt areas, wildlife parks, wetlands, landfill restoration green space, etc.

223. The Shanghai Master Plan (2001-2020) defines six kinds of strategic green space:

(a) green belt,

(b) sensitive areas for construction,

(c) sensitive areas for ecology,

(d) forests,

(e) vegetable protected areas and

(f) green wedges.[30]

(g) Shanghai's strategies for preserving green spaces include:

(a) developing small public green spaces in the central city and forests in suburbs;

(b) setting a target of green space as a percent of total land area (35% in Shanghai); and

(c) setting for each resident a green space area (in Shanghai, at least 12 m^2 public green space by 2020).

224. The Wuxi Green Space System Plan (2001-2020) has a number of strategies:

(a) develop a 500 meter green space control building area at the border between Wuxi, Changzhou and Suzhou that acts as a green belt to prevent urban sprawl;

(b) develop three green space corridors along north to south streets; and 1 green space corridor along the east-west river to improve the linkage of the green spaces into a green system;

[30] Jinghuan He. 2012. *"Implementation of the Shanghai Master Plan (2001-2020)*", Association of European Schools of Planning (AESOP) 26th Annual Congress, Middle East Technical University (METU), Ankara Turkey, 11-15 July 2012.

(c) develop four green wedges and many green cores;

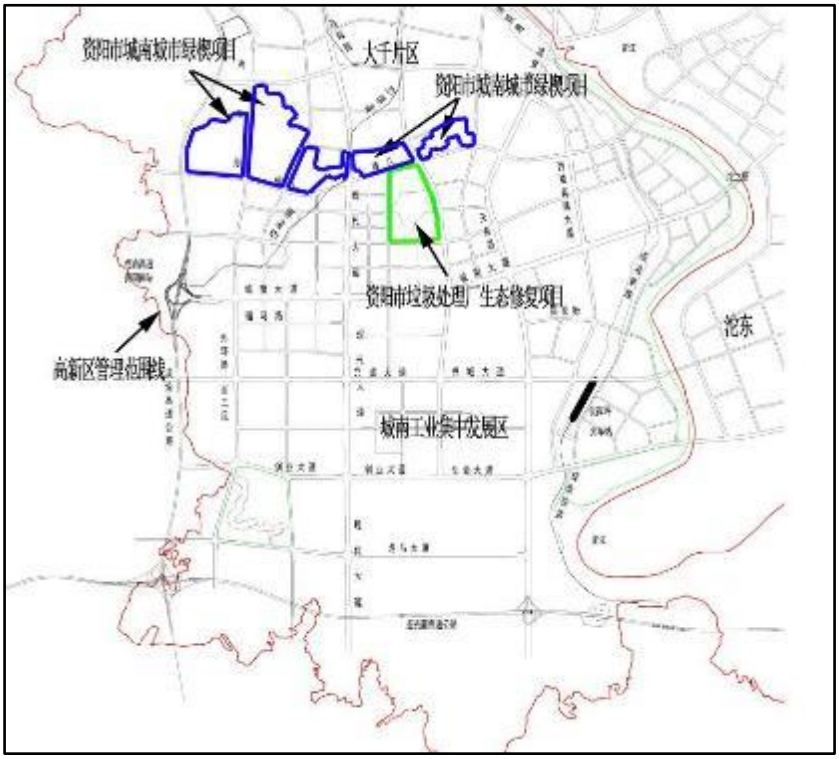
(d) set a target of green space as a percent of total land area (42% in Wuxi);

(e) set for each resident a green space area (in Wuxi, at least 13 m^2 public green space by 2007).

225. The existing hilly and gully area in Ziyang is a natural barrier between the residential Ziyang Old Town and the southern production part of SZHTDZ. This area forms an "urban green lung", improves the urban environment, and can also be a public place for citizens to enjoy nature. The green wedge is planned to spatially coordinate with the green landscaping of the closed landfill and the Yannan Wetlands to form an area of green space.

226. 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 infrastructure development component (roads, parking, service oriented facilities such as toilets) about 13 ha. Land use within the Ziyang Green Wedge is shown in Figure 19.

