WB-Funded Project

Hubei Inland Waterway Improvement Project

(Yakou Navigation Complex Project)

Yakou Complex Works

Environmental and Social Management Plan (ESMP)

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Contents

1 Introduction

The middle and lower reaches of the Han River are vast and boast a large population, rapid socio-economic development and rich hydro-energy resources, and the mainstream boasts good conditions for development of water transportation, and serves as an important channel for water transportation. Han River Yakou Navigation Complex Project ("The Project") is the 6th complex along Han River mainstream in Hubei Province. The dam site is located in Yakou Village of Xiangbei Farm, 15.7km downstream from Yicheng City, 52.67km from Cuijiaying dam, and 59.38km from the planned Nianpanshan dam. The Project is provided with comprehensive functions in addition to shipping, such as power generation, irrigation, and tourism, etc.

The control drainage area of the dam site of the Project is 133,087km^2, with the annual average discharge of 1,100m^3/s. The main buildings and structures consist of earth-rock dam, sluice gate, low-head powerhouse, ship lock, and fishway, etc. The normal water level of the reservoir is 55.22m, with the corresponding storage capacity of 350.2 million m^3 (daily regulation); the Grade-III waterway is 52.67km long, design ship tonnage allowed by the ship lock is 1,000t, installed capacity of the power station is 75.0MW, and annual average generating capacity is 252 million kW·h.

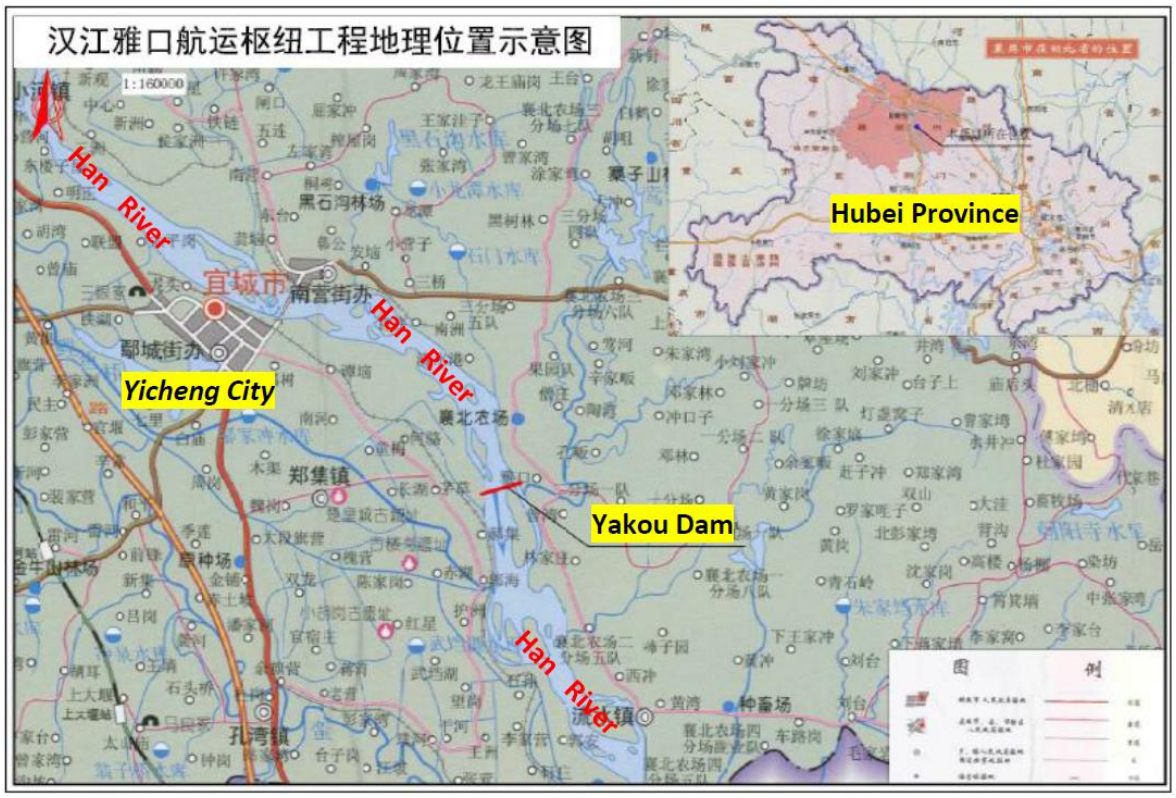


Figure 1-1 Map of Project Location

According to the Reply to the *Request of Xiangyang Municipal People's Government for Instructions on Determining the PIU of Han River Yakou Navigation Complex Project* issued by Hubei Provincial People's Government in November 2011, Hubei Provincial Transportation Department organized a special team to start the preliminary research of the Project.

To speed up the preliminary preparatory work of the Project and fulfill the environmental protection and water and soil conservation of the Project, according to the *Notice on Strengthening Environmental Protection of Hydropower Construction* (HF[2005] No. 13) jointly issued by the Ministry of Environmental Protection (MEP) and the National Development and Reform Commission, in August 2012, Hubei Provincial Transportation Department Port and Waterway Administration entrusted Zhongnan Engineering Corporation Limited of Power Construction Corporation of China (hereafter referred to as "the Company") to undertake the preparation of the environmental impact statement (EIS) of the Project. In November 2015, the Company completed the preparation of the *Environmental Impact Statement of Han River Yakou Navigation Complex Project*. The

latter passed the technical assessment by the Environmental Engineering Assessment Center of the Ministry of Environmental Protection in December, was published on the website of Hubei Provincial Transportation Department Port and Waterway Administration and the website of the Ministry of Environmental Protection in January 2016, and was approved by the Ministry of Environmental Protection on February 17, 2016 on the HS [2016] No. 13 Document.

As the Project is currently applying for the World Bank loan financing, as entrusted by Hubei Provincial Transportation Department Port and Waterway Administration in December 2015, the Company prepared the *Supplemental EIA Report*, *CEIA Report*, *ESMP of the Project*, *ESMP of Reservoir Embankment Project* and *EIA Executive Summary* tailored for the assessment requirements of the World Bank according to the safeguard policies of the World Bank.

The *ESMP of the Project* (ESMP) is prepared based on the conclusions and comments of the original and the Supplemental *EIA Report* in combination with the general principles of the best environmental management practices in the construction period. The ESMP will serve as an Appendix to the contract documents of the Contractor of the Project, and form a part of the legal documents of the World Bank loan agreement. This document is the second draft of the *ESMP of the Project* (ESMP).

2 Purpose of the ESMP

The EIA of the Project shows that the main adverse environmental impact of the Project mainly includes the impact of waste gas, waste water, solid waste and noise caused by construction, damages to the aquatic ecosystem of the original natural river section caused by changes of the water regime after impounding, submersion and inundation impact of vegetation, soil and other natural resources around the reservoir, etc. This ESMP will describe the environmental mitigation measures, environmental management, and supervision and monitoring, etc. in details, serving as the guiding document for the implementation of these activities, and its role is shown as follows:

(1) Determine the environmental mitigation measures for the affected items: Hubei Provincial Transportation Department Port and Waterway Administration, the EIA unit and the design institute carried out detailed on-site verification and validation for the affected items, and proposed effective environmental mitigation measures, which were incorporated into the engineering design.

(2) Provide the guiding document for environment protection: After review of the World Bank, this ESMP will be provided for the CSC, environmental supervision organization and other related parties during the construction period and operation period as the environmental protection document.

(3) Determine the responsibilities and roles of related parties: Determine the responsibilities and roles of related functional departments and regulatory bodies, and propose the channels and methods for the communication between various departments.

(4) Propose the environmental monitoring plan during the construction period and operation period: In order to ensure effective implementation of the environmental mitigation measures and early treatment of unforeseen or unexpected environmental problem, this ESMP proposes the environmental monitoring plan during the construction period and operation period.

3 Scope and structure of the ESMP

This ESMP describes the environmental and social mitigation measures tailored for the expected impact of the Project made by related units during the construction preparation stage, construction stage and operation stage in order to eliminate or reduce the possible impact on the ecology, environment, society or public health of the project construction and operation activities.

According to the project characteristics, this ESMP is tailored for the expected construction and operation activities which are most likely carried out during the Project development process, and covers the Project and its auxiliary works, diversion works, construction ancillary works, resettlement works, reservoir area embankment reinforcement works, transmission line works and other works related to the construction and operation of the Project, and the details are shown below. This ESMP determines the typical project activities, potential environmental risks or impact and related mitigation measures. The environmental impact and mitigation measures defined in this ESMP are made based on the final draft of the domestic EIA report and the supplementary EIA report (including the CEIA).

Table 3-1 Scope of the ESMP

No.	Subproject	Description
I	The complex	Implementing agency: Port and Waterway Administration of Hubei Provincial Department of Transportation
1	Main work of the complex	● For buildings of the complex, it is recommended the plan of building ship lock on the right bank and building power house on the left bank. The total length of dam axis is 3179.9m and the maximum height is 14.0m. Altogether 44 drain holes are arranged in the sluice gates. ● Water diversion works ● Waterway regulation works (limited to the ship lock)
2	Material site	● Two earth borrow areas: Yakou earth borrow area on the left bank and Luojiazhuang earth borrow area on the right bank; ● One gravel quarry: Longmentan quarry
3	Disposal site	● Two disposal sites and all spoils will be used to form the construction site. One is located in Class I terrace in downstream of left bank dam line and the other one is located in Class I terrace near right bank dam site. ● Part of the construction site will be used for dam management area; the remaining that is not occupied permanently will be rehabilitated upon completion of construction.

4	Transportation works, access roads	● Roads to outside of the construction site: Newly built access road with pavement elevation of 59.0m and total length of 1.3km on the left bank to connect with provincial road S218. Materials transport is mainly realized via the existing local roads. ● Roads in construction sites at left and right bank: 8 temporary construction roads with total length of 10.2km and a temporary road with length of 2.0km for other temporary works are required to be newly built or rebuilt.
5	Work camps	The total number of workers in the peak period is 2100 and two construction camps occupying 0.83hm2, including working camps and office building.
6	Fish protection facilities	Total length of fish pass is 951.08m. The length of bionic fishway is 560.58m and that of the project fishway is 390.5m. Build new fish stock enhancement station and release fishes of 4 million every year.
7	Reservoir bottom cleanup	Clean the reservoir area, including the buildings, structures and vegetation and so on before the impoundment to ensure the navigation safety and water quality after impoundment.
II	Land acquisition and resettlement work	Implementing agency: Port and Waterway Administration of Hubei Provincial Department of Transportation and People's Government of Xiangyang City
8	Resettlement	Altogether 35 households (91 people) are to be displaced. 18 households which are scattered in the reservoir area will be resettled in a decentralized way and most of 17 households in fisherman's cooperative of Yakou Village, Liushui Town where the dam is located will purchase the house by themselves and only 2 of them will be resettled in a centralized way. The resettlement area is located in the region with existing roads.
9	Faciliities rehabilitation of the reservoir area	● Reconstruct roads for farm machinery of 7.5km, 3 cargo terminals and 4 ferries; ● Protect or upgrade the telecommunication lines of 3.0km affected by the reservoir inundation; ● Measures of seepage interception, drainage and waterlogging: Change direction of gradient of Huangjia Ditch and deepen Huangjia Ditch on the right bank; reform Guohai Sluice and build Yejicheng pump station; build two waterlogging pump station at Guanzhuang Culvert and Sluice and Guhekou Culvert and Sluice on the left bank; heighten 10 small pump stations; rebuild, or seal and compensate, or upgrade 12 culverts and sluices.
10	Cultivated land protection work	Lift land in the reservoir area to form 12 lifted land areas to protect cultivated land of 13,413.79mu.
III	Transmission line project	Implementing agency: Hubei Electric Power Company
11	Supporting transmission lines	Build 110KV transmission lines of about 12km (Yakou power station to existing Zhengji substation)
IV	Embankment reinforcement in the reservoir area	Implementing agency: Xiangyang Water Resources Bureau and Xiangyang Waterway Administration

12	Embankment reinforcement in the reservoir area	Include Xiangcheng Oumiao section, Yicheng urban section and Yicheng Hedong section. The total length is 86.74km. 5km of Yicheng urban section was alrady completed in 2015 and the remaining will be completed before impoundment of the reservoir.

This ESMP is divided into 8 chapters:

Chapter 1: Introduction, which gives a brief introduction to the background information of the proposed project, the preparation basis for this ESMP;

Chapter 2: Purpose of the ESMP, which determines the main purpose of this ESMP;

Chapter 3: Scope and Structure of the ESMP, which describes the scope of the ESMP as well as the content organizing method of this document;

Chapter 4: Regulatory Framework, which describes the general regulatory framework applicable to the ESMP;

Chapter 5: Environmental and Social Impact Mitigation Measures, which specifies the potential environmental and social impacts of the Project and its mitigation measures according to the conclusions and suggestions of the original and the supplementary EIA reports;

Chapter 6: Environmental Monitoring Plan, detailed environmental monitoring plan is developed to better understand the implementation of the ESMP throughout the project period;

Chapter 7: Investment estimate, which determines the cost estimates and sources of funds tailored for all proposed environmental and social mitigation measures (including environmental monitoring and training);

Chapter 8: Implementation and Operation, which aims to ensure the realization of the established environmental objectives during the project implementation and operation process, and to determine the implementation organization of the ESMP, environmental training and awareness improvement plan, communications, documents & records, report preparation, etc.

In addition to the text, this ESMP also describe the engineering and non-engineering measures to be implemented by the Contractor during the construction period. It consists of a series of general environmental protection plans, which serve as the basis for good environmental management practice, including:

Appendix 1: Water and Soil Erosion Control Plan

Appendix 2: Reservoir Bottom Cleanup Plan

Appendix 3: Construction Environmental Specifications of Contractors

Appendix 4: Hazardous Materials and Wastes Management Plan

Appendix 5: Intangible Cultural Resources Management Plan

Appendix 6: Outline for Stage-II Cumulative Impact Assessment (CIA)

Appendix 7: Outline for Ecological Regulation (ER) Research

Appendix 8: Work Plan for Effect Evaluation of Fish Pass

The above appendixes can be used by the Contractor as the basis framework for preparing and submitting the detailed environmental management system to the CSC for approval.

4 Regulatory framework

4.1 Environmental laws and regulations

a) National laws and regulations related to environmental protection

Environmental Protection Law of the People's Republic of China (January 1, 2015)

Environmental Impact Assessment Law of the People's Republic of China (September 1, 2003)

Water Law of the People's Republic of China (October 1, 2002)

Port Law of the People's Republic of China (January 1, 2004)

Water Pollution Control Law of the People's Republic of China (June 1, 2008)

Air Pollution Control Law of the People's Republic of China (September 1, 2000)

Environmental Noise Pollution Control Law of the People's Republic of China (March 1997)

Solid Waste Pollution Control Law of the People's Republic of China (April 1, 2005)

Soil and Water Conservation Law of the People's Republic of China (March 1, 2011)

Clean Production Promotion Law of the People's Republic of China (January 1, 2003)

Forest Law of the People's Republic of China (April 29, 1998)

Wild Animal Protection Law of the People's Republic of China (April 1998)

Fishery Law of the People's Republic of China (August 2004)

Flood Control Law of the People's Republic of China (January 1, 1998)

Environmental Protection Management Regulations of Construction Projects (State Council Decree No. 253, November 1998)

River Management Regulations of the People's Republic of China (State Council Decree No. 3, June 1988)

Waterway Management Regulations of the People's Republic of China (GF [1998] No. 31, October 1987)

Waterway Transportation Management Regulations of the People's Republic of China (amended in December 1997)

Environmental Protection Management Measures for Traffic Construction Projects

(Ministry of Communications Decree [2005] No. 5, implemented in June 1, 2003)

Pollution Prevention and Control Regulations for Drinking Water Source Protection Areas (July 10, 1989)

Notice on Further Strengthening the Environmental Protection of Hydropower Construction (Ministry of Environmental Protection, HF [2012] No. 4)

Notice on Further Strengthening the Protection of Aquatic Resources and Environmental Impact Assessment Management (Ministry of Environmental Protection, Ministry of Agriculture, HF [2013] No. 86)

Notice on Deepening the Implementation of Eco-Environmental Protection Measures for Hydropower Development (Ministry of Environmental Protection, National Energy Administration, HF [2014] No. 65)

Notice on Further Promoting the Environmental Supervision Pilot Work of Construction Projects (General office of Ministry of Environmental Protection, HB [2012] No. 5)

b) Relevant environmental protection laws and regulations in Hubei

Hubei Provincial Environmental Protection Ordinance (December 1997)

Decision of the Provincial People's Government on Implementation of the Scientific Outlook on Development and Strengthening of Environmental Protection (EZF [2006] No. 54)

Notice of the Provincial Environmental Protection Bureau on Further Strengthening of the Environmental Management of the Construction Projects in the Province (EHF [2008] No. 56)

Measures of Hubei Province on Implementation of Water Pollution Control Law of the People's Republic of China (December 1, 2000)

Notice of the General Office of the Provincial People's Government on Strengthening and Regulating the Management of New Projects (EZBF [2008] No. 9, February 2008)

Opinions of the General Office of the Provincial People's Government on Further Strengthening Water Pollution Control (EZBF [2008] No. 49)

Notice of Hubei Provincial People's Government on Division of Key Control Areas of Water and Soil Erosion (EZF [2000] No. 47)

Measures of Hubei Province on Implementation of Wild Animal Protection Law of the People's Republic of China (October 12, 1994)

Notice on functional categories of surface water environment of Hubei Province issued by the Provincial Environmental Protection Bureau forwarded by the General Office of the Provincial People's Government (EZBF[2000] No. 10, January 2000)

The PMO will regularly identify or update the relevant laws and regulations or guidelines enacted by the Chinese central government or provincial government, or recognized international agencies, which may involve the environmental management guidelines or standards applicable for the activities of Yakou project.

4.2 World Bank policies

The requirement of the World Bank includes ten basic safeguard policies. The summary of compliance of this project with the World Bank safeguard policies is shown in the following table. The designated contractors and subcontractors involving in the activity of Yakou Navigation Complex project shall abide by the corresponding environment and social security safeguard policies of the World Bank, especially the following operational policies/bank procedures.

Table 4-1 Analysis of Compliance of This Project with World Bank Safeguard Policies

Safeguard policy	Applicable or not	Compliance
Environmental assessment (OP / BP4.01)	Yes	• Category A , environmental and social impact assessment has been carried out; • EIA documents include: 1) the original EIA Report; 2) supplemental ESIA report; 3) the ESMP of the complex and other auxiliary works; 4) the ESMP for embankment reinforcement of reservoir area; 5) ESIA executive summary; • Multiple activities of public consultation have been carried out according to OP4.01 and the full text of EA Reports have been disclosed.
Natural habitats (OP/BP4.04)	Yes	• Survey on aquatic and terrestrial ecosystem has been implemented and potentially affected natural habitats and targets of ecological protection have been identified; • Potential impacts of the project on natural habitats and ecological sensitive areas and fish have been assessed;

		• Protective measures on the habitats, including protection on fish habitats, fish pass and ecological operation and so on; • The project will not cause remarkable degradation or conversion of key habitats.
Pest Management (OP4.09)	No	No procurement and use of pesticides is involved in this project.
Physical cultural resources (OP/BP4.11)	Yes	• Survey on cultural relics has been done and ancient tombs were identified in the project affected area. These ancient tombs will not be affected by the project construction but be subject to the inundation or erosion of impoundment of reservoir; • Physical cultural resources protection plan has been formulated • "Chance-find" measures of cultural relics have been included into environmental management plan
Dam safety (OP/BP4.37)	Yes	• Dam safety plan has been prepared
Forestry (OP/BP4.36)	No	No forest in the project affected areas, so this policy is not applicable.
Involuntary resettlement (OP/BP4.12)	Yes	Resettlement Action Plan has been prepared.
Indigenous peoples (OP/BP4.10)	No	No ethnic minorities in the project affected areas and this policy is not applicable.
Project in controversial areas (OP/BP7.60)	No	No controversial areas in the project affected areas and this policy is not applicable.
Projects on International Waterways (OP/BP7.50)	No	No international waterway projects in the project affected areas and this policy is not applicable.

Besides, this report also fully uses the EHS Guidelines of the World Bank as references.

4.3 Contract obligations

The designated contractors and subcontractors involving in Yakou project shall abide by any other environmental or social obligations that may be specified in the project contract document but may not be contained in the laws and regulations of China.

If there is discrepancy between the laws and regulations of China and the contract document, the activity of the Yakou Navigation Complex project shall execute the most stringent standards.

5 Environmental and Social Impact and Mitigation Measures

On the basis of major outcomes of domestic version of *Environmental Impact Statement on Han River Yakou Navigation Complex Project* (final version, December 2015), *Supplemental EIA Report of Han River Yakou Navigation Complex Project* submitted to the World Bank (July 2016), *Resettlement Action Plan for Han River Yakou Navigation Complex Project* (June 2016) and *Social Assessment Report on Han River Yakou Navigation Complex Project* (June 2016), this chapter summarizes all major environmental and social impacts as well as related mitigation measure/action plan and develops the ESMP (ESMP) specific to Yakou Navigation Complex, explicitly defining implementation time and budget for measures as well as implementing and supervising agencies, setting up monitoring indices and monitoring frequency for result monitoring of related measure implementation, so as to develop and take necessary actions in a timely manner to strengthen or adjust such measures and to ensure meeting the defined environmental and social objectives. Mitigation measures will be incorporated into detailed design, tender documents and project management manual, to be implemented by the Design Institute (DI), Contractor and the PIU under the supervision of Project Management Office, local environmental protection authority and the environment expert of the expert team. The effectiveness of these measures will be assessed according to environmental inspection and monitoring results so as to determine whether these measures shall be implemented continually or improved/adjusted.

As the navigation complex project has a long implementation cycle and involves in different project areas, this section will provide respective descriptions specific to the construction area (including project management area, plant area and living quarters, access roads, borrow pit/waste dump site), reservoir flooded and resettlement area as well as auxiliary projects (i.e. transmission line project) in three stages –preparation, construction and operation. The Contractor may practically implement corresponding ESMP in the project implementation stage according to related tables.

5.1 ESMP for preparation stage

There are a lot of tasks to be done during the preparation period, including some of

bidding procedures, other approval procedures and some of land acquisition and demolition works. The preparation period lasts for 6 months, which is a period before the construction commencement.

The ESMP for preparation period is shown in the Table 5-1.

Table 5-1 ESMP for Preparation Period

Potential impacts/issues	Mitigation measures/action plan	Source of budget	Implementing agency	Supervising agency
Project site selection	To select a site, existing and planning residential areas (villages and towns) shall be avoided, occupation of cultivated lands shall be reduced, environmental sensitive areas shall be avoided and existing roads leading to the planned construction site shall be utilized to the greatest extent.	Incorporated into the design cost	DI	Implementing agency, PMO
Selection of resettlement area	Select the area with better natural conditions, developed economy and plenty of lands to be the resettlement area. Meanwhile, the resettlement point shall be located above the design flood level of Yakou Reservoir, with reliable water source and infrastructures such as traffic, electrical, wastewater treatment and waste treatment facilities and convenience for health care of migrants and education for their children.	Incorporated into the design cost	DI for resettlement	Implementing agency, PMO
Design and management of borrow pit and waste dump site	Develop detailed management and rehabilitation plans for borrow pit and waste dump site. Submit the plans to PIU and Supervising agency for review or optimization. Then, submit the plans to local environmental protection authority for approval.	Incorporated into cost of detailed design	DI	Implementing agency, PMO and local environmental protection authority
As for underground water, porous phreatic water at dam site has close hydraulic connection with river way water level, which may cause reservoir water leakage. It is necessary to take preventive measures.	The reservoir has better topographical and geological closure conditions. Thus, the possibility of permanent leakage is small. Engineering measures shall be taken for the complex design to prevent leakage.	Incorporated into cost of detailed design	DI	Implementing agency, PMO
Contractor's environmental responsibility specified in the tender document and contract document	Incorporate environmental management requirements into the tender document; The environmental mitigation measures and provisions related to monitoring defined in the ESMP into the construction contract.	Incorporated into costs of detailed design and bidding	DI, tender agent	Implementing agency, PMO
Setup of project environment and social management department	Establish an environment and social management department in PMO	Incorporated into project management cost	PMO	Implementing agency, World Bank

Potential impacts/issues	Mitigation measures/action plan	Source of budget	Implementing agency	Supervising agency
Consulting agency for project implementation	Incorporate jobs related to environmental and social management into the Terms of Reference for the consulting agency	Incorporated into cost of project technical assistance	PIU, PMO	World Bank
Update and detail the ESMP specific to particular construction sites.	Update the environmental and social mitigation measures defined in the ESMP according to final detailed design. Develop specific ESMPs to particular construction sites and submit to PMO and World Bank for approval.	Incorporated into cost of project technical assistance	ESM unit, consulting agency for project implementation	PMO, local environmental protection bureau, World Bank
Internal environmental monitoring and supervision plan	Develop the internal environmental monitoring plan which conforms to requirements stated in EIA and ESMP.	Incorporated into project investment	CC, CSC	PMO, local environmental protection bureau, consulting agency for project implementation
External (compliance) environmental and social monitoring	Before construction, employ local qualified environment monitoring station and resettlement implementation monitoring team to be responsible for external compliance monitoring as required in the ESMP during the project construction period and operation period.	Incorporated into project investment	PIU, CC (as per contractual requirements)	World Bank
Environmental management training	The consulting agency for project implementation or environment expert and/or officer invited from local environmental protection bureau shall provide the Contractor, CSC and PIU staff, according to defined training program, with training courses related to environmental management, implementation and supervision of project construction and operation.	Incorporated into cost of ESMP	PMO, consulting agency for project implementation	Local environmental protection bureau, World Bank
Establish public grievance mechanism for environmental and social issues	Establish public appealing mechanism for environmental and social issues according to the ESMP and resettlement action plan.	Incorporated into project management cost	PMO and its ESM unit	Local environmental protection bureau, consulting agency for project implementation and World Bank
Resident environmental engineer	Between signing of construction contracts and construction commencement, a resident environmental engineer shall be assigned for each contract.	Incorporated into contract cost	CC	CSC, PMO
Appointment of environmental supervisor	An environmental supervisor shall be appointed internally in the CSC, responsible for daily inspection of implementation of environmental mitigation measures in construction stage, internal monitoring and assessment.	Incorporated into supervision cost	CSC	PIU, local environmental protection bureau

5.2 ESMP for Yakou Complex construction area

Pursuant to *Environmental Impact Assessment of Han River Yakou Navigation Complex Project* (final version, December 2015) and *Supplemental EIA Report of Han River Yakou Navigation Complex Project* submitted to the World Bank (July 2016), the construction and operation will result in adverse impact on regional environment, for example, water and soil loss due to vegetation deterioration as a result of construction, regional environmental quality polluted by "three wastes and one noise" in construction period as well as change in conditions of existence population quantity of fish and aquatic organism due to hydrological condition change resulted from project operation, particularly adverse impact on four famous domestic fishes and other fishes laying pelagic egg. Specific to adverse environmental impact as a result of the complex construction, it is intended to take the following environment and social management action as listed in the Table 5-2.

Table 5-2 ESMP for Construction Area in Construction Period and Operation Period

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
I.		Construction period						
Land acquisition and demolition	Dam site	The complex construction requires occupation of 1,152.34 mu of lands for permanent use and 840.38 mu of lands for temporary use. Lands for permanent use include 411.23 mu of state-owned mud flat, 741.11 mu of collectively-owned land. A total of 1,574m^2 of residential area involving in 17 households of fisherman's cooperative subordinate to Yakou Village of Liushui Town needs to be demolished.	• Develop resettlement plan and social assessment. Seek for public participation and advices sufficiently in project design so as to assure that their interest demand to be satisfied. • Give reasonable compensation to the affected person, particularly female head of household, households enjoying the five guarantees and other vulnerable groups to financially help them during rebuilding their residence. • Resettlement activities shall be carried out combining with local government skill/technology training. Migrants will have priority to be given non-technical jobs. Reasonable planning will be made for production development project. • Establish sound appealing/complaint mechanism to timely solve resettlement compensation and resettlement issues.	Refer to the RAP.	PMO,CC, Yicheng Immigration Office, Agricultural Bureau, Land and Resources Bureau, Forestry Bureau, villages and towns and village committee in the resettlement area as well as reservoir area	PMO, superior local government, local land and resources bureau, external monitoring agency	Refer to the RAP.	Refer to the RAP.
Water and soil loss	Complex area	Project development scheme and layout shall meet basic requirements for conservation of water and soil. In the project area, there's no ecologically vulnerable area and key control outcome area for water and soil loss nationally divided. The Yicheng City, Xiangcheng District and Xiangzhou District where the project is located are the key control area for water and soil loss in Hubei Province. By review of preliminary design, the Project will disturb the original landform of 537.71$hm^{2,}$ damage water and soil conservation facilities of 464.39 hm^2. By estimate, the Project may result in 102,500t of water and soil loss, 89,900t of additional water and soil loss. If no preventive measures are taken, it will impact the regional land productivity and ecological environment.	• Implement engineering measures, vegetation measures and temporarily preventive measures stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.	Included in the budget for *Control Plan for Water and Soil Loss* (Appendix 1).	CC, CSC	PMO, Xiangyang Environmental Protection Bureau, Xiangyang Water Resources Bureau	Refer to monitoring requirements stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.	Refer to monitoring requirements stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Borrow pit	By review, 2 borrow pit are confirmed in the preliminary design to provide 191,200m^3 of soil. Exploiting area amounts to 4.37hm^2, including 2.27hm^2 of shrubwood, 2.1hm^2 of cultivated land. Soil borrowing during the construction will cause water and soil loss in some areas.	• Implement engineering measures, vegetation measures and temporarily preventive measures for borrow pit stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.	Included in the budget for *Control Plan for Water and Soil Loss* (Appendix 1).	CC, CSC	PMO, Xiangyang Environmental Protection Bureau, Xiangyang Water Resources Bureau	Refer to monitoring requirements stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.	Refer to monitoring requirements stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.
	Waste dump site	The Project will produce 7,869,600m^3 of waste (rough estimate), including 948,700m^3 of temporary waste and 6,920,900m^3 of permanent waste. Without preventive measures, piling of a large number of wastes will cause water and soil loss to some extent, harmful to flood control in the downstream.	• Two waste dump sites – each for left and right bank sides – are determined for the main work. According to requirements stated in the *Control Plan for Water and Soil Loss* (Appendix 1), take slope control measures for the waste dump site. Set drainage system and grit chamber; strengthen management of temporary spoil; set temporary retaining wall; cover the spoil bank; plant trees on the spoil and slope.	Included in the budget for *Control Plan for Water and Soil Loss* (Appendix 1).	CC, CSC	PMO, Xiangyang Environmental Protection Bureau, Xiangyang Water Resources Bureau	Refer to monitoring requirements stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.	Refer to monitoring requirements stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.
Ambient air	Construction dust	The Project includes a large number of earth works. The TSP concentration in the air on the construction site will increase. The pollution is mainly produced in the dam site, borrow pit and other excavation areas. The dam site is far away from the sensitive point, while the borrow pit is 60m and 30m away from Luojiazhuang Village and Yakou Village. Therefore, soil excavation has impacts on surrounding residence points. Dust produced as a result of dam site excavation and building material piling has little impact. A concrete mixing system and aggregate system will be arranged at the left and right banks. As they are far away from Luojiazhuang Village and Yakou Village – 400m and 500m respectively – plus factory fence, the dust will not influence the residence points.	• Presplitting blasting, smooth blasting, cushion blasting and deep-hole millisecond tight blasting shall be given first priority to reduce dust. Dust removers shall be provided for the concrete mixing station on the left and right banks, operating simultaneously with the mixing station. Besides, maintenance of dust remover shall be strengthened to meet related environmental standards. • Closure fence (500m long) shall be provided around the construction site adjacent to residence points in Luojiazhuang Village and Yakou Village. Dust screen or dust cloth shall be provided outside the fence. In case of windy weather with the wind speed being 5.5-7.9 or above, earth excavation and filling shall be stopped. • Other mitigation measures during the construction are included in (Appendix 3: Rules for Contractor Construction Environment).	251.01	CC, CSC	PMO, Xiangyang Environmental Protection Bureau	SO_2, NO_2, TSP	Three times per year

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Vehicle exhaust and dust from transportation	A lot of mechanical vehicles will be used for the Project. Due to narrow landform in the project area and limited emission height, it is possible to increase concentration of SO_2 and NO_2 in partial environment. Identify whether the distance between the dam site and sensitive points related to the project area is far, whether the exhaust has impact on those points. Luojiazhuang Village and Yakou Village are close to the borrow pit, possible to be under the impact of excavation machine exhaust. Access roads on the left and right banks pass through Yakou Village, Luojiazhuang Village and Maocao Village. The vehicle exhaust and dust from transportation will impact the residents nearby.	• Drive speed shall be lowered (limited to 30km/h) for vehicles passing Yakou Village, Luojiazhuang Village and Maocao Village so as to reduce dust. • Other mitigation measures during the construction are included in (Appendix 3: Rules for Contractor Construction Environment).					
Noise	Construction noise	A lot of construction machines will be used for the Project. Large machines make such noise that influences a wide area. The Project involves blasting activities during the process of excavation of working faces for diversion channel, dam and plant as well as stone quarrying, residence points such as Yakou Village, Luojiazhuang Village and Maocao Village are close to shot points, which may be exposed to high noise at the instant of blasting. However, due to the short time of blasting, the impact is limited. By forecast, aggregate processing system, rebar processing workshop and mechanical vehicle maintenance depot may make such noise that influences a wide area. For sensitive residence points, the forecasted values of noise day and night for Yakou Village and Maocao Village are beyond the limit. The forecasted value of noise at night for Luojiazhuang Village is beyond the limit. Preventive measures shall be taken.	• Other mitigation measures during the construction are included in (Appendix 3: Rules for Contractor Construction Environment). • High-noise works are prohibited at night on the site adjacent to residential areas. Sound barriers shall be provided in Yakou Village and Maocao Village that are under the impact of borrow pit noise (earth excavation and transportation are prohibited at night on the side adjacent to Yakou Village and Maocao Village).	147.79	CC, CSC	PMO, Xiangyang Environmental Protection Bureau	Leq	Two times per year, two times per day, 24 hours per day

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Traffic noise	The access roads on the right and left banks of the Project pass through Yakou Village, Heluo Village and Maocao Village, respectively. According to forecasts, the transport vehicles have an impact on residential areas within the range of 35m and 130m of roads at the time of daytime and nighttime construction during the period of construction, especially nighttime construction, and protective measures shall be taken.	• Noise barriers shall be installed on one side of Yakou Village, Maocao Village and Heluo Village where the access roads pass, so the average value of noise reduction may be up to 7-10dB(A). • Other mitigation measures during the construction are included in (Appendix 3: Rules for Contractor Construction Environment).				Leq	3 times every year (4 years in total)
Water quality	Washing wastewater from aggregate system	The volume of flushing wastewater from aggregate system is about 360m^3/h (SS：2,5000-30,000mg/L).	• After the flushing wastewater from aggregate system is treated through sedimentation to make SS less than 300mg/L, water will be reused for the production system and not discharged.	1035.1	CC, CSC	PMO and municipal bureau of environmental protection	Flow & SS Water quality during the period of construction: pH, SS, DO, COD_{Mn}, BOD, COD_{Cr}, ammonia nitrogen and petroleum	4 times every year (during the production period of concrete mixing system) Water quality during the period of construction: twice every year (high- and low-flow
	Wastewater from concrete mixing system	The volume of flushing wastewater from the concrete mixing system is about 100m^3/d (pH: 9-11, SS: 3,000-10,000mg/L).	• After the wastewater from concrete mixing system is treated through sedimentation so that SS is less than 70mg/L and the pH value is between 6 and 9, watering will be performed for dust suppression and discharging will be not be performed.	35.6	CC, CSC	PMO and municipal bureau of environmental protection		

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Wastewater in the foundation pit of dam	Wastewater in the foundation pit of dam mainly consists of rainfall and water seepage; its main pollutant is SS.	• Flocculants shall be put into foundation pits on a regular basis, and after sedimentation, the supernatant will be used for watering and dust reduction or will be directly pumped to the downstream water, and the residual bottom mud will be removed manually on a regular basis.	included in the project investment	CC, CSC	PMO and municipal bureau of environmental protection		
	Service station Oily wastewater	On the construction site, the service station produces about $50m^3$ of oily wastewater per day, and the oil-bearing concentration may be up to 100mg/L.	• The service stations on the left and right banks will be installed with oil separators (with the design handling capacity of $3m^3/h$ and $5m^3/h$), respectively, and after oily wastewater is treated and qualified, it will be used to wash vehicles.	51.06	CC, CSC	PMO and municipal bureau of environmental protection		
	Domestic wastewater	The maximum quantity of domestic wastewater is $98m^3$ (BOD_5: 200mg/L, COD: 400mg/L) per day during the period of construction.	• A complete set of domestic wastewater treatment equipment will be adopted, and after primary sedimentation, biological contact oxidation, secondary sedimentation and disinfection and compliance with requirements, the wastewater may be used for agricultural irrigation.	364.63	CC, CSC	PMO and municipal bureau of environmental protection	COD, BOD5, ammonia nitrogen, total phosphorus and total nitrogen	4 times every year (4 years in total)
Solid waste	Waste slag generated in the construction	According to the construction design, the volume of waste slag generated in the construction is $297,700m^3$.	• The waste dump site on the left bank is located in the gully along the river 0.3km downstream from the left bank of dam site and about 0.5km upstream from the dam site; the waste dump site on the right bank is located in Grade-I terrace about 2km upstream from the dam site, having enough capacity to dispose of waste slag generated in the construction.	included in the costs of water conservation	CC, CSC	PMO, municipal bureau of environmental protection and municipal water resources bureau	/	/

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Construction wastes and domestic garbage	The daily maximum number of people during the period of construction is about 2,100 people and they will produce 2.1 tons of wastes which are mainly produced from construction management and living quarters on the left and right banks.	• In terms of collection of wastes, Yicheng Environmental Sanitation Administration intends to be responsible for clearing domestic garbage in the construction area and transporting them to the domestic refuse landfill of Yicheng for treatment.	192.03	Yicheng Environmental Sanitation Administration	PMO, municipal bureau of environmental protection and municipal environmental sanitation department	/	/
Terrestrial ecology	Vegetation deterioration	The total area of land for construction in the complex project area is 377.08hm^2, accounting for 0.25% of the total area of the assessment area, including 131.75hm^2 of permanent land and 374.31hm² of temporary land, and the area of forest land occupied is relatively small, and the species of plants occupied mainly consist of man-made forests, secondary shrubs and herbal shrubs widely distributed in the assessment area, having less impact on natural landscape, biodiversity and quality of ecosystem in the assessment area. No rare, endangered or endemic plants to be protected are found.	• In accordance with the relevant policies of China, the resettlement action plan of the Project provides the local bureau of forestry with adequate budget for recovery of vegetation. In the construction area, especially for the forest land damaged by temporary land, the recovery of slash will be carried out according to its actual situations. It shall be noted to avoid single varieties of trees or exotic species from invading the area.	Immigration investment	PIU, CC, CSC and local forestry department	Local forestry department	Status of resources of forest ecosystem, distribution and changes of main vegetation types, changes in the structure of agricultural ecosystem and quality and changes of quality of regional landscape ecosystem	once every year

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Terrestrial animal	The direct impact on terrestrial animals during the construction of the Project will be limited to the surrounding area of dam site and the species affected consist of common species, having less effect, e.g. the construction of the Project might occupy a small number of habitats and human hunting might occur; however, there is a relatively large number of suitable habitats in the construction area for transfer, and the impact will gradually disappear with the completion of construction. Besides, the second category of national key protected wild animals in the area of the Project consist of buteo, black kite and Eurasian Kestrel, etc., all of which are birds of prey with a strong hover ability and a large sphere of activity, so the impact of the construction of the Project will have less impact which is temporary.	• Publicity and education: publicity of environmental protection and general knowledge of wildlife conservation shall be strengthened for construction personnel, displaced persons and managerial personnel of power plant; • The environmental management shall be reinforced during the period of construction, the scope of construction strictly controlled, the activities of construction standardized, blasting strictly prohibited in the morning and evening and at noon, hunting by construction personnel strictly prohibited, the emission of wastewater, waste gas and domestic sewage strictly controlled and the ground vegetation recovered as soon as possible. • For the national and provincial protected wild animals distributed in each construction area, the relevant pamphlets about identification methods, protective measures and administrative provisions, etc. shall be prepared and distributed to construction personnel.	14.25	PIU, CC and local department of wild animal conservation	Local department of wild animal conservation	Habitats, diversity and changes of terrestrial wildlife: composition, mores, distribution and changes of regional wildlife fauna; species, quantity, distribution and growth situation of rare, endangered or endemic animals	once every year (2 years in total) (incl. 1 year of background monitoring before construction and construction period)
Aquatic ecosystem	Fish resources	In case of underwater construction like approach channels, etc., a variety of machinery operates underwater, so the physical factors, such as sound, light and electricity, etc., have an adverse impact on the habitats, growth and reproduction, etc. of fishes in the construction river reaches. There are many construction personnel during the period of construction, and the fishing and demands for aquatic animals and plants by construction personnel will increase the damage to fish resources.	• During the construction of the Project, the construction management and environmental protection publicity shall be strengthened and construction personnel shall be strictly prohibited from fishing with electricity and fishing.	10	PIU, CC and CSC	Local authorities of wild animal conservation	/	/