Figure 19: Location of Green Wedge in Western Part of SZHTDZ



(Green wedge in blue)

Table 13: Ziyang Green Wedge Elements

Item	Name	size (ha)	Percentage
1	Green area (ecological restoration)	110.4	90%
2	Water area	2.3	2%
3	Hard paving area (roadway, sidewalk, activities, playground)	8.8	7%

4	Rest (pavillion) and service facilities (toilet, security, plant greenhouse)	1.6	1%
Total area		123	100%
Green rate (including water)		92%	

Project Benefits and Outcomes

227. The prime benefit of this sub-component is to create a natural barrier and non-building zone between the residential Ziyang old town to the north and an industrial area within SZHTDZ to the south. Creating a geographic separation between residential and industrial areas benefits the urban residents as they are not impacted by noise, dust, traffic, and air emissions from the industrial area. A parallel benefit of this 123 ha "urban green lung" is to improve the urban environment, by making this area accessible to the public as a recreational resource and for the enjoyment of nature.

228. As cities become more populated, there is increased pressure on municipal authorities to develop more "accessible" land for housing. Green areas are often high on the list of possible sites. However, the community as a whole benefits where a green wedge has been designated as non-building zones, as such zoning can provide a high level of protection against urban encroachment.

Climate Change Aspects

229. This sub-component includes the restoration and improvement of an existing hilly and gully area, and tree planting and other soft landscaping. Such restoration and planting has a climate change benefit through carbon sequestration, i.e. the natural capture of carbon dioxide from the atmosphere through biological, chemical, and physical processes, thereby slowing the atmospheric accumulation of greenhouse gases, which are released by the burning of fossil fuels.

Innovative Aspects

230. As with the green wedge, this sub-component is another example of a greener, more sustainable, public-oriented approach to urban planning. An area of natural and largely unspoilt terrain has been "saved" and will not be bulldozed to create a featureless cityscape. The natural characteristics of the green wedge's topography, which contribute to the character of this part of Ziyang, are protected including slopes and prominent ridgelines that have a high visibility in the landscape. The design of this green open space is sensitive to natural settings, and respects existing landforms, whilst minimizing re-grading and site disturbance. Prominent topographic features such as knolls, outcrops, ravines and lakes are included in the scheme, without much alteration. Where earthworks are necessary to include tracks and paths, a minimum of hard surfaces are used; and uniform and sharp geometric forms are avoided, with finished contours appearing smooth, rounded and natural.

231. The development of the scheme has been coordinated between different stakeholders[31] taking account of the planning for urban residential developments, industrial areas, access, transport links, agriculture, sustainability and environmental protection. The

[31] "Challenges, Lessons Learned and Best Practices in Establishing Landscape Conservation Areas in Namibia", Ministry of Environment and Tourism (MET), Windhoek, Namibia, Africa, 2015.

resulting development provides a natural recreational and attractive resource for public education and enjoyment, and adds character to this corridor on the western side of SZHTDZ.

3.7 Ecological Preservation of Bare Hills

Summary

232. This sub-component consists of remedial measures to a series of steep un-vegetated cut and fill slopes located in the urban areas, some in immediate juxtaposition to occupied residential buildings. The slopes were formed as a result of improper excavation for roads, buildings, and borrow pits. These un-vegetated slopes are vulnerable to soil erosion from rain and wind. Increased precipitation and extreme rain storm events, as a result of climate change, could potentially result in more erosion, with the possibility that parts of these slopes could fail suddenly if the soil becomes saturated and loses strength. The remedial works at nine sites will provide stabilization and ground cover and reduce vulnerability to weather events.

Sub-Component Rationale and Objectives

233. Improper excavation for roads and buildings, and the development of borrow pits (to supply soil for filling low-lying areas) has resulted in series of steep and un-vegetated slopes that are vulnerable to raveling and soil erosion from wind and water. Increased precipitation and more extreme storms could result in even more erosion and perhaps a sudden slope failure.

234. This sub-component comprises remedial works to stabilize these slopes, and providing ground cover to reduce vulnerability to weather events.

(f) Slopes of this nature can be categorized by the risks that they pose to persons and property:

(a) A steep slope behind a building (see ***Photos 2 and 5***) poses a risk of slope failure that could cause property damage, and potentially impact the building occupants. This type of slope needs immediate action. In the case of ***Photo 5,*** the slope has been covered with sprayed concrete (also known as shotcrete), which provides protection from erosion and raveling of the slope face, but although this slope is not particularly high, its stability should be checked by carrying out slope stability calculations. A slope of the type shown in ***Photo 2*** should be cut back to a flatter angle based on slope stability calculations. Subject to PRC codes, a factor of safety of at least 1.4 should be achieved.