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Material and cultural resources	Cultural relics	There are 9 cultural relics below the proposed reservoir flooded line, 3 cultural relics, all of which are cemeteries, are eroded, and Wangjiagang Cemetery eroded is the county-level protected relics.	• For the county-level cultural relics inundated due to the construction of reservoir, Yicheng Municipal Administration of Culture, Sports, Press, Publication, Radio, Film and Television (local authority of cultural relics) shall organize and implement the exploration and key excavation in accordance with the requirements and procedures of the Law of Protection of Cultural Relics, and for other relics, the excavation shall be performed only in a small area (see Appendix 5).	Immigration investment	PMO, CC and Yicheng Municipal Administration of Culture, Sports, Press, Publication, Radio, Film and Television	Xiangyang Bureau of Cultural Heritage	/	/
	Graves	According to the resettlement report, the relocation of 467 graves will be involved in the Project.	• According to the wishes of villagers, relocation will be performed based on the local customs and habits, and the compensation for affected graves shall be made as per the local replacement price (see Appendix 5).	232.5	PMO, CC, CSC and affected families	Village committees at all levels and local government	See the resettlement action plan of the Project.	See the resettlement action plan of the Project.
	Discovery of cultural relics	The cultural relics might be discovered at the time of earth excavation, and the valuable relics or handiwork will be damaged.	• If any historical and cultural resources are discovered, construction shall be suspended and the cultural relics protected (see **Appendix 5**).	/	PIU, CC, CSC and Yicheng Municipal Administration of Culture, Sports, Press, Publication, Radio, Film and Television	Xiangyang Bureau of Cultural Heritage	/	/
		Some cultural relics, which have little value or are damaged seriously, are discovered during the process of site survey in the area of influence of the Project, so it is relatively difficult to protect or integrally relocate them or it is not worth protecting or integrally relocating them.	• For these relics, it is recommended that the procedures of archaeological filing shall be carried out in the whole area of influence of the Project and the direct and vivid methods, such as photographing or making documentaries, etc., shall be adopted to record the valuable data of architectural structures. This plan will implement one of the assemblies under the technical assistance project.	20	PMO and Bureau of Culture & Radio	Yicheng Municipal Administration of Culture, Sports, Press, Publication, Radio, Film and Television	/	/

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Health of population	At present, the local sanitation conditions and the level of medical treatment and health technology are poor in Yakou Project, where the houses are close to livestock, the management of feces is not good and garbage is piled at random, etc., so that the activities of mosquitoes and flies are relatively frequent, which will be liable to result in the transmission of some infections.	• Sanitization: cleaning and disinfection shall be performed in construction camps, places where the activities of construction personnel are concentrated, original toilets, cesspools, pens, refuse dumps and graveyard buried in the last 10 years. • Sterilization of vectors: under the guidance of the personnel for health and disease prevention, the construction personnel will use tools or medicine to kill rats, mosquitoes and flies mainly in the office areas, living quarters and temporary work sheds, which shall be regularly performed in a unified way in spring and autumn per annum.	97.90	PMO, CC and CSC	Local department of hygiene and disease control	Species and density of rats and species and density of mosquitoes in the construction area	twice every year (from the preparation period to the completion of the Project)
	During the period of construction, there are many external construction personnel and other relevant personnel, which will be up to 2,100 persons in the peak period, and for the density of population is increased, the living facilities are built temporarily and the conditions of sanitation are relatively poor, and so if the sanitary control and the quarantine and inspection are not strengthened for such areas, the probability of transmission of water-borne infections, such as dysentery, hepatitis and typhoid fever, etc., and arthropod-borne infections, such as malaria, etc., might be increased.	• Plan of hygiene and disease control: the hygiene and disease control shall be performed for the construction personnel and management personnel, who plans to enter the construction areas, mainly used to prevent malaria and leptospirosis. During the period of construction, 10% of the construction personnel shall be inspected at random twice. • Prophylactic immunization: the prophylactic immunization will be performed mainly for construction personnel according to the physical examination and the monitoring of infections (leptospirosis and typhoid fever) and medicine shall be taken (malaria), ，and 2 sets of medicine will be prepared according to the number of workers.	42.75	PMO, CC, CSC and county-level center for disease control and prevention	Local department of hygiene and disease control	Infectious diseases of Categories A, B and C (e.g., entity, time and age of morbidity, gender and job)	When an infection case is found,

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
		• Physical examination: After the commencement, the personnel working in the canteen and restaurant in the construction areas, construction personnel exposed to dust and strong noise and other personnel of the type of work which will be seriously harmful to health shall accept physical examination once per year, while other personnel shall accept physical examination once every two years, and the files of results of examination shall be created. • Health publicity and management: the health publicity and management shall be reinforced in the construction areas, the level of health knowledge level and awareness of health protection of population in the construction areas shall be improved, the health supervision and management of drinking water and canteens in the construction areas shall be strengthened and special persons shall be appointed to take responsibility for sanitary examination once every quarter.	28.50				
		• Public health infrastructure: according to the overall layout of construction, the aggregate process systems, multipurpose processing plants and machinery repair stations at both right and left banks shall be provided with temporary public toilets and the dam construction area at both right and left banks shall be configured with movable toilets; the living quarters at both right and left banks and the PIU's living quarters shall be provided with garbage cans (bins), and the domestic garbage is required to be cleaned timely and transported to the local waste treatment facilities on a regular basis, and it is strictly prohibited to dump wastes into rivers or drain ditches.	28.5	PMO, CC and CSC	Local department of hygiene and disease control	/	/
Hazardous materials	If the explosive is stored improperly, explosion will be caused so as to make an adverse impact on the surroundings.	• See Appendix 4: Precautions for Use and Storage of Insecticide in the Management Plan of Hazardous Materials and Wastes	/	PMO, CC and CSC	Local department of hygiene and disease control	/	/

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Traffic safety	There are more accident risks on the roads around the waste dump site, cement mixing equipment and residential areas.	• The local radio stations and television channels are utilized for publicity and the notices are posted, with the aim to make the public know the potential, increased traffic pressure and corresponding safety measures. • Drivers shall be trained, vehicles shall be maintained, the speed of a vehicle shall be limited, the road signs shall be increased and the parking area shall be divided. • A notice shall be given to the public during rush hours or special period and the cooperation with traffic police will be provided. • In case an off-site traffic accident occurs, the safety emergency plan shall be adopted immediately.	included in the overhead cost of the Project	PMO, CC, CSC and local traffic police department	Local traffic police department	/	/
Occupational health and safety on site	The problems and accidents of occupational health and safety may result in injury or death of workers.	• According to the requirements of Appendix 3, the contractors shall establish the occupational health and safety plan and submit it to CSC for approval. In this plan, the contractors shall define the safety emergency procedures in case of an accident on site, ensure that all construction sites are equipped with the most basic first-aid equipment and ensure and strengthen the use of labor protection articles by construction personnel.	included in the overhead cost of the Project	CC	PMO and CSC	/	/
II.	Operating period						
Social and economic benefits	The Project will increase the navigation level of 52.67km reach upstream of dam site from 500t to 1,000t and make it have the functions of power generation and irrigation, so as to promote the local social and economic development.	• Positive impact; no mitigation measure are required to be taken.	/	/	/	/	/
Public health	After the reservoir operates, the environmental sanitation and drinking water of residents around the reservoir will be improved, which will be conducive to the prevention of occurrence of water-borne infections.	• Positive impact; no mitigation measures are required to be taken.	/	/	/	/	/
Stage-II cumulative impact analysis (CIA)	The investigation contents of CIS have been included in EIA appendix, but the scarcity of information/data and the tight project progress limits the results of cumulative impact.	• As a part of technical support of implementation of the Project, the second stage of CIA will correct the problems found in the first stage and refine the mitigation measures.	380	The PIU of the Project and PMO	WB	/	/

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Study on ecological regulation experiment	The construction of navigation complexes at middle and lower reaches of Han River impedes fish migration and affects the conditions of reproduction of fishes spawning drifting eggs. Only when the joint ecologic regulation is realized for the complexes below Danjiangkou in the trunk stream of Han River and the river recovers to its natural status, the hydrological and hydraulic conditions necessary for reproduction of fishes laying drifting eggs can be basically met.	• In order to realize the objectives of sustainable development at middle and lower reaches of Han River, the ecologic regulation tests shall be carried out, the model of optimal regulation on water resources shall be established, the regulation decision support system directly serving the application of ecologic regulation at middle and lower riches of Han River shall be developed, and the mode of joint regulation of complexes at middle and lower reaches of Han River shall be optimized, so as to establish an easy-to-operate, targeted, flexible and timely joint ecologic regulation scheme.	460	The PIU of the Project and PMO	WB	/	/
Effect assessment of fish pass structures	Up to now, in the existing complexes at middle and lower reaches of Han River, Cuijiaying navigation complex and Xinglong navigation complex have been provided with fish passes, but the effect of monitoring and operation of fish passes is not satisfactory, and in the planning complexes, Xinji navigation pass, Yakou navigation pass and Nianpanshan navigation pass will be equipped with fish passes; therefore, whether the fish passes can play a full part and can become the main channel for fish migration is worthy of being studied, summarized and improved continuously.	• After the fish passes are put into operation, the actual effect shall be tracked and monitored, and according to the results of monitoring, the local links of fish passes shall be properly modified and improved.	280				
Management of adaptability	Based on the research results of CIA and CRMP in the second stage, the mitigation measures shall be further developed.	• The supplementary mitigation measures shall be taken during the period of construction and operation or the original mitigation measures adjusted.	180	The PIU of the Project, CC and CSC	Municipal bureau of environmental protection	/	/

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Water quality	Impoundment of reservoir	At the initial impounding period of reservoir, the decayed substances and soil remained in the inundation zone will be decomposed to release organic matters, resulting in the increase in concentration of BOD_5, COD, nitrogen and phosphorus, etc. in water and the reduction of dissolved oxygen. If the reservoir is cleaned as per the specification before impounding, there might be many extracts on the reservoir bottom, which will affect the quality of water during the initial impounding period.	• Before impounding, the reservoir bottom shall be cleaned properly, including building cleaning, hygienic cleaning and cleaning of forest land and orchards, etc. (see Appendix 2 for details).	117.8	The Project Operation Unit, CC and CSC	The Project Operation Unit and municipal bureau of environmental protection	21 items, including water temperature, pH, SS, DO, COD_{Mn}, COD_{Cr}, ammonia nitrogen, TN, TP, chlorophyll a, transparency, Hg, As, volatile phenol, fluoride, Cr^{6+}, Pb, petroleum and sediment content, etc.	Twice every year (high- and low-flow periods)
	Convergence of sewage from the periphery	The sources of pollution of living and agriculture in the area of Yakou Reservoir converge uniformly and 2 main sources of industrial pollution converge separately fed at Xiaohe Town and the inlet under Nanying Subdistrict Office. Based on the forecast, the concentration of COD and NH_3-N in the reservoir during the low-flow period (December) varies from 13.54mg/L to 13.89 mg/L and from 0.082mg/L to 0.090mg/L, respectively, which complies with the standards like GB3838-2002II, and as expected, the concentration of algae will be kept at a lower level and the possibility of occurrence of eutrophication in the reservoir is relatively small.	• As per the requirements of the prevention and control planning of pollution in the drainage basin of Han River, a series of water pollution prevention and control works will be constructed in the reservoir area, including treatment works of industrial wastewater, domestic wastewater and ecological control works, etc. • The cage culture is strictly prohibited in the water area of reservoir. • The agricultural structure is adjusted and the consumption of fertilizers like nitrogen and phosphorus, etc. is limited.	included in the overhead cost of the Project	The Project Operation Unit and municipal bureau of environmental protection	Municipal bureau of environmental protection		
	Domestic wastewater in the management area	70 management personnel will be provided during the period of operation of the Project, and the volume of domestic wastewater generated is estimated to be $8m^3$ per day, and if the untreated wastewater is discharged, the surrounding water environment will be influenced.	• A biological purification tank (with the volume of about $40m^3$) intends to be employed to treat the construction and domestic wastewater, and the tail water after treatment will be used for agricultural irrigation and not discharged.	94.05	the Project Operation Unit	Municipal bureau of environmental protection		

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Water quality	Treatment of oily wastewater treatment within the plant area	During the period of operation of power plant, the oily wastewater is mainly from the generator units or the treatment equipment of turbine oil and insulating oil in case of overhaul of transformers and oily wastewater from floor flushing caused by pipeline leakage.	• Management shall be reinforced, leakage shall be avoided and cleaner production shall be realized. • A sump shall be set in the oil treatment chamber to collect oily wastewater, and after treatment with an oil-water separator, the waste oil will be recovered and the wastewater will be used to water roads, flowers and trees, etc. 2 oil-water separators will be selected, and the capacity of treatment of each separator is $10m^3/h$.	136.8				
	Wastewater treatment	Navigation ships in the reservoir area: in 2020, the volume of generation of oily wastewater on the bottom of ship's hold will be up to 55.66t per year and the average concentration of oil content in oily wastewater on the bottom of ship's hold will be up to 500-1,000mg/L.	• Relying on the existing integrated wharf in Xiaohe harbor district of Xiangyang Port (about 23km upstream from the dam site of Yakou navigation complex), a new onshore oily wastewater receiving and processing system will be constructed.	830				
Terrestrial ecology	Terrestrial plant	In the inundation zone, the inundation area will be increased by $17.68km^2$, including 10.00 km^2 of cultivated land, 6.04 km^2 of forest land and 0.93 km^2 of grassland. In the stage of impounding in the reservoir, the species and quantity of plants in the inundated zone will be lost to some extent. The inundated zone is dominated by the cultivated land mainly consisting of crops, followed by the forest land mainly consisting of poplar forest and the grassland consisting of dominant species like paper mulberry, hemarthria altissima and conyz canadensis, etc. The reservoir inundation has little impact on the generation of flora.	• According to the construction progress, the reservoir cleaning shall be reasonably arranged, which shall not be performed in the rainy season to the greatest extent possible, and the measures, including, excavation, filling, compaction of surface and local protection, etc., shall be taken to reduce water and soil erosion. • The establishment of ecological protection forest system around the reservoir area shall be strengthened and a variety of species of plants in the reservoir banks and greening areas shall be effectively management, and if any dead tree is found, new trees shall be planted timely. • The vegetation on the beach shall be recovered and the wasteland in the flood land shall not be brought into cultivation.	14.25	The Project Operation Unit, CC and CSC	Municipal water resources bureau and municipal bureau of environmental protection	See Appendix 1: Water and Soil Erosion Control Plan.	See Appendix 1: Monitoring Plan of Soil and Water Conservation Scheme.

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
		The total area of land for construction is 377.08hm^2 and the species of plants occupied mainly consist of man-made forests, secondary shrubs and herbal shrubs widely distributed in the assessment area; consequently, the occupation of land for the Project has less impact on plants.	• Ecological restoration of construction site: after the construction is completed, vegetation measures of water and soil conservation shall be taken to carry out the ecological restoration of various construction slashes, including cupressus funebris forest and deciduous broad-leaved shrub area, Italian poplar area, scrub-herbosa area, wetland vegetation area on the beach, agricultural cultivation area, landscape zone around power plant facilities and temporary restoration area.					
		Wanyangzhou National Wetland Park: after the Project is implemented, the water level in the Park will rise to 55.22m and the expected area of wetland conservation area will be increased to 1,818.27hm^2 (increased by about 360hm^2), accounting for 73.73% of the total area of the Park; the area of recovery and rehabilitation area is reduced to 391.72hm^2, accounting for 15.88% of the total area of the Park; the area of reasonable utilization area is reduced by 10 hm^2; the scope of publicity & education area and management service area will not be changed.	• The ecological system of wetland shall be protected. The management of sand excavation activities in the assessment area of the Project shall be intensified, the sand excavation activities are prohibited in the wetland park and its surrounding regions, and the regional wetland resources and the habitats of birds in the wetland shall be protected. • For protection works and land elevation works, the scope of construction work and the layout of temporary sites shall be strictly controlled as per the planning of wetland park, the management shall be strengthened and the impact on wetland shall be mitigated to the greatest extent possible, and before construction, construction shall not be started until the opinions on the specific construction scheme are sought to the Wetland Park Administration. • Combined with the planning of Wanyangzhou National Wetland Park, the local vegetation shall be planted on the edges of the waters like, Han River and the area of influence of the wetland park, etc.	-	Local port and waterway administration, bureau of forestry and wetland park administration	Municipal bureau of forestry and municipal water resources bureau	-	-

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Terrestrial animal	After Yakou Reservoir is completed to impound water, the water surface will be increased, which will be beneficial to lentic amphibians, so the quantity of reptiles (e.g. lizards and snakes) and birds will significantly increase. The habitat of beasts will be inundated, so their habitat will relatively rise and the range of habitat will be relatively reduced, but due to their activities, a new habitat can be sought nearby, having less impact; meanwhile, the density of reservoir area might increase to some extent.	• The construction personnel shall accept the education of protection of rare, endangered animals, with the aim to improve the environmental awareness. • Before clearing of the reservoir and leveling of the construction site, whistling, drumming, etc. are recommended to drive the wild animals away, so as to guarantee their relocation as expected. • Before the construction personnel and machinery enter the construction site, it shall be fenced with ropes. Meanwhile, clear signs shall be provided to forbid activities in the non-construction areas, such as fireworks and hunting.	14.25	The Project Operation Unit, CC and CSC	Municipal bureau of environmental protection	Habitats, diversity and changes of terrestrial wildlife: composition, mores, distribution and changes of regional wildlife fauna; species, quantity, distribution and growth situation of rare, endangered or endemic animals	1 time/year, altogether 2 years (the 1st year after impounding and the 5th year thereafter)
Aquatic ecosystem		With the construction of Wangfuzhou, Cuijiaying and Xinglong Navigation and hydropower complexes, some spawning grounds are inundated, fish migration channels are obstructed, spawning grounds shrink, breeding groups reduce, and spawning ground size significantly decreases. Especially, in dry year, due to low peak discharge and attenuation of multi-level junctions, the flood peak process is not obvious. At present, the spawning function of the remaining spawning grounds in Yicheng, Guanjiashan and Zhongxiang are weakened obviously.	**Joint ecological regulation:** During the spawning period of "four famous domestic fishes" in Han river every year, it can make sure a certain ecological flow of discharge through Danjiangkou, and implement the discharge and regulation in cascade joint combined with a certain scale of flood of Tangbai River at least for 2 times. Ensure the smoothing in spawning of existing spawning grounds, drifting hatching of fertilized eggs and fertilized fish migration channels to finish the reproduction. To be implemented based on the regulation test	To be included in the project operation costs	Provincial Department of Water Resources, Port and Waterway Administration and operation units of downstream complexes	Hubei Provincial Environmental Protection Bureau	Survey of fish spawning grounds: Species composition and proportion, spatial and temporal distribution, larval resources, hydrological factors (temperature, flow rate, water level), distribution and size of spawning sites, breeding time, and frequency	2 times/year (April, August), altogether 6 years (1 year before impounding and the 1st, 2nd, 4th, 7th and 10th year after impounding)

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	The barrage in the main stream in the middle and lower reaches of Han River has blocked the fish habitat. The dam construction blocks the passage of migratory fish, affecting their feeding or spawning upstream. The construction of Yakou shipping hub will further deteriorate the fish habitat fragmentation, producing more impacts on the migratory fish and semi-migratory fish. The dam construction will not only block the passage of migratory fish, but also the passage of semi-migratory fish and non-migratory fish. The individual and genetic exchange of semi-migratory fish, such as grass carp, black carp, silver carp, bighead carp, yellow check carp, will also be blocked.	**Habitat Protection:** • During flood seasons, the river segments (from Cuijiaying dam to the tail of the Yakou reservoir and downstream of Yakou dam) with a flow rate of 0.2m/s are protected as fish habitats in the main stream. It is estimated that the river segments are respectively 5km and 7km long. It is recommended that fishing shall be banned in the aforesaid river segments. During the breeding season (from March to August), fishing and other activities that may disrupt the aquatic habitat in the aforesaid areas shall be banned; warning signs shall be put up near these areas. • About 18km of Ying River, a tributary in the downstream of dam, is protected as a habitat. Habitats for fish can be created by placing pebbles and gravels in an area and transplanting water plants to the area. Artificial spawning grounds can be built for fish.	63	Project Operation Unit, Fishery Administration Station, Bureau of Animal Husbandry and Aquatic Products and Agricultural Bureau	Project Operation Unit and Fishery Administration Station	Habitat conditions: Online ecological flow monitoring, water temperature, dissolved oxygen, pH, transparency, water depth, flow rate, and content of gas dissolved in water (only cross section in the downstream of dam) Aquatic wildlife: Chlorophyll (a) content and distribution, plankton, sessile organism, benthonic animal, aquatic vascular plants, distribution density and biomass	
		Artificial fish passing: Guided by professional personnel, professional fishermen will be organized to catch fish in the downstream of dam, transport them upstream and put them in the reservoir as well as river segments upstream, so as to guarantee fish exchange in the upstream and downstream of dam.	30	Project Operation Unit, Fishery Administration Station, Bureau of Animal Husbandry and Aquatic Products and Agricultural Bureau	Project Operation Unit and Fishery Administration Station		

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Aquatic ecosystem	Fishes, such as common carp, crucian carp, catfish, squaliobarbus curriculus, culter alburnus, siniperca chuatsi, and yellow cheek carp and rhodeus spinalis adapted to slow flow or static water, will become the dominant species, due to water raise, slow flow and satisfactory breeding conditions in the reservoir area. Fishes, such as the four famous domestic fishes, opsariichthys bidens, coreius heterodon, rhinogobio typus, saurogobio dabryi, mahi-mahi, loaches and squalidus argentatus, will gradually shift to the tail of the reservoir and the river segments in the downstream of Cuijiaying Dam, due to changes in feeding and breeding conditions. Therefore, their number will decrease.	**Artificial fish enhancement:** Preliminary releasing number is 4 million per year, among which 3.5 million are to be subcontracted for cultivation and 0.5 million fish are to be reproduced and cultivated by the enhancement and releasing station. Immediate key releasing species include hypophthalmichthys molitrix, aristichthys nobilis, ctenopharyngodon idellus, mylopharyngodon piceus, leiocassis longirostris, megalobrama skolkovii, parabramis pekinensis, squaliobarbus curriculusand distoechodon tumirostris; and enhancement and releasing subject added in the long term includes leiocassis crassilabris. The aquatic organism in the reservoir area as well in the downstream of dam shall be kept under long-term monitoring and survey. Meanwhile, relevant scientific research planning shall be made, so as to provide necessary technical support for fish protection. The Project has planned for a 20-year fish releasing cycle. After 20 years, releasing plan will be adjusted according to the restoration situation of fish resources.	1494.71	Project Operation Unit, Fishery Administration Station, Bureau of Animal Husbandry and Aquatic Products and Agricultural Bureau	Project Operation Unit and Fishery Administration Station	Recapturing analysis and enhancement and releasing effect evaluation (fluorescence labeling method)	1 time/year in the 1^{st}, 2^{nd}, 4^{th}, 7^{th} and 10^{th} year after impounding

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
		Fishery administration: Enhance the fishery administration of waters affected by the Project, try to maintain the natural fish resources, and minimize damage to the existing fish resources: • Cage culture and other activities that might pollute water environment in the reservoir area shall be forbidden; • Research on fishery development in Yakou Reservoir area shall be made; • Fishery transferring and compensation shall be implemented in accordance with the resettlement action plan and social impact assessment; • The local fishery administration will be enhanced through institutional building and capacity construction.	150	Project Operation Unit, Fishery Administration Station, Bureau of Animal Husbandry and Aquatic Products and Agricultural Bureau	Project Operation Unit and Fishery Administration Station	Dynamic survey of fish gathering and population: Specific composition, population structure, resources, etc., focusing on the dynamic monitoring of key commercial fishes under national protection and those spawning in water	Monitoring in the year before reservoir impounding and in the 1st, 2nd, 4th, 7th and 10th year after impounding, altogether 6 years; dynamic survey of fish gathering and population from March to June and from October to November, about 10 days each month; and survey of fish spawning grounds from March to July, no less than 60 days/year
Fisherman's livelihood	The dam obstruction, reservoir regulation, etc. result in changes in the aquatic habitat. In this case, the number of fish might reduce, producing certain impacts on fishermen's income.	• Fishery transferring and compensation shall be implemented in accordance with the resettlement action plan and social impact assessment. Meanwhile, the ecological protection measures mentioned above shall be effectively taken.	60	Project Operation Unit, Fishery Administration Station, Bureau of Animal Husbandry and Aquatic Products and Agricultural Bureau	Project Operation Unit and Fishery Administration Station	Refer to the resettlement action plan and monitoring plan	Refer to the resettlement action plan and monitoring plan

5.3 ESMP for reservoir inundated area and resettlement area

The Project involves land acquisition and resettlement in 36 villages, 8 townships (offices), 3 cities (districts) (including Xiangcheng District and Xiangyang District in Xiangyang City, and Yicheng City). The population involved in production arrangement due to land acquisition is 660. The agricultural arrangement depending on land reallocation in the villages concerned or those in the neighborhood is combined with other arrangement forms. The population relocated is 91. There is mainly the centralized backward resettlement, scattered backward resettlement within the village concerned, etc. The special items of Yakou Navigation Complex Project include 7.5km-long farm machinery accesses, 3 cargo terminals, 4 ferries, 3km-long power cables, 3km-long 110kV power cables, 10 pumping stations and 12 drainage culverts and sluices. The affected roads, bridges, power transmission facilities, communication facilities, and water facilities will be transformed or rebuilt. The living conditions and the per capita net income after the resettlement will be greatly improved.

Within the land acquired by the Project, there is no environmental sensitive area, such as the natural conservation area or the scenic spot. The land acquisition and resettlement mainly produces adverse impacts on the water environment, atmospheric environment, noise environment and ecological environment. The impacts on the ecological environment mainly include the occupation of land, vegetation destruction, water and soil erosion, etc. In the entire assessment area, the vegetation directly destroyed takes a small proportion. Moreover, the vegetation affected mainly includes the secondary savanna shrub and grass, not affecting the ecological and landscape stability of the assessment area.

Since the resettlement work is carried out by the lump-sum contractor selected by the local government, the PIU only needs to take certain environmental protection measures: using grit chamber to reutilize construction wastewater instead of direct discharge; using water spray to prevent dust; making full use of construction wastes and storing those that cannot be reused to the specified dumps; collecting domestic garbage and carrying out landfill disposal in Yicheng landfill sites for domestic garbage. During project operation, the domestic wastewater will undergo pre-treatment in septic tank first and then be

disposed by integrated domestic sewage treatment facility. The ESMP for resettlement area is given in Table 5-3.

Table 5-3 ESMP for reservoir inundated area and resettlement area during construction and operation

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
I.	Construction period						
Land acquisition and demolition	The land area inundated in the hydro-junction totaled to 27,584.03 *Mu* (1 *Mu* ≈ 666.7 m^2), all located between the levees of Han River.	For 12 zones selected within the area inundated, the field lifting plan is introduced, so as to minimize the area of cultivated land within the reservoir area. The field so lifted has an area of 13,892.85 *Mu* (1 *Mu* ≈ 666.7 m^2), with 13,413.79 *Mu* (1 *Mu* ≈ 666.7 m^2) bringing benefits, offsetting 93.94% of the cultivated land to be inundated. In this way, the cultivated land acquired within the reservoir area due to inundation is reduced by at least 865.27 *Mu* (1 *Mu* ≈ 666.7 m^2), greatly lowering the adverse impacts of the Project inundation on the production and daily life of farmers around.	Budget for resettlement action plan	Yicheng Municipal PRO, Project Resettlement Office (PRO) and the local township governments in the resettlement area	Superior local governments and local land departments	Refer to the RAP.	Refer to the RAP.

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
		For the 91 persons from 18 households in the reservoir area expecting house building arrangement, the scattered backward resettlement within their own village will be adopted. The area of the house site shall be controlled at 140m^2/household if cultivated land is selected and 200m^2/household if forest land is selected.	For the Project, a detailed resettlement action plan has been made to ensure the land acquisition and resettlement procedures meet the laws and regulations in China as well as applicable policies introduced by the World Bank and help people resettled maintain and improve their daily life and production level. When the Project is implemented, the resettlement action plan will be effectively carried out.	Budget for resettlement action plan	County Supporting Team, County-level PRO and the local township governments in the resettlement area	Superior local governments and local land departments	Refer to the RAP.	Refer to the RAP.
Water and soil loss	Reservoir inundated area	According to the engineering design, the reservoir is located in the zone of transition between Nanxiang Basin and Jianghan Plains. When the water level rises, the banks will be immersed in water for a long time, resulting in changes in the hydrogeological conditions. In this case, the stability of reservoir banks will be affected.	The field-lifting operation shall be conducted when the water and soil erosion is controlled. Filed-lifting area During the cleaning of woodland, the specifications for cleaning of reservoir bottom (Appendix 2) must be strictly followed to avoid any new exposed surface due to human factors. According to the *Water and Soil Erosion Control Plan* (Appendix 1), the monitoring of reservoir banks shall be enhanced during construction.	Included in the budget for the *Water and Soil Erosion Control Plan* (Appendix 1) and *Reservoir Bottom Cleanup Plan* (Appendix 2)	CC, CSC	PMO, Xiangyang Environmental Protection Bureau, Xiangyang Water Resources Bureau	Refer to monitoring requirements stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.	Refer to monitoring requirements stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Resettlement area	If operation within the resettlement area, such as the excavation, is not properly controlled, local water and soil erosion might be deteriorated.	According to the *Water and Soil Erosion Control Plan* (Appendix 1), the balance between excavation and filling shall be kept, the natural conditions shall be fully utilized, and grass and trees shall be planted around the residential areas and roads.					
Ecology	Vegetation deterioration	The construction will cause certain destruction to the existing forest and vegetation in the resettlement area. The vegetation occupied mainly includes the timber production forest, farmland vegetation and shrubwood with low ecological values.	Trees shall be planted around the resettlement area. Additionally, if the vegetation recovery area fails to meet applicable requirements, the construction department shall make a certain payment in accordance with relevant requirements and the provincial forestry department will carry out forest and vegetation recovery in proper locations.	Included in the budget for the *Water and Soil Erosion Control Plan* (Appendix 1)	PMO, CC, CSC, local forestry departments	Local forestry department	Refer to **Table 3** - Vegetation Destruction Monitoring Indexes in Project Area	Refer to **Table 3** - Vegetation Destruction Monitoring Frequency in Project Area
	Terrestrial animal	The key animals under national protection in the resettlement area might be subject to habitat destruction, noise, pollution, hunting, etc.	Publicity and education: The publicity of resettlement environment and wildlife protection shall be enhanced; For the wildlife under national protection and provincial protection in the resettlement area, corresponding publicity brochure about the wildlife identification, protection measures and management provisions shall be prepared and issued to those resettled.	15	PMO, CC, CSC, local wildlife protection departments	Local department of wild animal conservation	Refer to **Table 3** - Vegetation Destruction Monitoring Indexes in Project Area	Refer to **Table 3** - Vegetation Destruction Monitoring Frequency in Project Area

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Ambient air	Construction dust	The construction in the resettlement area might produce dust, causing certain impacts on residents around.	Alleviation measures are given under **Appendix 3** - Construction Environmental Specifications of Contractors	Included in the budget for atmosphere protection (**Table 3**)	CC, CSC	PMO, Xiangyang Environmental Protection Bureau	SO_2, NO_2 and TSP	2 times/year, no less than 18 hours of monitoring per day for 5 consecutive days each time
	Vehicle exhaust and dust from transportation	The tail gas from material transport vehicles as well as dust along the roads might produce certain impacts on residents around.	Alleviation measures are given under **Appendix 3** - Construction Environmental Specifications of Contractors.					
Noise	Construction noise	The noise from construction in the resettlement area might produce certain impacts on residents around.	Alleviation measures are given under **Appendix 3** - Construction Environmental Specifications of Contractors	Included in the budget for atmosphere protection (**Table 3**)	CC, CSC	PMO, Xiangyang Environmental Protection Bureau	Leq	24 hours/day, 2 days/time, 2 times/year, altogether 4 years
	Traffic noise	The noise from material transport vehicles might produce certain impacts on residents around.	Alleviation measures are given under **Appendix 3** - Construction Environmental Specifications of Contractors					
Water quality		If discharged without proper treatment, the wastewater from construction in the resettlement area and domestic sewage from the construction personnel might pollute the local surface water.	In the backward resettlement area, sewage shall be treated with the existing local sewage treatment facilities before discharge into local waters;	179.1	CC, CSC	PMO, Xiangyang Environmental Protection Bureau	Surface water quality during construction: pH, SS, DO, COD_{Mn}, BOD, COD_{Cr}, ammonia nitrogen and petroleum	2 times/year (flood season and dry season), altogether 4 years, in combination with the project area monitoring
Solid waste		The excavation and filling is kept balanced. There is only a small quantity of discarded residue during the construction of new houses and living facilities.	According to the *Water and Soil Erosion Control Plan* (Appendix 1), the said discarded residue shall be placed in the low-lying areas around for land leveling.	Included in the budget for *Water and Soil Erosion Control Plan* (Appendix 1)	CC, CSC	PMO, Xiangyang Environmental Protection Bureau, Xiangyang Water Resources Bureau	Refer to monitoring requirements stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.	Refer to monitoring requirements stated in the *Control Plan for Water and Soil Loss* as shown in the Appendix 1.

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Material and cultural resources		Based on existing survey, there is no cultural object involved in the construction of the resettlement area. However, during excavation, cultural relics might be found. In this case, the relics or handiworks with values might be damaged	If historical and cultural resources are found, the construction shall be suspended immediately and the cultural relics shall be protected.	/	PMO, CC and CSC	Xiangyang Bureau of Cultural Heritage	/	/
Social influence	Traffic safety	The construction and transport in the resettlement area might increase the traffic accidents along roads near the residential areas.	a. Local people shall be informed of the increased traffic pressure and corresponding safety measures through local radio and television programs and official notices. b. Drivers shall be trained, vehicles shall be maintained, the speed of a vehicle shall be limited, the road signs shall be increased and the parking area shall be divided. c. A notice shall be given to the public during rush hours or special period and the cooperation with traffic police will be provided.	included in the overhead cost of the Project	PMO, CC, CSC and local traffic police department	Local traffic police department	/	/

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Vulnerable groups	During resettlement, their benefits and interests will be easily neglected; insufficient labor results in difficulties in resettlement work; increased pressure; low participation; and various difficulties;	a. Special assistance or treatment will be provided to the designated vulnerable groups or those being brought to poverty due to resettlement, such as cooperation with local civil affairs bureau in establishing the special assistance funds; b. Priority will be given to those from the vulnerable groups in terms of vocational training, employment guidance and opportunities; c. During construction and operation of the Project, those from the vulnerable groups will be first considered when there is unskilled work; d. The housing subsidy will be provided to the vulnerable groups; e. During resettlement, the local village collective will help them select the house sites and assist them with the resettlement and house building.	Included in the budget for resettlement action plan and special funds of local civil affairs bureau	PMO, CC, civil affairs bureau, county human resources and social security bureau, agricultural bureau, tea bureau and village committee	PMO, civil affairs bureau, supervisors, and external monitoring unit	Participation in main activities at different stages of the Project; number of unskilled workers during implementation; number of people and times to training as well as suggestions; subsidy to vulnerable groups; and resettlement progress	Refer to the social assessment report

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
		Adverse impacts are produced on women mainly engaged in agricultural production; the employment opportunities of a small number of women are affected; the employment opportunities of women are affected as a result of vegetable production affected by land acquisition or temporary occupation; and women's demands and ideas about the selection of house type, kitchen layout, etc. are neglected.	a. Women's demands and opinions shall be considered during design; b. The vulnerable groups, including women, shall be first considered when there is unskilled work during implementation; c. Training shall be provided on the date and in the form accepted by women; d. The construction shall be promoted as soon as possible and the suspension period shall be shortened; e. The reserved collective land, if any, shall be first allocated to women marrying those in the village concerned in strict accordance with the resettlement action plan and applicable policies.	Included in the budget for resettlement action plan and special funds of the women's federation and other departments concerned	PMO, women's federation, village committee, agricultural bureau, tea bureau, human resources and social security bureau	PMO, women's federation and external monitoring unit	The number of people and times to the symposiums and interviews during design as well as suggestions; the number of women engaged in unskilled work during implementation; project progress; land of women marrying those in other places, compensation, etc.	Refer to the social assessment report

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Original residents	Reduction in land resources, great pressure of infrastructure and public services, and allocation of public resources and others	Land resources: a. The original residents shall be fully informed before the land readjustment and their opinions shall be solicited; b. Compensation shall be made in accordance with the new land acquisition uniform annual output standard in Hubei Province, policies regarding comprehensive land price in each district and immigrant investment. Public resources: a. The "three supplies and one leveling" shall be implemented in the centralized resettlement area to avoid or alleviate the situation where there is insufficient infrastructure and community service facilities; b. Governments need to reasonably guide the allocation of public assets in the resettlement area, so as to promote the harmony between immigrants and original residents.	Included in the budget for resettlement action plan	PMO, DI, CC, village committees at project area and resettlement area	PMO and external monitoring unit	Investigation of original residents' willingness; land compensation; infrastructure and community facilities; allocation of collective assets; and complaints from original residents	Refer to the social assessment report
II.		Operating period						

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Water quality	Centralized resettlement point	If domestic sewage is not properly disposed, it will affect the surrounding environment.	After comparison and selection, the Project intends to use the domestic sewage biogas purification pool to dispose domestic sewage in the resettlement point, and discharge it after reaching the GB8978-1996 Grade I standards. If the water quality is not stable, coagulant dosage may be increased for improvement.	123.9	Project operation unit, relevant village committees	Municipal bureau of environmental protection	/	/
Solid waste	Centralized resettlement point	If domestic garbage is not properly disposed, it will affect the surrounding environment.	Strengthen environmental sanitation management, focusing on farmers, carry out the six kinds of garbage disposal methods, including putting farmers' garbage into barrels, putting public garbage into trash bins, putting organic waste into waste storage tanks, putting inorganic waste into garbage station, putting construction waste into landfill site and putting other waste into the furnace, using the local existing sanitation facilities nearby for proper disposal of garbage; at the same time, strengthen the propaganda work of garbage classification for farmers.		Local environmental sanitation authorities	Higher environmental sanitation authorities	/	/

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Hazardous materials		In the resettlement area, 0.5% bromadiolone will be used for deratization. Improper use or storage of rodenticide may be harmful to human health.	See Appendix 4: Notes of use and storage of rodenticide in Management Plan of Hazardous Materials and Wastess.	/	the center for disease control and prevention of the county	Local sanitary control authorities, the village committee of resettlement point	/	/
Social influence	Quality of life	After the implementation of the resettlement, displaced persons have equivalent quantity and quality of land to that before inundating. At the same time, taking the advantage of land compensation and built reservoir, the productivity of land in the resettlement point will be improved without influence on producing and living ways of displaced persons basically, living environment, transportation conditions will also be improved significantly, and the overall quality of life will be greatly improved.	Positive impact and no need to slow down measures	/	/	/	/	/

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
	Public health	During the initial impounding period, the inundation of toilet, stock barn, cemetery and others cause water pollution easily. The increase of water area in reservoir region is favorable to mosquito breeding. Due to the inundation, rat density around the reservoir area will increase, and the incidence of rodent vector and insect-borne infectious disease may rise. Increase of demand for health and epidemic prevention in the resettlement area.	Strengthen the medical care institutions: grant allowance to health centers in towns in resettlement area, increase the basic testing equipment and testing drugs, reagents and others in each health clinic in towns in the reservoir area. Health technique training: strengthen the professional training of medical personnel in village clinics and health centers in towns in resettlement area.	10	PMO	Local health and epidemic prevention departments in charge	/	/
			Reservoir bottom cleaning: the toilet, cesspit, stock barn, cemetery and others to be inundated shall be disinfected and sterilized, and the domestic garbage in cities and towns shall go through harmless disposal. Living environment sanitation: improve the sanitary condition of drinking water, strengthen the disinfection and management of water source.	36.5	PMO, CC and CSC	Local health and epidemic prevention departments in charge	/	/

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
			Disease detection and preventive inoculation: during the resettlement period, for the rural displaced persons for backward resettlement, carry out one insect-borne infectious disease and natural focus disease detection every two years (about 150 persons / time), and for all the feverish displaced persons, carry out malaria blood test (590 persons / year, 2 years in total).	10	the center for disease control and prevention of the county	Local sanitary control authorities	Disease surveillance: Category A, Category B and Category C infectious diseases, including diseased population, incidence and time distribution, age distribution, gender distribution, etc. Emergent epidemic surveillance	According to the surveillance requirements of health care and epidemic prevention network of county, town and village, construction period of 4 years
			Health propaganda: during the resettlement period, give publicity to prevention knowledge and preventive inoculation knowledge of common infectious diseases once each year to improve the health care and disease prevention knowledge and health protection awareness of displaced persons.	3.5	the center for disease control and prevention of the county	Local sanitary control authorities	/	/

Environmental/social factor		Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
			Vector control: take deratization measure for indoor and outdoor, places in front and back of houses and farmlands where people often make more activities and many rats exist, so as to ensure the rat density in the areas above the inundation line in resettlement area does not exceed the current level or the standard in the state provisions after impounding. Coordinate deratization time and impounding time, and carry out one deratization after the of the first power generator in the powerhouse and one after impounding respectively.	3.0	the center for disease control and prevention of the county	Local sanitary control authorities	Rat species and rat density Pestis Mosquito species and mosquito density	2 times / year (May, August), construction period of 4 years

5.4 ESMP for power transmission and transformation project

This supporting project mainly involves the construction of about 12 km110kV transmission lines (from Yakou hydropower station to local Zhengji transformer substation). The adverse environmental impact of transmission line is caused by construction, operation and maintenance of transmission lines.