(b) The failure of a steep slope below a building poses the risk of the building collapsing, and again this type of slope needs immediate action. Firstly to investigate the slope by sinking geotechnical drillholes, and carrying out a geological assessment, and secondly carrying out a slope stability assessment.

(c) A moderately steep slope adjacent to a highway, although it may be raveling and eroding, poses a lesser risk (see ***Photos 4 and 6***). In this case surface protection to control surface deterioration may be sufficient.

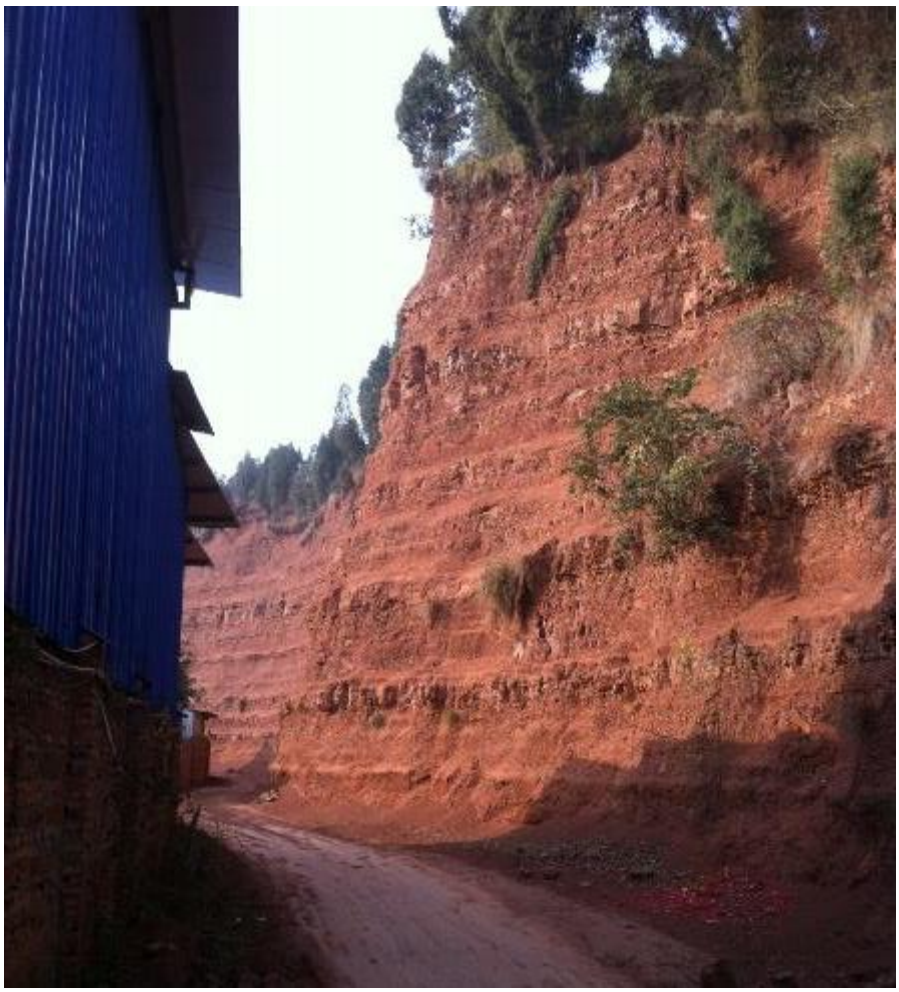
(d) An irregular steep slope, including near vertical faces (see ***Photos 1 and 3***), adjacent to a highway or track, poses a greater risk than the case (c) above, and the slope

should be trimmed to a flatter angle (based on slope stability calculations), and surface protection provided.

235. Some steep slopes may appear to be stable, and may show no signs of raveling and erosion (see Photo 7), but in the context of a “green city” should be given some vegetative cover

236. One method of addressing raveling and erosion is to use sprayed concrete (also known as shotcrete) (see Photos 5 and 8). Although such surface protection can address raveling and erosion, it does not improve the overall stability of a slope, which would normally require excavating the slope to a flatter angle or providing some external support such as a concrete buttress, or using dowels or bolts to strengthen the slope. However the use of sprayed concrete in an urban environment, especially a green city, is generally seen as “unattractive”.