For the typical potential environmental impacts of the power transmission project, the general environmental and social management framework for construction and operation period is formulated specially, which can be taken as a reference for relevant power departments when carrying out EIA in the future.

See Table 5-4 for the ESMP for power transmission and transformation project.

Table 5-4 ESMP for supporting transmission line project in construction and operation period

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
I.	Construction period						
Land acquisition and resettlement	The implementation of the project will occupy a certain land, which may affect the surrounding residents, but because the project design has not yet been determined, the specific impact of land acquisition and resettlement needs to be determined.	Optimize the line, reduce the area, and avoid densely inhabited areas as far as possible. As the local power sector will be responsible for the implementation of the supporting transmission line, the detailed resettlement action plan shall be prepared and practically implemented in accordance with the Chinese laws and regulations and the relevant policies when implementing the project.	Undetermined	PIU, local government	Governments of higher levels, local land authorities	See the resettlement plan prepared for the supporting transmission line project.	See the resettlement plan prepared for the supporting transmission line project.

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Water and soil erosion and ecology	The implementation of the project may destroy the original topography, landforms and surface vegetation, and may increase the local water and soil erosion. In addition, construction activities may also cause disturbance and destruction of the living environment of the local wildlife.	- Take high-span way for the forest region spanned by the line and reduce felling of trees caused by line erection; take driven cast-in-place pile as tower foundation, reduce excavation area and minimize damage to vegetation; set up temporary line holder in line erection and avoid destroying vegetation under the line. - During the construction of tower foundation, the topsoil and deep soil shall be piled up respectively. When backfilling, fill the deep soil first, and level the excess mellow soil in the tower foundation and its surrounding. Timely restore vegetation after the completion of construction. - Construction shall avoid rainy season and windy days to reduce water and soil erosion. - Strengthen the propaganda and education of construction personnel, strengthen the environmental management during construction period, strictly control the scope of construction, standardize the construction activities, and prohibit hunting wild animals.	Undetermined	PIU, CC, CSC	Municipal water resources bureau and municipal bureau of environmental protection	Undetermined	Undetermined

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Ambient air	The dust caused by construction activities will have a certain impact on the local air quality.	- The side slope of earth material piling up shall not be too large. Waste dump site shall be compacted in time. Earth material in the open air shall be humidified properly in sunny and windy days. - For the construction area of centralized excavation, take sprinkling dust suppression measure according to dust on the site in days without rain. - Construction shall avoid windy days. - According to the prediction results of the environmental impact assessment, the closed enclosure shall be set up for sensitive receptors around the construction site.	Undetermined	PIU, CC and CSC	Municipal bureau of environmental protection	Undetermined	Undetermined
Noise	The noise caused by construction activities will have a certain impact on the residents along the line.	- Strictly implement the existing noise standards related to construction machinery and construction time. - High-noise works are prohibited at night on the site adjacent to residential areas. - According to the prediction results of the environmental impact assessment, the sound barrier and other temporary engineering measures shall be taken for sensitive receptors around the construction site.	Undetermined	PIU, CC and CSC	Municipal bureau of environmental protection	Undetermined	Undetermined
Water quality	In the construction period, the arbitrary discharge of domestic sewage and production waste water without any disposal may pollute the local surface water.	The sedimentation tank shall be set up in the construction camp and the construction site to dispose sewage in a simple way and discharge it after reaching the standards.	Undetermined	PIU, CC and CSC	Municipal bureau of environmental protection	Undetermined	Undetermined

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Construction safety	In the construction process, there is the risk of construction safety when striding across the power line, which may result in power failure and affect the operation of local power grid.	Strengthen the construction management, especially the construction safety education and training for construction personnel, to avoid any possible safety accidents.	Undetermined	PIU, CC and CSC	Power management department	Undetermined	Undetermined
Material and cultural resources	Ancient cultural relics may be found in the earthwork excavation of the project. Valuable sites or arts and crafts may be damaged.	If historical and cultural resources are found, the construction shall be suspended immediately and the cultural relics shall be protected.	/	PMO, CC and CSC	Yicheng Municipal Administration of Culture, Radio, Film & TV and Xiangyang Municipal Administration of Culture Heritage	/	/
II.	Operating period						
Ecology	The maintenance personnel may cause damage to the local ecological environment in the process of maintenance.	Strengthen the education and training of the maintenance personnel inspecting the line, strengthen the awareness of ecological protection, and require the maintenance personnel shall minimize the scope of activities in the maintenance to reduce the disturbance to the natural environment.	included in the overhead cost of the Project	Power management department	Municipal bureau of environmental protection	Undetermined	Undetermined

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Noise	During the operation period of transmission line, corona in adverse weather conditions will produce certain audible noise.	- Select a reasonable line trend and path to avoid residents' houses and other sensitive receptors as far as possible. - Reduce the corona and noise of line through optimizing design, selecting high voltage electrical equipment and conductors, increasing the equivalent radius of wire, selecting wire following that corona does not appear in sunny days and other measures.	Incorporate into project design cost and project investment	DI, PIU, CC, CSC	Power management department	Undetermined	Undetermined
Ecology	The maintenance personnel may leave domestic garbage in the site in the process of maintenance.	Require the maintenance personnel to take their domestic garbage away from the site after the completion of work.	included in the overhead cost of the Project	Power management department	Municipal bureau of environmental protection	/	/
Electromagnetic radiation	In the process of power transmission or voltage transformation, the supporting transmission line project will form power frequency electric field and power frequency magnetic field, producing electromagnetic radiation, affecting the surrounding environment and residents, disturbing radio, and affecting the normal work of the surrounding radio communication, information technology and medical instruments and other equipment.	- Select a reasonable line trend and path to avoid residents' houses and other sensitive receptors as far as possible. - In design, select equipment and accessories of low disturbance to power frequency electric field, power frequency magnetic field and radio; take the necessary shielding and joining and sealing measures for the hole, mouth and crack of equipment for electromagnetic oscillation equipment producing high power; take voltage-sharing measures for high voltage primary equipment. - Increase the overhead height of wire and install the shielding wire in the place of better shielding effect so as to avoid any influence on the communication system.	Incorporate into project design cost and project investment	DI, PIU, CC, CSC	Power management department	Undetermined	Undetermined

Environmental/social factor	Potential impacts/issues	Mitigation measures/action plan	Budge (CNY 10,000)	Implementing agency	Supervising agency	Monitoring index	Monitoring frequency
Public health and safety	Improper erection of transmission lines, may cause fire, electric shock and other risks in the course of operation, endangering public property and safety.	- Maintain a reasonable distance of wire to ground and span and cross to meet the "Code for design of 110-750kV overhead transmission line". - Strengthen the inspection and maintenance during the operation period to ensure line safety.	Incorporate into project design cost and project investment and project management cost	DI, PIU, CC, CSC, power management department	Power management department	/	/

6 Environmental monitoring plan

6.1 Purpose of environmental monitoring

In order to ensure environmental protection work of the Project, verify the prediction results of the environmental impact assessment, prevent harms of urgent accident to environment, and simultaneously provide the scientific basis for environmental pollution control and environmental management in construction period and operation period and environmental protection for river basin cascade development, it is necessary to carry out the work of environmental monitoring, and timely grasp of the changes of ecological environment in the construction period and after operation.

6.2 Distribution principle of monitoring stations

a) Principle of close combination with the project construction

The scope, object and key points of the monitoring work shall be combined with the characteristics of project construction and operation, fully reflect the changes of the surrounding environment in the process of project construction and operation, and the influences of changes in the environment on project construction and operation.

b) Pertinence principle

According to the project characteristics, the environmental status and the prediction results of environmental impact, select main factors significantly impacting and controlling the environmental impact on regions or watershed for monitoring, and select monitoring points and monitoring items reasonably, striving for the monitoring plan of pertinence and representativeness.

c) Economic and operational principles

In accordance with the relevant professional technical specifications, take the premise of monitoring items, frequency, period of time and method meeting the main task of the monitoring system, and use the existing results of monitoring institutions, striving to obtain more complete environmental monitoring data with less input.

6.3 Environmental monitoring during construction period

Environmental monitoring during construction period includes water environment monitoring, atmospheric environmental monitoring, acoustic environmental monitoring,

terrestrial ecological monitoring and population health monitoring. See Table 6-1 for more.

Table 6-1 Environmental monitoring plan during construction period

Category	Monitoring area	Monitoring parameters	Duration (year)	Frequency	Total number of times
Surface water	Han River: Check cross-section: upstream of the dam site (500m from the dam site) Control section: about 1km in downstream of the dam site	PH, SS, DO, CODMn, BOD5, CODCr, NH3-N and petroleum	4	2 times / year, one for high flow period and one for low flow period	8
Air quality	3 points: Left bank near the dam site (Yakou Village) and right bank (Group 4, Haoji Village), residential area in stockyard	TSP, NO_2, SO_2	4	Three times per year	8
Noise	5 points: Left and right banks of the dam site, access roads, camps, residential area	Leq(A)	4	2 times / year, each time including day and night respectively	8
Sewage discharge	Discharge outlet of living area in construction camp	COD, BOD5, NH3-N, TP, TN	4	4 times / year (once every three months)	16
	Discharge outlet of sand and gravel aggregate processing field, discharge outlet of waste water of concrete mixing system, discharge port of foundation pit	SS, pH		4 times / year (random sampling)	16
Health of population	Construction area	Category A, Category B and Category C infectious diseases	4	According to requirements of local center for disease control and prevention	/
	Set up 4 points in resettlement area	Category A, Category B and Category C infectious diseases and emergent epidemic report	4	According to requirements of local center for disease control and prevention	/
	Four points (indoor and outdoor, less than 1km away from inundation line of reservoir)	Rat species and rat density	4	Twice a year (mid ten days of mousing months: May and August)	8
		Occurrence of pestis			
		Mosquito species and mosquito density	4	Twice a year (May and August), twice a month	8

Category	Monitoring area	Monitoring parameters	Duration (year)	Frequency	Total number of times
Water and soil loss	Areas prone to water and soil erosion, such as stockyard excavation slope, borrow pit, and waste dump site, especially the areas of mild landslide found in the project preparation	Water and soil loss	4	See plan of control of water and soil erosion	See plan of control of water and soil erosion

6.4 Environmental monitoring during operation period

Environmental monitoring during operation period includes water environment monitoring, atmospheric environmental monitoring, acoustic environmental monitoring, terrestrial ecological monitoring and population health monitoring. See Table 6-2 for more.

Table 6-2 Environmental monitoring plan during operation period

Category	Monitoring area	Monitoring parameters	Duration (year)	Frequency	Total number of times
Surface water	Check cross-section: below Cuijiaying dam Section in the middle of reservoir: Yicheng bridge section Section in front of dam: upstream of the dam site (500m from the dam site) Section in downstream of the dam: about 1km in downstream of the dam site	Water temperature, pH, SS, DO, CODMn, BOD, COD, NH3-N, TN, TP, chlorophyll a, transparency, Hg, As, volatile phenol, fluoride, cyanide, chromium (VI), Pb and petroleum and sediment charge	3	2 times / year, one for high flow period and one for low flow period	6
	Tail water discharge of Yakou power station	Ecological flow	3	On-line monitoring	/
Ecology	8 sections (or sampling points) are intended to set up in main stream and tributaries for aquatic organisms and habitat survey: above Cuijiaying dam, below Cuijiaying dam, Weishui, Yicheng bridge, Chun River, Ying River, Yakou dam site and Huji	Environmental indicators: water temperature T℃, DO, pH, transparency, depth of water and flow rate In section under the dam, it is necessary to monitor the dissolved gas content (mainly nitrogen).	1 year before impounding; the first, second, fourth, seventh and tenth years after impounding, 6 years in total.	Twice a year (in April and August)	12
		Aquatic organisms: content and distribution of chlorophyll a and species, distribution density and biomass of plankton, periphyton, benthic animals and aquatic vascular bundle plants			12
		Fish assemblage and population dynamics	1 year before impounding; the first, second, fourth,	Twice a year (March-June and October-November)	12

Category	Monitoring area	Monitoring parameters	Duration (year)	Frequency	Total number of times
		Fish spawning site	seventh and tenth years after impounding, 6 years in total.	March-July, not less than 60 days a year	6
	The area below the first watershed on both sides of the valley in inundated area, mainly includes the inundated area of reservoir, the resettlement area and the construction area.	Terrestrial organism: Habitat, biodiversity and distribution change;	Background monitoring: one time before construction; The first year and the fifth year after impounding	Once a year	3
Water and soil loss	Areas prone to water and soil erosion, especially areas of mild landslide found in the project preparation	Water and soil loss	3	See plan of control of water and soil erosion	See plan of control of water and soil erosion
Dam safety	Project area and dam	Dam safety	Action plan prepared according to World Bank dam safety procedure		

7 Investment estimate

The total investment in environmental protection of Yakou navigation complex is CNY 273,012,500, accounting for 8.41% of the total investment in project of CNY 3,245,711,000, of which special fund in environmental protection is CNY 151,082,800, and special fund in water and soil conservation is CNY 121,929,700.

7.1 Special fund for environmental protection

The special fund in environmental protection of Yakou navigation complex is CNY 151,082,800, of which the investment in environmental protection of the Complex project is CNY 89,425,300, the independent cost is CNY 14,685,300, and the basic preliminary cost is CNY 10,411,100. See Table 10.6.1-1 for special fund in environmental protection. See Table 7.1-1 for detailed estimate investment in environmental protection project of Yakou Navigation Complex Project.

Table 7.1-1 Estimate of special fund for environmental protection of Yakou navigation complex

S/N	Item	Cost (CNY 10,000)	Percentage of total investment (%)	Remarks
Part one	Investment in environmental protection of complex	11830.73	78.31	
I	Water environmental protection measures	2621.1	17.35	
1	Flushing wastewater from aggregate system	1035.1	6.85	
2	Waste water of concrete system	35.6	0.24	
3	Oily wastewater of construction plant	51.06	0.34	
4	Domestic sewage in construction camp on right bank	364.63	2.41	
5	Disposal of domestic sewage in PIU's camp	94.05	0.62	
6	Excrement and sewage in construction area	73.86	0.49	
7	Treatment of oily wastewater treatment within the plant area	136.8	0.91	
8	Wastewater treatment	830	5.49	
8.1	Vessel sewage receiving ship	150	0.99	
8.2	Collection and disposal facilities for wharf and vessel sewage	460	3.04	
9	Quality improvement and reform of waterworks in reservoir area	220	1.46	Investment allocation

S/N	Item	Cost (CNY 10,000)	Percentage of total investment (%)	Remarks
II	Atmospheric environmental protection project	251.01	1.66	
1	Dust reduction and control measures for sand and gravel aggregate processing system	42.75	0.28	
2	Reduction and control measures for waste gas of fuel oil	0	0.00	Included in the main body
3	Transportation dust reduction and control measures	150.48	1.00	
4	Dust control of construction site	57.78	0.38	
III	Acoustic environmental protection project	149.79	0.99	
1	Noise control measures for sand and gravel aggregate system	0.00	0.00	Included in the main body
2	Measures for noise of road transport	149.79	0.99	
IV	Domestic garbage disposal project	202.03	1.34	
1	Domestic garbage disposal in camp	192.03	1.27	
2	Domestic garbage disposal on vessel	10	0.07	
V	Ecological environmental protection measures	4642.90	47.17	
1	Cost of terrestrial ecological protection measures	699.95	4.63	
1.1	Ecological remediation	685.70	4.54	
1.2	Cost of in situ conservation and propaganda and education	14.25	0.09	
2	Aquatic ecological protection measures	6426.52	42.54	
2.1	Construction of fish proliferation station	1824.00	12.07	
2.2	Operating cost of the proliferation station (1-4 years)	1103.31	7.30	Reach the scale of operation in the fourth year
	Operating cost of the proliferation station (5-25 years)	282.77	1.87	Begin to be included in the operating cost of power generation in the fifth year
2.3	Carry out scientific research	622.55	4.12	
	Study of habitat conservation and habitat restoration	150	0.99	
	Research on ecological regulation mode	150	0.99	
	Succession of aquatic organisms in the middle and lower reaches of Han River after the formation	200	1.32	

S/N	Item	Cost (CNY 10,000)	Percentage of total investment (%)	Remarks
	of the reservoir			
	Study of artificial proliferation technique	122.55	0.81	
2.4	Habitat conservation	871.25	5.77	
2.5	Fishway	1807.76	11.97	Included in complex investment, not included in environmental protection investment
2.6	Fishermen compensation investment	197.65	1.31	Include the first 3 years, later included in the operating cost
VI	Population health protection	197.65	1.31	
1	Sanitation and cleaning	97.90	0.65	
2	Personal health	28.50	0.19	
3	Management and supervision of environmental sanitation and food hygiene	28.50	0.19	
4	Health and epidemic prevention institution in construction area	42.75	0.28	
VII	Protection measures for cultural relics and historic sites	/		Included in other projects
VIII	Environmental monitoring and investigation project	1112.68	7.36	
1	Environmental quality monitoring (water, air, sound)	241.68	1.60	Include water quality monitoring in the reservoir area
2	Aquatic ecological monitoring	320.6	2.12	
3	Terrestrial ecological survey	68.4	0.45	
4	Fish pass effect monitoring	75	0.50	CNY 250,000/ year, included in the operating cost of power generation of power station 3 years later
5	Proliferation and releasing effect monitoring	165	1.09	CNY 550,000/ year, included in the operating cost of power generation of power station 3 years later
6	On-line monitoring of ecological flow	50	0.33	
	Equipment installation and commissioning cost	20	0.13	
	Operating cost	30	0.20	CNY 100,000/ year, included in the operating cost of power generation of power station 3 years later

S/N	Item	Cost (CNY 10,000)	Percentage of total investment (%)	Remarks
7	Constructing and operating cost of Dongpo special station for flood prevention	70	0.46	
	Equipment installation and commissioning cost	40	0.26	
	Operating cost	30	0.20	CNY 100,000/ year, included in the operating cost of power generation of power station 3 years later
8	Population health monitoring	122	0.81	
IX	Emergency and prevention measures for environmental risks and accidents	170	1.13	
1	Oil fence, oil adsorption machine, oil adsorption felt, oil adsorption boom	145	0.96	
2	Fish rescue equipment (netting gear, medicine, means of transportation)	20	0.13	
3	Wangjia Dagou river mouth emergency gate	5	0.03	
Part two	Independent cost	1904.07	12.60	
I	Project construction management cost	699.71	4.63	
1	Project construction management cost	319.43	2.11	2.70% of Part one
2	Project construction supervision cost	120.00	0.79	
3	Consulting service cost	130.14	0.86	1.10% of Part one
4	Technical and economic evaluation and review cost of project	53.24	0.35	0.45% of Part one
5	Project insurance premium	76.90	0.51	0.65% of Part one
II	Production preparation cost	230.70	1.53	1.95% of Part one
III	Scientific research, survey and design cost	946.46	6.26	
1	Construction scientific research and test cost	118.31	0.78	1% of Part one
2	Survey and design cost	828.15	5.48	7% of Part one
IV	Other taxes and fees	27.21	0.18	0.23% of Part one
Part three	Basic preliminary cost	1373.48	9.09	10% of sum of Part one and Part two
	Static total investment	15108.28	100.00	

7.2 Special fund for water and soil conservation

The special fund in water and soil conservation is CNY 121,929,700, in which

investment in project measures is CNY 83,366,400, investment in plant measures is CNY 15,091,300, temporary project is CNY 3,086,300, independent cost is CNY 7,772,200 (in which the water and soil conservation monitoring cost is CNY 2,298,000, project construction supervision cost is CNY 1,520,000), preliminary cost is CNY 6,559,000, and compensation cost for water and soil conservation is CNY 6,054,600. See Table 7.1-2 for the details.

Table 7.1-2 General estimation statement of special fund in water and soil conservation for the project Unit: CNY 10,000

S/N	Name of project or cost	Construction and installation project cost	Forest project cost		Equipment cost	Independent cost	Total
			Planting cost	Forest and grass and seed cost			
	Part one Engineering measures	8336.64					8336.64
(I)	Prevention and control area of complex project						
I	Prevention and control area of dam construction	2415.11					2415.11
II	Prevention and control area of PIU's camp	84.07					84.07
III	Prevention and control area of borrow pit	154.30					154.30
IV	Prevention and control area of temporary soil storage field	115.51					115.51
V	Prevention and control area of waste dump site	2794.25					2794.25
VI	Prevention and control area of road works	47.24					47.24
VII	Prevention and control area of production and living	641.03					641.03
(II)	Prevention and control area of reservoir area						
I	Prevention and control area of protection works	217.66					217.66
II	Prevention and control area of waste dump site	1842.31					1842.31
III	Prevention and control	20.43					20.43

S/N	Name of project or cost	Construction and installation project cost	Forest project cost		Equipment cost	Independent cost	Total
			Planting cost	Forest and grass and seed cost			
	area of temporary road for construction						
IV	Prevention and control area of production and living	4.72					4.72
	Part two Plant measure		716.59	792.64			1509.13
(I)	Prevention and control area of complex project						
I	Prevention and control area of dam construction		368.80	553.20			922.00
II	Prevention and control area of PIU's camp		52.60	78.90			131.50
III	Prevention and control area of waste dump site		73.75	35.10			108.84
IV	Prevention and control area of road project		3.71	2.95			6.66
V	Prevention and control area of production and living		10.71	6.76			17.47
(II)	Prevention and control area of reservoir area						
I	Prevention and control area of protection works		31.63	3.87			35.51
II	Prevention and control area of waste dump site		165.13	105.22			270.35
III	Prevention and control area of temporary road for construction		9.39	5.98			15.37
IV	Prevention and control area of production and living		0.87	0.55			1.42
	Part three Temporary works	264.52	40.66	3.45			308.63
I	Temporary protection works	166.06	40.66	3.45			210.17
II	Other temporary works	98.46					98.46
	Part four Independent cost					777.22	777.22
I	Construction management cost					101.54	101.54
II	Scientific research, survey and design cost					208.87	208.87

S/N	Name of project or cost	Construction and installation project cost	Forest project cost		Equipment cost	Independent cost	Total
			Planting cost	Forest and grass and seed cost			
III	Water and soil conservation supervision cost					152.00	152.00
IV	Water and soil conservation monitoring cost					229.80	229.80
V	Completion and acceptance cost of water and soil conservation Preparation cost of technical evaluation report					85.00	85.00
	Total from Part one to Part four	8601.15	757.25	795.99		777.22	10931.61
	Preliminary cost						655.90
	Project static investment						11587.51
	Compensation cost for water and soil conservation						605.46
	Total investment in water and soil conservation project						12192.97

8 Implementation and operation

8.1 Organization for the implementation of ESMP

8.1.1 General organizational structure

All environmental protection responsibilities described in the ESMP will be performed by Project Management Office (PMO) governed by Jiangxi Xiangyang Yakou Navigation Complex Project Development Co., Ltd. (who is responsible in construction and operation phases) as well as Construction Supervision Company (CSC), Construction Contractor (CC) and its subcontractors (who are responsible only in construction phase).

During implementation period of the Project, PMO will be responsible for tracking environmental issues in respect of Yakou Project and communicating with other Chinese governmental authorities and Word Bank on all environmental and social issues. PMO will appoint full-time, trained and qualified environmental management staff (EMS) to conduct environmental and social management works in construction and operation phases in order for effective development and implementation of mitigation measures set out in the ESMP.

In the construction period of the Project, CSC will establish Environmental Management Unit to deal with all daily environmental issues related to project construction activities on site. Each environmental manager and his or her employees (environmental engineers and site inspectors) will be appointed by CSC. Each main contractor is required to establish its environmental department consisting of environmental coordinator, engineer and site inspector. Environmental personnel of CSC and contractors will be independent from construction personnel. Environmental personnel will closely work and cooperate with construction personnel.

Whether in construction or operation phase, independent consulting experts will be employed by PMO as part of technical support service, to provide necessary aids for the Project in the whole implementation process of the Project.

General organization structure of the ESMP is shown as follows.

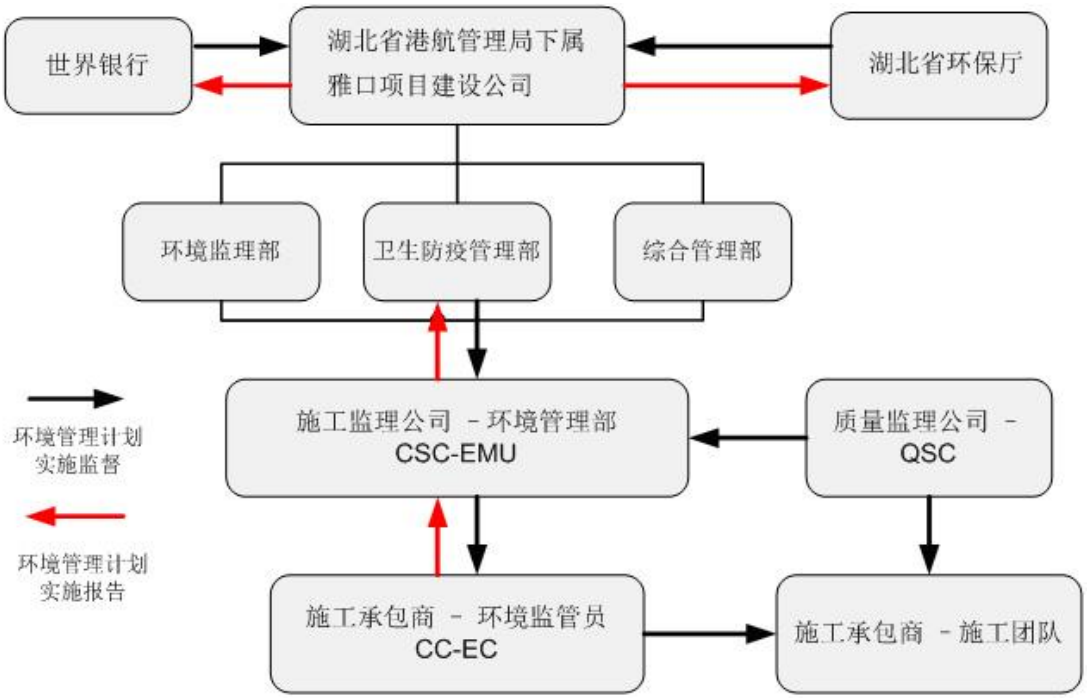


Figure 8.1 General Organization Structure for Implementation of ESMP of Yakou Project

世界银行	World Bank
湖北省港航管理局下属 雅口项目建设公司	Hubei Port and Waterway Administration's Yakou Project Construction Company
湖北省环保厅	Hubei Provincial Environmental Protection Bureau
环境监理部	Environmental Supervision Department
卫生防疫管理部	Health and Disease Control Management Department
综合管理部	Comprehensive Management Department
环境管理计划实施监督	EMP Implementation Supervision
环境管理计划实施报告	EMP Implementation Report
施工监理公司-环境管理部 CSC-EMU	CSC - Environmental Management Unit CSC-EMU
施工承包商-环境监管员 CC-EC	CC - Environmental Controller CC-EC
质量监理公司- QSC	Quality Supervision Company - QSC
施工承包商-施工团队	CC - Construction Team

8.1.2 Local governmental and relevant authorities

Local governments and relevant authorities, including Hubei Government, Xiangyang Government and Yicheng Government, will play a supervising role in construction, operation and other phases of the Environmental and Social Project Management Plan, particularly in the implementation of industry environmental management plans, including Water and Soil Erosion Control Plan (Appendix 1), Reservoir Bottom Cleaning Plan

(Appendix 2), Environmental Management Procedures of Contractor for Construction Phase (Appendix 3), Hazardous Substances and Wastes Management Plan (Appendix 4), Hazardous Substances Emergency Response Plan (Appendix 5), Material Culture Resource Management Plan (Appendix 6), Mitigation Measures based on Stage-II Cumulative Impact Assessment (CIA) Research (Appendix 8) and Comprehensive Reservoir Management Plan (CRMP) (Appendix 9). The specific organizational structure is shown below and described in relevant Appendix of the Report.

Table 8.1-1 Organizational Structure for Industry Environmental Management Plans under Yakou ESMP

Name of industry environmental management plan	Implementation	Measurement	Supervision
Water and Soil Erosion Control Plan	CC and CSC	Xiangyang Water Resources Bureau	PMO, Xiangyang Water Resources Bureau and Xiangyang Environmental Protection Agency
Reservoir Bottom Cleaning Plan	Project Operator, CC and CSC	Xiangyang Environmental Protection Agency	PMO and Xiangyang Environmental Protection Agency
Contractor in construction phase Environmental Management Procedure	CC and CSC	Xiangyang Water Resources Bureau	PMO, Xiangyang Water Resources Bureau and Xiangyang Environmental Protection Agency
Hazardous Substances and Wastes Management Plan			
Material Culture Resource Management Plan	PMO, Culture, Radio and TV Bureau of Yicheng, relevant town owners, CC and CSC	Cultural Heritage Bureau of Xiangyang / Culture, Radio and TV Bureau of Yicheng	Cultural Heritage Bureau of Xiangyang / Culture, Radio and TV Bureau of Yicheng and relevant town owners
Mitigation Measures based on Stage-II Cumulative Impact Assessment (CIA) Research	Project Operator, CC and CSC	Xiangyang Environmental Protection Agency	PMO and Xiangyang Environmental Protection Agency
Ecological Dispatch Experimental Study	Project Operator	Hubei Provincial Department of Water Resources, Hubei Provincial Department of Environmental Protection, Hubei Provincial Department of Agriculture	PMO, Hubei Provincial Department of Water Resources and Hubei Provincial Department of Environmental Protection
Effect assessment of fish pass structures	Project Operator	Hubei Provincial Department of	PMO, Hubei Provincial

Name of industry environmental management plan	Implementation	Measurement	Supervision
		Environmental Protection and Hubei Provincial Department of Agriculture	Department of Environmental Protection and Hubei Provincial Department of Agriculture

8.1.3 Hubei Port and Waterway Administration's Project Management Office

PMO is generally responsible for development and management of the Project and will perform the following specific duties:

- Approve the ESMP before implementing it.
- Cooperate with tendering company to i) include the ESMP in tender documents; ii) provide for technical specifications in respect of the ESMP; and iii) finally treat the ESMP as part of contract documents;
- Appoint or designate one Environmental Director of Project Management Office (PMO-ED) and other necessary assistants;
- Coordinate and manage relevant communications with relevant domestic departments;
- Coordinate and manage relevant communications with Word Bank on environmental issues.
- Coordinate and communicate through CSC's EMU and effectively implement the ESMP on construction site;
- Ensure that relevant CC will immediately correct any breach found by CSC's EMU;
- Review monthly environmental progress reports prepared by CSC's EMU, give opinions and prepare semi-annual and annual project environmental reports;
- Employ professional company to supervise and prepare training plans and materials for employees of CC and CSC.

8.1.4 Construction Supervision Company (CSC)

CSC has the following main responsibilities:

- Establish an Environmental Management Unit (EMU)
- Appoint one director for Environmental Management Unit to be leaded by CSC's Project Director.
- Through its EMU, CSC will:
- Supervise all construction activities to ensure the general implementation of the Environmental and Social Management in the whole construction phase and take certain measures in case of any event of default;
- Conduct daily inspection on construction site and report any behavior of noncompliance described in the ESMP if it is defected.
- Review all weekly and monthly environmental reports delivered by CC;
- Ensure that CC will immediately correct any defected behavior of noncompliance;
- Attend weekly construction meetings;
- Prepare and deliver to PMO's environmental management personnel monthly reports;
- Communicate with all CCs and distribute with all CCs environmental regulations, including the ESMP;
- Assist CC in environmental awareness training and report training situations to PMO's environmental management personnel through training register;
- Develop environmental awareness training for PMO's environmental management personnel;
- Review CC's construction method statement and detailed environmental control procedures to ensure compliance with all requirements of the ESMP;
- Ensure that CC will take targeted environmental control measures even if these are not set out in the ESMP;
- Attend annual management inspection pursuant to the ESMP;
- Track on complaints register and give rapid response to the complaints on the register.

- Manage documents and establish environmental database according to the requirement of the ESMP; and
- Assist relevant units in necessary site inspections upon the request of PMO.

8.1.5 Contraction Contractor (CC)

Any Construction Constructor who participates in the implementation of Yakou Project must appoint one Environmental Coordinator (CC-EC) to conduct coordination works with the aid of environmental engineers and site inspectors. Through the Environmental Coordinator, CC will perform the following duties:

- Attain the objectives and requirements set out in the ESMP during the whole implementation process of the Project;
- Ensure that all processes, procedures and methods set out in the ESMP in terms of environmental issues will be implemented in the whole process;
- Prepare specific construction method statement and environmental plans and deliver them to CSC for review and approval;
- Ensure that the employees of all CCs and their subcontractors are informed of all environmental protection duties required in the ESMP;
- Prepare environmental awareness training plan and deliver it to EMU for review and training the employees of all CCs and their subcontractors;
- Ensure that all site workers have been provided with basic knowledge training and that the employees at special positions (who are engaged environmentally-sensitive activities) have been provided with corresponding training;
- Determine any extra work or impact unpredicted in the ESMP and prepare corresponding environmental processes and methods;
- Conduct daily inspection over construction activities and immediately correct all discovered behaviors of noncompliance;
- Ensure that all behaviors of noncompliance discovered by CSC's EMU can be corrected rapidly;

- Prepare and deliver to CSC's EMU weekly and monthly reports;
- Manage environmental documents and monthly reports in the whole implementation process of the Project.

8.1.6 All site workers

Each site worker shall attend induction training that is provided to introduce the environmental duties under the ESMP. All site workers must report to their respective superior any environmental event occurring at work.

8.2 Environmental training and environmental protection awareness

The Environmental Management Unit of Yakou Navigation Complex Project Development Co., Ltd. will provide publicity and education for technical personnel in ways of all kinds like radio, TV, newspapers, bulletin, expo and lectures on special topics to improve their environmental protection awareness and achievement. The Unit will prepare *Management Measures of Environmental Protection for Construction Area* and *Detailed Rules for Environmental Protection Implementation* to set out specific requirements for environmental protection in construction area.

Each CC and CSC will ensure that their employees are provided with the training on the environmental and legal duties required in the ESMP. CC's Environmental Coordinator will provide induction introduction on environmental awareness for all CC's employees, and CSC's EMU will provide it for all CSC's employees.

CC is responsible for preparing training attendance records, including training date, trainer's name and attendees' name and signature.

The training will be provided at four levels:

- Develop training plan on basic environmental protection awareness for all employees of CCs and their subcontractors to improve their basic knowledge on environmental management;
- Develop training plan on health and safety awareness for CCs;
- Provide position environmental protection training for workers who are engaged in environmentally-sensitive works;

- Provide the training on the purpose, contents and implementation methods about the ESMP for CSC's EMU and CC's environmental management personnel.

For avoidance of any discrepancy between the training materials for CC and for CSC, one full-time consulting expert will be responsible for preparing the training plans and materials, and the provincial PMO will supervise the expert's preparation.

In addition to regular training, in order to improve the ability of local authorities / cities to implement, supervise and report mitigation measures, upon consultation with the Owner, the following series of activities are proposed as part of technical support subproject:

(1) Stage-II Cumulative Impact Assessment (CIA): As the assessment of this phase is desk review based on limited data, Stage-II Cumulative Impact Assessment (CIA) is suggested for implementation of Yakou Project on the basis of the results of the assessment of this phase. In this way, the impact analysis would be further quantized, and more specific mitigation measures would be involved in the implementation period of the Project. To be introduced in the proposed Cumulative Impact Assessment Report and Appendix 8 Environmental and Social Management Plan (ESMP). As part of ESMP and technologies to be provided by Word Bank to the Owner, the research plan will be implemented concurrently with CRMP within 30 days after the Project comes into force (October 2016), and will be completed 6 months before the reservoir begins to store water, in no case later December 2019. This research is established to last 24 months (2 years) and to cost CNY 2.8 million.

(2) Ecological Dispatch Experimental Study: While the cascade reservoir in the downstream of Danjiangkou in the main stream of Han River plays a social and economic role, all reasonable efforts will be made to maintain ecological sustainability of the downstream of Han River. Analyze the impact of reservoir operation in Han River on water ecosystem by investigating and analyzing the characteristics of cascade reservoir in the downstream of Danjiangkou in the main stream of Han River; recognize and preliminary determine objects under ecological protection in key reaches and required

ecological flow process; discuss and guide eco-hydrological requirements of living things and establish a cascade reservoir dispatch plan for key ecological process with respect of living history of targeted living things. Prior to further Cumulative Impact Assessment, detailed and technically supported ecological support experimental plan shall be provided. This study will be completed in 2 to 3 years of the construction period of the dam. The study results shall be reviewed and approved prior to the approval for reservoir inundation to ensure other subprojects on Han River can correctly adapt into new reservoir operation conditions. The draft terms of the proposed Ecological Dispatch Experimental Plan Study are set out in Cumulative Assessment Report (Section 7.2) and ESMP Appendix 8. As part of ESMP and technologies to be provided by Word Bank to the Owner, the research plan will be implemented concurrently with Stage-II CIA within 30 days after the Project comes into force (June 2013), and will be completed 6 months before the reservoir begins to store water, in no case later December 2019. This research is established to last 26 months and to cost CNY 2.5 million.

(3) Fishery Management Research: The effect evaluation on fish passage faculties for more specific measures result in adverse impact on local fish resources, and Fishery Management Research is suggested to be part of the Project.

8.3 Communication

8.3.1 Internal communication

CSC's EMU, CC and construction managers will attend daily and weekly communications and conduct official monthly reporting and inspection. In case of any environmental emergency, it shall be communicated among these units and employees in an emergency case.

8.3.2 External communication

CSC's EMU will firstly communicate environmental issues with PMO through its Environmental Director and the communications will be recorded in the monthly process report. EMU's Environmental Director will meet with PMO’s Environmental Director (together with PMO Director and CSC Director if necessary) at monthly communication

meetings to discuss current or threatened main environmental issues as an official way for communication.

The external communication with Chinese governmental authorities, organizational organizations, Word Bank, non-governmental organizations and other third parties on environmental affairs may not be realized through PMO.

Any external complaint about environmental damage or misconduct occurring on site in respect of the Project shall be handled by EMU's ED. Any complaint must be solved to satisfaction in 48 hours.

8.3.3 Communication in emergency

On all construction areas, construction works may use wireless system or mobile phone network to timely communicate with related parties.

Each senior worker shall have a latest sheet of main worker's telephone numbers, and the sheet shall be posted on each important construction area (dangerous substances and wastes warehouse, explosives warehouse and fuels warehouse).

8.4 Documents and reports

All documents in connection with environmental management of construction activities and with the procedures described in the ESMP will be classified. Some of them will be retained in the archives room of CSC's office in form of documents and registers, and the other part will be kept in the CC's office. The documents to be filed as estimated includes (without limitation):

- Domestic environmental rules
- License, legal documents and authorizations issued by PMO and domestic governmental authorities, which will be sorted into compliance registers.
- Generally-accepted ESMP
- Environmental plans prepare and submitted by Contactor's EC
- Environmental research for construction period
- All communications that may result in any change to project design/scope in terms of environmental impact

- Daily, weekly and monthly reports of site environment monitoring submitted by EMU and Contractor's environmental personnel
- Compliant records
- Training materials
- Training attendance register
- Internal audit reports
- Out of limit specific reports
- Minutes for weekly and monthly meetings
- Current and repealed versions of the ESMP

Mail communications, minutes of meeting, regular and irregular monitoring and inspection sheets, out of limit notices, corrections sheets, technical researches, maps, drawings, pictures and others will be kept in CSC's database for future reference, and filed in the security/quality control archives room of the Project in a safe manner. The registration number of all documents will comply with the registration system determined in project quality plan.

CSC's Project Manager will prepare project construction progress documents, while EMU's ED will prepare a monthly progress report on environmental work progress and main environmental issues discovered or solved in the prior month. Monthly Environmental Report (MER) constitutes an official document for CSC to report environmental situations to PMO. The main issues raised in MER will be further discussed in the monthly environmental meeting.

According to the results from EMR, site observation and environmental monitoring, whether in compliance with environmentally required documents records or in breach of environmental requirements, EMU will prepare monthly, quarterly and annual reports (as shown below). The adoption of standard forms ensures the filling of all compliance related investigation results in accordance with unified standards. In this way, relevant information may be put in computer database and thus users can use the information in the database, track violations and analyze data. PMO's ED will ensure all Environmental Coordinators

of CCs and all Environmental Directors of CSC use the same standard forms.

Table 8.5 Routine report

S/N	DOCUMENT NAME	PREPARED BY	SUBMITTED TO	FREQUENCY	TYPE OF REPORT
1	Daily paper	Contractor - Environmental Management Persons	Contractor - Environmental Sub-Management Persons	Every day	Routine inspection report
2	Weekly paper	Contractor - Environmental Sub-Management Persons	Construction Supervision Company - Environmental Manager	Every week	Summarization of prepared daily paper and field checklist within a week
3	Monthly environmental report specific to construction activities	Construction Supervision Company - Environmental Manager	PMO - Environment Supervisor	Every month	Include monitoring results from the Contractor and the Supervision Engineer, completed environmental work, registered public complaints, discovered excessive list and amendment measures. Estimate the major work in next month
4	Environmental semiyearly report	Independent Environmental Consultant	PMO - Environment Supervisor	Every half year	Report on the environmental work carried out within six months, and commit to World Bank for inspection

8.5 Grievance and Complaint Mechanism

In order to discover and handle the possible public complaints related to the environmental issues of the Project in time, reduce its risk, and give a full play to its environmental and social benefits, it has agreed to establish Public Complaints Office under Environmental Management Department of the PMO according to the local conditions after consultation with the construction unit, and establish the following grievance and complaint mechanism specific to environmental issues.

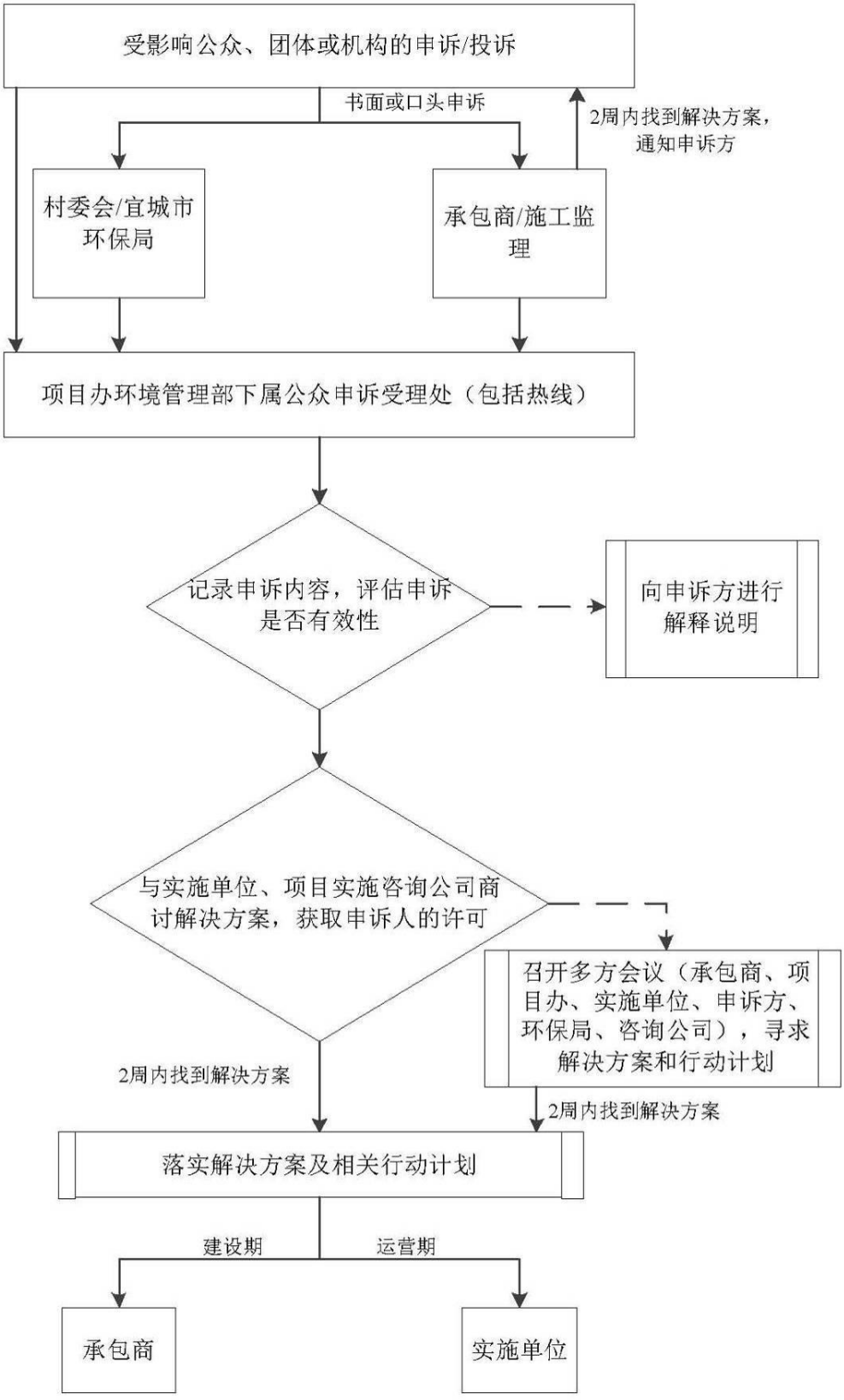


Figure 8.5 Environmental Grievance and Complaint Mechanism of Yakou Navigation Complex Project

受影响公众、团体或机构的申诉/投诉	Grievance / Complaint of influenced public, organization or authority
书面或口头申诉	Written or verbal grievance
村委会/宜城市环保局	Village Committee / Yicheng Environmental Protection Bureau
承包商/施工监理	Contractor / Construction Supervisor
2 周内找到解决方案，通知申诉方	Work out a solution within two weeks and inform the grievance party
项目办环境管理部下属公众申诉受理处（包括热线）	Public Grievance Acceptance Office subordinated to Environmental Management Department of the PMO (including hot line)
记录申诉内容，评估申诉是否有效性	Record the grievance contents and assess its validity
向申诉方进行解释说明	Explain to the grievance party
与实施单位、项目实施咨询公司商讨解决方案，获取申诉人的许可	Consult the solution with exploiting unit and the project exploiting consulting company, and get the permission of grievance party
召开多方会议（承包商、项目办、实施单位、申诉方、环保局、咨询公司），寻求解决方案和行动计划	Hold multiparty conference (the Contractor, the PMO, the exploiting unit, the grievance party, Environmental Protection Bureau and consulting company); seek for solution and action plan.
2 周内找到解决方案	Find out the solution within two weeks
2 周内找到解决方案	Find out the solution within two weeks
落实解决方案及相关行动计划	Implement the solution and relevant action plan
建设期	Construction period
运营期	Operating period
承包商	Contractor
实施单位	Exploiting unit

The grievance and compliant mechanism will be accessible to all local residents, especially to vulnerable groups including women. Any influenced person, organization or authority can carry out grievance by telephone, mail and e-mail. Before the Project starts, the contactors of each grievance acceptance link (e.g. cadres of Village Committee, the Contractor, the Environmental Management Persons of exploiting unit, officials of local Environmental Protection Bureau, etc.) will be settled down. And their detailed contact information (e.g. telephone number, address, e-mail address, etc.) will be publicized on the information bar of construction site or the website of local government.

Environmental Management Department of the PMO will establish a set of tracking and record system of public grievance and complaint mechanism, to: (1) establish trace table and tracing program to collect information from project persons and grievance party; (2) designate someone to update the database information periodically; (3) establish information analysis system, recognize grievance reason, improve the transparency of

grievance processing program, and assess its overall operation situation periodically; (4) establish program to inform the relevant party of processing information; (5) report the grievance processing information to PMO, exploiting unit and World Bank periodically.

APPENDIX 1: WATER AND SOIL EROSION CONTROL PLAN

1 Overview

In accordance with the requirements of laws and regulations including *Law of the People's Republic of China on Water and Soil Conservation*, and *Administrative Measures on Water and Soil Conservation of Development and Construction Project* jointly issued by Ministry of Water Resource, National Development and Reform Commission, and Ministry of Environmental Protection of the People's Republic of China, and *Administrative Regulations on Preparation and Approval of Water and Soil Conservation Plan of Development and Construction Project* (No. 5 Order of MWR), and authorized by the PIU, Hubei Provincial Water Resources and Hydropower Planning, Survey and Design Institute undertakes the preparation task of *Report on Water & Soil Conservation Plan of Han River Yakou Navigation Complex Project* in feasibility study phase. After receipt of the authorization, the institute firstly further reviews the Project in accordance with the *Notification on the Strict Review and Approval of Water and Soil Conservation of Development and Construction Project* (SB [2007] No. 184 Document of MWR), and on the premise of execution of No. 184 Document, organize engineering staff to conduct an on-site survey, collect information of project area concerned about socioeconomic status as well as conservation of water and soil. In December 2013, it has finished the preparation of Report on Water & Soil Conservation Plan of Han River Yakou Navigation Complex Project based on the analysis study and Feasibility Study Report of the Project.

On March 4 to 5, 2014, the Soil and Water Conservation Monitoring Centre of Ministry of Water Resource chaired the review panel of the Project in Xiangyang, Hubei. Plan preparing unit modified and perfected the report according to the opinions of the review group, and finished the Report on Water & Soil Conservation Plan of Han River Yakou Navigation Complex Project based on the analysis study and Feasibility Study Report of the Project in March 2014. Ministry of Water Resource approved the report by SBH [2015] No. 132 in March 2015. The approval required that the construction unit shall conform to the approved water and soil conservation plan, make the follow-up designs including preliminary design of water and soil conservation and construction drawing

design, strengthen the work of construction organization and management, earnestly implement the Three Simultaneities system of water and soil conservation in the project construction, strictly implement the water and soil conservation measures as required, and earnestly work out the monitoring and supervision of water and soil conservation.

In the preliminary design phase, reestablish the prevention measures on water and soil loss based on the new plan of complex and construction layout.

2 Estimation on Water and Soil Loss

2.1 Scope of prevention liabilities

The scope of liabilities of water and soil loss mainly includes two aspects: the constructing area of the project and the directly affected area.

The constructing area of the project refers to the scope of land acquisition, land rented and jurisdictional limit of land utilization of development and construction unit. In accordance with the principle that "whoever develops shall protect, whoever causes the water and soil loss shall take remedial measures" and the requirements of *Technical Manual on Water and Soil Conservation of Development and Construction Project*, integrating the Feasibility Study Report of the Project and field investigation, the constructing area of the project is divided into the area of project area and protective area. The project area includes dam construction area, PIU campsite area, borrow pit, temporary storage site, waste dump site, road engineering area, and production and living area. The protective area includes reservoir inundated area, protective engineering area, waste dump site, construction road area and production and living area, which is the area that directly causes damage and disturbance, and is also the key area of governance. The determination of space shall be subject to the space of the land acquired and occupied by project construction. The directly affected area refers to the area outside the constructing area of the Project, may cause direct damage to surrounding area due to water and soil loss caused by development and construction activities.

In accordance with the determining basis and principle of the scope of prevention liabilities as well as statistics, the scope of prevention liabilities of water and soil loss of the Project is 2,973.56 hm^2, with the constructing area of the Project of 2,919.46 hm^2 and

directly affected area 54.10 hm². See Tab. 2.1-1for the scope of prevention liabilities of water and soil loss of the Project.

Table 2.1-1 Scope of Water and Soil Loss Prevention of Yakou Navigation Complex Project

Unit: hm^2

Project Partition			Scope of prevention liabilities			Remarks
			Subtotal	Construction area	Directly affected area	
Project area	Dam construction area	Complex area	61.2	61.2		Directly affected area included in the managing scope
		Earth and rockfill dam area	17.17	17.17		Directly affected area included in the managing scope
		Cofferdam area	18.5	18.5		Directly affected area included in the managing scope
		Other areas within the managing scope	18.16	14.53	3.63	The upstream is reservoir inundated area, the 15 m in downstream and 10 m outside the control lines on the both sides of dam head shall be included.
	PIU campsite area		7.5	7.5		Directly affected area included in the managing scope
	Borrow pit		4.59	4.37	0.22	Peripheral area within 2 m
	Quarry site		25.79	24.56	1.23	Peripheral area within 2 m
	Temporary storage site		2.6	2.6		Coincide with the complex area
	Waste dump site		120.66	120.66		Coincide with the inundated area
	Road engineering area	Approaching road area	1.09	0.7	0.39	Upper side slope 3 m, lower side slope 5 m
		Construction shortcut area	24.13	19.3	4.83	Peripheral area within 2 m
	Production and living area		10.96	8.77	2.19	Peripheral area within 2 m
	Subtotal		189.09	176.6	12.49	
Protective area	Reservoir inundated area		2487.88	2487.88		Not included in directly affected area
	Protective engineering area	Floodways area	82.8	82.8		Next to the disposal area
		Inundation prevention area	43.2	43.2		Next to the disposal area
	Waste dump site		156.64	125.31	31.33	Upper side slope 2 m, lower side slope 4 m
	Construction shortcut area		4.09	3.27	0.82	Peripheral area within 2 m
	Production and living area		0.5	0.4	0.1	Peripheral area within 2 m
	Demolition and resettlement as well as special facilities restoration area		9.36		9.36	
	Subtotal		2784.47	2742.86	41.61	
Total			2973.56	2919.46	54.1	

2.2 Estimation of water and soil loss

2.2.1 Surface area of disturbance

The Project takes up land of 413.58 hm² in total (reservoir inundated area not included). According to the design, integrating the field investigation, in the project construction, the parts of land are not disturbed other than the part of land disturbed by temporary soil storage in the managing area of complex area which belong to the space of land acquisition, not included in the disturbing space. The surface area of disturbing is

537.71 hm² (there is 120.66 hm² of waste dump site of complex area in the reservoir inundated area), with complex area of 282.73 hm² and protective area of 254.98 hm².

2.2.2 Area of damaged soil and water conservation facilities

After the field investigation, there is no soil and water conservation engineering facility in the project area.

As per the collection standard and management policy on the use of compensation for water and soil conservation and soil and water prevention fee issued by Hubei, SB [1996] No. 393 Document of MWR *(Reply on the Explanation of Soil and Water Conservation Facilities*) and ESBF [2001] No. 593 *(Reply on the Explanation of Soil and Water Conservation Facilities by Provincial Department of Water Resources*), etc., the area of damaged water and soil conservation landscape vegetation in the Project refers to area of occupied cultivated land, forest land, transportation land, other land, as well as the area of inland mud flat in water area and water conservancy facilities area. The upstream area of dam construction area belongs to reservoir inundated area, excluded from the damaged water and soil conservation landscape vegetation. It is counted to be 464.39 hm².

2.2.3 Estimation of quantity of waste

In the project construction, there is still a certain number of digging soil after foundation excavation and dispatching utilization in each partition. It can be inferred from the earthwork balance table that, the permanent digging soil is waste from the clearing of hardened layer in dam construction area, protective engineering area as well as production and living area, and shall be transported to relevant water disposal area to backfill. Besides, the surface soil stripped in each partition will be used for vegetation recovery or second plowing soil in later period, and is piled up temporarily on the open spaces of relevant area as temporary waste. Thus, the total amount of waste of the Project is 7,869,600 m³, with the temporary waste of 948,700 m³ and permanent waste of 6,920,900 m³.

2.2.4 Estimation of possible amount of water and soil loss

Calculate the amount of water and soil loss in each partition by estimating formula of water and soil loss in disturbing surface. It can be calculated that, the possible amount of water and soil loss in construction period is 102,500 t, with new amount of water and soil

loss of 89,900 t, accounting for 87.69% of the amount of water and soil loss in construction period. This means the construction of project is the main reason that causes the water and soil loss in the area.

The native erosion degree in most of the area is slight. In the case of not laying the prevention measures of water and soil loss, in the project construction, the erosion degree of main engineering area is strong or beyond, and that of other parts is medium. The degree of water and soil loss in area which is in restoration stage of vegetation is relatively light, which is slight.

According to the estimation result of water and soil loss, the prevention and monitoring focus of water and soil loss shall be laid on areas including the waste dump site and temporary storage site in the project construction. The loss of areas including waste dump site of the Project is relatively large in the project construction, which is the key prevention area of water and soil loss.

If the Project fails to take effective water and soil conservation measures, the water and soil loss may aggravate the deposition of the riverway, damage the plough layer of surrounding farmland, deposit the ponds and drains in the project area, and cause larger influence on the regional ecological environment. There will be potential risk of erosion form of water and soil loss including landslide and collapse due to inadequate protection in protective engineering, also causing large economic loss to the project itself.

2.2.5 Potential damage of water and soil loss

In the construction of the Project, the surface within the scope of land acquisition will suffer damages at various levels, and the local landscape will change considerably. If the Project fails to take water and soil conservation measures, the amount of soil loss in project area caused by construction will be 271,858 t, which will have different influence of the safety of the Project itself, regional soil resource and the change of erosion and deposition of the riverway of Han River.

(1) Influence the stability of reservoir bank and endanger the safety of embankment: Although the Project is low-head run-of-the-river hydroelectricity station, there will be elevation of foreland water level due to back-up water level in some embankment

segments. After the elevation, the bank slope will be inundated for long time, and the hydrogeologic condition will change, influencing the stability of reservoir bank.

(2) Riverway deposition, reduced flood carrying capacity of riverway and the influence of the station in downstream: Most of the construction area of the Project locates at the riverway of Han River. The earthwork produced in the construction will be directly flowed to Han River, causing the riverway deposition. With the inflow of sediment, there will be some deposition in downstream riverway, which elevates the riverbed, influences the flood carrying safety of Han River as well as causes the sediment deposition in complex area in Nianpanshan in the downstream, and influences the normal function of its benefit of power generation.

(3) Reduce the soil fertility and the land resources: The original earth surface and vegetation area is damaged due to the excavation and filling. There may be water and soil loss under the washing of rain, which brings away the nutrient elements in the surface soil and reduces the soil fertility, influences the growth of forest and crops, bringing adverse effect on the recycling of land resources.

3 Development of water and soil conservation measures

3.1 Prevention target

The general target for the water and soil conservation plan is: to prevent and control the water and soil loss in the project construction, and on the premise of successful construction of the Project and safety, protect and rationally use the water and soil resources, increase the land productivity, and promote the harmonious development of project construction and ecological environment. Yicheng, Xiangcheng District and Xiangzhou District where the Project is involved are the key rehabilitation regions of water and soil loss in Hubei. Meanwhile, the Project is constructed across the Han River. Therefore, the water and soil prevention standard shall be the primary standard of construction projects, and shall be based on relevant regulations as well as the conditions of rainfall and water and soil loss in the project area. See Tab. 3.1 for the water and soil prevention targets of the Project.

Table 3.1 Water and soil prevention targets

Indicator	Standard Value		Prevention Targets for Level Years	
	Construction period	Trial operation	Construction period	Trial operation
Renovation rate of disturbing land (%)	*	95	*	95
Total control degree of water and soil loss (%)	*	95	*	97
Control ratio of soil loss	0.7	0.8	0.7	1.0
Waste holding rate (%)	95	95	95	95
Restoration rate of vegetation cover (%)	*	97	*	99
Coverage of vegetation (%)	*	25	*	17

3.2 Layout principle

a) Layout principle of engineering measures

(1) Adjust measures to local conditions and layout the project measures of water and soil conservation in accordance with the construction layout of the Project and the features of water and soil loss, to give a play to its water and soil conservation function;

(2) The layout of project measures shall conform to the principles of less disturbance of the earth surface and excavation of earth work as far as possible, and ensure that the implemented project measures of water and soil conservation will not aggravate the soil erosion in the project area;

(3) Principle of integrating the permanent project measures and temporary project measures;

(4) Principle of dynamic integration of project measures and plant measures

b) Layout principle of plant measures

(1) Principle of land and grass suitability: Grass seed suitable for the natural environment features in project area;

(2) Principle of integrating the afforestation and beautification with water and soil control

c) Layout principle of temporary measures

(1) Principle of block covering on the temporary soil storage: Temporary protective measures shall be set for the temporary soil storage;

(2) Principle of protection priority: Control the scope of temporary land acquisition and reduce the disturbance to the original earth surface.

3.3 Overall layout and system

Based on the estimation results and the scope of liabilities of water and soil loss and integrating the analysis and assessment on the prevention partitions of water and soil loss and the existing function project of water and soil conservation of main project, it determine that different prevention partitions shall adopt different prevention measures and layouts, to form the system and overall layout of prevention measures of water and soil loss of the Project.

The current soil and water conservation measures of the Project shall be combined into different types of prevention measures to integrate temporary protective measures, engineering measures and vegetation measures. Take temporary protective measures as guidance to ensure that water and soil loss during the construction is effectively controlled. Meanwhile, pay close attention to protect the humus at the surface layer in all prevention areas to enhance later vegetation recovery; focus on engineering measures to ensure their fast-acting property and security effect; take vegetation measures as supplement to ensure a long-term and stable soil and water conservation, so as to guarantee the security of project construction and operation.

The system of prevention measures for water and soil loss in the Project is composed of two primary subareas - prevention area for the complex project and prevention area for the reservoir area, which can be further divided into prevention areas for the dam construction, the PIU campsite, the borrow pit, the temporary soil storage area, the waste dump site, the road engineering (construction roads), the production and living, reservoir inundated area, protective engineering, demolition and resettlement as well as special facilities restoration area. See 3.3 for the prevention system for water and soil loss in the Project.

Table 3.3 Prevention System for Water and Soil Loss

Prevention subareas			Current water conservation measures in the main body	Additional water conservation measures
Prevention and control area of complex project	Prevention and control area of dam construction	Engineering measures	/	Soil stripping and return
		Plant measure	Greening of islet and earth and rockfill dam	/
	Prevention and control area of PIU's camp	Engineering measures	Gabion retaining wall, gabion slope and foot protection and drains	Soil stripping and return and sand basin
		Plant measure	Greening	/
		Temporary	/	Bag soil blocking and demolition;

Prevention subareas			Current water conservation measures in the main body	Additional water conservation measures
		measures		temporarily strew grass seeds
	Prevention and control area of borrow pit	Engineering measures	Soil stripping and return; second plowing	Drains and sand basin
		Temporary measures	/	Bag soil blocking and demolition; cover with non-woven fabrics; temporarily strew grass seeds
	Quarry site	Engineering measures	Soil stripping and return; second plowing	Drains and sand basin
		Temporary measures	/	Bag soil blocking and demolition; cover with non-woven fabrics; temporarily strew grass seeds
	Temporary soil accumulated prevention area	Temporary measures	/	Bag soil blocking and demolition; cover with waterproof cloth
	Prevention and control area of waste dump site	Engineering measures	Soil stripping and return; slag dam; steel wire gabion slope and foot protection; interception ditch; second plowing	Sand basin
		Plant measure	Tree planting and seeding	/
		Temporary measures	/	Bag soil blocking and demolition; cover with non-woven fabrics; temporarily strew grass seeds
	Prevention and control area of road project	Engineering measures	Soil stripping and return on temporary occupied cultivated land; second plowing	Soil stripping and return on other occupied lands; drains; sand basin; loose rolling layers
		Plant measure	Tree planting and seeding	Plant street trees and strew grass seeds
		Temporary measures	/	Temporary drains; temporary sand basin; temporarily strew grass seeds
	Prevention and control area of production and living	Engineering measures	Soil stripping and return; slag dam; steel wire gabion slope and foot protection; drains; sand basin; second plowing	Clearing of hardened layer
		Plant measure	Tree planting and seeding (forest land)	Tree planting and seeding (additional)
		Temporary measures	/	Bag soil blocking; cover with non-woven fabrics; temporarily strew grass seeds
Prevention and control area of reservoir area	Prevention and control area of protection works	Engineering measures	Soil stripping	/
		Plant measure	/	Strew grass seeds
		Temporary measures	/	Cover with waterproof cloth
	Prevention and control area of waste dump site	Engineering measures	Soil stripping and return on cultivated land and forest land; second plowing on occupied cultivated land	Soil stripping and return on other occupied lands; bag soil blocking, drains and sand basin outside floodways and waste dump site
		Plant measure	Tree planting and seeding on occupied forest land	Tree planting and seeding on other occupied lands
		Temporary measures	/	Cover with waterproof cloth
	Prevention and control area of temporary road for construction	Engineering measures	Soil stripping and return on cultivated land and forest land; second plowing on occupied cultivated land	Soil stripping and return on other occupied lands; loose rolling layers
		Plant measure	Tree planting and seeding on occupied forest land	Tree planting and seeding on other occupied lands
		Temporary measures	/	Temporary drains; temporary sand basin; temporarily strew grass seeds
	Prevention and control area of production and	Engineering measures	Soil stripping and return on cultivated land; second plowing on occupied cultivated land	Soil stripping and return on other occupied lands; clearing of hardened layer

Prevention subareas			Current water conservation measures in the main body	Additional water conservation measures
	living	Plant measure	/	Tree planting and seeding
		Temporary measures	/	Temporary drains; temporary sand basin; cover with waterproof cloth

3.4 Design principles and design standards

3.4.1 Design principles

1) Principle of security and liability;

2) Principle of economical rationality and technical feasibility;

3) Principle of overall coordination

3.4.2 Design standards

1) Project grade

Determine the grade of buildings of the protective engineering for the waste dump site, the grade of the protective engineering for inclined slope, and the grade of vegetation recovery and construction based on the requirements of *Criterion of Flood Control* (GB50071-94), *Classification and Design Safety Standard of Hydropower Projects* (DL5180-2003) and *Technical Specification on Soil and Water Conservation for Water Conservancy and Hydropower Engineering* (SL575-2012).

① Grade of buildings of the protective engineering for the waste dump site:

In the waste dump site of the project area: ① the waste quantity at the waste dump site is between 0.5 million to 1 million m^3 and the average waste height is 4.0 m. In case of any accident at the waste dump site, no damage will be caused to the main works or the environment. Therefore, the waste dump site is determined as grade 4; the slag dam as grade 5 and the flood control project as grade 4. ② The waste dump site and ③ the waste quantity on the site is between 1 million to 5 million m^3 and the average waste height is 4.5 - 6.0 m. In case of any accident at the waste dump site, no damage will be caused to the main works or the environment. Therefore, the waste dump site is determined as grade 3; the slag dam as grade 5 and the flood control project as grade 4. The layout of floodways and drains along the protective area for the reservoir area and the waste dump site: the stacking height is 1.0 - 1.5 m and the waste quantity per unit length is relatively small. Therefore, the waste dump site is determined as grade 5 and the flood control project as grade 5.

② Grade of protective engineering for inclined slope: Through analysis, the waste dump site, borrow pit and the construction road are filling projects in plain area. The side slope has relatively small impact on the safety of peripheral facilities and personal and property safety; losses, social influence, and environmental impact are relatively small in case of any accident to the side slope; therefore, the protective engineering for inclined slope is determined as grade 5.

③ The grade of vegetation recovery and construction: through analysis, the major buildings in main works in the project are determined as grade 2; the vegetation recovery and construction on permanent occupied land of corresponding main works as grade 1; and the vegetation recovery and construction on waste dump site, borrow pit and construction shortcut in temporary land use area and production and living area as grade 3.

2) Criterion of flood control

① Based on the *Technical Specification on Soil and Water Conservation for Water Conservancy and Hydropower Engineering* (SL575-2012) and referring to the *Criterion of Flood Control* (GB50071-94), the Project is located in plain and tiny hillock area, therefore, the Project, the waste dump sites are divided into grade 3, grade 4 and grade 5. The Project is located in plain and tiny hillock area, so the criterion of flood control for grade 3 waste dump sites is designed for flood that happens once in 20 years and that for grades 4 and 5 waste dump site is design for flood that happens once in ten years.

② Based on the established project and referring to the Technical Specification for Comprehensive Control of Soil and Water Conservation, the temporary drainage is determined as once-in-five-year design.

4 Design of prevention measures in subareas

4.1 Prevention and control area of complex project

4.1.1 Prevention and control area: dam construction area

Dam construction area: during the construction period, the construction is carried out in cofferdam area; after the Project, the main focus is on curing and water surface submerge. According to the requirement for water and soil conservation, the order of excavation and filling during the construction of the main works shall be reasonably

planned to ensure a balance between excavation and filling, so as to avoid repeated transportation and construction; the excavation side slope of the works shall be controlled within the stable side slope to avoid instability of side slope and water and soil loss; during the construction, try to protect the current vegetation and avoid excavation outside the lines; avoid excavation in rainy days and the excavation face shall be timely protected based on the major construction progress and requirements; cofferdam removal shall be carried out in dry seasons and the waste of cofferdam shall be transported to and stacked in designated waste dump site.

1) Engineering measures

① Surface soil treatment

Before the construction, strip the available surface soil in occupied cultivated soil, forest land and free area with vegetation within the occupied area of the dam construction and the stripped soil can later be used in second plowing of surface layer at the waste dump site or vegetation measures. The stripped surface soil is 30 cm thick and is transported to temporary storage site for temporary stacking. Corresponding temporary protective measures shall be taken in the temporary storage site. After the Project, 26,000 m^3 of surface soil has been returned in the greening area of islet and earth and rockfill dam; other surface soil is transported to the waste dump site for second plowing or vegetation recovery. The stripped surface soil quantity in dam construction area in the Project is 146,000 m^3 and the returned surface soil is 26,000 m^3.

2) Plant measure

In the design of main works, greening measures are taken in downstream platform of the earth and rockfill dam with a normal water level of more than 1 m, earth and rockfill dam between the power station and left-bank sluice gate and the ship lock area. The greening area is 18.44 hm^2. The main body design just aims to estimate the area and investment of the vegetation measures of this part and not design detailed greening measures. And this design will propose corresponding suggestions for the vegetation measures:

① Layout principle

a Based on the on-site conditions, the vegetation for green belt recovery shall select the current landscape vegetation in the neighborhood to ensure the consistency with the peripheral landscape. In areas where new vegetation is needed to enhance the beauty of landscape, other varieties of vegetation may be selected.

b Based on the site conditions in the project area, various green trees and grass can be used for population distribution under the condition that basic requirements such as water and soil conservation and regional greening are met. Besides, the relationship between various trees shall be properly handled to ensure the stability of plant population. As for selection of trees and grass, try to select local native trees and grass in accordance with the principle of "selecting trees and grass suitable for the land". Generally, exotic varieties are not recommended. Combine landscape beautification with ecological construction to improve the land utilization rate and the quality of ecological environment in the Project area.

c To meet the requirement of multifunctional vegetation measures, select flowers, trees and law plants of various tree forms, leaf shapes, heights and seasons. In the selection of arbors and shrubs, choose those with beautiful shape and strong anti-pollution an anti-noise abilities; in the selection of grass, choose those with anti-pollution ability and trampling resistance.

d The selected trees and grass shall have developed roots, resistance to infertility, strong drought-resisting and flood-resisting abilities and the ability to improve soil physical and chemical properties, thus preventing the water and soil loss in the Project area.

e Vegetation measures shall have not only greening effects, but also artistic effects. The height, shape, color, taste and other aspects of trees and grass must be taken into consideration to ensure scientific allocation, thus building a beautiful and exquisite garden city.

② Selection of grass and trees

The main design doesn't include selection of grass and trees. Based on the site conditions in the Project area, the recommended varieties for the design are as follows:

arbors: camphor tree, southern magnolia and prunus cerasifera; shrubs: ligustrum vicaryi, redrlowered Loropetalum, ficus microcarpa, etc.; herbaceous plants: pink reineckea herb, zoysia japonica, and zephyranthes candida, etc.

③ Selection and arrangement of green trees and grass

a Street trees

Street trees have a significant leasing role in greening. Different varieties may be selected based on the scale, property and characteristics of the roads in the PIU campsite. Trees with big crowns such as camphor tree and southern magnolia may be selected for the main streets; trees with beautiful shape and rich colors such as redrlowered Loropetalum and ligustrum vicaryi or hedges may be selected for street trees and zoysia japonica, zephyranthes candida, etc. can be paved under those trees.

b Greening in front of buildings

Zoysia japonica, carpetweed and other sods are mainly planted in the stripe slashes between buildings and roads in the station. Meanwhile, ornamental trees and flowers such as palms, southern magnolia, prunus cerasifera, Chinese littleleaf box, canna and roses can be planted in a specified or scattered shape in the sods for the sake of beautification.

c Greening in flower beds

Flower beds of circle, rectangle and rhombus may be built based on the overall layout of the subsidiary zone. Greening trees such as Cedar, gladiolus, palm and redrlowered Loropetalum can be planted in the flower beds, with zephyranthes candida, roses and other flowering trees in the surrounding area and carpetweed, zoysia japonica and other sods under those trees.

④ Greening plan

a Comprehensive greening with arbors, shrubs and grass

Taking the large seedling of southern magnolia, redrlowered Loropetalum and zoysia japonica for example, plant these trees in mixed strips. Transplanting with soil shall be adopted for both trees and the diameter of soil shall be no less than 3 - 4 times of the diameter at breast height of the large seedling. The distance between southern magnolias is 4 m × 5 m. Pruning is necessary before planting to reduce the evaporation of water after

transplanting, so as to increase the survival rate. The distance between redrlowered Loropetalum is 0.5 m × 0.5 m. Zoysia japonica is planted on the space between southern magnolia and redrlowered Loropetalum. Water the trees and grass through after transplanting and then determine the reasonable frequency of watering based on weather changes.

b Planting of street trees

Large seedlings of southern magnolia with soil are used for street trees. The distance between plants is 4 m. Stamp the soil firmly with feet after planting and water the seedlings through. Determine the reasonable frequency of watering based on weather changes. Grass shall be planted in the surrounding areas of street trees for protection if permitted.

c Greening in open space on lawns

All areas around the houses and open space on lawns in the station area shall be afforested mainly with sods and embellished with shrubs. It is recommended to mainly adopt zoysia japonica and reineckia carnea for turf and Loropetalum chinense var rubrum and Ficus microcarpa for shrub.

4.1.2 Prevention and control area: PIU's camp

The campsite covers an area of 7.50 hm^2 with occupied type of flood land.

1) Engineering measures

① Surface soil treatment

Before the construction of the Project, conduct Soil stripping for the areas in attached facilities area requiring being hardened with a stripping thickness of 30 cm. The surface soil stripped can be stacked in the scope of green area for the late greening.

② Blocking slope protection

The gabion box barricade is adopted in the side near water, with section height of 1.5 m, top width of 0.5 m and burial depth of 0.25 m. The Steel mesh gabion slope protection is adopted for the slope from the barricade top to the place of normal water level + 0.5 m. And the steel mesh gabion foot protection is adopted with size of 2.0 m × 1.0 m × 0.3 m.

③ Drainage measures

Drains have been constructed in the management area for the main body where 30 cm × 30 cm trapezoidal section is adopted, the side slope is 1: 1 and the thickness of grouted rubble is 30 cm to timely drain the water in the area. Meanwhile, sand basin shall be set at the outlet of drains. As the water flow collected from the disturbed surface and surrounding areas of the Project contains sediment under rainy weather, it may affect the downstream water quality so as to sediment the river if not being settled. Therefore, it is necessary to set a sand basin at the outlet of drains. The sand basin, in rectangle, with size of 3.0 m × 2.0 m and depth of 1.0 m, is constructed by grouted rubble lining with thickness of 30 cm. The inlets and outlets are laid in dislocation mode. The water will be settled in the sand basin then drained into surrounding drains and the sediment settled in the sand basin will be cleared periodically by specially-assigned person. The main body for prevention areas of the PIU campsite has been equipped with gabion box barricade of 235 m, gabion slope protection of 2,120 m^2, and drains of 1,100 m. In this design, Soil stripping and return of 22,500 m^3 has been added newly and two sand basins have been laid.

2) Plant measure

After the completion of the Project, the PIU campsite surface is basically in the form of “hardening and greening”. The ground is paved with concrete, plaza brick, etc. and the green coverage area is 2.63 hm^2. The main body design just aims to estimate the area and investment of the vegetation measures of this part and not design detailed greening measures. And this design will propose corresponding suggestions for the vegetation measures. As the PIU campsite is close to the earth and rockfill dam of right bank, the kinds and layout form of vegetation measures taken shall coordinate with the greening of earth and rockfill dam. Refer to the dam construction area for corresponding suggestions on vegetation measures.

3) Temporary measures

During the construction of management area, for the surface soil stacked temporarily, earth excavation and material, it is recommended to supplement temporary protective measures in this design. Bagged soil shall be stacked into a trapezoidal section with top width of 0.5 m, height of 0.5 m and slope ratio of 1:1 to block surrounding area

temporarily and the surface will the sowed with seeds of white clover for protection.

The newly-added interim measures for prevention area of PIU campsite mainly include blocking with bagged soil, dismantling 459 m, and temporarily sowing the seeds of white clover for 1.17 hm^2.

4.1.3 Prevention and control area: borrow pit

The borrow pit involved in the Project covers an area of 4.37 hm^2 with occupied type of flood land.

1) Engineering measures

① Surface soil treatment and second plowing

In the main body design, reclamation measure is taken for the borrow pit, including Soil stripping and return, second plowing. The excavation process of borrow pit is divided into layer excavation and fragment excavation. Based on reasonable arrangement of construction procedures, the borrow pit used to backfill waste may be firstly excavated for use, so that the waste can be timely transported to the borrow pit for backfill during the excavation. The surface soil stripped from borrow pit and the waste from the Project shall be stacked by regions for the use of late backfilling in layers.

The size of Soil stripping and return of the borrow pit is 20,300 m^3 and the second plowing area is 4.37 hm^2.

② Drainage measures

In order to timely drain the incoming water surrounding borrow pit, reduce the impact on the excavation face of borrow pit and lower the quantity of water and soil loss, it is needed to excavate drains surrounding borrow pit. The construction area is the first one in ten years, with the maximum rainfall of 62.9 mm in 1 h. According to the open channel uniform flow formula, the drains of borrow pit shall be designed as grouted rubble trapezoidal section, with bottom width of 40 cm, depth of 30 cm, slope ratio of 1:1 and lining thickness of 30 cm. Construct a sand basin at the outlet of drains, in rectangle, with plan view size of 3.0 m (L) × 2.0 m (W) and depth of 1.0 m, grouted rubble thickness of 30 cm. The water shall be settled in the sand basin and then drained into surrounding downstream drains. During construction, special-assigned personnel shall be arranged to

clean surrounding drains and sand basins in rainy season. The prevention area of borrow pit shall be equipped with drains of 1,102 m long and two sand basins.