Figure 20: Photo of Slope 4



237. **Slope 4:** This is an example of a cut slope alongside an unpaved track that provides access to a village community. There is a factory building on the left hand side of the photo. The slope is near vertical in places, and because of its irregularity would appear to have been formed without reference to any approved design scheme. The slope is heavily weathering mudstone, and includes characteristic horizontal “rock” lenses, though these lenses are also significantly weathered. Typically too there is a debris “pile” of material at the

toe of the slope from material that has raveled[32] from the slope face. Natural ground is visible at the top of the slope, which is well vegetated. The slope is likely to continue to deteriorate, with debris falling down the slope face. Drier conditions allow the surface to desiccate, with the soil losing its natural cohesion, and in turn promoting raveling. Wetter conditions could in turn promote erosion. If a sufficiently large amount of soil debris ravels from the face, a block of "rock" from one of the lenses could be undermined, and fall into the road. In turn this could result in material above the lense losing support, and also falling. The photo shows some vegetation at the top of the slope has been dislodged, illustrating the gradual deterioration of the slope surface causing undermining. Remedial works here comprise flattening the slope angle, and providing coconut fiber surface protection.

Figure 21: Photo of Slope near Kill Mountain Community

238. **Slope near Kill Mountain Community**: This is an example of slope which is immediately adjacent to an occupied building. In fact to reach the slope, one needs to walk through the building. This slope has similar features to Slope 4, but appears to have a

[32] Where a slope is raveling, granular particles and small stones become loosened or dislodged from the slope surface, and fall or roll down the slope surface.

somewhat more uniform face. Again there is evidence of a lot of debris at the toe of the slope that has raveled from the face. If this overly steep slope were to fail (i.e. if there was a landslide), the adjacent building would be damaged, and building occupants could be impacted. As there is very limited working space at the toe of the slope, it appears that the slope was formed initially and the building erected subsequently. In many jurisdictions the construction of a building in such close proximity to a steep slope of this nature would not be permitted, and would be in breach of building regulations. Similar to Slope 4, there is evidence that vegetation at the top of the slope is being undermined and falling from loss of support. Slope remedial works here should include cutting the slope back to a safer angle, rounding the face to blend into the natural terrain, followed up by slope protection.

Figure 22: Photo of Slope 2

239. **Slope 2:** This slope has similar features to Slope 4, and is near vertical at the top. A lot of debris has accumulated at the slope toe. The slope has been formed adjacent to a

concrete paved road that serves a local community. A particular feature of this slope is the presence of a transmission pylon at the crest of the slope that precludes any significant re-shaping of this slope to a flatter angle.

Figure 23: Photo of Slope near Slope 3

240. **Slope near Slope 3:** This is a roadside slope, which from its appearance, is older than the slopes pictured above. This slope too is similar to the slopes pictured previously, but appears to be less steep. There are obvious signs of vegetation developing on this slope, though there is still debris raveling from the face. Being a roadside slope, remedial works here could be limited to surface protection, i.e. some form of grassing.

Figure 24: Photo of Slope near Slope 3

241. **Slope near Slope 3:** This slope is a “leftwards” extension of the slope above. Here the steep slope behind the building has been shot-creted for protection against raveling or failure.

Figure 25: Photo of Highway Slope in Waihuanlu Xiyiduan

242. **Highway Slope in Waihuanlu Xiyiduan:** this is shown as an example – this slope is not part of this sub-component. This roadside slope is formed at an angle of approximately 2 (V) to 1 (H), although some of the upper faces appear a little steeper. The slope has been covered by a protective mesh, and there are signs that vegetation is gradually developing on this slope. Slopes of this type should be kept under observation, but no immediate remedial action is suggested.

Figure 26: Photo of Slope on Industrial Site in Waihuanlu Xiyiduan

243. **Slope on Industrial Site in Waihuanlu Xiyiduan:** this is only shown as an example – this slope is not part of this sub-component. This slope appears relatively stable, and is not exhibiting major signs of raveling and erosion, but in the context of a "green city" should be given some vegetative cover

Figure 27: Photo of Slope behind Meteorological Bureau in Waihuanlu Xiyiduan

244. **Slope behind Meteorological Bureau in Waihuanlu Xiyiduan**: this is only shown as an example – this slope is not part of this sub-component. This steep slope has been covered by sprayed concrete (shotcrete) to protect it from raveling and erosion.