2) Temporary measures

The surface soil stripped form borrow pit shall be stacked on free area and the stacking height shall be controlled at about 2 m and the stacking side slope shall be controlled at about 1:2. In order to prevent water and soil loss from the washing of strong rainfall, the measure of bagged soil for temporarily blocking shall be taken for the temporary storage site, where trapezoidal section of 50 cm × 50 cm (top width × height) is adopted for the bagged soil barricade and the side slope is 1:1. As the surface soil in construction area is stacked for a longer time, after being stripped and stacked, it is better to sow the seeds of white clover with usage of 50 kg/hm². Meanwhile, cover the surface with non-woven fabrics during initial period to prevent water and soil loss. The late surface soil is used for second plowing. Dismantle the blocking and coverage. The newly added interim measures for prevention area of borrow pit mainly include blocking with bagged soil, dismantling 2,160 m, covering 10,700 m² with non-woven fabrics and temporarily sowing the seeds of white clover for 1.07 hm².

4.1.4 Prevention and control area: quarry site

The quarry site involved in the Project covers an area of 24.56 hm² with occupied type of dry land and forest land.

1) Engineering measures

① Surface soil treatment and second plowing

In the main body design, reclamation measure is taken for the quarry site, including Soil stripping and return, second plowing. The excavation process of quarry site is divided into layer excavation and fragment excavation. Based on reasonable arrangement of construction procedures, the quarry site used to backfill waste slag may be firstly excavated for use, so that the waste slag can be timely transported to the borrow pit for backfill during the excavation. The surface soil stripped from borrow pit and the waste from the Project shall be stacked by regions for the use of late backfilling in layers.

The size of Soil stripping and return of the quarry site is 40,300 m³ and the second

plowing area is 9.68 hm².

② Drainage measures

In order to timely drain the incoming water surrounding quarry site, reduce the impact on the excavation face of quarry site and lower the quantity of water and soil loss, it is needed to excavate drains surrounding such quarry site. The construction area is the first one in ten years, with maximum rainfall of 62.9 mm in 1 h. According to the open channel uniform flow formula, the drains of quarry site shall be designed as grouted rubble trapezoidal section, with bottom width of 40 cm, depth of 30 cm, slope ratio of 1:1 and lining thickness of 30 cm. Construct a sand basin at the outlet of drains, in rectangle, with plan view size of 3.0 m (L) × 2.0 m (W) and depth of 1.0 m, grouted rubble thickness of 30 cm. The water shall be settled in the sand basin and then drained into surrounding downstream drains. During construction, special-assigned personnel shall be arranged to clean surrounding drains and sand basins in rainy season. The prevention area of quarry site shall be equipped with drains of 2,302 m long and two sand basins.

2) Temporary measures

The surface soil stripped form quarry site shall be stacked on free area and the stacking height shall be controlled at about 2 m and the stacking side slope shall be controlled at about 1:2. In order to prevent water and soil loss from the washing of strong rainfall, the measure of bagged soil for temporarily blocking shall be taken for the temporary storage site, where trapezoidal section of 50 cm × 50 cm (top width × height) is adopted for the bagged soil barricade and the side slope is 1:1. As the surface soil in construction area is stacked for a longer time, after being stripped and stacked, it is better to sow the seeds of white clover with usage of 50 kg/hm². Meanwhile, cover the surface with non-woven fabrics during initial period to prevent water and soil loss. The late surface soil is used for second plowing. Dismantle the blocking and coverage. The newly-added interim measures for prevention area of quarry site mainly include blocking with bagged soil, dismantling 4,710 m, covering 21,700 m² with non-woven fabrics and temporarily sowing the seeds of white clover for 2.17 hm².

4.1.5 Prevention and control area: temporary soil storage field

Temporary storage site, located in upstream pit of the left bank, is mainly responsible for the storage of the utilization materials after the excavation of main works, covering an area of 2.6 hm^2, and with occupied type of forest land. The average stacking height is 8.5 m. After the completion of the Project, as the temporary storage site is located in pit, no additional restoration measures will be taken.

1) Temporary measures

The side slope of stacked materials in temporary storage site shall be controlled at about 1:1. In order to prevent water and soil loss from the washing of rainfall, the measure of bagged soil for blocking shall be taken for the temporary storage site, where trapezoidal section of 100 cm × 100 cm (top width × height) is adopted for the barricade section and the side slope is 1:1. As the earthwork is stacked for a shorter time, it shall prepare standby waterproof cloth for the side slope of temporary storage site to cover the earthwork under rainy weather so as to reduce the washing from rainfall on such temporary storage site, where the standby waterproof cloth is prepared by the 50% of the number of temporary storage sites.

As there is no water catchment surrounding temporary storage site affecting such temporary storage site, there is no need to establish temporary drainage measures additionally. According to calculation, the temporary blocking of bagged soil in temporary storage site is 645 m long, and the coverage area of waterproof cloth is 13,000 m^2.

4.1.6 Prevention and control area: waste dump site

In the main body design, there are two waste dump sites which are located on the bund outside of upstream causeway within dam site. One is in reservoir-area type and the other is in flat-group type. The total coverage area of both waste dump sites is 120.66 hm^2 with occupied type of inland mud flat.

1) Engineering measures

In order to ensure stable waste body, it shall exercise strict control over the waste stacking process and timely level the waste during the construction.

① Surface soil treatment

Before stack on waste dump site, the available surface soil of the waste dump site shall be stripped firstly with stripping thickness of 30 cm to temporarily stack on the rear part of the waste dump site where the stacking height shall be controlled at about 2 m. During construction, it needs to strengthen the temporary blocking protection measures. And in the late construction, return the waste body for surface utilization. In addition, some surface soil stripped from the construction area of the dam shall be transported to the waste site for backfill from temporary storage site after completion of the Project.

② Retaining

For the main body design, gabion retaining wall is provided for waste dump site. The top of the slope retaining wall to the normal water level +0.5m slope is provided with a steel-wire gabion slope. The waste dump site shall be retained by a 2m-wide gabion banket at its water side to prevent them from soil erosion. The section of the gabion retaining wall is 1.5m high, with a top width of 1.0m, base width of 2.0m, burial depth of 0.5m and the specification of 2.0m×1.0m×0.5m. The specification of the steel-wire gabion slope and pad is 2.0m×1.0m×0.3m.

③ Drainage measures

Considering the surface drainage of waste dump site during construction period and drainage issues after its re-cultivation, we have designed drain ditch at the top of the waste dump site. The ditch is a trapezoidal cross-section (30cm×30cm) with the slope ratio of 1:1 and the spacing between two drain ditches is 50m. A desilting basin with the plane size of 3.0m x 2.0m, depth of 1.0m, and brickwork thickness of 30cm shall be arranged at the outlet of the drain ditch around the waste dump site. The inlet and outlet shall be arranged in a staggered manner. The sediment in the water flow shall be settled in the desilting basin, and then be discharged into the nearby river or ditch, and be regularly cleaned by special personnel.

④ Re-cultivation

The waste shall be leveled off and compacted by a tractor for 3-4 times. The waste slope is not less than 1:3.

The waste dump sites are mainly seasonal arable flood lands. After the completion of

the construction, the elevation of this area shall be lifted up, being 1.78-2.78m higher than normal water level. For the main design, the surface of the waste dump site top is provided with the re-cultivation measures. The stripped-off topsoil of the waste dump site protection zone of the Complex Project is 248,200 m^3, and topsoil returned is 368,200m^3. The gabion retaining wall is 4,923m long and the steel-wire gabion slope and banket protection are 67,071m^2. The surrounding drain ditch and top drain ditch are 32,918m. There are 4 desilting basins. The re-cultivated area is 68.9hm^2.

2) Plant measure

The design has considered the vegetation recovery measures for the waste dump site. However, these measures are mainly focusing on estimation of its areas and investment. Therefore, the plan will put forward corresponding vegetation measures.

According to overall arrangement of soil and water conservation plan and the site condition, the waste dump site top and side slope protection forest shall be provided. As its forming conditions causes poor stability of the whole waste dump site, soil erosion may occur in case of heavy rain, therefore, in addition to engineering measures, the waste dump site top and side slope protection forest shall be provided as the protective measures to retain the spoil with the roots of trees to enhance stability, and restore vegetation to increase the green space.

① Land reclamation project

In order to restore the damaged land to an available state, land improvement measures such as leveling off, reconstruction and restoration shall be taken.

a Land leveling

The completion of spoil is followed by land leveling of the waste dump site, which is divided into rough leveling and fine leveling. First, the top and slope of the waste dump site undergo comprehensive coarse leveling, before settling stability, the subsidence hole shall be filled, and undergo fine leveling to be covered.

b Covering method

Since the top of the waste dump site is mostly gravel with loose body, large pores and easy leakage, in order to ensure the moisture content in the soil and no vertical soil erosion

after covering, the surface of the waste dump site must be first treated before covering, and the specific measures are: first, pave a layer of topsoil inside the tree planting hole, at the top and slope of the waste dump site, roll and compact it to form an impermeable layer, second, fill the topsoil.

② Selection of tree species

As the waste dump site is the area which is most prone to soil erosion inside the project area, the following principles shall be followed in the selection of tree species: developed root system and strong root turion; strong soil retention, vigorous growth, rapid canopy, dense crown, rich fallen leaves and easy to decompose, can quickly form soft deadwood fallen leave layer, can improve the soil properties, and water and fertilizer retention capacity of the soil; strong adaptability and resistance; has a certain economic value, taking into account a variety of business needs of local people; select the corresponding species according to different topography partition. On this basis, according to the principle of "suitable trees for suitable land, and suitable grass for suitable land", combined with the site conditions and vegetation characteristics, according to a comprehensive analysis of survival rate and adaptability, the local cold-resistant, barren-resistant and fast-growing excellent trees and grass seeds are selected to restore vegetation of the wasted dump site as soon as possible, so as to achieve the purpose of erosion control and improvement of the ecological environment

For the designed plant species, suitable local native species shall be selected. According to the site survey, lots of fast-growing poplars are planted in the beaches on both banks of Han River near the project area, so it is initially proposed that poplars are planted as arbor in the top of the waste dump site, amorpha fruticosa is planted in the bare slope between the steel-wire gabion slope and the top of the waste dump site, and bermuda grass seeds is sown under the trees.

③ Afforestation density

According to the different forest species, tree species, site conditions and operating conditions, both the plant spacing and line spacing of amorpha fruticosa are 1.5m; both the plant spacing and line spacing of poplar are 2m; the bermuda grass seeds are 50kg/hm^2.

④ Configuration of growing points

Line configuration of growing points is adopted, which evenly distributes trees in the woodland, and make full use of the woodland space.

⑤ Land leveling

According to the local site conditions, the land leveling shall be performed in autumn or winter before the afforestation year, which can make land leveling holes store more water to promote ripening of immature soil, resulting in a higher survival rate of afforestation.

3) Temporary measures

In construction period, the stripped-off topsoil shall be temporarily stacked up in the back of waste dump site with a height of 2m. Retaining measures shall be taken for the stripped-off topsoil stacked at one side of the waste dump site by piling up a trapezoid section which is 0.5m wide, 0.5m high and has a slope ratio of 1:1. Since the topsoil stacking time is relatively long, and will be used for re-cultivation or restoration of vegetation in later stage, during the temporary stacking period, white clover seeds are sown for temporary protection. To increase the survival rate of seeds and to prevent erosion of the grass seeds by rain, the surface is covered with non-woven fabric for protection.

The retaining and removal of the bagged soil of the waste dump site protection zone is 2.439m, and the sowing seeds and non-woven fabric are 90,100m².

4.1.7 Prevention and control area: road works

According to the construction organization design, the construction roads of the construction area are arranged based on utilization of the existing roads, combined with the permanent traffic roads. The complex project area is provided with the permanent roads of 0.500km long, new temporary roads of 5.78km long, the renovated and expanded temporary roads of 5.8km long, covering a total land area of 20.00hm², of which the permanently occupied land is 0.70hm², and the temporarily occupied land is 19.3hm².

After construction is completed, the left-bank construction road will continue to be used while temporary road shall be restored according to its location. The construction road is concrete pavement road, while the remaining roads are clay-bound macadam

pavement roads.

1) Protection zone in construction road area

① Engineering measures

Before construction, the topsoil within the scope of land occupancy of road which can be stripped off shall be stripped off by 30cm for greening of both sides of the roads after completion of construction. The stripped-off topsoil of the construction road can be temporarily stacked up within the scope of land occupancy of the left-bank production and living area. Its corresponding temporary protective measures shall be included in the production and living area.

A drain ditch of rectangular section with a bottom width of 30cm, depth of 30cm. and lining thickness of 30cm shall be arranged on the inner slope for the construction road. If the sediment in the water flow gathered by the drain ditch is directly discharged into ditches or rivers, it will cause blockage or increase of sediment content, resulting in soil erosion, therefore, a desilting basin with the plane size of 2.0m×1.0m, depth of 1.0m, and brickwork thickness of 30cm shall be provided in low-lying section of the drain ditch to settle the sediment in the water flow before discharge.

According to the design, the stripping off and return of topsoil is 900m^3, the drain ditch is 1,000m, and the number of desilting basins is 2.

② Plant measure

Triennial strong cinnamomum camphora shall be planted on the slopes on both sides of the permanent road with the plant spacing of 3m. 50kg/hm^2 of Class I bermuda grass seeds shall be sown on the subgrade filling slope.

According to the design, the number of cinnamomum camphora needed for the protection zone in construction road area is 334, while the sowing area for bermuda grass seeds is 0.08hm^2.

2) Prevention and control area: temporary road for construction

Most of the temporary roads in the complex project area have been included in each zone of the complex project area, and the soil erosion control measures are included in corresponding zones and are not repeatedly listed here. The temporary roads only consider

the construction road to stockyard and construction road outside the foundation pit of dam construction area.

① Engineering measures

Before construction, the topsoil within the construction road area which can be stripped off shall be stripped off by 30cm for vegetation restoration or re-cultivation after completion of construction. The stripped-off topsoil from the construction road of the borrow pit can be temporarily stored in the borrow pit together with the stripped-off topsoil from the borrow pit, the stripped-off topsoil of the construction road of the dam construction area can be transported to temporary soil storage area for storage, and the corresponding temporary protective measures are included in the stacking area. The construction road surface is hardened due to the vibration of vehicles and construction workers during the construction process. After construction is completed, the surface compacted layer shall be loosened and leveled off, and the occupied arable land shall be re-cultivated.

According to the design, the topsoil which needs to be stripped off and returned is 34,000 m^3. After construction is completed, 4,400m^3 of the compacted layer shall be loosened, and 1.15hm^2 of occupied arable land shall be re-cultivated.

② Plant measure

At the end of the project, the vegetation restoration measures shall be provided for the construction roads occupying the inland tidal flat area and vacant land area within the scope of land occupancy. The poplar is planned for vegetation restoration, with the plant spacing of 3.0m×3.0m, and 50kg/hm^2 of bermuda grass seeds shall be sown under the trees. According to the design, the number of poplars needed for the construction road protection zone is 561, and the area of bermuda grass seeds is 9.92hm^2.

③ Temporary measures

Most of the temporary roads are arranged on the river side or near the soil borrow pit, and are basically excavated, filled and leveled along the existing terrain; it is proposed to excavate temporary drain ditch of trapezoidal section with the bottom width of 30 cm, depth of 30 cm, and slope ratio of 1:1 on both sides of the newly-built construction road. A

rectangle desilting basin with the plane size of 1.5m×1.0m, depth of 1.0m, and brickwork thickness of 6cm shall be provided in low-lying section of the drain ditch to settle the sediment in the water flow before discharge. In addition, 50kg/hm² of white clover seeds shall be sown on the bare slopes on both sides of the construction road.

According to the design, the drain ditch needed to be excavated is 17,600m, the desilting basins needed are 37 and the white clover seeds needed is 1.1hm².

4.1.8 Prevention and control area: production and living

According to the demand of project construction, concrete system, sand processing system, metal structure assembly plant, automobile parking and maintenance plant, construction substation, comprehensive processing plant, comprehensive warehouse and construction camps, etc. are arranged. The production and living area covers an area of 8.77hm², covering types of dry land, forest land and inland intertidal zone.

1) Engineering measures

① Surface soil treatment

Before stacking in the waste dump site, the topsoil which can be utilized in the production and living area shall be stripped off by 30cm and be temporally stacked at a corner of the production and living area with the height of no more than 2m. Temporary retaining protective measures shall be taken during the construction period. The stripped-off topsoil shall be returned to the surface of the waste dump site for use in the later construction stage.

② Drainage measures

For the main body design, a drain ditch of trapezoidal section of 30cm×30cm, with the slope ratio of 1:1 and brickwork thickness of 30cm shall be provided near the production and living area.

As the production and living area covers a large area, drain ditch shall be provided within it to discharge water flow, so as to reduce erosion on the surface of the site. The drain ditch of 30cm×30cm non-lining trapezoidal section with the slope ratio of 1:1 within the production and living area is mainly arranged along the construction road. A desilting basin with the plane size of 3.0m×2.0m, depth of 1.0m and brickwork thickness of 30cm

shall be provided at the outlet of the drain ditch on the slope.

③ Hardened layer treatment and re-cultivation

After completion of the construction site, the hardened layer and construction waste shall be transported to the waste dump site. The quantities shall be calculated by taking into consideration of 60% of covering area. The thickness of hardened layer shall be calculated by 20 cm.

After completion of the production and living area, according to the type of the original land, the type of the original land of the right-bank production and living area is dry land, which shall be re-cultivated after the completion of construction.

According to the design, the stripped-off and returned topsoil in the production and living area is 54,700 m^3, the drain ditch is 2,363m, and the number of desilting basin is 2. The hardened layer shall be removed by 25,380m^3. 17.9hm^2 of land shall be re-cultivated.

2) Plant measure

After the completion of the construction, vegetation restoration measures shall be provided for the production and living area with the type of the original land of forest land. For the main body design, only part of the area and investment of the vegetation restoration measures are estimated, and no specific vegetation restoration measures design is made. For this design, according to the vegetation growth situation of the original land, it is recommended that after the completion of construction, fast-growing poplar shall be planted for use by local farmers, and bermuda grass seeds shall be sown under the trees for vegetation restoration. Triennial poplar seedling shall be planted with the plant spacing of 3m×3m, and 50kg/hm^2 of Class I bermuda grass seeds shall be sown.

The vegetation measures for vacant land are the same as that of the forest land.

In addition, amorpha fruticosa is planted in the bare slope between the steel-wire gabion slope and the top of the waste dump site, and 50kg/hm^2 of Class I bermuda grass seeds is sown under the trees with the plant spacing f 1.5m×1.5m.

According to calculations, a total of 1,628 poplars, 64,247 of amorpha fruticosa and 15.12hm^2 of bermuda grass seeds shall be planted in the production and living area.

3) Temporary measures

The stripped-off topsoil of the production and living area shall be stacked in a vacant place of the soil storage area. Its stacking height shall be controlled at 2m and slope shall be controlled at 1:2. To prevent soil erosion, bagged soil shall be used for temporary retaining of the temporary stacking yard. The retaining wall section shall be a 50cm×50cm (top width × height) trapezoidal section with the slope of 1:1. As the stacking time of the topsoil of the production and living area is long, 50kg/hm² of white clover seeds shall be sown on the surface of the stacked topsoil. At initial stage, the topsoil shall be covered with non-woven fabric to prevent soil erosion. In later stage, the topsoil will be used for re-cultivation or vegetation restoration, and retaining and coverage shall be removed.

According to calculations, for temporary protection of topsoil, the retaining and removal of bagged soil is 1,039m, the sowing area of seeds is 3.00hm² and the non-woven fabric is 30,000m².

4.2 Prevention and control area: reservoir area

4.2.1 Reservoir inundated area

There is no elevated-up protection area in reservoir inundated area. During the reservoir cleaning process, the construction progress shall be reasonably arranged in accordance with the construction schedule, and construction shall avoid the rainy season as far as possible. High area shall be excavated and low area shall be filled. Ground surface compaction and local protection and other measures shall be taken to reduce soil erosion, and this part of the measures has been considered in the relevant resettlement report, and is not listed in this design.

4.2.2 Protection works

1) Protection zone of floodways

The length of floodways for the project is 30.00km, which are evenly arranged in Yicheng City. It covers an area of 82.80hm², and the land types in the area include paddy field, dry land, forest land and vacant land. The two sides of the floodways are waste dump sites, wand are used for storing excavated earthwork of the floodways.

① Engineering measures

For the main body design, before construction, the topsoil within the floodways area

which can be stripped off shall be stripped off by 30 cm, the stripped-off topsoil from the floodways area can be temporarily stored in the waste dump site area on both sides of the floodways together with the stripped-off topsoil from the waste dump sites, and the corresponding temporary protective measures are included in the waste dump site area. After the construction, the topsoil shall be returned to the surface of the waste dump site for re-cultivation or vegetation re-cultivation of the waste dump site.

According to calculations, the stripped-off topsoil of the floodways area is 195,700 m^3.

② Plant measure

For the bare slope on both sides of the top of the floodways in the floodways area, 50kg/hm^2 of Class I bermuda grass seeds can be sown for slope protection. 13.80hm^2 of bermuda grass seeds shall be sown for the floodways area.

③ Temporary measures

There are a large number of exposed slopes during the floodways excavation process, so soil erosion may occur in case of heavy rain and strong wind. The exposed slopes shall be covered with tarpaulin to soil erosion caused by rain and wind. The floodways adopts segmented construction, and only needs to be covered in case of heavy rain and strong wind, so the covering area is calculated as 20% of the slope area of the floodways. Besides, the tarpaulin can be reused, and its quantities are calculated as 30% of the total covering area, therefore, the covering area of tarpaulin of the floodways area is 126,000 m^2, and the spare tarpaulin required is 37,800 m^2.

The quantities of the soil and water conservation measures of the protection zone of floodways are shown in Table 8-1, and typical soil and water conservation design is shown in Figure 19.

2) Anti-immersion zone

Anti-immersion drain ditch totals 48.000km, which are located in Yicheng City. It covers an area of 43.20hm^2. The land types include paddy field, dry land, forest land and vacant land. The two sides of the anti-immersion drain ditch are waste dump sites used to store earthworks of the drain ditch.

① Engineering measures

For the main body design, before construction, the topsoil within the anti-immersion zone which can be stripped off shall be stripped off by 30 cm, the stripped-off topsoil from the anti-immersion zone can be temporarily stored in the waste dump site area on both sides of the anti-immersion drain ditch together with the stripped-off topsoil from the waste dump sites, and the corresponding temporary protective measures are included in the waste dump site. After the construction, the topsoil shall be returned to the surface of the waste dump site for re-cultivation or vegetation re-cultivation of the waste dump site.

According to calculations, the stripped-off topsoil in anti-immersion zone totals 102, 100m³.

② Temporary measures

There are a large number of exposed slopes during the drain ditch excavation process, so soil erosion may occur in case of heavy rain and strong wind. The exposed slopes shall be covered with tarpaulin to soil erosion caused by rain and wind. The drain ditch adopts segmented construction, and only needs to be covered in case of heavy rain and strong wind, so the covering area is calculated as 20% of the slope area of the floodways. Besides, the tarpaulin can be reused, and its quantities are calculated as 30% of the total covering area, therefore, the covering area of tarpaulin of the anti-immersion zone is 76,800 m², and the spare tarpaulin required is 23,000 m².

4.2.3 Prevention and control area: waste dump site

The waste dump site of the reservoir area protection zone serves as the stacking area for the excavated spoil of the protection zone floodways and anti-immersion drain ditch, and is arranged on both sides of the floodways and drain ditch. To facilitate later stage use, the spoil stacking slope is 1:2, the average stacking height of the waste dump site of floodways is 1.5m, and the land occupancy width on both sides is about 19-27m. The average stacking height of the waste dump site of anti-immersion drain ditch is 1.0m, and the land occupancy width on both sides is about 12m. The waste dump site covers an area of 125.31hm², and its land types include paddy land, dry land, forest land and vacant land.

1) Engineering measures

① Surface soil treatment and second plowing

The waste dump site is arranged near both sides of the protection zone. For the main body design, re-cultivation measures are taken for the paddy land, dry land and forest land occupied by the waste dump site, including topsoil stripping-off, returning and re-cultivation. In addition, for this design, the topsoil stripping-off measure is taken for the vacant land with well-grown vegetation and the stripped-off topsoil is used for vegetation restoration in later stage.

The stripped-off topsoil of the waste dump site is 296,200m³, and the returned topsoil is 594,000m³. The re-cultivated area totals 72.18hm².

② Retaining measures

As the area where part of the floodways lies is subject to great undulating terrain, to prevent the spoil from rolling down the slope to affect the surrounding area, bagged soil with the trapezoid section of 50cm×50cm (top width × height) and the slope ratio of 1:1 is arranged at the lower slope of the waste dump site of floodways for retaining. The area where the waste dump sites of other floodways and the anti-immersion drain ditches lie is subject to a relatively flat terrain with the spoil slope of 1:2. To facilitate local re-cultivation and restoration, the waste dump sites along both sides of the anti-immersion drain ditches are not provided with bagged soil retaining measures. According to calculations, the bagged soil for retaining provided for the waste dump site is 12, 000m.

③ Drainage measures

One side of the waste dump site is arranged along the floodways and the anti-immersion drain ditch, and the other side of the waste dump site is arranged with drainage measures. As the surroundings of the reservoir area waste dump site is subject to relatively flat terrain with densely arranged ditches, and developed farmland drainage system, the soil drain ditch of trapezoid section with the bottom width of 30cm and depth of 40cm with the slope ratio of 1:1 can meet the requirements, and the inner wall shall be compacted. Temporary rectangular desilting basin with the plane size of 1.5m (length) x 1.0m (width) x1.0m (depth) and brickwork thickness of 6cm shall be arranged at the outlet of the drain ditch. The sediment in the water flow is settled in the desilting basin, and is

then discharged into the ditches near the downstream. During the raining season in the construction period, designated personnel shall be arranged for desilting work of the surrounding drain ditch and desilting basin. During the construction period, drainage measures are taken for the collection of surrounding runoff, so as to reduce the impact on the waste dump site of the water flow. After completion of the construction, it can be used for drainage in farmland.

The drain ditch in waste dump site protection zone is 156,000m, and the number of desilting basin is 312.

2) Plant measure

After the completion of the construction, for the main body design, vegetation restoration measures shall be provided for the waste dump site with the type of the original land of forest land. For the main body design, only part of the area and investment of the vegetation restoration measures are estimated, and no specific vegetation restoration measures design is made. For this design, according to the vegetation growth situation of the original land, it is recommended that after the completion of construction, fast-growing poplar shall be planted for use by local farmers, and bermuda grass seeds shall be sown under the trees for vegetation restoration. Triennial poplar seedling shall be planted with the plant spacing of 3m×3m, and 50kg/hm² of Class I bermuda grass seeds shall be sown.

The vegetation measures for vacant land are the same as that of the forest land.

A total of 59, 033 poplars shall be planted and 53.13hm² of bermuda grass seeds shall be sown in the waste dump site protection zone for vegetation restoration.

3) Temporary measures

The protective works adopts segmented construction. Spoil stacking in the waste dump site shall be performed in the construction order of the protective works. Thus, the stripped-off topsoil from the waste dump site area and from the preventive works area can be stacked up in the waste dump site area of the non-construction section, or be directly backfilled on the surface of the completed waste dump site. For the topsoil temporally stacked for return in later stage, the stacking slope shall be controlled at about 1:2, and the stacking height shall be controlled at 2m. Since the construction time of each section of the

floodways and drain ditch is short, in case of rain, strong winds or other weather conditions, the topsoil temporally stacked shall be covered with tarpaulin to prevent soil erosion due to rain. The protective works adopts segmented construction, and only needs to be covered in case of heavy rain and strong wind which concentrate in rainy season, so the covering area of tarpaulin is calculated as 20% of the area of the topsoil temporally stacked. Besides, the tarpaulin can be reused, and its quantities are calculated as 30% of the total covering area, therefore, the covering area of tarpaulin of the waste dump site is 59,900 m^2, and the spare tarpaulin required is 18,000 m^2.

4.2.4 Prevention and control area: temporary road for construction

The construction roads within the reservoir area protection zone are mainly connection roads of the protective works, with the length of 4.090km, pavement width of 6m, and subgrade width of 8m. The clay-bound macadam road covers an area of 3.27hm^2, and the land types include dry land, forest land and vacant land.

1) Engineering measures

Before construction, the topsoil within the construction road area which can be stripped off shall be stripped off by 30cm for vegetation restoration or re-cultivation after completion of construction. The stripped-off topsoil can be shipped to the waste dump site for temporary storage, and its corresponding protective measures are included in the temporary storage area.

The construction road surface is hardened due to the vibration of vehicles and construction workers during the construction process. After construction is completed, the surface compacted layer shall be loosened and leveled off, and the topsoil shall be returned, and the occupied arable land shall be re-cultivated.

According to the design, the topsoil which needs to be stripped off and returned of the construction road area is 0.53m^3. After completion of the construction, 6,540m^3 of the compacted layer shall be loosened, and 0.25hm^2 occupied land shall be re-cultivated.

2) Plant measure

After the completion of the construction, vegetation restoration measures shall be provided for the construction road area with the type of the original land of forest land. For

the main body design, only part of the area and investment of the vegetation restoration measures are estimated, and no specific vegetation restoration measures design is made. For this design, according to the vegetation growth situation of the original land, it is recommended that after the completion of construction, fast-growing poplar shall be planted for use by local farmers, and bermuda grass seeds shall be sown under the trees for vegetation restoration. Triennial poplar seedling shall be planted with the plant spacing of 3m×3m, and 50kg/hm² of bermuda grass seeds shall be sown.

The vegetation measures for vacant land are the same as that of the forest land.

According to calculations, a total of 3, 356 poplars and 3.02hm^2 of bermuda grass seeds shall be planted in the construction road area.

3) Temporary measures

The construction roads are basically excavated, filled and leveled along the existing terrain; it is proposed to excavate temporary drain ditch of soil trapezoidal section with the bottom width of 30 cm, depth of 30 cm, and slope ratio of 1:1 on both sides of the newly-built construction road. A rectangle desilting basin with the plane size of 1.5m×1.0m, depth of 1.0m, and brickwork thickness of 6cm shall be provided in low-lying section of the drain ditch to settle the sediment in the water flow before discharge. In addition, 50kg/hm² of white clover seeds shall be sown on the bare slopes on both sides of the construction road.

According to the design, the temporary drain ditch needed is 8,180m, the number of desilting basins is 16, and the temporary sowing of white clover seeds is 0.08 hm².

4.2.5 Prevention and control area: production and living

The production and living area of the reservoir area protection zone is mainly provided with the construction site and construction camps built for the protective works, with an area of 0.40hm², and land types of dry land and vacant land.

1) Engineering measures

According to the main body design, taking into account the vegetation restoration and re-cultivation needs after the completion of construction, the topsoil from the dry land in this area shall be stripped off by 30cm before leveling-off. This plan intends to strip off the

topsoil in part of the vacant land. The stripped-off topsoil shall be stacked in a corner of the production and living area, and shall be used for re-cultivation of cultivated land and vegetation restoration of other land types after the construction is completed.

After completion of the construction site, the hardened layer and construction waste shall be transported to the waste dump site. The quantities shall be calculated by taking into consideration of 60% of covering area. The thickness of hardened layer shall be calculated by 20 cm.

According to the design, the stripped-off and returned topsoil in the production and living area is 900m^3. 480m^3 of the hardened layer shall be removed, and 0.12hm^2 of land shall be re-cultivated.

2) Plant measure

The vegetation measures for vacant land are the same as that of the forest land. Triennial poplar seedling shall be planted with the plant spacing of 3m×3m, and 50kg/hm^2 of Class I bermuda grass seeds shall be sown.

According to calculations, the number of poplars needed is 311, and the bermuda grass needed is 0.28hm^2.

3) Temporary measures

The stripped-off topsoil of the production and living area shall be stacked in open space, with the stacking height of 2 m and stacking slope of 1:2. Since each production and living area of the reservoir area protection zone covers a small area, and the topsoil stripping off amount of single site is small, it is proposed to cover the surface of the temporarily stacked topsoil with tarpaulin for protection to reduce the soil erosion due to heavy rain and strong wind.

In order to prevent adverse impact on the production and living area of the surrounding rain, while leveling of the construction site, drain ditches of soil trapezoidal section with bottom width of 30cm and depth of 30cm shall be excavated around the construction site. A desilting basin with the plane size of 1.5m×1.0m, depth of 1.0m, and brickwork thickness of 6cm shall be provided around the drain ditch.

According to calculations, the number of drain ditches that need to be excavated for

temporary protection of topsoil is 759m, the number of desilting basins that needs to be excavated is 8, the covering area of tarpaulin is 500 m^2, and the spare tarpaulin required is 500 m^2.

4.3 Prevention and control area: demolition and resettlement as well as special facilities

4.3.1 Resettlement area

The resettlement of the project adopts one-time compensation for the resettled people, and is performed by the local immigration department. The prevention of soil erosion and legal responsibilities has been transferred as a whole, and are not specially designed in this design. This design only proposes constructive opinions for protective measures for soil erosion, soil and water conservation requirements and preliminary estimates of investment in soil and water conservation. In order to prevent soil erosion, in the resettlement process, corresponding measures must be taken to reduce the impact on the surrounding environment and soil erosion:

1) Unified planning shall be adopted for the resettlement area. Besides, the local resettlement department shall prepare special soil and water conservation plan according to law. The buildings in the resettlement area shall be arranged in a concentrated manner. Occupancy of farmland without permission is prohibited to protect land resources. The waste soil and spoil generated during the "three supplies and one leveling" process shall not be dumped into the ditch without permission, and shall be used for leveling of the homestead in combination with foundation compaction and yard cushion as far as possible to make full use of spoil. When the spoil is used for platform filling inside the yard, it shall be compacted layer by layer to meet the stability requirements. Other spoil shall be stacked up in a certain place in a concentrated manner and be provided with timely greening in combination with the construction of the village and town.

2) Slope stability shall be maintained for the excavated section. When necessary, corresponding engineering measures shall be taken, and vegetation protection measures shall be taken on the exposed surface. 3) A reasonably drainage system shall be arranged in the resettlement area, so as to prevent the area from soil erosion.

3) After house demolition is completed, the construction waste shall be classified,

and the wood and bricks shall be recycled as far as possible, and other waste shall be transported to lower areas for soil backfilling. Besides, greening measures for villages and towns shall be taken in the resettlement area, and trees shall be planted beside the road, ditch, canal and house to beautify the environment, to protect the village, and to develop the courtyard economy. As for greening, suitable trees shall be planted in the resettlement area, and evergreen arbors, shrubs, flowers, lawns, etc. shall be planted to achieve water and soil conservation, vegetation restoration and landscape improvement purposes.

4.3.2 Re-construction of special facilities

Re-construction of special facilities mainly includes re-construction of roads, telecommunication facilities and transmission lines. The relevant design of the re-construction of telecommunication facilities and transmission lines is not made in the current stage, and this design proposes the following requirements for soil and water conservation tailored for these re-construction items:

Farm machinery accesses, optical cable, and electric cable shall be compensated by cash, and shall be reconstructed by relevant units. Pump station and drainage culvert

1) In selecting sites for re-cultivation, try to avoid cultivated land and forest land to reduce occupancy of and disturbance to land and vegetation, so as to reduce soil erosion.

2) To avoid soil erosion due to stacking of the excavated spoil without permission, avoid construction of earthworks in rainy season as far as possible, and use the excavated soil and stone for backfilling as far as possible.

3) Build necessary interception and drainage system to drain the precipitation and surface runoff to prevent erosion of houses.

4.4 Quantities of water and soil conservation measures

Quantities of water and soil conservation measures of the project are shown in Table 4.4.

Table 4.4 Summary of Quantities of Water and Soil Conservation Measures

	Water and Soil Conservation Measures	Unit	Project area								Protective area				Total
			Dam construction area	PIU's camp	Borrow pit	Quarry site	Temporary soil stacking area	Waste dump site	Road works	Production and living area	Protective engineering area	Waste dump site	Construction road	Production and living area	
Engineering measures	Soil stripping	50,000 m^3	14.6	2.25	2.03	4.03		24.82	0.56	5.47	29.78	29.62	0.53	0.09	113.78

	Topsoil covering		50,000 m^3	2.6	2.25	2.03	4.03		36.82	0.56	5.47		59.4	0.53	0.09	113.78
	Drain ditch	Length	m		1100	1102	2302		32918	1000	2363		156000			196785
		Earth excavation	m^3		822	823	1728		22858	747	1154		28080			56212.3
		Masonry	m^3		591	592	1243		7550	537	582					11095.2
	Desilting basin	Quantity	Nr.		2	2	2		4	2	2		312			326
		Earth excavation	m^3		24	24	24		48	11	24		531			686
		Masonry	m^3		12	12	12		24	7	12					79
		Brick	m^3										63			63
	Gabion retaining wall	Length	m		235				4923							5158
		Earth excavation	m^3		235				4923							5158
		Volume	m^3		353				7384							7737
	Steel-wire gabion slope and banket	Area	m^2		2120				67071							69191
		Volume	m^3		636				20121							20757
	Bagged soil retaining	Length	m										12000			12000
		Earthwork filling	m^3										6000			6000
	Loosening of compacted layer	Earthworks	m^3							4400				6540		10940
	Clearing of hardened layer	Earthworks	m^3								25380				480	25860
	Re-cultivation		hm^2			4.37	9.68		68.9	1.15	7.9		72.18	0.25	0.12	164.55
Plant measure	Greening		hm^2													
	Cinnamomum camphora		Nr.							334						334
	Poplar		Nr.						90280	45466			59033	3356	311	198446
	Amorpha fruticosa		Nr.						40004		3863					43867
	Sowing of bermuda grass seeds	Sowing area	hm^2						45.05	18.15	0.87	13.8	53.13	3.02	0.28	134.3
		Seeds	kg						2252.5	907.5	43.5	690	2625.5	151	14	6684
Temporary measures	Bagged soil	Length	m		459	2160	4710	645	2855		1039					11868
		Filling	m^3		230	1080	2268	1290	1428		520					6816
		Demolition	m^3		230	1080	2268	1290	1428		520					6816
	Tarpaulin covering	Tarpaulin covering area	10,000 m^2					2.6				20.28	5.99		0.05	28.92
		Tarpaulin area	10,000 m^2					1.3				6.08	1.8		0.05	9.23
	Temporary drain ditch	Length	m							17600				8180	759	26539
		Earth excavation	m^3							3168				1472	137	4777
	Desilting basin	Quantity	Nr.							37				16	8	61
		Earth excavation	m^3							64				31	15	110
		Brick	m^3							7				7	3	17
	Non-woven fabric covering		10,000 m^2			1.07	2.17		9.01		3					15.25
	Temporary sowing of white clover seeds	Area	hm^2		1.17	1.07	2.17		9.01	1.1	3			0.08		17.6
		Seeds	kg		58.5	53.5	108.5		450.5	55	150			4		880

5 Investment estimate and benefit analysis for water and soil conservation

The total investment of water and soil conservation measures reaches CNY 80,232,700 (an increase of CNY 25,208,100 on the existing CNY 55,024,670 of the main body), of which the complex project is CNY 52,997,000, and the reservoir area protective works is CNY 27,235,700.

The comprehensive treatment benefits of soil and water conservation measures include the basic benefits, economic benefits, social benefits and ecological benefits. The soil and water conservation measures defined in this design are mainly used to prevent soil erosion, conserve soil and water, and beautify landscaping, so specific analysis and calculation of basic benefits and economic benefits is not performed, but mainly the social

benefits and ecological benefits after the implementation of the soil and water conservation measures.

(1) Ecological benefits

After the implementation of soil and water conservation measures, and after the implementation of vegetation measures in the main project area, temporarily occupied land, etc., the ground vegetation coverage will be greatly improved, and various vegetation measures can improve the physical and chemical properties of soil, improve soil fertility, improve the ecological environment in the project area, and promote harmony between man and nature.

After the implementation of soil and water conservation measures and vegetation measures, the artificial soil erosion during the project construction process can be effectively controlled, and it plays a certain role in improving the ecological environment in the project area, and can reduce soil erosion. The temporary protective measures for PIU's camp area, soil borrow pit, temporary stacking area, waste dump site area, construction road, production and living area, etc. defined in the soil and water conservation design are implemented based on the design and will have a significant water and soil conservation benefits.

(2) Social benefits

After the implementation of the soil erosion and soil conservation plan, a comprehensive control system combining engineering and biological measures is formed, and can reduce the amount of soil erosion of 91,000 t, effectively control and govern the man-made soil erosion in the project area, basically utilize and govern the excavated earthworks of the project, preventing the loss of temporary stacked soil, reducing the impact on the environment of nearby residents, and ensuring the safe operation of the project.

Environment is a condition for the survival of human, and the quality of the environment directly affects the quality of people's lives. Through the implementation of the soil and water conservation measures, the amount of increased soil erosion is effectively controlled, reducing soil erosion and river sediment deposition, and improving

water quality. According to the simultaneous design, construction and completion requirements, after the completion of the project, the implementation of the soil and water conservation measures have been completed.

APPENDIX 2: RESERVOIR BOTTOM CLEANUP PLAN

The reservoir bottom must be cleaned before impoundment of the reservoir, so as to:

- ✓ Ensure operational safety of Yakou Navigation Complex;
- ✓ Protect the health of the population in and near the reservoir, in the downstream and the benefited areas;
- ✓ Protect the sanitation of the reservoir;
- ✓ Lay a foundation for the comprehensive utilization of the waters of the reservoir;
- ✓ Promote the normal economic development of the area around the reservoir.

The Preliminary Design Report of the Project prepared in November 2015 and the Resettlement Action Plan of the Project (May 2016 edition) have identified the specific scope, technical requirements and Investment estimate of the reservoir bottom cleanup of the project.

1 Scope of reservoir bottom cleanup

The scope of reservoir bottom cleanup is determined in accordance with the requirements of the operation mode of the Project and the development of various businesses, and is divided into general cleanup and special cleanup.

General cleanup refers to ① the cleanup of the reservoir area below the resident resettlement line, including cleanup of the sources of infection and pollutants, as well as a variety of easily floating substances on the ground; ② the cleanup of a variety of buildings and structures below the resident resettlement line within 3m elevation scope below the death water level, including cleanup of all kinds of houses, ancillary buildings, poles, brick (stone and concrete) walls, dams (gates), wells, merit monuments, underground buildings, etc.; ③ the cleanup of forest land below the normal water level, including cleanup of a variety of forest lands and relics.

Special cleanup refers to the cleanup of the aquatic product cultivation and fishing sites, waterways, ports, wharfs, berths, water supply intake areas, etc. according to the different requirements of the development and utilization.

2 Object of reservoir bottom cleanup

2.1 General cleanup

The reservoir bottom cleanup shall be performed before impoundment of the reservoir

in accordance with the requirements of the design specifications for the reservoir inundation treatment. The cleanup contents include: demolition and cleanup of buildings, health cleanup, deforestation and forest cleanup.

Cleanup of buildings: the cleanup area is calculated as 5,255.51m^2 according to the area of the relocation of various structures and housings, with plugging of 25 wells.

Epidemic diseases: include cleanup of the cesspits, pig and cattle pens and debris of 18 households, as well as 467 graves, etc.

Cleanup of forest land: the cleanup area is calculated as 9,631.48*mu* (1*mu* = 0.0667 hectare) according to the area of the flooded forest.

2.2 Special cleanup

The special cleanup is independently undertaken by the development benefit division.

3 Technical requirements for reservoir bottom cleanup

3.1 Cleanup of buildings

All houses and ancillary buildings within the scope of cleanup shall be removed, the walls (except soil ones) shall be overturned and flattened, and the useless and easily floating waste materials shall be burned in place.

Highways (bridges), power transmission, telecommunication, broadcasting and other lines and industrial and mining enterprises, water conservancy and hydropower engineering and other ground buildings and all ancillary facilities within the scope of cleanup hampering the safe operation, development and utilization of the reservoir must be dismantled, and the equipment and materials shall be shipped out of the reservoir. The residual abutments, piers, gate dams, etc. within the scope of cleanup shall be removed by explosion, and generally the residual height shall not exceed 0.5m above the ground. For large obstacles which are indeed difficult to be removed, visible clear marks shall be provided after impoundment, and their position and elevation shall be indicated on the topographic map.

The wells (pits), cellars, biogas digesters, mine engineering and other underground structures within the reservoir level hydro-fluctuation zone shall undergo packing, blocking, covering or other measures in combination with the reservoir geology and

reservoir waters use requirements.

3.2 Health and epidemic prevention cleanup

Health and epidemic prevention cleanup shall be performed under the guidance of the local health and epidemic prevention departments.

The sources of pollution within the reservoir area such as toilets, cesspits (cesspools), livestock stables, garbage, etc. shall undergo health and epidemic prevention cleanup to transport the pollutants out of the reservoir as much as possible, or shall be paved on the ground under the blazing sun for quite a long time in a thin manner for sterilization. The pits shall be disinfected, and the sewage sumps shall be filled with clean soil.

The graves having been buried for no more than 15 years must be relocated outside the reservoir or be treated in place, and each pit shall be disinfected with bleaching powder. The graves, whether they have existed for more than 15 years or not, shall be relocated depending on local customs.

3.3 Cleanup of forest land

Forest and scattered trees shall be cut in a ground-flush manner as far as possible, and be cleaned and transported away, and the residual stump shall not be more than 0.3m above the ground; residual branches, dead trees, bushes, straws, peats and other easily floating materials shall be burned in place or undergo anti-drift measures before impoundment of the reservoir.

4 Investment estimates of reservoir area cleanup

Referring to similar projects in the province, for cleanup of buildings, the cleanup unit price of various types of houses is CNY 3.4/m^2, and unit price of plugging of wells is CNY 200/well. Cleanup of forest land includes the cutting, collection, burning, etc. of remaining small branches after cutting of grown trees, and the cleanup price per *mu* (1*mu*=0.0667 hectare) is CNY 200; the sanitation cleanup price mainly includes the cost of materials required for disinfection and filling of toilets, cesspits, etc., and is planned as CNY 100 per household; the price of cleanup of graves is CNY 200 /grave.

The total investment of cleanup of the reservoir area reaches CNY 2,071,500, as shown in Table 4-1.

Table 4-1 Investment estimates of reservoir cleanup for Yakou Navigation Complex Project

Item	Sub-item	Unit	Quantity	Unit Price	Amount (CNY 10,000)
Total					207.15
I. Cleanup of buildings					5.0
	1. Cleanup of houses	m^2	13238.47	3.4	4.5
	2. Plugging of wells	Nr.	25	200	0.5
II. Cleanup of forest land		*mu* (1*mu*=0.0667 hectare)	9631.48	200	192.63
III. Sanitation and cleaning		Household	18	100	0.18
IV. Cleanup of graves		Nr.	467	200	9.34

APPENDIX 3: CONSTRUCTION ENVIRONMENTAL SPECIFICATIONS OF CONTRACTORS

1 General

As the guiding document, this procedure specifies the environmental management guidelines which must be obeyed by the Contractor of the project in the construction process, and shall be used in conjunction with national and local regulations. The Contractor and its employees shall strictly abide by the environmental protection measures defined in this procedure to minimize the adverse impact on the environment of construction activities.

When the project is completed and before final acceptance, effective implementation of the following measures must be ensured:

- All the affected area shall undergo landscaping by planting trees and grasses for vegetation restoration as soon as possible;
- All rivers, drains and canals in the affected area shall be cleaned and the smoothness of the drain ditches shall be inspected;
- All construction sites shall be cleaned, and all residual materials shall be properly disposed;
- The waste dump sites shall be repaired.

2 Management Plan of Construction Camp

In order to solve the potential adverse impact on the local area caused by about 2,100 resident construction workers of the construction team during the peak time, the construction contractor shall implement a series of activities, and the relevant construction workers and camps are shown below.

2.1 Basic requirements

The Contractor shall recruit local labors as far as possible, and provide corresponding training, if necessary. The Contractor shall fully consider the relevant human resources management to solve the relationship between the potential workers and the local population, the prostitution, communicable diseases, theft, drugs and alcohol abuse and other risks which may occur, and the tension relationship caused by increased unemployment, different nationalities and different cultural values for the local economy and other local situation due to temporary input of labors.

The construction camps shall follow the following basic measures:

- Establishment of the construction camps shall be approved by the relevant local authorities;
- The Contractor shall submit the all design information including the buildings, facilities and services two months before the start of construction for declaration. All building and infrastructure construction work within the camp area shall be consistent with the relevant laws, standards and environmental protection requirements, and obtain approvals and permits;
- The Contractor shall provide adequate and suitable laundry facilities and utensils for the contractual workers;
- The location and entrances of the construction camps shall avoid tree and vegetation coverage areas as well as aquatic habitats as much as possible;
- The construction camps shall be close to the natural environment with good drainage as far as possible to avoid erosion of the environment;
- The Contractor shall provide convenient, safe and comfortable accommodations for the workers;
- The Contractor shall provide adequate sanitation facilities (toilets and washing areas) for the on-site construction workers and site visitors. The sanitation facilities shall be supplied with adequate clean drinking water, soap and toilet paper. Sufficient bathing facilities for men and women shall be provided and be separated. These facilities shall be accessible, and shall be kept clean and sanitary at all times.
- During construction and use of the construction camps, the Contractor shall follow the relevant environmental requirements defined in the ESMP, implement effective sediment and erosion control measures, especially in the area near the river;
- The Contractor shall provide recreational facilities for workers in the construction camps to help mitigate the impact on locals and the potential conflict due to activities of workers;
- The Contractor shall provide food, drinking water and safe bathing water for the construction camps;

- The Contractor shall install a temporary septic-tank system for every residence of the workers and maintain it to avoid pollution to the nearby river. Waste water shall be discharged into the water body after undergoing treatment in accordance with the relevant national standards;
- The Contractor shall establish a temporary storage and disposal or recycling points for solid waste generated at the workers' camp and the construction site;
- The Contractor shall not use firewood heating to process or prepare any materials required for the project, and shall provide other alternative fuels;
- The Contractor shall ensure that the on-site offices, warehouses and workshops are located in the places considered by the relevant environmental engineer or Engineer of PMO as suitable;
- The Contractor shall ensure that the diesel fuel and lubricant storage areas are not located within 100 m from the water sources, so as to prevent contaminants from polluting water sources through surface or groundwater seepage, especially on rainy days. A ditch shall be built near the outlet of the sedimentation basin/oil collector approved to be built;
- The fuel or lubricant storage area and the maintenance workshop shall be provided with fence, and be paved with a compacted/impervious layer to prevent fuel and lubricant from accidental leakage at the construction site. The surface water within the fence shall be discharged through the designed and built oil collector; the empty fuel tubes and empty oil drums shall be cleaned away from the project site; waste lubricant shall be recycled rather than being thrown away without permission or being discharged into the adjacent water body;
- The Contractor shall ensure that the on-site offices, warehouses and workshops are located in the places considered by the relevant environmental engineer or Engineer of PMO as suitable; these facilities shall not be arranged within the scope of 200 m in the vicinity of the existing resettlement area;
- The concrete mixing station shall not be arranged in the place of residence, the communities or within the scope of 500 m from the plant;

- The Contractor shall establish the medical care and first-aid facilities in each camp area;
- All medical waste shall be placed in appropriate containers and undergo safe disposal in accordance with the established procedures.

2.2 Safety

The security measures shall be in place to ensure the safety and safe operation of the camp and its inhabitants. As a minimum, these security measures shall include:

- Only allow resident workers, staff of the construction camps and visitors due to work to enter the camp;
- Require the visitors entering the construction camps to obtain the approval of the construction camps manager in advance;
- Provide adequate lighting during the day and night for the workers' camp;
- Erect a safe fence made of appropriate materials with a height of no less than 2m around the camp;
- Install fire-fighting equipment and portable fire extinguishers for all buildings.

2.3 Maintenance of equipment in the camp

The following measures shall be implemented to ensure that the entire camp and its equipment are arranged and maintained within the acceptable scope in compliance with the relevant standards:

- The camp shall be provided with cafeteria in strict accordance with the hygiene and health standards;
- Develop fix-time meal system;
- Prohibit cooking or preparing food in the vicinity of the residential area;
- Develop fix-time rest system;
- Designate the entertainment time in the camp;
- Strictly prohibit smoking in the workplace;
- Strictly implement the relevant measures to maintain that the construction camps and facilities meet the clean and sanitary conditions;
- Toilets and urinals shall be provided with adequate lighting, and shall maintain

clean and sanitary at all times;

- Water tanks shall be located near or inside toilets and urinals for water supply;
- A complaint receipt and feedback point shall be set up to respond to the complaints about the facilities and services made by residents of the camp.

2.4 Code of conduct

During project construction, a major concern is the adverse impact on the community life caused by the workers. For this reason, the code of conduct shall be developed to define appropriate code of conduct and to prevent drug and alcohol abuse, so as to meet the relevant laws and regulations. After establishment of employment with the client or Contractor, every employee must strictly implement the relevant code of conduct and be restricted by it. The code of conduct shall be provided to the project information center of local communities or other accessible communities. The code of conduct shall address the following measures (but not limited to):

- All workers and subcontractors must comply with Chinese laws and regulations;
- Forbidden goods, weapons and firearms shall be prohibited;
- Pornographic materials and gambling shall be prohibited;
- Fight (physical and verbal) shall be prohibited;
- Workers are not allowed to hunt, fish or deal with wildlife trade;
- Eating of wild animals is prohibited in the camp;
- Cultivation of pets is not allowed in the camp;
- It is not allowed to seek a quarrel and challenge a fight nearby the community;
- The local customs and traditions must be respected;
- No smoking in the workplace;
- Workers shall meet the relevant clothing and personal hygiene standards;
- The dormitories at the construction site shall comply with the relevant hygiene standards;
- Workers entering the local communities shall ensure that their behaviors are consistent with the code of conduct;
- Workers failing to obey the code of conduct or relevant rules, systems and

procedures made for the camp shall be subject to disciplinary sanction.

3 Construction impact management plan

In order to minimize the impact of construction on local communities and the environment, the construction contractor of the subprojects shall strictly abide by the following convention:

3.1 Erosion and sediment

The project must take the following measures to reduce or curb soil erosion. These measures include the use of erosion control structures, vegetation protection, reforestation and slope protection. This report has developed a detailed plan for the control of soil erosion to minimize the soil erosion impact in the project area, see Appendix 1 for details. The Contractor shall strictly implement the plan for the control of soil erosion in the project construction process.

Various works at the project site shall be strictly managed to avoid the impact of the erosion and sediment at the construction site on the downstream waterway. General principles/measures include:

- Erosion and sediment shall be controlled during the construction period. The area at the site not affected by the project construction shall maintain its current state;
- Damages to the ground shall be minimized to maintain the stability of the ground; the water and sediment passing the area shall be controlled. Erosion control fence shall be installed beside the main roads, disposal pits and driveways;
- Slope protection and earth transportation/excavation shall be performed to minimize the impact of the exposed soil surface on the relevant area and duration. Temporary soil erosion control and slope protection works shall be performed in accordance with the construction order;
- The topsoil containing dead branches, fallen leaves and organic matters can be reused in the affected areas for promoting the growth of local native vegetation;
- Native grass seeds shall be sown in the local infertile areas or closed construction area, so as to utilize their root covering ability to prevent soil erosion;
- Before the rainy season begins, erosion control measures shall be provided

immediately after the project is started. Erosion control measures shall be provided by referring to those of other completed construction site;

- Sediment control devices shall be provided in the areas requiring mitigation or redirection of runoff and the sediment trap areas within the construction site until the vegetation is restored and grows. Sediment control devices include hay wetlands, rock berms, sediment catchment basins, straw bags, shrubs and silt fences;
- Water flow shall be controlled through ditch excavation, installation of berms, inspection apparatus, and live-root obstacles, rocks, etc. in the site or the affected area;
- The ground of the construction site office shall be made of concrete or asphalt to minimize soil erosion;
- Erosion control measures shall be carried out until the vegetation is restored and grows;
- Regular watering shall be provided for muddy paths, roads, fillers and large reserves of sand to reduce soil erosion and dust; and
- Great terrain changes caused by quarrying (sand), construction of tunnels, etc. shall be landscaped and replanted with trees to reduce soil erosion and the visual impact due to construction.

3.2 Particulate emissions and dust

The Contractor shall propose control methods and measures for the dust generated during construction, including the quarries, crushing and concrete mixing stations; civil works includes construction of roads, embankments and channels, transportation of materials and construction camps. The Contractor shall strictly implement the following measures:

- Minimize the generation of dust and particulate materials at all times to avoid the impact on the surrounding communities, especially for vulnerable groups (children and the old);
- Prevent large areas of land from exposure to the wind caused by seasonal vegetation peeling;
- Build a dustproof fence around the construction site to minimize dust spreading,

especially for the areas near the local communities;

- Water the muddy roads, channel areas, soil storage or filler stacking areas according to the needs. Watering shall be carried out at least twice (in the morning and afternoon) every day on dry and windy days. Properly increase the frequency of watering for the areas near the communities according to the needs;
- Reduce the airborne dust caused by airborne transmission for the gravel roads near the communities and other sensitive areas;
- Provide corresponding supporting ventilation systems and other measures to control the concentration of air pollutants inside the tunnel in a concentrated manner;
- The transport vehicles and construction roads for transporting construction materials shall be properly designed. For example: concrete/asphalt or small rocks can be used to pave the roads; before the start of the main earthworks, a lot of on-site and offsite construction materials may need to be transported;
- Ensure the maintenance of all vehicles. The vehicles that may cause serious air pollution and the vehicles poorly maintained shall be prohibited to enter the construction site;
- During the transportation process of chemicals or materials, such as cement, sand, lime, etc. shall be fully covered with clean impervious materials to avoid leakage or spillage of these materials during transportation;
- The exhaust gas of construction machinery and vehicles is inevitable, but the engine shall be checked and adjusted according to actual needs to reduce air pollution.

3.3 Noise

The construction contractor shall do the following for noise reduction:

- Limit the speed of vehicles passing on all construction roads related to the construction of the project;
- Unless otherwise specified, the speed of all vehicles entering the site shall not exceed 30 km/h;
- If possible, keep the noise of all the machinery and equipment during running below 90 dB;

- Strictly implement noise reduction measures to prevent noise nuisance in sensitive areas (including residential areas, etc.);
- Take appropriate measures to avoid vibration or noise caused by construction activities;
- Develop the construction material transportation schedule to minimize the adverse impact on neighboring residents and off-site ground traffic; transportation vehicles passing the sensitive areas must slow down and not honk. Reduce transportation during the rush hour as far as possible. The construction contractor shall provide the transportation traffic routes to the engineering director in advance;
- The construction equipment shall maintain its optimum operating conditions and minimum noise level;
- Use temporary noise barriers to minimize the noise caused by the construction equipment;
- Hearing protection must be provided for the operators of noisy equipment, such as piling, blasting, mixing, etc., and noise control shall be performed;
- The fuel or lubricant storage area shall be provided with fences and paved with compacted/impervious ground or other surface to prevent accidental spill of fuel and/or lubricant from the fence. The surface water drainage of the fence area shall pass through the oil skimmer or other devices to eliminate hydrocarbon emissions. Empty fuel/lubricant barrels shall not be stored in the project site but shall be affixed with MSDS label, and training shall be provided for the workers handling these materials;
- The construction supervision team shall be equipped with portable noise detector to monitor the noise level of sensitive receptors;
- The transportation time of construction materials from the site shall be non-peak hours to reduce traffic and noise;
- Properly designed muffler, noise barriers, acoustic shed, shield, etc. shall be used. Mufflers and other noise control equipment shall be regularly repaired, and be replaced when affecting the use;
- Electric equipment shall be used as much as possible to substitute diesel-powered

or pneumatic equipment;

- When the high-intensity noise equipment emits noise in one direction, it shall be far away from nearby sensitive receptors if possible;
- The construction machinery and equipment shall be used intermittently, and shall be shut down or the speed shall be reduced to a minimum during the shutdown period.

Noise mitigation for nighttime construction :

Although in general, nighttime construction is not allowed around sensitive receptors, but some works may still require continuous nighttime construction due to technical and other reasons (for example, the bridge pile requires continuous pouring of concrete). If nighttime construction is close to the local communities, it will cause a serious impact on local residents and other sensitive receptors, so the following special measures shall be taken during this period:

- Inform the residents living in the potentially affected areas of the specific time and total time for nighttime construction in advance. Inform the residents of the necessity of nighttime construction and the mitigation measures provided for the project, so as to be understood by them. The affected residents are able to put forward their own ideas, difficulties and suggestions, and the appropriate advices and suggestions shall be implemented before nighttime construction;
- The concrete mixers, generators and other noisy fixed equipment shall be arranged far away from residential areas as much as possible. If possible, the municipal power supply shall be used to substitute diesel-powered generators for nighttime construction to mitigate the impact of noise;
- Low noise equipment shall be used for concrete pouring, as this work may require 24-hours uninterrupted construction;
- Temporary noise barriers shall be installed in proper place to avoid the impact of noise at night, and
- The notice boards shall be posted at all construction sites, and shall provide the project information, contact information of the person in charge at the construction site, phone number of the environmental protection staff and other contact information, so as to

provide channels for any affected person to voice its concerns and suggestions.

3.4 Blasting

- Before blasting, the Contractor shall remind the local communities and/or residents of the causes of noise in advance, and shall minimize the impact of such work on the residents;
- More stringent measures are required in the sensitive areas (e.g. near the residential area) to prevent adverse impact caused by noise;
- Blasting shall not be performed within 200 m from the residential area or local communities;
- Blasting shall not be performed under adverse weather conditions;
- Before blasting, the blasting area shall be watered to increase its moisture content. The top of the blasting area shall be covered with wire mesh bags and sandbags to prevent pollution on the environment caused by flying of rocks and dust;
- Before blasting, detailed survey shall be performed in advance to assess the impact of the blasting activities on the nearby communities (for example, the possible damages to the building structures or infrastructure, as well as animals, the local population, etc. due to vibration);
- Except with prior approval and authorization of the Government and PMO, blasting activities at night are not allowed;
- During the blasting activities, everyone shall be more than 200 m from the bursting point;
- During the implementation period of blasting activities, except the blasting equipment, all electrical facilities within 50m from the blasting point shall be shut down;
- Quantity of the materials used for blasting shall be managed in a safe manner and be reviewed on a weekly basis.

3.5 Earthworks, channels, and filled slopes

The Contractor shall ensure that the construction is carried out in compliance with the following procedures:

- All earthworks shall be controlled properly, especially in the rainy season;

- During the process of excavation and filling of slope, the Contractor shall keep its stability in the whole process, and minimize the interference to the areas beyond the project scope as far as possible;
- When the Contractor performs the excavation and filling of the last cross-sectional of an area, continuous operation shall be performed if possible to avoid local construction of earthworks, especially in the rainy season;
- In order to avoid erosion of the slope caused by excavation and filling, the slope top and bottom shall be provided with cut-off curtain and toe drainage equipment, and be covered by grass or other vegetation according to the drawings. The cut-off curtain shall be provided on higher ground to reduce surface runoff and slope erosion;
- The excavated earth or unstable materials shall be disposed in the designated disposal area with the approval of the Engineer;
- The disposal area shall not be arranged in the area with possibility of landslide in the future to avoid affecting agricultural land or the lands of other property, or the area which is likely to cause surface runoff and affect any water source. The canal may need to be excavated in and around the landfill, and the specific construction forms are determined by the Engineer.

3.6 Stacking area and borrow pit

The Contractor shall prepare a comprehensive inventory and borrow pit management plan for the entire project. Opening up a new borrow pit on land, in the river, or in the existing area shall obtain prior approval of the environmental supervision department, and the construction shall be stopped when it is questioned by the Engineer;

It is prohibited to set borrow pit in the areas which may affect the nature or design drainage, because it may cause erosion or destruction of the riverbank, or it may carry too many fine particulate materials to the downstream of the river;

The location of the mixer shall be approved by the Engineer, and shall not be arranged in the environmentally sensitive areas or near the existing residential areas, and supporting dust control devices need to be equipped with;

The rock or gravel with the depth of no greater than 1/10 of the width of the river in

the same position in the river not affecting the river flow, or causing damages to the riverbed shall be taken.

These plans shall include:

- A map displaying the scope of the area to be developed;
- Propose a job specifications including the planned work methods;
- The entrances and transportation routes for the vehicles transporting materials from the borrow pit to the target area;
- The reason for the quantity of materials which need to be extracted and the detailed disposal methods of the resulting waste;
- Specific measures to minimize the visual impact of the borrow pit on the surrounding areas;
- Detailed measures for long-term ecological restoration of the borrow pit to avoid threat to health and safety, and deterioration of the environment.

Under normal circumstances, the Contractor shall:

- Determine and divide the location of the stacking areas and borrow pit, ensuring at least 15 m from the critical areas such as the steep slopes, and the areas subject to direct entering of erosion-prone soils and drainage into the sensitive water bodies;
- Limit the materials to be extracted and divide the borrow pit;
- The first batch of topsoil taken from the borrow pit shall be stacked and stored. When all available materials have been extracted, the topsoil previously stacked shall be re-dispersed and backfilled to the borrow pit, and the soil surface shall be leveled, and the drainage slope shall be reserved. Steep areas must be provided with stairs and terraces to control soil erosion;
- The areas subject to serious damage to the soil need to be repaired and re-planted with vegetation. In appropriate circumstances, the soil surface may be covered with organic debris to promote vegetation restoration. Natural vegetation is the best;
- Minimize the load of the existing main drainage pipes;
- After the project is completed, all debris generated by construction shall be transported from the project site to the approved disposal site in a unified manner for

disposal;

- The Contractor shall ensure that all excavated borrow pits are eventually restored to have a stable slope, restored ecology and vegetation and natural waterways, so as to avoid the possibility of breeding of mosquitoes due to the stagnant water of the excavated areas;
- In case the construction activities cause that the borrow pit or low-lying lands cannot be reasonably re-filled or drained, the Contractor shall negotiate with the local communities to convert such lands into fish farming or other purposes according to the actual needs.

3.7 Disposal of construction waste

The Contractor shall implement the following initiatives:

- Establish and enforce the daily cleanup procedures, including repair and maintenance of the construction waste disposal facilities;
- The debris generated by removal of the existing structures shall be reused as much as possible (for example, used as the filler for the embankment). Disposal of debris must be performed after identification of the disposal sites and be approved by the Engineer of the project. The Contractor shall ensure that these disposal sites meet the following conditions: (i) they shall not be located in designated forest areas; (ii) they shall not affect the natural drainage; and (iii) they shall not affect the endangered/rare plants. In any case, the Contractor shall not carry out material disposal in the environmentally sensitive areas;
- In case any debris or silt is deposited on the land near the construction area, the Contractor shall immediately remove it, and restore the affected area to its original state until being confirmed as correct by the Engineer;
- All traffic arrangements during construction including supply, maintenance, demolition, debris removal, etc. shall be deemed as part of the work if necessary, and shall be deemed as to be managed, planned, implemented and approved by the Contractor, and be assigned by the Engineer;
- The local communities shall be consulted to see whether there are living areas

which are located near the waste dump site, which may affect their lives. The consultant shall provide the detailed information of the potential waste dump site for PIU, and provide opportunities for them to express their views and concerns on this plan. All information and feedback generated during construction shall be deemed as a part of the reference content and be incorporated into the final design of the waste dump site;

- The design and construction of each waste dump site must adopt the safest and the most stable technical provisions;
- Risk assessment shall be performed for the potential impact of surface water permeation caused by waste materials;
- Proper analysis shall be performed to ensure that the location of the waste dump site does not affect the surface drainage;
- The safe and secure waste dump site shall be built according to the landscape and vegetation restoration plan to avoid soil erosion.

3.8 The existing infrastructure shall be removed.

The Contractor shall implement appropriate measures to ensure that during the process of dismantling of existing infrastructure, workers and the masses are not hurt by the falling construction debris and other flying objects. Among these measures, the Contractor shall:

- Reserve, specify and restrict the construction waste discard and disposal area, and/or install the safe mobile chute for waste from high place to low place;
- Take appropriate protection and fixation (if applicable) during the sawing, cutting, crushing, grinding, chipping or cutting process;
- Ensure clean transportation to avoid waste drop, etc. during transportation by vehicles and other heavy equipment;
- Erect temporary falling protection facilities (such as handrails and baseboards, etc.) in the periphery of the scaffolding and aerial work areas to prevent falling of construction materials or workers;
- Retreat all staff during blasting, and provide explosion-proof pad or other mitigation measures for the nearby staff to reduce hurting by the flying rock or popped

debris;

- Provide safety glasses, side shields, masks, helmets, safety boots or shoes to all relevant staff.

4 Other management plans

The Contractor shall be responsible for the preparation of the management plans in accordance with relevant terms and provisions:

4.1 Waste management plan

During the construction stage, the Contractor shall prepare the waste management plan before the project begins. The plan shall include:

4.1.1 Water and wastewater

- A detailed design containing the review comments on the preliminary site drainage design;
- The preliminary design updates (such as the nature and geographical conditions, location and construction of the ramp) according to the actual construction scheme and specific site conditions;
- Detailed design, including the design drawings, location map, drainage collection canals and sewage treatment facilities;
- Planned discharge locations and treatment standards;
- A detailed implementation plan for the proposed drainage system;
- As part of the design of the site drainage system, the surface runoff at the construction site shall be drained to avoid washing away the soil, and the water needs to be treated by the sediment traps and other devices prior to discharge;
- The domestic sewage from the site office, toilet and kitchen shall be collected by the licensed waste collectors or be treated by the treatment facilities. The discharge of the treated wastewater must comply with the emission limits prescribed by Chinese laws;
- Wastewater treatment facilities such as the sedimentation basin can be installed near each construction zone which may generate wastewater. In addition, the sedimentation basin built at the site can effectively treat the excessive suspended solids (SS) before discharge;

- The retaining walls and sandbags isolation facilities shall be provided near the bored-hole pile driver to prevent the swelling soil and sewage from entering the piling area. The collected bentonite or pumped wastewater needs to be treated before discharge;
- Before the rainy season, all exposed surfaces and ramps shall be properly covered or be provided with landscaping;
- to minimize the sediment contained in the runoff . The slope can be constructed in an orderly manner prior to the rainy season;
- The drainage control devices such as sediment traps, etc. shall be installed in each discharge outlet, and be regularly cleaned;
- the public toilets can be provided at each work site, and at least 5 workers shall be employed; and
- Every 25 workers shall be equipped with at least one public toilet. The domestic sewage collected from the site office and toilets shall be regularly treated. Only licensed waste collectors can be hired to treat it. The sludge shall be treated according to the requirements of the waste management plan made by the Contractor.

4.1.2 Solid waste

The following waste may be generated during the construction of the project :

- ✓ The surplus excavated materials need to be treated generated by earthwork transportation and cutting of slopes;
- ✓ The waste wood, scaffolding steel, site hoardings, packaging materials, and container of fuels, lubricants and paints generated by excavation;
- ✓ The waste generated by damages to the existing houses/buildings or breakage of the existing concrete surface caused by the project;
- ✓ The waste from the site wastewater treatment facilities (such as treatment of the bentonite generated in the subsidence process of the tunnel works);
- ✓ The domestic waste generated by the construction workers, construction camps and other facilities; and
- ✓ The medical waste from on-site clinic

The above waste must be properly controlled by implementing the following

measures:

- Minimize the generation of the waste which need to be treated or cleared;
- Identification and classification of the waste types: For hazardous or chemical waste, appropriate storage, collection, transportation and treatment procedures must be taken. (See Appendix 4: Hazardous Substances and Waste Management Plan and Appendix 5: Contingency Plan for Hazardous Substances);
- Identify and divide the treatment areas, indicate the treatment areas for specific materials; and
- Control the position of all construction waste (including earthwork cutting) to ensure that the treatment areas pass the review (>300 m from rivers, streams, lakes or wetlands). Collect, recycle and treat all the garbage, metal and waste oils within the designated area, and integrate the surplus materials generated by the recycling system or separation of materials.

The Contractor shall make commitment to waste recycling and reuse methods by considering the following aspects:

- A method statement for waste recycling, reuse and waste output minimization;
- The excavated earthworks shall be used for the road sections/other projects on or near the site to reduce the amount of materials to be treated;
- Recyclable materials, such as the wooden boards, steel, scaffolding materials, on-site supports, and packaging materials. during excavation shall be collected and be separated from other on-site waste sources. The collected recyclable materials shall be reused for other projects or be sold to waste collectors for recycling; and
- The collected garbage shall be properly treated by licensed waste collectors.

4.2 Pollution prevention plan

4.2.1 Contingency plan for hazardous substances

If there are expected or suspected hazardous substances (chemicals, asbestos, hydrocarbons or other similar harmful substances) at the construction site, the Contractor shall be required to prepare the Harmful Substances and Waste Management Plan (Appendix 4) and Appendix 4-3 Contingency Plan for Hazardous Substances approved by

the environmental protection supervisor. The existing hazardous waste at the project site can only be removed and disposed by specially trained personnel in accordance with the national or provincial requirements, or the internationally recognized procedures.

The Contractor shall:

- Provide the harmful substances and waste management plan to all personnel involved in the operation and transportation activities;
- Hazardous waste (chemical waste) shall be properly stored, treated and disposed in accordance with local laws and regulations. Hazardous waste shall be stored in the specified location, and shall be affixed with the warning signs;
- Any accidental leakage or incident shall be notified to the environmental protection supervisor or the construction supervisor;
- Prepare a contingency plan for harmful substances outlining the measures tailored for the leakage or accidental release;
- Start the remedial action for any leakage or incident; and
- Provide a report describing the cause of the leakage incident or accident, the remedial measures to be taken, the consequences/damage of leakage, and the proposed corrective actions. The contingency plan for harmful substances shall then be updated and be submitted to PMO, and they have no objections after making comparison.

4.2.2 Chemical waste

- During the construction process, some chemical waste may pollute the nearby habitats and waterways, such as waste oil, waste lubricant and leakage of hydraulic oil, or the soil contamination due to the construction project or fuels of vehicles, etc.
- The following measures need to be put in place to minimize the damages caused by chemical waste:
- Refueling of all heavy equipment and machinery shall be performed through the service vehicles to prevent any spillage or contamination of chemical waste, such as maintenance oil, lubricants, etc.
- Storage of all fuels and hazardous materials shall be adequately sealed to prevent any leakage;

- The rainwater from the work area, maintenance area and enclosed storage area needs to be collected and be treated in the oil-gas separation pit/tank before being discharged into sewers or waterways,
- Transportation, storage and handling of all explosives shall be performed in accordance with the applicable laws, good engineering design and construction practices. The Contractor shall provide details of the proposed arrangements for storage and safety,
- Packaging, labeling, handling, storage and disposal of pesticide shall be consistent with the standards accepted by the World Bank and the Chinese government.

4.2.3 Maintenance of construction equipment

The Contractor shall:

- Determine and divide the equipment maintenance areas (>15 m from rivers, streams, lakes or wetlands). Fuel storage site shall be arranged in proper place and be approved by PMO.
- All equipment maintenance activities shall be ensured, including replacement of engine oil, operation within the defined area, and no treatment of the oil on the ground, in the river, drain ditch or sewer system, and
- All leaked and collected petroleum products shall be treated in accordance with standard environmental procedures/specifications. Fuel storage sites and fuel filling stations shall be arranged at least 100 m from the crossing drainage structures and important water bodies; or as specified in the instructions of PMO.

4.3 Cleanup and salvage of the reservoir

4.3.1 Cleanup of the construction area

It is suggested that the construction areas to be cleaned up shall be included in the reservoir bottom cleanup plan (Appendix 2). Only those suggested areas shall be cleaned up in accordance with the plan and approval of the project director. The plan has taken into account the land use of the existing project to maintain the current use situation without interference from the activities of the Contractor. The vegetation in the areas having not been submitted in the plan shall not be disturbed.

The Contractor shall arrange for the consultation with the local communities to serve

as a part of the reset plan to clean up the reservoir area.

The following measures shall be implemented:

- The large or significant trees and passages in the camp area shall remain unchanged as far as possible.
- The chemicals used for clearing the vegetation shall be minimized. The chemicals without residual chemicals and with almost no adverse impact on human health shall be selected as far as possible.
- The herbicides used in the project shall be proven to be effective for the target plant species, and with minimum impact on the natural environment, and shall be proven to be safe for the residents, the personnel using the herbicides and livestock in the treatment area.
- The herbicides shall be properly packaged, labeled, handled, stored and disposed, and be in full compliance with the international norms proposed by the Contractor, and PMO has no objection for it.
- Design of roads, including deign of temporary and permanent roads shall avoid the potential or actual crop areas.

4.3.2 Landscape, visual impact and vegetation restoration

The construction scheme of the project shall be implemented according to the stages, especially in those areas with severe visual impact. The details of the proposed landscape and vegetation restoration measures have been included in the Soil Erosion Control Plan (Appendix 1).

The following measures need to be adopted as the general principle:

- The construction shall be performed in order to minimize the surface area of bulldozing activities and the size of the exposed surface area.
- Vegetation restoration shall be started as early as possible, and shall use the appropriate native plant species.
- The requirements for compensatory planting shall be included in the design and project contract. During the design stage, a master landscape plan and ecological monitoring or survey requirements of different stages of the project shall be prepared, and

shall be implemented during the construction period and be maintenance during the operation process.

- The facilities and structures shall be arranged according to the topographical and geographical characteristics of the project site.
- The cleared areas, such as the borrow pits no longer used, disposal areas, construction roads, construction camps, storage areas, working platforms and any site temporarily used in the project construction process, shall be restored by landscaping, adequate drainage and vegetation restoration.
- The existing trees and plants within the scope of construction shall be marked to indicate whether the trees shall be transplanted or removed. Before construction, the existing trees affected by the project and need to be transplanted shall be first dealt with.
- The excavation shall avoid damages to the root system. Mitigation measures need to be taken to prevent damages to the trunks and branches of trees.
- Temporary stockpiling barriers shall be sunk in terms of color and shape.
- After the construction is completed, the affected area shall be restored to its original state as soon as possible, including the reconstruction of a natural and rocky coastline, sidewalks and affected plants.
- The construction of visually highly sensitive area shall be performed in the tourist off season as far as possible.
- The trucks shall be driven at night, and shall be kept clean and be well covered when transporting bulk materials.
- The construction site shall be surrounded by a fence, and direct visual effect of the construction site shall be avoided if being located in the landscape area.
- Construction camps shall not be arranged in scenic spots.
- It shall be strictly prohibited to dispose the solid waste in scenic spots without permission.
- The mixing station and concrete mixing plant shall not be arranged in the vicinity of rivers or in scenic spots. The inventory area shall be arranged in a hidden place to avoid the sight of tourists;

- The existing roads shall be used as passages whenever possible, so as to reduce the demand for new roads, as they will lead to the destruction of the existing topography and vegetation.
- The land shall be first used for agricultural activities instead of construction activities, and needs to be restored to its state to allow agricultural activities.
- Corrosive deposits and excavated slope soil shall be reformed to stable slopes, and be planted with vegetation to prevent erosion.
- The stripped-off topsoil from the workspace shall be used for landscaping works, and
- The temporary drainage waterways due to the construction activities shall be restored to their original flow paths.

4.3.3 Site restoration

- After the completion of construction, the facilities of all construction camps shall be dismantled and cleared away from the site; besides, the site needs to be returned to its original state, or the state agreed by local authorities and communities.
- The remedial measures which cannot be effectively carried out during construction shall be implemented after the completion of restoration (and before final acceptance).
- A variety of activities need to be performed for site restoration include -
- The construction camps need to be re-planted with grass, and the sites with felled trees need to be planted with the saplings of the same species.
- All affected areas need to be landscaped, and any restoration work shall be carried out without delay, including grass planting and reforestation.
- Debris in the waterways shall be cleared to ensure the smooth flow of drain ditches and culverts.
- Rubbish of all sites shall be cleared, and all excessive materials shall be properly disposed.
- Borrow pit shall be restored.
- The soil contaminated by petroleum and fuels shall be removed, transported and

buried in the waste disposal area.

- Planted saplings shall be transferred to the community or landowner for maintenance and watering, and
- the seepage pits and septic tanks need to be covered and effectively sealed.

4.4 Health management

Most of the construction workers and personnel come from different places, and will bring other diseases to this area. These common health problems of these groups are: sexually transmitted diseases, HIV/AIDS, tuberculosis, respiratory infection, diarrhea, parasites, and vector-borne diseases, such as malaria, alcoholism, drug abuse, zoonosis, schistosomiasis, and leptospirosis.