Design Requirements and Considerations

245. This sub-component includes 9 slopes

Table 14: Location of Bare Hills for Preservation Work

Number	Name	Longitude	Latitude	Slope (meters)		Type	Repair measures
				length	height		
1	Huai Shu bei Lu exit	104.608589°	30.143314°	100	30	Sandy Mudstone cut slope	Engineering Management Ecological restoration
2	Outer Ring Palace Mountain	104.609167°	30.146116°	200	30	Sandy Mudstone cut slope	Engineering Management Ecological restoration
3	Kill Mountain Community Ten Group of Hydraulic machinery	104.615949°	30.111851°	300	30	Strong weathering, fully weathered mudstone cut slope	Engineering Management Ecological restoration
4	Kill Mountain Community 6 Group Peace car industry	104.615317°	30.109949°	300	30	Strong weathering, fully weathered mudstone cut slope	Engineering Management Ecological restoration
5	Hongyan Community 6 , 8 Group Dumping site	104.602851°	30.128562°	800	40	Engineering excavation of dumped soil	Engineering Management Ecological restoration
6	Five shows 11 social dumping ground	104.610294°	30.097932°	1500	30	Engineering excavation of dumped soil	Engineering Management Ecological restoration
7	North of Chuangye Avenue	104.632605°	30.067352°	1350	15	Strong weathering, fully weathered mudstone cut slope	Ecological restoration
8	Thriving Road	104.627987°	30.071350°	650	15	Strong weathering, fully weathered mudstone cut slope	Ecological restoration
9	Xing Sheng Lu	104.623733°	30.069979°	460	15	Strong weathering, fully weathered mudstone cut slope	Ecological restoration

Source: Table 6.3-1 Information Table of Hill Ecological Restoration Point, Ziyang FSR.

246. Remedial works (see Table 15) are based on a combination of:

(a) Engineering management – e.g. cutting the slope to a flatter angle, or using some engineering means to support the slope

(b) Ecological restoration – surface protection using grassing or some other form of treatment e.g. coconut fiber mesh turf protection (see ***Figure 10***).

Table 15: Ecological Rehabilitation Works of Bare Hills

Number	Name of the Hill	Earthwork m^3	Eco-fix area m^2	Type of repair action
1	Huai Shu bei Lu exit	/	6,708	Anchor Shotcrete + Vine cover
2	Outer Ring Palace Mountain	210,437	11,562	Slope Repair +CF Mesh Turf Protection
3	Slaughter Mountain Community Group of hydraulic machinery	93,750	7,537	Slope Repair +CF Mesh Turf Protection
4	Kill Mountain Community 6 Group Peace car industry	36,450	7,537	Slope Repair +CF Mesh Turf Protection
5	Hongyan Community 6,8 Group dumping site	40,000	63,630	Excavation, compaction and grassing
6	Wu Hin Village 11 social dumping ground	49,280	149,790	Compaction and grassing
		6000	10,800	Planting Soil + Greening
		/	/	Interception drainage 1,400m
7	Chuangye Avenue	/	6,000	Grassing
8	Thriving Road	/	5,000	Grassing
9	Xing Sheng Lu	/	9,000	Grassing

Source: Table 6.5-1 Preservation Works of Bare Mountains, Ziyang FSR,.

CF = coconut fiber

Figure 28: Coconut Fiber Mesh "Turf" Protection

Project Benefits and Outcomes

247. Remedial works to slopes under this sub-component include a combination of two aspects:

(a) **Engineering measures** to increase the factor of safety of the slope against failure, e.g. reducing the risk of a slope failing in a landslip mode, and damaging property and/or impacting members of the public

(b) **Surface protection** to the slope surface to arrest raveling and erosion (i.e. small particles of soil and rock, and occasional boulders falling down from the slope face), which can pose a risk to property and the public at the slope toe. An excessive degree of raveling and/or erosion could however ultimately cause part of a slope to fail in a landslip mode.

248. Therefore both engineering measures and surface protection are providing the benefit of risk reduction in terms of lessening the risk of property damage or personal injury.

249. A secondary benefit is providing “green” slopes that improve landscape views, and enhances the urban cityscape.

Climate Change Aspects

250. Climate change is expected to see more severe storms and higher rainfall, and periods of drought. Any increased precipitation increases the risk of slope failure, and slope erosion.

Innovative Aspects

251. This sub-component consists of slope remedial works to improve the stability of slopes and reduce the risk of slope face erosion. Retrofitting such works is complex. For example carrying out remedial works on a slope such as that shown in Photo 2 would be complicated and costly. But this sub-component does demonstrate the need to construct slopes “properly” in the first place.

252. An innovative outcome from this sub-component would be a set of guidelines that could be used by planners and engineers to reduce the risk of “improper” slope construction in the first place.

===end of main text===