The Contractor shall take the following measures to ensure the completion of sufficient health plans:

- Screen the workers in the annual recruitment stage;
- Implement a comprehensive vaccination plan in accordance with ESMP and local regulations;
- Implement anti-malaria measures under the current conditions the camp area, and set up the facilities used for early diagnosis and treatment of patients;
- Store enough drugs which treat malaria;
- Collect and test the saliva of the individual with tuberculosis (TB) infection risk;
- Store the antibiotic which treats the respiratory infection;
- Store the medicine and transfusion which treat food poisoning, diarrhea, etc.;
- Prepare the solutions tailored for large-scale outbreaks of food poisoning;
- Regularly monitor the public kitchen of the construction camps;
- Store and distribute insect repellent to workers;
- Take disease control and pest management measures during the construction period of the construction camps;
- Distribute condoms to the workers in the camp free of charge;
- Monitor the health indicators by closely following the trend;
- Provide mosquito net for workers if mosquitoes cannot be controlled effectively

in the building;

- Take appropriate measures to carry out risk assessment and review for the environmental impact caused by mosquito control;
- Implement the monitoring and screening plan for sexually transmitted diseases, especially the spread of HIV/AIDS;
- Establish a medical center for the diagnosis and treatment of infectious diseases before being transferred to the hospital, simple medical complaints, emergencies and accidents by utilizing the existing health center in the construction camps. The medical center shall:
  - Be provided with 7-10 beds equipped with complete health facilities to provide emergency medical care, so as to well settle the emergency patients before being transferred to the county or municipal hospitals;
  - Provide the medical equipment necessary for emergency services;
  - Provide short-term care for the patients requiring hospitalization treatment;
  - Be provided with the isolation room (a bed) for the patients with infectious diseases (when there is an outbreak of diseases, the regional and provincial facilities need to be used;
- Small construction camps shall be provided with an affiliated treatment station or first aid station equipped with trained nurses or local trainees;
- Check and screen the schistosomiasis of the construction workers before employment;
- Select the appropriate workers to receive additional training on professional health and first aid, and form two or three work teams in each site. They shall work under the supervision of medical staff;
- Develop the provisions on health check of employees, including the check of drug abuse and sexually transmitted diseases defined in the resolution of the International Labor Organization (ILO) and the World Health Organization (WHO) (Code of Practice of ILO on HIV/AIDS and the Code of Practice of the Industry, ILO, Geneva; June 2001).
- Develop the provisions on the full disposal of the medical waste from clinics and

other medical practices.

4.5 Safety during construction

In case of construction accidents, the Contractor's responsibilities include protecting everyone and nearby properties. The Contractor is responsible for complying with all national and local safety regulations, and taking any necessary measure to avoid the accidents, including the following:

- The maximum allowable speed at each road crossing shall be considered;
- Establishment of safe horizon in the construction site and construction camps;
- Set marks in the construction area to facilitate traffic operation, and provide guidance for each part of the work and provide safe recommendations and warnings. All marks shall be in Chinese, and be produced according to Chinese specifications;
- Estimated maximum traffic flow (vehicle/h);
- As agreed by the project environmental protection officials, the selected routes to the project site shall be used, and the size of vehicles shall be appropriate for the size of the region's road grade, and the amount of cargo shall be strictly controlled to prevent damages to local roads and bridges used for transportation;
- The Contractor shall be held accountable for the damages to local roads and bridges caused by overloading, and shall repair the damages with the approval of environmental protection officials;
- Do not use the vehicles with noise or exhaust emissions which seriously exceeding the standards. In the built-up area, the Contractor shall use detection equipment to ensure that the noise silencer is installed and is running in good condition;
- Throughout the period of the contract, appropriate traffic control shall be maintained, and these measures require the prior approval of the project environmental protection officials;
- Carefully and clearly mark the pedestrians' safety channel;
- If there are schools in the vicinity, the traffic safety personnel shall command the traffic after school;
- Ensure the supply of traffic signs (including paint, easel, sign materials, etc.),

road markings and guard rails to maintain pedestrians' safety during the construction period;

- Provide safety training for the construction workers before construction
- Provide personal protective equipment and clothing (goggles, gloves, masks, dust masks, helmets, steel-toed boots, etc.) to the construction workers and enforce their use;
- Provide material safety data sheet for each chemical at the site;
- Require the workers to read all of the material safety data sheets. Clearly explain the risks of workers and partners, especially during pregnancy or when planning to establish a family. Encourage employees to share information with their doctors;
- Ensure that the specially trained workers remove or dispose the asbestos-containing materials or other toxic substances;
- Suspend all work in case of heavy rain or emergency;
- Firmly fix the electronic or mechanical equipment during construction to prevent being affected by earthquake.

- Provide environmental protection training for construction workers

During construction, there is possibility of damages to the protected areas and waterways in the vicinity of the camps or construction area by the workers. The Contractor shall prepare an environmental protection training plan for all construction workers to solve the following items:

- All employees of the Contractor must comply with the environmental protection regulations, and they must be able to provide evidence to show that they have participated in the planned training courses;
- The plan shall educate all construction workers of the following questions, but are not limited to: the use of firearms, traffic regulations, illegal logging and collection of non-timber forest products, no interference to the communities, restrictions on hunting and fishing, waste management, erosion control, health

and safety issues, all prohibited activities, code of conduct, disciplinary procedures, and information about their work and living area;

- Establish the punishment regulations for the personnel in violation of the rules; and
- Implement the methods proposed in the training plan, including formal training courses, posters, real-time communication data, marks in the construction area and camp area, and 'toolbox' meetings.

4.6 Community safety and interrelation

4.6.1 Community safety

➢ Impoundment of the reservoir:

The Contractor shall inform the environmental protection supervisor and local authorities of any planned construction activity which may lead to increased reservoir level, or stranding or drowning of residents at least 30 days in advance.

➢ Traffic safety:

The Contractor shall jointly implement the community traffic and safety plan with the local communities and community leaders. It aims to minimize the risks associated with traffic during construction (see Article 5 of this Appendix). The community traffic and safety plan shall include the following:

- Provide the maximum allowable speed for each road in the community;
- Establishment of safe horizon in the construction site and construction camps;
- Set marks in the construction area to facilitate traffic operation, and provide guidance for each part of the work and provide safe recommendations and warnings.
- All marks shall be in Chinese, and be produced according to Chinese specifications;
- As agreed by the project environmental protection officials, the selected routes to the project site shall be used, and the size of vehicles shall be appropriate for the size of the region's road grade, and the amount of cargo shall be strictly controlled to prevent damages to local roads and bridges used for transportation;

- The Contractor shall be held accountable for the damages to local roads and bridges caused by overloading, and shall repair the damages with the approval of environmental protection officials;
- Do not use the vehicles with noise or exhaust emissions which seriously exceeding the standards. In the built-up area, the Contractor shall use detection equipment to ensure that the noise silencer is installed and is running in good condition;
- Throughout the period of the contract, appropriate traffic control shall be maintained;
- Carefully and clearly mark the pedestrians' safety channel;
- If there are schools in the vicinity, the traffic safety personnel shall command the traffic after school;
- Ensure the supply of traffic signs (including paint, easel, sign materials, etc.), road markings and guard rails to maintain pedestrians' safety during the construction period;
- Carry out safety awareness programs in local schools and communities.

4.6.2 Blasting

➢ The Contractor shall ensure no threat to the local residents and communities by blasting (see Section 3 of this Appendix) by implementing the following methods.

➢ The Contractor shall remind local communities and/or residents of the disturbance by noise-generating activities, such as blasting in advance, and shall maintain the blasting to a minimum;

➢ More stringent measures may need to be implemented in sensitive areas (including residential areas, schools, etc.) to prevent undesirable noise level;

➢ Blasting shall not be carried out within the scope of 200 m from the houses or local communities;

➢ Before blasting, detailed survey shall be performed in advance to assess the impact of the blasting activities on the nearby communities (for example, the possible damages to the building structures or infrastructure, as well as animals, the local

population, etc. due to vibration);

4.7 Camp-follower management plan

The water conservancy and hydropower project starts construction "boom". This will provide opportunities of paid employment to local people to some extent, so there will always be a large influx of foreign labors and camp-followers (such as family, trade men, business men, etc.). Generally, the camp-followers are stationed in the vicinity of the camps, and will not have a serious impact on the local communities (land consumption) and environment (such as the uncontrolled use of wood fuel, feed on wild animals, and waterway pollution due to the lack of waste management). The spontaneous resettlement area is also subject to the risk of growing HIV/AIDS and other sexually transmitted diseases.

Besides, the camp-followers will suffer epidemic diseases such as malaria, respiratory diseases, tuberculosis, food poisoning and traffic accidents. The camp-followers also need housing, water and sanitation facilities and health services.

To avoid damage to the surrounding areas and agricultural areas, to avoid contamination of nearby waterways, and to minimize the impact of the camp-followers on the local communities, PMO shall cooperate with the construction contractor to provide the areas beyond the formal construction camps for the camp-followers.

PMO shall prepare a camp-follower management plan, which shall include the following:

- Select the appropriate area to solve the problem of stationing of the camp-followers.
- Camp-followers shall be provided with medical care, and access to local medical institutions and clinics.
- Camp-followers shall be provided with the minimum services, such as drinking water (riser), public toilets, solid waste collection and disposal services, electricity, etc.
- The Contractor is responsible for the camp-followers, and shall be defined and developed by PMO.
- In view of the high uncertainty of the camp-followers, as the assessment is

extensively based on the number of the camp-followers, the camp-follower management plan shall be prepared based on the actually monitored number of the camp-followers in the area.

4.8 Environment supervision during construction

The Project Engineer will oversee the implementation of these specifications. The Contractor failing to obey the specifications will result in suspension of the project or be punished until the violations are solved to the satisfaction of the Project Engineer. The Contractor must also comply with the national and municipal regulations on environment, public health and safety.

APPENDIX 4: MANAGEMENT PLAN OF HAZARDOUS MATERIALS AND WASTES

PURPOSE This general plan aims to outline the handling, storage and disposal of the on-site chemicals during construction.

RISK The level of expected risks depends on the type and quantity of the chemicals to be stored, the sensitivity of the on-site environment and the ability to prevent leakage.
This general plan will describe the chemicals which may need to be stored. The quantity of all kinds of chemicals stored at the site shall be limited, and the leakage of these chemicals will cause harm to the environment.
This general plan will also describe the successful operation practices of chemical storage facilities. The chemical storage facilities shall have high leak-proof ability by taking into account the chemical protection and installation of fence around the pass box. A series of measures shall be taken to minimize harm to the environment caused by spills. The most effective ways to reduce the risk of chemical spills are installation of fence around the chemical pass box and taking appropriate processing procedures.

ACTION PLAN

NO.	DESCRIPTION	SUPERVISION
The list of chemicals contained in this general plan		
4.01	The following items are considered as dangerous substances, and shall be handled and stored in accordance with the measures set forth in the this general plan. These items include new substances and residual substances and waste. ✓ Explosive ✓ Fuel ✓ Engine oil and lubricant ✓ Hydraulic oil ✓ Paint and solvent ✓ Acid drug ✓ Coagulant and flocculant ✓ Cleaning chemical ✓ Oil in the substation ✓ Shotcrete and concrete mixture ✓ Chemical resin ✓ Bentonite and drilling fluid	-
Prevention of contamination of hazardous substances		
4.02	Select the type of safe chemicals and minimize the use of chemicals. To protect the environment, the chemicals stored and used in the construction site shall be selected according to the suggestions of the general successful operation practices as far as possible. Appendix 1 of this general plan lists the recognized unsafe substitutes for human and environment, and the substitutes with few hazards.	The environmental management unit shall review the registration of the hazardous substances of the construction contractor
4.03	Storage of hazardous substances Hazardous substances shall be stored in the area with fence protection (**see Appendix 4-2 Typical Storage with Fence Protection**). The volume of fence shall exceed 110% of the maximum volume of single pass box within the fence. Diesel shall be stored in the tank with the maximum volume of 20,000L in the pass box. The waste oil stored in the pass box shall be stored in the tank with the maximum volume of 1,000L. The fence shall be designed and built in accordance with the guidelines for the successful operation practices. The storage area shall be provided with roof to prevent exposure to direct sunlight and rain. The rainwater of all areas (workshop, garage and storage area) storing or using hazardous substances shall be discharged and collected to the hydrocarbon separation tank/pit before discharge. In the areas with water treatment facilities, the acid drugs, coagulants and flocculants shall be stored in separate pass boxes. The surroundings shall be provided with similar fence to prevent leakage. Acid drugs shall also be stored in the ingredient area, buffer devices may be required before the sewage is discharged into the site drainage facilities and desilting basin.	Visual inspection

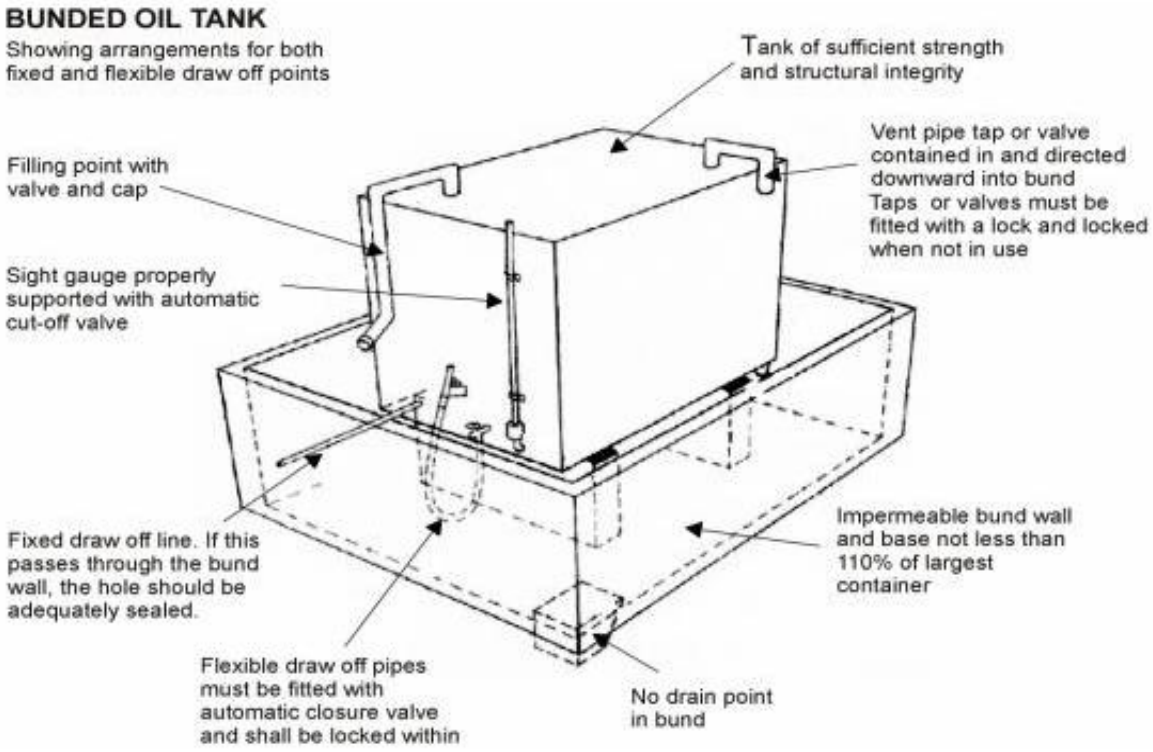
NO.	DESCRIPTION	SUPERVISION
	Shotcrete accelerator, chemical resin and cement grout shall be stored together and be protected from the impact of weather. The storage site shall be located within the safe area at the site where spills can be easily controlled and no water inflow incidents will occur. Hazardous substances of waste oils and other fluids shall be collected and disposed in a safe temporary hazardous waste disposal area, see the ESMP for details.	
4.04	Registration of hazardous substances All chemicals and waste which may be regarded as hazardous substances shall be registered to keep track of their type, inventory, use amount or generation amount. Movement from the storage point to the waste disposal site shall be registered. The registration information shall be disclosed in various hazardous material storage areas. The registration shall contain the following details: i Confirm all hazardous substances used at the site; ii. Inventory of each kind of hazardous substances at the site; iii. State (solid, liquid or gas state) of each kind of hazardous substances; iv. Hazardous properties (such as flammable, corrosive, toxic and reactive) of each kind of hazardous substances; v Main risks (poisoning, burning, harmful for eyes, skin and lung, and environmental pollution) caused by of each kind of hazardous substances; vi. The detailed emergency response procedures to be implemented on the basis of this general plan. The fuel allocation registration and fuel transportation record shall be retained to coordinate the use amount.	The registration status shall be provided in the monthly environmental statement
4.05	Labeling of hazardous substances The containers of hazardous chemicals or waste shall be affixed with the labels containing the following information: vii. The words of "hazardous waste" viii. Name of the user of the construction contractor ix. Storage date of chemicals or the initial date of waste accumulated in the container; x Name of the substance and its physical state (solid or liquid state); xi. Hazardous properties (such as flammable, corrosive, toxic and reactive) of waste. Main risks (poisoning, burning, harmful for eyes, skin and lung, and environmental pollution) of the user.	Visual inspection
4.06	Handling safety procedures and personal protective equipment The handling safety procedures for hazardous substances shall be established and serve as a part of the training plan. The safety code shall be translated into English and be printed into poster to be posted on the walls of the buildings which may use hazardous substances. Personal protective equipment shall be provided to the relevant workers, and must be used.	Visual inspection
4.07	Refueling procedures The fuel shall be stored in the steel tank in the safe area, be provided and maintained by the fuel supplier. The area storing the fuel and diesel shall be provided with large enough protective wall (more than 110% of the volume) to mitigate leakage or overflow of these substances. The discharged water and oil/petroleum shall be collected in the oil pit before the rainwater is discharged into the drainage facilities and desilting basin at the site. Oil tanks shall be protected to prevent accidental displacement due to the vehicle at the site or natural causes. Oil tank and fuel tank trucks shall be equipped with screw connecting device. Oil tank trucks shall be equipped with automatic shut-off valve to prevent excess filling. Refueling of heavy equipment and machinery shall be performed by special service vehicles. Anti-spill prevention measures shall be taken for the special service vehicles which refuel the machinery outside the service area, including placement of oil drum drip tray under the nozzle. The oil tank truck drivers shall have the awareness of being alert to prevent harm to environment. It is included in the training plan. The safety procedures on fire and accidental leakage management shall be affixed at the site. The	Visual inspection

NO.	DESCRIPTION	SUPERVISION
	areas handling or storing fuels shall be affixed with the no smoking signs.	
4.08	Emergency kit for leakage The emergency kit for leakage shall be used to control the leakage onto the ground which may be caused by maintenance or other reasons. The emergency kit for leakage shall be placed in the maintenance workshop and refueling points. All workers related to refueling or equipment maintenance shall be familiar with the use of the emergency kit for leakage, and receive the training on the emergency procedures defined in Appendix 5--Contingency Plan for Hazardous Substances.	Visual inspection Review the registration form of training participation
4.09	Leakage contingency procedures The leakage contingency procedures shall be described in detail in Appendix 4-5.	-
4.10	Leakage prevention of generator All generators shall be placed in a permanent fence area (refer to 5.03), or, in case of temporary operation, be placed inside the metal drip pan with the size and side height being in line with the requirements for hazardous substances fence storage (the size is 110% of the volume of the chassis of the generator).	Visual inspection
4.11	Precautions for use and storage of alpha-Cypermethrin during the process of cleanup of reservoir bottom: xii. The agents shall be stored in a cool and dry place and be out of reach of children. xiii. Gloves shall worn during use, and do not let the liquid contact the skin and eyes. xiv. Due attention shall be paid to the use amount, with particular attention to evade staff in case of indoor use, especially for the people prone to allergies, and sufficient ventilation shall be provided to indoors after use to avoid human discomfort.	
4.12	Precautions for use and storage of rodenticides (0.5% bromadiolone) in the resettlement area: xv. Closed operation shall be performed, and adequate local ventilation shall be provided. The dust shall be prevented from being released into the air in the workshop. xvi. Operators must receive special training, and strictly obey the operating instruction. xvii. It is suggested that operators shall wear dust mask (full cover), protective clothing and rubber gloves. xviii. Away from fire and heat source, and no smoking in the workplace. Using explosion-proof ventilation systems and equipment. Avoiding generating of dust. Avoiding contact with oxidizing agents. xix. Be stored in cool and ventilated warehouses. Away from fire and heat source. Preventing exposure to direct sunlight. Sealing of packaging. Be stored separately with oxidants and food chemicals, and avoiding mixing reservoir. xx. Be equipped with the appropriate variety and quantity of fire-fighting equipment and emergency equipment for leakage. Empty containers may have harmful residues.	

APPENDIX 4-1
LIST OF SUBSTANCES BANNED OR RESTRICTED TO BE USED AT THE CONSTRUCTION SITE

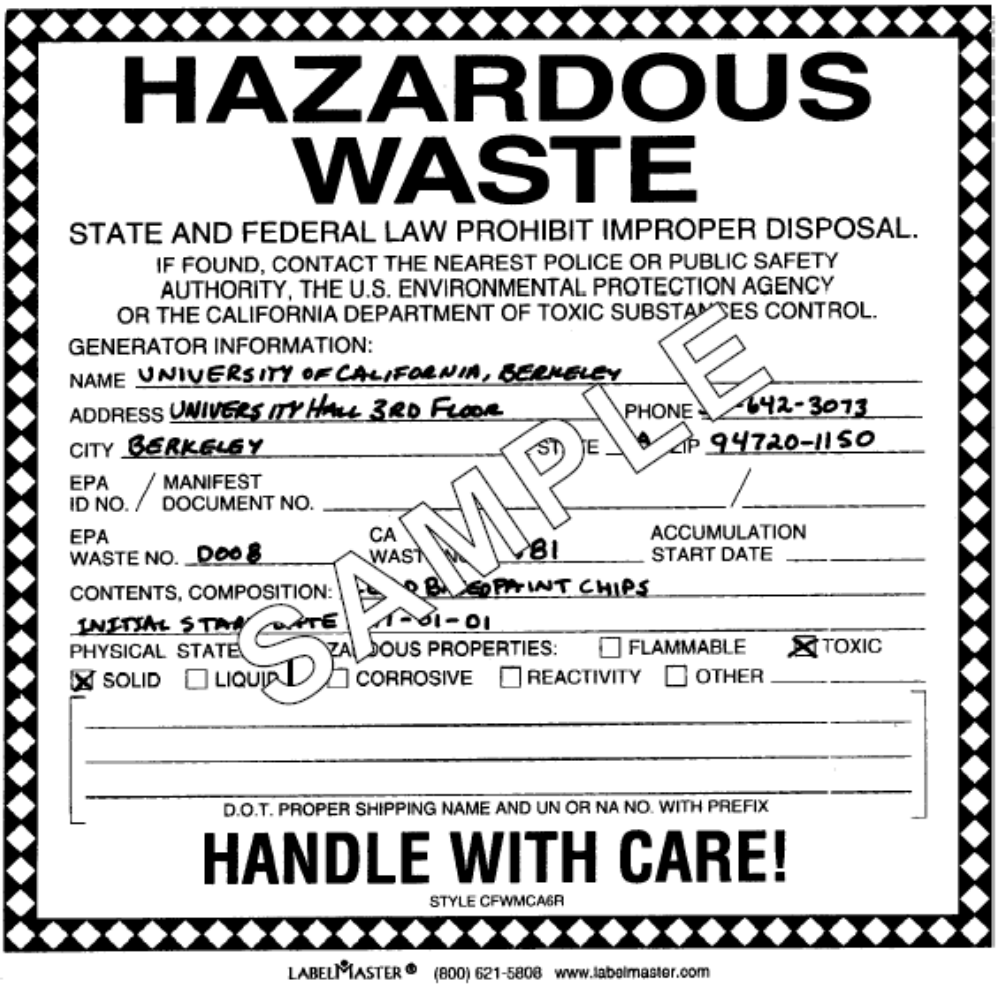
THE SUBSTANCES BANNED OR RESTRICTED TO BE USED	REASON FOR RESTRICTION	SUBSTITUTE SUBSTANCE
Polychlorinated biphenyls (PCBs)	Carcinogens and toxic substances can be accumulated in the body.	Organic silicon, lipids and casting resins.
Friable asbestos	Inhaling of fibers can damage the lungs. It is classified as hazardous substances by the World Bank and shall be prohibited to be used.	There are stable substitutes for insulation and roof. There are no better substitutes for brakes of the truck.
Pentachlorophenol (PCP) and formaldehyde (pesticides)	Carcinogens and ecological toxins. The waste products may be defined as hazardous waste by the World Bank.	Glutaraldehyde and isothiazoline (or other low-toxicity pesticides).
Lead-containing paint	With low toxicity, and the toxic substances can be accumulated in the body. The waste products may be defined as hazardous waste by the World Bank.	Lead-free paint. In addition, water-based paints or low-volatile solvent formulations can reduce the potential impact of paint on health.
Chlorinated solvents (such as carbon tetrachloride and trichlorethylene)	It may be toxic (depending on what kind of compounds).	Chlorinated hydrocarbons-free solvents and steam cleaning.
Heavy metal (reverse demulsifier)	Various reverse effects. The waste products may be defined as hazardous waste by the World Bank.	Polymer formulations (non-latex)
Mercury (in the pressure measuring devices and instruments)	With neurotoxic effects. The waste products may be defined as hazardous waste by the World Bank.	Differential pressure unit/transmitter, pneumatic or electric instruments.
Lead-containing naphthenate (lubricant)	With neurotoxic effects. The waste products may be defined as hazardous waste by the World Bank.	Lead-free lubricant.
Lead-containing thread oil	With low toxicity, and the toxic substances can be accumulated in the body. The waste products may be defined as hazardous waste by the World Bank.	Lead-free thread oil, such as Bestolife 2000 (pipes and casings).
Chromate inhibitor	The chromium in hexavalent form is toxic to humans and animals.	Sulfites or organic phosphorus inhibitors, especially those with the effect of reducing toxic amines.

APPENDIX 4-2
TYPICAL FENCE STORAGE OF HAZARDOUS SUBSTANCES



Bunded oil tank	围堤油罐
Showing arrangements for both fixed and flexible draw off points	说明固定式和灵活式泄水点设计
Filling point with valve and cap	带阀门和阀盖的灌注点
Sight gauge properly supported with automatic cut-off valve	用自动截止阀恰当支撑的观测计
Fixed draw off line. If this passes through the bund wall, the hole shall be adequately sealed	固定式泄水管。如果通过围堤，应将孔洞恰当密封。
Flexible draw off pipes must be fitted with automatic closure valve and shall be locked within	灵活式泄水管必须配备自动关闭阀并在里面锁紧
Tank of sufficient strength and structural integrity	有足够强度和结构完整性的油罐
Vent pipe tap or valve contained in and directed downward into bund	内含风管龙头或阀门并向下导入围堤内
Taps or valves must be fitted with a lock and locked when not in use	龙头或阀门必须配锁，在不用时锁上
Impermeable bund wall and base not less than 110% of largest container	防渗围堤和基座不低于最大箱罐的110%
No drain point in bund	围堤内无排水点

APPENDIX 4-3
LABEL SAMPLES OF CONTAINER OF HAZARDOUS SUBSTANCES



HAZARDOUS WASTE CONTAINER LABEL

HAZARDOUS WASTE	危害废物
STATE AND FEDERAL LAW PROHIBIT IMPROPER DISPOSAL.	州和联邦法律禁止处理不当
IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY. THE U.S. ENVIRONMENTAL PROTECTION AGENCY OR THE CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL.	如发现本物质，请联系最近的警察或公共安全部门、美国环境或加利福利亚毒害物质控制部门
GENERATOR INFORMATION	物质制造人信息
NAME	名称
ADDRESS	地址
PHONE	电话
CITY	城市
ZIP	邮编
EPA ID NO. / MANIFEST DOCUMENT NO.	环保局编号/文件号
EPA WASTE NO.	环保局废物编号

CA WASTE NO.	加州废物编号
ACCUMMULATION START STATE	收集开始日
CONTENTS, COMPOSITION	成分、组分
PHYSICAL STATE	物理状态
HAZARDOUS PROPERTIES	危害性质
FLAMMABLE	易燃
TOXIC	有毒
SOLID	固体
LIQUID	液体
CORROSIVE	腐蚀性
REACTIVITY	反应性
OTHER	其他
D.O.P. PROPER SHIPPING NAME AND UN OR NO. WITH PREFIX	交通部正确危险品学名及联合国编码或无前缀编码
HANDLE WITH CARE!	小心轻放！
HAZARDOUS WASTE CONTAINER LABEL	危害废物容器标示

APPENDIX 4-4
EMERGENCY RESPONSE PLAN FOR HAZARDOUS MATERIALS

PURPOSE This general plan aims to describe the successful operation practices in the measures taken for the leakage of hazardous substances. The Contractor's OH & S plan must cover other emergencies.

RISK If no appropriate response measures are taken, the impact of leakage of hazardous substances could be very serious. Any emergency may kill people or pollute the environment (air, water and soil). Therefore, the key of successful risk management lies in:

1 Emergency plan
2 Emergency procedures
3 Emergency training

The implementation of the above methods will greatly reduce the risk of leakage. If a leakage does occur, then the procedures listed in this general plan can minimize the possible impact.

ACTION PLAN

NO.	DESCRIPTION	SUPERVISION
Leakage contingency procedures		
5.01	The general leakage contingency procedures is outlined below: 1- Stop the flow ✓ Shut down the equipment ✓ Shut down valves and pumps ✓ Plug hoses 2- Remove sources of ignition ✓ Flameout of vehicles ✓ Torches, vehicles, smoke or other sources of ignition are not allowed in the vicinity. ✓ The hand-held fire extinguishers shall be kept a safe distance from potential sources of ignition (the fire extinguisher must be got in case of fire) 3- Control of leakage ✓ Construction of fence around the leaked materials ✓ Sprinkle absorbent or provide blanket at the leakage point ✓ Assist and support the on-site personnel ✓ Notify the supervision unit as soon as possible. Contact the emergency coordinator in this area if the supervision unit cannot be contacted.	

NO.	DESCRIPTION	SUPERVISION
	4- Notice ✓ The refueling personnel shall record the events in the log ✓ If the leakage is >50L or the leakage involves the surface water bodies, the construction contractor shall notify the environmental management unit—environmental protection director ✓ If the leakage is >100L (NC2 level), the construction contractor shall notify the environmental management unit—the environmental protection director, and the latter shall notify PMO—Project Manager 5- Cleanup and disposal The construction contractor—environmental coordinator shall confirm and immediately implement appropriate cleanup and disposal measures. 6- Report The construction contractor—environmental coordinator shall record the events and report them to the environmental management unit—the environmental protection director.	
5.02	In case of leakage of hazardous substances, all nearby jobs shall immediately be stopped, and all construction workers shall be evacuated from the area except the personnel who are responsible for cleaning. Different emergency procedures shall be taken for different substances defined in the registration form of hazardous substances.	Visual inspection
5.03	In case of leakage of hazardous substances, the procedures defined in 5.01 shall be taken, and specific emergency procedures shall be developed and adopted in accordance with the following order of importance: xxi. The first, seeking medical care for the injured xxii. The second, preventing further injury of personnel xxiii. The third, preventing damage to the environment xxiv. The fourth, cleaning the leakage xxv. The fifth, remedying the incident point xxvi. The sixth, completing the reporting requirements	-
5.04	For leakage of solid substances, the emergency procedures shall be developed according to the guidelines defined in the Material Safety Data Sheet (MSDS) and the following principles: i Consider whether the leaked materials shall be temporally covered to avoid dust ii. Guard railings shall be installed as required to prevent diffusion of the leaked materials iii. Proper equipment shall be used to collect the leaked materials, and place them in an appropriate container in line with the requirements of GP4—Disposal Plan of Hazardous Substances and ESMP iv. The waste shall be disposed in accordance with ESMP	-

NO.	DESCRIPTION	SUPERVISION
	v Potential contamination in the leakage area and site remedy need (e.g.: removal of topsoil and regional blockade) shall be identified	
5.05	For the leakage of liquid substances, the emergency procedures shall be developed according to the guidelines defined in the Material Safety Data Sheet (MSDS), the procedures defined in Appendix 5 and the following principles: i Guard railings shall be installed as required to prevent diffusion of the leaked materials, especially in the vicinity of water sources or drain ditches ii. In case of small diffusion scope and shallow extent of the leaked materials, sawdust or clean rag can be used as absorbent material to absorb the leaked materials as many as possible iii. In case of large diffusion scope and deep extent of the leaked materials, pumping equipment shall be used to collect leaked liquids iv. Acidic or alkaline leaked materials shall be provided increased mitigation materials as required v The soaked absorbing materials or pumped liquids shall be disposed according to the requirements of ESMP vi. Potential contamination in the leakage area and site remedy need (e.g.: removal of topsoil and riverway treatment) shall be identified	-
5.06	For the leakage of gaseous substances, the emergency procedures shall be developed according to the guidelines defined in the Material Safety Data Sheet (MSDS) and the following principles: i Determine the scope of evacuation ii. Consider whether ventilation equipment is required to disperse gas	-
5.07	All sites using hazardous substances shall equip all hazardous substances with emergency kit for leakage and appropriate emergency procedures. The emergency kit for leakage shall have appropriate personal protective equipment and emergency equipment for leakage. The emergency kit for leakage shall be checked once a month.	The emergency kit for leakage shall be checked by the construction contractor—environmental protection coordinator and the environmental management unit once a month.
5.08	Portable emergency kit for leakage shall be used for leakage of vehicles or outside the site.	The emergency kit for leakage shall be checked by the construction contractor—environmental protection coordinator and the

NO.	DESCRIPTION	SUPERVISION
		environmental management unit once a month.
Emergency contact		
5.09	In each of the major sites shall express emergency situations shall take emergency procedures, emergency contact numbers and inform the reporting procedures.	Visual inspection
Staff training		
5.10	In various sites the use of hazardous substances, as well as leakage hidden place, must have at least two staff members received proper emergency procedures and communication of reporting procedures have been trained in the field.	Review the registration form of training participation
Emergency communication procedures		
5.11	In case of leakage of hazardous substances, the communication procedures defined in ESMP shall be taken. The communication procedures are verbal in the beginning, and the table in Appendix 5-1 shall be completed as soon as possible.	-
5.12	The communication procedures shall include the information related to the following accidental leakage: iii. Location iv. Property of leaked materials v Amount of leakage vi. Cleanup procedures proposed to be taken vii. Whether there are casualties viii. Whether in need of emergent or external assistance ix. Whether there are on-site safety/evacuation requirements	-
5.13	Within 48 hours after the leakage cleanup is completed, a report shall be submitted to PMO-ED. The content shall be in line with the form defined in Appendix 5-2. The report shall be used to confirm whether corrective or preventive actions shall be taken, and whether the emergency procedures and training plan shall be appropriately changed.	-

APPENDIX 5: INTANGIBLE CULTURAL RESOURCES MANAGEMENT PLAN

1 Project impact on local tangible cultural resources

According to the survey results of previous domestic EIA and supplementary EIA of the project, including the survey findings of local heritage experts in 2016, the local material and cultural resources which may be affected by the project include 12 underground cultural heritages and 467 graves, as shown below.

Table 6-1 General information of cultural heritages in project area

S/N	Item	Location	Coordinates	Elevation (m)	Period	Cultural heritages class	Preservation status	Relation with project route
1	Han dynasty Cemetery in Guanzhuang Village	Group 6, Guanzhuang Village, Nanying Street Sub-district Office, Yicheng City	N31° 42′ 56.2″ E112° 20′ 46″	53.5	Eastern Han Dynasty, Six Dynasties and Ming Dynasty	Unclassified	General	Inundation
2	Haogouquan Cemetery Complex	Ziran Village, Haogouquan, Ronghe Village, Xiaohe County, Yicheng City	N31° 47′ 11.0″ E112° 9′ 33.0″	68	Han Dynasty	Unclassified	General	Erosion
3	Wangjiagang Cemetery	Wangjiagang, Mingzheng Village, Xiaohe County, Yicheng City	N31° 45′ 24.0″ E112° 12′ 30.0″	71	Han Dynasty	County level	Relatively good	Erosion
4	Tongmei cemetery complex	Tongmei Village, Zhengji County, Yicheng City	N31° 39′ 38.0″ E112° 19′ 16.0″	57	Wei and Jin Dynasties to Sui Dynasty	Unclassified	General	Erosion
5	Six Dynasties Cemetery in Group 3, Tongmei Village	Group 3, Tongmei Village, Zhengji County, Yicheng City	N31° 40′ 12.0″ E112° 19′ 23.5″	53	Six Dynasties	Unclassified	General	Inundation
6	Six Dynasties Cemetery in Heluo Village	Group 6, Heluo Village, Zhengji County, Yicheng City	N31° 40′ 5.9″ E112° 20′ 45.3″	52	Six Dynasties	Unclassified	General	Inundation
7	Six Dynasties Cemetery in Maocao Group 3	Group 3, Maocao Village, Zhengji County, Yicheng City	N31° 39′ 31.1″ E112° 21′ 25.3″	53.5	Six Dynasties	Unclassified	General	Inundation
8	Cemetery at Taishanmiao	Group 5, Tannao Village, Yancheng Office, Yicheng City	N31° 42′ 22.7″ E112° 17′ 29.2″	55	Ming and Qing Dynasties	Unclassified	Relatively poor	Inundation
9	Ming and Qing Dynasties cemetery in Tannao Group 3	Group 3, Tannao Village, Yancheng Office, Yicheng City	N31° 42′ 23.1″ E112° 18′ 15.2″	53.5	Ming and Qing Dynasties	Unclassified	Relatively poor	Inundation
10	Han dynasty cemetery at Shuita in Tannaoji Group 3	Group 3, Tannao Village, Yancheng Office, Yicheng City	N31° 42′ 23.1″ E112° 18′ 15.2″	53	Han Dynasty to Six Dynasties	Unclassified	General	Inundation
11	Miaotai cemetery in Nanhe Village	Group 11, Nanhe Village, Yancheng Office, Yicheng City	N31° 40′ 57.3″ E112° 19′ 6.9″	54	Ming and Qing Dynasties	Unclassified	Relatively poor	Inundation
12	Yakou Village Cemetery	Fishery community of Liushui County, Yicheng City	N31° 39′ 51.3″ E112° 23′ 15.7″	54	Six Dynasties and Ming Dynasty	Unclassified	General	Inundation

2 Protective measures against project impact on tangible cultural resources

2.1 Protective measures tailored for cultural heritages

Hubei Provincial Institute of Cultural Relics and Archaeology proposes to implement cultural heritage conservation through archaeological survey, avoidance of cultural heritages, archaeological exploration, archaeological excavation, data compilation, preparation of reports, preservation and display of cultural heritages and other methods and steps.

Currently, Hubei Provincial Institute of Cultural Relics and Archaeology has completed the preliminary archaeological survey, has determined the level of cultural heritage conservation of 12 surveyed cultural heritages, and has proposed the corresponding cultural heritage conservation opinions for the next stage. Among the 12 underground cultural heritages found in the survey, there is 1 Class-A cultural heritage, 4 Class-B cultural heritages, 7 Class-C cultural heritages, and 1 Class-D cultural heritage.

In accordance with the provisions of Article 29 of the *Law of the People's Republic of China on Cultural Heritage Conservation*: for large-scale infrastructure construction project, the PIU shall firstly apply to the cultural heritage administrative department of the people's government at corresponding province, autonomous region and municipality levels to organize the unit engaged in archaeological excavation to carry out archaeological survey and exploration in the places with possible cultural heritages within the project scope. Archaeological exploration shall be carried out before the impoundment for the project. According to the levels and conservation opinions, combination of general exploration and key exploration is proposed to be adopted for the archaeological exploration. Within the distribution scope of cultural heritages, Class-B cultural heritages shall undergo 50% general exploration and 50% key exploration, Class-B cultural heritages shall undergo 70% general exploration and 30% key exploration, and Class-C cultural heritages shall undergo 90% general exploration and 10% key exploration.

Archaeological exploration follows the principle of "key exploration and key

protection" and "double keys", Class-A cultural heritages with high value and good state of conservation but cannot be avoided by the project shall undergo priority conservation and key exploration, while Class-B cultural heritages shall undergo only a small area of exploration.

Currently, according to the budget, the required archaeological survey, exploration and excavation cost for Han River Yakou Navigation Complex Project reaches CNY 2,325,000.

Table 6-2 General information of cultural heritages in project area

S/N	Item	Location	Level of cultural heritage conservation	Conservation opinion
1	Han dynasty Cemetery in Guanzhuang Village	Group 6, Guanzhuang Village, Nanying Street Sub-district Office, Yicheng City	B	Exploration and excavation
2	Haogouquan Cemetery Complex	Ziran Village, Haogouquan, Ronghe Village, Xiaohe County, Yicheng City	B	Exploration and excavation
3	Wangjiagang Cemetery	Wangjiagang, Mingzheng Village, Xiaohe County, Yicheng City	A	Exploration and key excavation
4	Tongmei cemetery complex	Tongmei Village, Zhengji County, Yicheng City	B	Exploration and excavation
5	Six Dynasties Cemetery in Group 3, Tongmei Village	Group 3, Tongmei Village, Zhengji County, Yicheng City	C	Exploration and excavation
6	Six Dynasties Cemetery in Heluo Village	Group 6, Heluo Village, Zhengji County, Yicheng City	B	Exploration and excavation
7	Six Dynasties Cemetery in Maocao Group 3	Group 3, Maocao Village, Zhengji County, Yicheng City	C	Exploration and excavation
8	Cemetery at Taishanmiao	Group 5, Tannao Village, Yancheng Office, Yicheng City	C	Exploration and excavation
9	Ming and Qing Dynasties cemetery in Tannao Group 3	Group 3, Tannao Village, Yancheng Office, Yicheng City	C	Exploration and excavation
10	Han dynasty cemetery at Shuita in Tannao Group 3	Group 3, Tannao Village, Yancheng Office, Yicheng City	C	Exploration and excavation
11	Miaotai cemetery in Nanhe Village	Group 11, Nanhe Village, Yancheng Office, Yicheng City	C	Exploration and excavation
12	Yakou Village Cemetery	Fishery community of Liushui County, Yicheng City	C	Exploration and excavation

2.2 Mitigation measures tailored for affected graves

According to the site survey, the local graves are generally scattered in the hills near the village. According to local customs, relocation of grave is a major event for a family, and is related to the fate of the family, and generally will undergo the three steps of "lifting of the grave, relocation of the grave and placement of the grave", and land god shall be

asked to recite or chant scriptures before lifting of the grave. In the process of relocation of grave, relocation of grave shall be performed according to the wishes of the villagers and local customs; the geomancy man shall select the date, time, grave settlement point and direction, and family ceremony shall be held. Affected graves shall be compensated in accordance with local prices, and relevant costs have been included in the resettlement action plan for the project.

3 Handling of cultural relics discovered during construction

PURPOSE This procedure aims to illustrate the good operation practices for management of the cultural resources found during construction.

RISK This procedure shall explain the measures to be taken for the relics which may be very important found during construction. These measures include training of personnel, and the notification and reporting mechanism to the construction contractor - environmental management unit to determine the appropriate management measures to be taken. In addition to the confirmed cultural heritages, from the currently obtained information, there is little possibility of finding valuable resources in Han River Yakou Navigation Complex Project.

ACTION PLAN

NO.	DESCRIPTION	SUPERVISION
Training of construction workers		
GP6.01	Training of construction workers includes description of possible cultural heritage sites or items. The construction workers shall understand how to perform the reporting and notification procedures and the importance of the implementation of these procedures if they find possible cultural heritages.	Review the registration form of training participation
The steps which shall be taken if the location is determined		
GP6.02	The following steps shall be taken to protect the cultural heritage sites/items which are undetermined before: i Once the worker confirms that they are cultural heritage sites/items, he/she shall immediately notify the on-site construction supervisor ii. The construction supervisor shall confirm whether they are	-

NO.	DESCRIPTION	SUPERVISION
	cultural heritage sites/items or not iii. If the construction supervisor confirms that they are cultural heritage sites/items, he or she shall immediately stop the work performed within the scope of 50m from the boundary of such site. iv. The construction supervisor shall immediately notify the construction contractor - environmental protection coordinator v The construction contractor - environmental protection coordinator shall follow up the notification procedures and notify the environmental management unit - environmental protection director, and the environmental protection director shall notify the construction supervision company- Project Manager and PMO of the county The reporting form defined in Appendix GP6-1 shall be completed within 24 hours after determination of the site	
GP6.03	Temporary fence or similar facilities shall be provided within the scope of 50m from the boundary of such site.	Examination
Guidance of the DI		
GP6.04	No work shall be performed within the scope of 50m from the boundary of such site until being guided by the environmental management unit.	Visual inspection
GP6.05	The construction contractor - environmental protection coordinator shall be notified 15 days before construction at the confirmed target or site. The guidance or requirements for the measures to protect the site of the construction supervision company - environmental management unit shall be recorded by the construction contractor - environmental protection director as well as site inspector, and be communicated to the construction workers by them	Examination

APPENDIX 6-1

NOTICE SHEET FOR POSSIBLE CULTURAL HERITAGES

Section 1 – Confirmation of location	
Date of confirmation of location	
Description of location (including the name of the construction area)	
Location type	
General description of location	
Confirmed by	
Time and date of stopping the work	
Time and date of notifying the construction contractor - environmental protection coordinator	
Time and date of notifying the environmental management unit -environmental protection coordinator	
Filled by	
Verified by	
Part 2: Guidance of the environmental management unit	
Date of receipt of the requirements of the environmental management unit	
Summary of the requirements of the environmental management unit (refer to the Appendixs if necessary)	
Date of training for workers	
Verification of the implementation of the requirements of the environmental management unit (signature and date)	

APPENDIX 6: OUTLINE FOR STAGE-II CUMULATIVE IMPACT ASSESSMENT (CIA)

Outline for Stage-II Cumulative Impact Assessment (CIA)

1 Overview

In October 1993, CWRC prepared the *Comprehensive Utilization and Planning Report of Han River Mainstream below Jia River*, which suggested the nine-level development program of Gushan – Danjiangkou – Wangfuzhou – Xinji – Cuijiaying – Yakou – Nianpanshan – Huajiawan – Xinglong as the representative program for regulation and development of this river section. A total of eight complexes from Danjiangkou to Xinglong are located in the middle and lower reaches of Han River. At that time, as the state had no requirements for planning of EIA, therefore, the planning of EIA was not performed for the construction of navigation and hydropower complexes along the middle and lower reaches of Han River.

In 2004, Hubei Provincial Water Resources and Hydropower Planning Survey and Design Institute worked out the *Construction Plan of Pilot Modernized Hydraulic Complexes at Middle and Lower Reaches of Han River in Hubei Province* (hereinafter referred to as the *Construction Plan*). In January 2005, the Construction Plan passed the technical review organized by China Renewable Energy Engineering Institute of the Ministry of Water Resources, see Appendix 1 for the review comments; in February 2005, the Construction Plan was approved by the Ministry of Water Resources and the People's Government of Hubei Province in Document SGJ [2005] 85, see Appendix 2 for the approval document. The Construction Plan adjusted the construction of navigation complexes along the middle and lower reaches of Han River, and canceled Huajiawan Complex Project. According to the Construction Plan, by 2020, seven complexes including Danjiangkou – Wangfuzhou – Xinji – Cuijiaying – Yakou – Nianpanshan – Xinglong will be built below Danjiangkou Reservoir at the main stream of Han River at the middle and lower reaches, the comprehensive development and utilization project of the main stream will be comprehensively completed.

The initial-stage project of Danjiangkou dam was completed in 1973, and the follow-up project (Danjiangkou dam heightening) was commenced in September 2005 and

has been completed now; Wangfuzhou project was completed and put into production in 2000 and passed inspection and acceptance for individual items in 2003; Xinji project has completed the feasibility study design work; the main works of Cuijiaying project was completed and put into operation in 2010; the earlier-stage design work for Yakou and Nianpanshan projects has been carried out; Xinglong project was commenced in 2009 and has been completed now.

On October 28, 2002, the State promulgated the *Law of the People's Republic of China on Environmental Impact Assessment*, which clearly stated the requirements for planning EIA, and came into effect on September 1, 2003. Thereafter, the *Environmental Impact Statement for High-grade Waterway Construction Program for Han River and Jianghan River Canals (2011-2015), Retrospective Report on the Environmental Impacts of Hydropower Development in the Upper Reach of Han River Mainstream (Shaanxi Section)* and *Retrospective Report on the Environmental Impacts of Hydropower Development in the Middle and Lower Reaches of Han River* were prepared in different periods: The relevant results of the EIA report for the above river basin are fully referred in the preparation process of Yakou Supplemental EIA report.

The cumulative impact study of the second stage shall perform a detailed assessment for the cumulative impact of the construction of navigation complexes along Han River, quantify the potential impact on some key ecological elements found during the study in the first stage, and assess whether the threshold can be reached. On the basis of assessment, the mitigation measures for the whole Han River basin shall be further elaborated and be incorporated into the environmental management plan of the project, and be implemented in the course of the implementation and operation of the project.

2 Purpose and principle of CIA

2.1 Purpose

The purpose of this study is to implement the *Law of the People's Republic of China on Environmental Impact Assessment* and the strategy of sustainable development, to perform retrospective assessment for the environmental impact caused by the navigation and hydropower complexes in the middle and lower reaches of Han River which have been

built or under construction, to perform CEI prediction assessment after completion of the navigation and hydropower complexes in the middle and lower reaches of Han River, to identify the environmental problems after construction of these complexes, and to provide basis for the further development of the planned river section and the comprehensive decision-making concerning the environment and development of the middle and lower reaches of Han River.

2.2 Principles

(1) Retrospective study

This retrospective study focuses on retrospective study and assessment, supplemented by prediction assessment.

The main content of retrospective study is: survey and study of the environmental impact of the completed projects in the middle and lower reaches of Han River, making comparison with the environmental prediction assessment results, review of the actual occurrence of environmental impact, and review of the difference with the prediction assessment results. Danjiangkou navigation complex was built a long time ago, and there were no requirements for environmental impact assessment at that time, but the impact of the construction of Danjiangkou navigation complex on the middle and lower reaches of Han River was global. This retrospective study focuses on the study of the impact of the construction of Danjiangkou navigation complex on water temperature, fish, etc. in the middle and lower reaches of Han River.

If necessary, this retrospective study can also analyze the changes of prediction preconditions of and review the prediction results of the environmental impact of South-to-north water diversion middle route phase-I project on the middle and lower reaches of Han River, serving as the work content of this retrospective study.

(2) Sustainable development and ecological protection

Natural resources are the material basis for human survival and development, and the biological resources, land resources, water resources and other natural resources will be protected based on the long-term interests and the overall interests, serving as the conditions for achieving sustainable development. The impact of hydropower development

(i.e. construction of navigation and hydropower complexes) on the integrity of the ecosystem of the region is assessed, so that environmental protection can be people-oriented, with full consideration of regional socio-economic development, demand for improvement of living standards, achievement of harmonious development and mutual win-win situation of environmental protection and economic development and social progress, avoiding serious ecological damages and loss of resources caused by implementation of hydropower development of the river section, and avoid affecting the sustainable development of the region.

(3) Scientific, objective and fair

The impact on the environment of the completed hydropower shall be reviewed, and the environmental friendliness of the construction of water conservancy and hydropower projects shall be summarized in a scientific, objective and fair manner; the impact on water temperature, fish, etc. of the construction of navigation and hydropower complexes in the middle and lower reaches of Han River shall follow the principle of scientific, objective and fair, and the adverse environmental impact after the implementation of the planning shall be summarized in a scientific manner, so as to raise awareness to solve such problems, and to propose objective and fair solutions.

(4) Macro and integrity

The retrospective assessment of the river section shall focus on the assessment of the environmental factors with strong integrity, wide-ranging impact scope, long period and cumulative impact for the basin, for example, the analysis, comparison and assessment of the integrity and macro of the regional ecosystem, utilization of water and land resources, regional socio-economic development and improvement of people's living standards, water conservancy and hydropower planning implementation area and overall coordination and promotion of infrastructure development, etc. From the scope and scale of the river section, macroscopic assessment shall be performed for common problems, and holistic solutions shall be proposed.

(5) Practicability

Simple, practical and accumulated historical data shall be selected and evaluated as

far as possible, the proposed environmental protection measures, especially for the environmental protection measures tailored for the environmental problems of the completed hydropower, shall be operational to facilitate decision-making of the government competent departments.

(6) Public consultation

Public consultation activities shall be carried out, the comments of relevant units, experts and the public shall be surveyed in the retrospective EIA process, so that the EIA takes into account various comments and requirements, making the project more harmonious with the surrounding social environment.

3 CIA tasks

Task 1: Further collection of information and preliminary review of information

According to the information collection situation in the first stage, the relevant information of the cumulative impact assessment in the second stage shall be collected, including the information not collected in the first stage, such as the 13th Five Year Plan regarding water conservancy, environmental protection, transportation and other aspects in Xiangyang City, and the information on hydrology, water temperature, etc. of the hydrological station of the mainstream of the middle and lower reaches of Han River since 2010.

Task 2: Site visits and targeted public survey

According to previous study results, a detailed survey (about 2 weeks) for the important ecological elements throughout the middle and lower reaches of Han River shall be performed. The purpose of the survey is to verify the environmental baseline established in the first stage.

The preliminary results of the first stage shall be submitted to some of the main surveyed stakeholders (especially the local residents and relevant department being surveyed in the first stage) to further seek their opinions. Public survey shall be performed throughout the second stage to better understand the stakeholders' feedback on the findings.

Task 3: Environmental survey and monitoring

For a detailed cumulative impact study, environmental survey and monitoring is required to obtain necessary information. To this end, a number of local agencies shall be entrusted to carry out hydrographic survey and environmental monitoring. The survey and monitoring results shall be used for hydrodynamic force and water quality model to quantify the cumulative impact of the hydropower development of the middle and lower reaches of Han River.

Hydrology: the information on hydrology, water temperature, etc. of the 5 hydrological stations, namely, Huangjiagang Hydrological Station, Xiangyang Hydrological Station, Huangzhuang Hydrological Station, Shayang Hydrological Station and Xiantao Hydrological Station of the middle and lower reaches of Han River since 2010 shall be collected. The impact of the increased water diversion (up to 9.5 billion m^3/a) resulting from Danjiangkou dam heightening on the hydrological regime of the middle and lower reaches of Han River and the estuary shall be analyzed.

Water quality monitoring: the current status monitoring information of the surface water of the routine monitored section shall be collected, combined with the water pollution source situation, the current status of the surface water quality shall be analyzed. In theory, water quality monitoring shall include the high flow season, normal flow season and low flow season.

Water temperature: the measured information on water temperature in front of dam of Danjiangkou Project shall be collected, and shall undergo statistical data and collation to analyze the change trends of water temperature structure in front of dam, average monthly distribution, and reservoir water temperature after Danjiangkou navigation complex is completed. Through comparative analysis of the average monthly temperature changes of Huangjiagang Hydrological Station, Xiangyang Hydrological Station, Huangzhuang Hydrological Station, Shayang Hydrological Station and Xiantao Hydrological Station before and after the constriction of Danjiangkou navigation complex, the retrospective study for the average monthly temperature changes of discharged water temperature and

the impact scope of discharged water temperature before and after the constriction of Danjiangkou navigation complex shall be performed

Aquatic ecosystem: PIU shall entrust a professional agency to carry out current status survey for the aquatic organisms, fish resources and habitats within the scope of survey. A total of 16 survey sections are set up in the middle and lower reaches of Han River, in which a total of 13 survey sections are set up in the mainstream river section, and 3 survey sections are set up in the tributary; the mainstream sections from top to bottom are: Danjiangkou navigation complex tail of reservoir and middle of reservoir area; Wangfuzhou reservoir middle of reservoir area, Wangfuzhou navigation complex downstream from the dam; Xinji Power Station; Cuijiaying middle of reservoir, Cuijiaying navigation complex downstream from the dam; Yakou navigation complex dam site, Nianpanshan navigation complex dam site; Xinglong reservoir middle of reservoir area; Xinglong navigation complex downstream from the dam, and at 10km of the downstream of the plant site. 1 section is set up for each of the three tributaries, namely, Tang River, Bai River and Nan River. The fish species composition, age composition, number composition, length composition, weight composition, fishing gear and methods, status of fisheries, aquaculture in the reservoir area, output and benefits shall be surveyed. Special ecological environment for fishes: the habitat features of fish spawning ground, wintering ground, fishing ground and the fattening ground at different growth stages, etc., especially the changes of the wintering ground, spawning ground and feeding ground for the fishes spawning floating eggs.

Terrestrial ecosystem: according to the current environment situation of the assessment area of the latest analysis of satellite images and existing data, combined with the findings of this terrestrial ecosystem survey, with analogy with the degree and scope of the actual impact of the completed project on the terrestrial ecosystem of the project area, the impact of the project remained to be constructed on the terrestrial ecosystem of the project area shall be predicted, the cumulative impact of the full implementation of the planning on the terrestrial ecosystem shall be evaluated, and the impact on the integrity and

stability of the regional ecological environment shall be evaluated through landscape ecosystem method.

Task 4: Establishment of hydrodynamic force and water quality model

On the basis of collected information, the hydrodynamic force and water quality model for construction of navigation complexes in the middle and lower reaches of Han River shall be established. Basic information required includes: river morphology, hydrological data of river, rainfall data, reservoir operating rules, water quality, point source pollution, and non-point source pollution. Sophisticated modeling software shall be adopted for the model, such as MIKE 11 and Infoworks RS. The hydraulic model is mainly used for operation of the complex in flood season and non-flood season, and the water quality model is mainly used for COD, BOD, ammonia nitrogen and TN.

Task 5: Assessment of cumulative impact

According to the results of modeling, the quantitative assessment for the cumulative impact of hydropower development of Han River on the main important ecological elements found (such as changes in hydrological situation, water quality, aquatic ecosystem, etc.) shall be performed.

According to the size, development, operation methods, etc. of the project remained to be constructed, combined with the findings of this aquatic ecosystem survey, with analogy with the actual impact of the completed project on the aquatic ecosystem, the further impact of the project remained to be constructed on the aquatic ecosystem shall be predicted, and the cumulative impact of the full implementation of the planning on the aquatic ecosystem shall be evaluated.

Terrestrial ecosystem: the terrestrial ecosystem survey information and the images of analysis of satellite images and existing data within the assessment scope during carrying out environmental impact of the project for all hydropower stations shall be collected, combined with the survey on the current status of the terrestrial ecosystem.

Task 6: Development of mitigation measures

A series of mitigation measures shall be proposed for the hydropower development

according to the main cumulative impact on the middle and lower reaches of Han River. These measures shall serve as a part of the environmental management plan and be implemented during implementation and operation of the project. These impacts and measures shall be finalized after discussion with key stakeholders (the relevant authorities and the local residents).

(1) Measures for water environment protection

The effectiveness of the measures shall be analyzed according to the measures for water environment protection of previous individual projects having been completed or under construction; the water pollution source prevention and control measures for the basin and the engineering and management measures guaranteeing continuous flow of the river shall be proposed according to the current national environmental protection requirements for hydropower development, and necessary suggestions for water environmental protection remedy measures for the projects having been completed or under construction shall be proposed.

(2) Measures for fish protection

According to the measures for fish protection of previous individual projects having been completed or under construction, the effectiveness of the measures shall be analyzed, the measures for fish protection for the planned river section shall be proposed, including fish pass, fish reproduction and release, tributary protection, fishery management and other measures, and necessary suggestions for fish protection remedy measures for the projects having been completed or under construction shall be proposed.

(3) Measures for terrestrial ecological protection

According to the measures for water environment protection of previous individual projects having been completed or under construction, the effectiveness of the measures shall be analyzed, the measures for terrestrial ecological protection for the development of the projects remained to be constructed shall be proposed, with emphasis on the measures for flora and fauna protection, and measures for nature reserve protection, measures for soil erosion control, and necessary suggestions for remedy measures for the projects

having been completed or under construction.

(4) Measures for social environment protection

According to the measures for resettlement protection of previous individual projects having been completed, the effectiveness of the measures shall be analyzed, the measures for resettlement protection for the development of the projects remained to be constructed shall be proposed, and necessary suggestions for social environment protection remedy measures for the projects having been completed or under construction shall be proposed.

(5) Other environmental protection measures

Other environmental protection measures for the implementation process of the planning shall be proposed, such as the measures for construction pollution control, measures for cultural heritage conservation, measures for population health protection, etc.

Task 7: Training

The staff of relevant local authorities such as Water Resources Bureau, existing and proposed dam operational unit, local Environmental Protection Bureau, etc. shall receive necessary training on environmental management. The training plan shall be designed according to the results of the above analysis and assessment to improve the local environmental management capacity.

Task 8: Reporting

A comprehensive report shall be prepared to reflect all of the main results of the study. The title of the results of the cumulative environmental impact assessment in the second stage is initially proposed as the *CEIA Report for Hydropower Development in the Middle and Lower Reaches of Han River mainstream*.

4 CIA focuses

The focuses of environmental impact assessment of the hydropower development program shall be determined according to the engineering characteristics and basin environmental characteristics:

(1) Impact of hydropower development on water environment (including hydrology, water temperature and water quality);

(2) Impact of hydropower development on aquatic ecosystem;

(3) Impact of hydropower development on terrestrial ecosystem;

(4) Impact of hydropower development on social environment.

5 Scope of CEIA

5.1 Spatial coverage

Both banks of upstream channel of Han River are featured by steep slope, deep water, rapid flow and numerous mudflats. On the right bank of the river is Daba Mountain System, which is basically parallel to Qin Mountains. The climate is obviously affected by Qin Mountains and Daba Mountain, and the region belongs to subtropical monsoon climate zone. The upstream basin of Han River has good vegetation and belongs to northern subtropical mixed forest zone of broadleaved deciduous forest and evergreen deciduous forest, with forest coverage of 49.2% (Ankang Region), and there is no large industrial pollution source and the pollution level is low.

Han River Basin is high in northwest and low in southeast, and the elevation falls to 1000m from 3000m from west to east. The middle and lower reaches of Han River incline eastwards toward wide Jianghan Plain from hills. The plain is flat with anastomosing streams, dense lakes and numerous embankments, and the elevation is generally lower than 50m. The territory at middle and lower reaches of Han River is vast with mountainous land, hills and plains, and the diversified natural ecological environments and the extensive land adaptability form the diversity of species. The plain at the lower reach is flat, with fertile soil, scattered lakes and staggered canals, and it is the main producing area of grain, cotton and oil as well as the commodity grain base. The characteristics of the upper, middle and lower reaches of Han River Basin are shown in Table 2-1.

Table 2-1 Characteristics of the upper, middle and lower reaches of Han River Basin

Item	Upper reach	Middle reach	Lower reach
Position	Shaanxi	Hubei	Hubei
Starting and ending points	Upstream from Danjiangkou	From Danjiangkou to Zhongxiang	Downstream from Zhongxiang
Length	925km	270km	382km

Controlled drainage area	9.52×10^4 km^2	4.68×10^4 km^2	1.70×10^4 km^2
Average gradient	0.6‰	0.19‰	0.06‰
Main tributaries	Left bank: Bao River, Xun River, Jia River and Danjiang River; Right bank: Ren River, Du River, etc.	Left bank: Xiaoqing River and Tangbai River; Right bank: Nan River, Man River, Bei River, etc.	Hanbei River inflows on the left bank, and Dongjing River on the right bank flows into Yangtze River.
Main landform	Mainly medium and low mountainous land, accounting for 79%, hills, 18%, and valley basin, 3%.	Mainly plain, accounting for 51.6%, mountainous land, 25.4%, and hills, 23%.	Plain accounting for 51%, mountainous land, 22%, and hills, 27%.
Construction of hydropower and navigation complexes along Han River	Huangjinxia - Shiquan - Xihe - Ankang- Xunyang - Shuhe - Baihe- Gushan - Danjiangkou	Wangfuzhou - Xinji - Cuijiaying - Yakou - Nianpanshan	Xinglong

It is observed that, the natural environment at the upper reach of Han River is different from that at middle and lower reaches and is controlled by Danjiangkou Reservoir with overyear storage, and the variation trend of ecological environment at middle and lower reaches is also entirely different from that at the upper reach. The spatial coverage of CEIA includes river sections below Danjiangkou, i.e. the middle and lower reaches of Han River, covering the affected areas of navigation and hydropower complexes planned to be constructed at middle and lower reaches of Han River, including seven complexes, i.e. Danjiangkou - Wangfuzhou - Xinji - Cuijiaying - Yakou - Nianpanshan - Xinglong, as well as the regions below Xinglong Reservoir through which the main stream of Han River passes, as shown in Figure 2-1.

(1) Water environment

Water environment impact assessment involves surface water of the river section of the main stream of Han River from the dam of Danjiangkou Hydropower Complex to the inflow mouth where Han River flows into Yangtze River. The length of the river section is about 652km, and the main tributaries are also incorporated in the CEIA.

(2) Aquatic ecology

Aquatic ecology impact assessment involves surface water of the river section of the main stream of Han River from the dam of Danjiangkou Hydropower Complex to the inflow mouth where Han River flows into Yangtze River. The length of the river section is about 652km, and the main tributaries are also incorporated in the CEIA.

(3) Terrestrial ecology

Terrestrial ecology impact assessment covers 1km (both banks) of the main stream below Danjiangkou Hydropower Complex at middle and lower reaches of Han River, including the affected area and the resettlement area of hydropower complexes, and appropriately extends to the nearby protected ecologically-sensitive objects.

(4) Social environment

Social environment impact assessment involves the construction area and the affected area of navigation and hydropower complexes at middle and lower reaches of Han River, covering Shiyan City (Danjiangkou City and Laohekou City), Xiangyang City (Gucheng County, Xiangzhou District and Yicheng City), Jingmen City (Zhongxiang City), and Qianjiang City in Hubei Province (cities within brackets are prefecture-level cities).

Figure 2-1 Schematic Diagram of Scope of Cumulative Environmental Impact Study of Han River

丹江口	Danjiangkou
王甫州	Wangfuzhou
崔家营	Cuijiaying
新集	Xingji
雅口航运枢纽	Han River Yakou Navigation Complex
碾盘山	Nianpanshan
兴隆	Xinglong
一级航道	Grade I waterway
二级航道	Grade II waterway
三级航道	Grade III waterway
四级航道	Grade IV waterway

5.2 Temporal coverage

The navigation and hydropower complexes constructed or to be constructed at middle and lower reaches of Han River concentrate in the river section from Danjiangkou dam to Xinglong, which is significantly affected by the implementation of South-to-North Water

Diversion Project, and the service area of Yangtze-Han Water Diversion Project is just below Xinglong. Therefore, the construction of navigation and hydropower complexes in the section from Danjiangkou to Xinglong will have good compensations for the ecology, navigation and water supply after South-to-North Water Diversion Project is implemented.

At present, four complexes at middle and lower reaches of Han River have been constructed, i.e. Danjiangkou, Wangfuzhou, Cuijiaying and Xinglong. Danjiangkou complex was started very early, and Wangfuzhou, Cuijiaying and Xinglong complexes were put into operation in 2000, 2010 and 2015 respectively. The South-to-North Water Diversion Phase-I was put into operation at the end of 2014 but the quantity of water diversion in 2015 only reached 1/5 of the design scale. It is observed that the environment at middle and lower reaches of Han River were still in dynamic change in 2015 and is not representative. Therefore, the base year of this CEIA is defined as Year 2014 when South-to-North Water Diversion Project had not be implemented (to be extended for some environmental elements according to needs), and the forecast year is Year 2020 when all the navigation complexes at middle and lower reaches of Han River will be completed and South-to-North Water Diversion Project would have been put into operation.

6 Assessment system and indicator system

The assessment objective of the construction plan for hydropower and navigation complexes at the middle and lower reaches of Han River is a multi-project and multi-level system, which is composed of project system and environment system. The environmental impact study and assessment indicator system for hydropower and navigation complexes specifically and systematically reflects the environmental impacts. Assessment indicators are mainly used to describe and identify environmental background, environmental change trend and macro effect.

(1)Project system and major indicators

The project system consists of seven hydropower and navigation complexes at the middle and lower reaches of Han River, i.e., Danjiangkou Complex, Wangfuzhou Complex, Xinji Complex, Cuijiaying Complex, Yakou Complex, Nianpanshan Complex and Xinglong Complex. The major assessment indicators include:

① Distribution of complexes: number of complexes, confirmation of core reservoir and leading power station, controlled drainage area of each complex, average annual runoff, and development mode.

②Complex scale: dam height, normal pool level, dead water level, flood control level, total storage, regulation storage, dead storage, annual energy output, guaranteed capacity, etc.

③ Complex development sequence: construction sequence and implementation time of each complex.

(2) Environment system and major indicators

①Water environment system: hydrology, sediment, water temperature, water quality, etc.

② Ecological environment system: terrestrial ecology, aquatic ecology, important sensitive zones etc.

③ Social environment system: economy, society, resettlement, sustainable development, etc.

The project assessment system is shown in Figure 1-1.

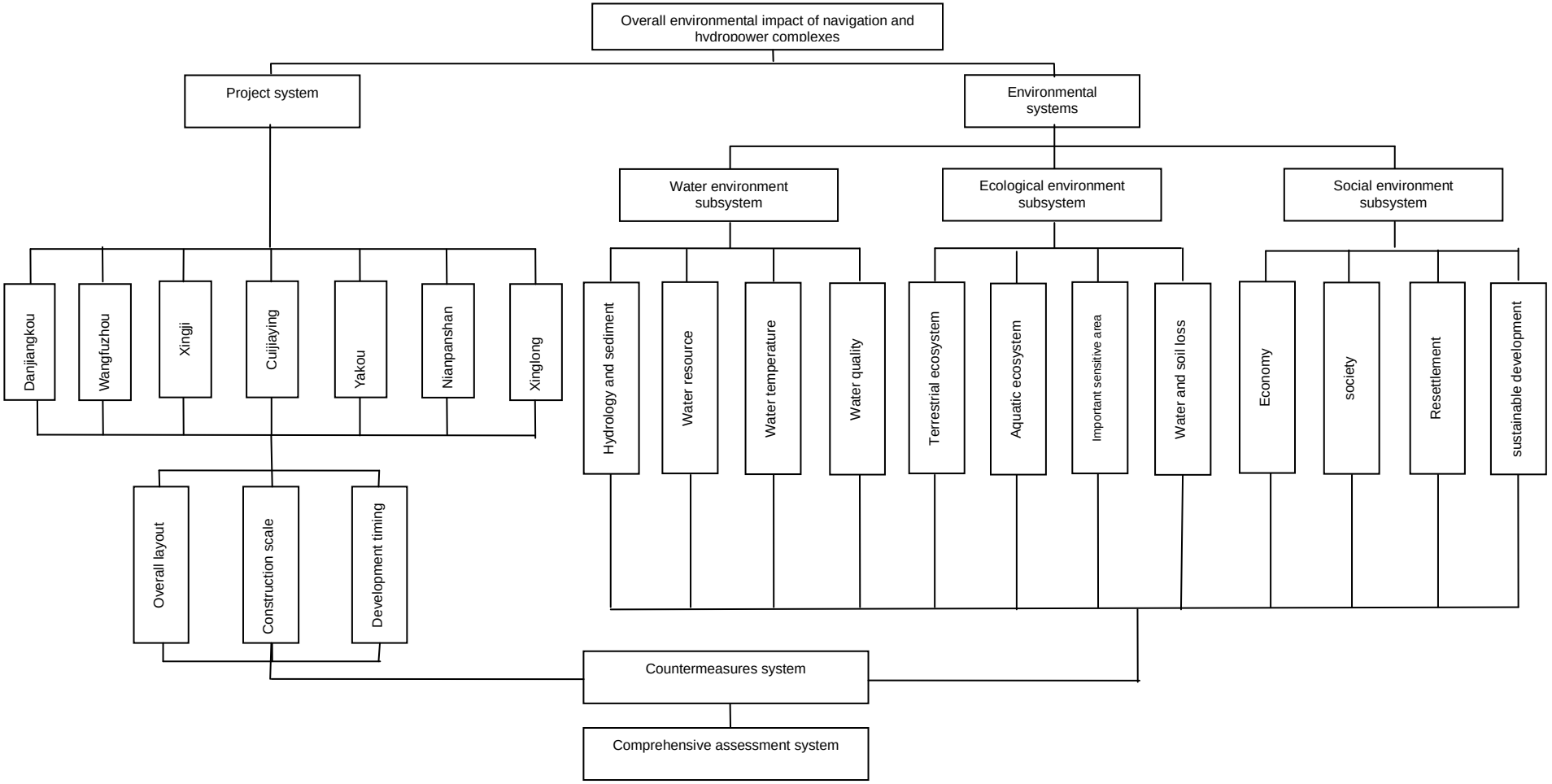


Figure 1-1 Assessment system

7 Progress and budget

The assessment procedures are shown in Figure 1-2.

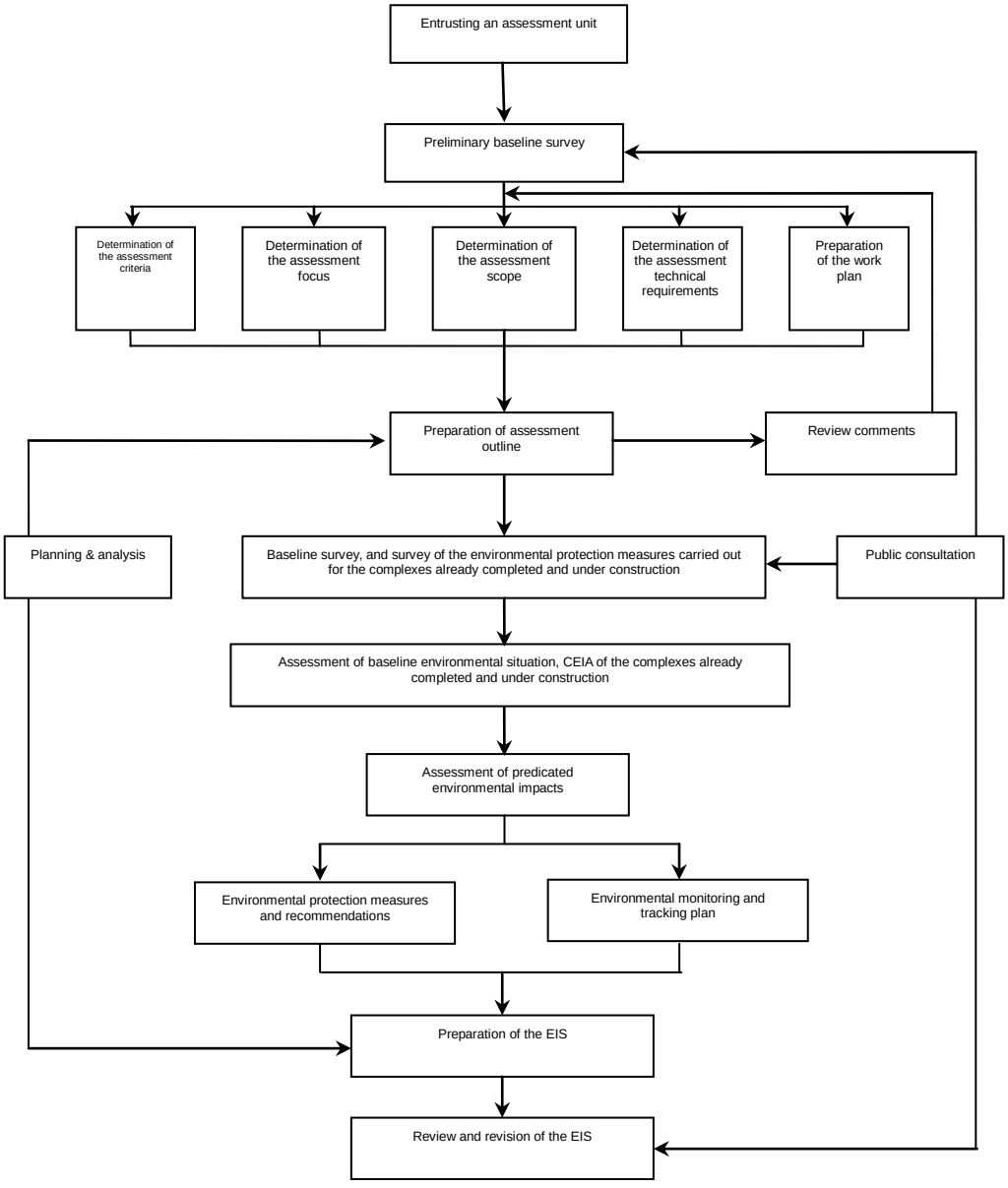


Figure 1-2 Block diagram of CEIA Procedures

8 Progress and budget

This study begins within 30 days after the effective date (October 2016) of the project. It shall be completed no later than December 2019, and shall be at least 6 months before the impoundment of the reservoir. This study is expected to last about 24 months (2 years), with the estimated budget of CNY 3.8 million.

S/N	Main task	Time (month)	Budge (CNY 10,000)
Task 1	Further collection of information and preliminary review of information	1	25
Task 2	Site visits and targeted public survey	1	50
Task 3	Environmental survey and monitoring	6	90
Task 4	Establishment of hydrodynamic force and water quality model	3	45
Task 5	Cumulative impact assessment	8	85
Task 6	Development of mitigation measures	2	40
Task 7	Training	1	25
Task 8	Reporting	2	20
Total		24	380

APPENDIX 7: OUTLINE FOR ECOLOGICAL REGULATION (ER) RESEARCH

Study on Ecological regulation Scheme for Danjiangkou, Main Stream of Han River

1 Objective of ER research

The objective of the project is that: the hydropower development on Han River mainstream below Danjiangkou maintains the ecological sustainability of the downstream area of Han River basin as far as possible based on its social and economic benefits. Through survey, the analysis on the hydropower reservoir characteristics of mainstream of Han River below Danjiangkou and the impact of reservoir regulation of Han River basin on the aquatic ecosystem shall be performed; the ecological protection objects and the required ecological flow process of key river sections shall be identified and preliminarily confirmed; the eco-hydrological demand indicating organisms shall be explored, and the hydropower reservoir regulation scheme during key ecological process indicating the life cycle of organisms shall be established.

2 Content of ER research

(1) Types and functions of hydropower reservoirs in Han River basin. In accordance with the functional classification of reservoirs, such as flood control, power generation, irrigation, navigation, etc., the hydrological factors, hydrological rules and change form of hydrological parameters of upstream and downstream from the dam of various hydropower reservoirs in mainstream of Han River below Danjiangkou shall be studied, and their scope of impact shall be determined.

(2) The impact (including ecological effect) of dam construction and operation on the river environment structure shall be analyzed. Study relevant domestic and foreign data, focusing on changes of the hydrological regime, water temperature, sediment and other environmental factors in the downstream after operation of the hydropower reservoirs, and analyze the impact of changes of environmental factors on the structure and population of aquatic biocenosis. Propose the reservoir regulation method favorable for environmental factors.

(3) The impact of operation of the hydropower reservoirs on the hydrological pattern

in the middle and lower reaches of Han River. By simulating the hydrological characteristics of the hydropower reservoirs under different flood regulation schemes under different water regimens and water conditions, analyze the changes of hydrological characteristics of the hydropower reservoirs under different flood regulation schemes, summarize the impact of different hydropower reservoir operation schemes on the hydrological pattern in the lower reaches of Han River, select suitable flood regulation starting flow, and calculate and propose the preliminary flood regulation process.

(4) The impact of hydrological regime changes on completing the life cycle of key aquatic organisms. Select the indicating organisms to analyze their physiological characteristics and ecological habits, analyze the changes in the hydrological regime after hydropower construction, and analyze the change trends of the structure, quantity, distribution and abundance of the indicating organisms due to changes in the hydrological regime according to historical and surveyed data. Quantify the demand for hydrological process of the indicating organisms at important stages of life, and propose the ecological regulation scheme tailored for completion of the life cycle of the indicating organisms.

3 Technical route of ER research

Through site survey, data comparison, eco-hydraulics and model analysis and other means, compare the impact of hydrological changes under different hydropower regulation schemes in mainstream of Han River below Danjiangkou on rare and endemic fishes and famous domestic fishes; according to the degree of dependence on runoff, water temperature and other key environmental factors of rare and endemic fishes and four famous domestic fishes during the life cycle stages, on the basis of full consideration of the social and economic needs, initially propose the best reservoir regulation scheme which effectively guarantees the rare and endemic fishes and four famous domestic fishes complete the life cycle.

4 Schedule of ER research

Study period: 2016-2017

Schedule:

(1) In early August 2016, carry out bidding to determine the study unit.

(2) In August 2016, begin to survey the structure and population of aquatic biocenosis in the lower reaches of Han River, especially for the hydrological needs of the indicating organisms during the critical life cycle stages. Survey the types and functions of the hydropower reservoirs in Han River below Danjiangkou, reservoir regulation and the use of gate, and simulate the hydrological regime, water temperature, sediment and other environmental factors of the river section in the middle and lower reaches of Han River under different hydropower reservoir regulation schemes. Combined with the flood situation of Tangbai River, carry out the early resource observation of rare and endemic fishes and four famous domestic fishes in the middle and lower reaches of Han River.

(3) Before April 2017, analyze and summarize the hydrological demand of the indicating organisms during the critical life cycle stages, analyze the environmental factor demand of the indicating organisms, propose the flood flow indicators guiding ecological regulation and the flood process, and propose the reservoir regulation methods in line with the critical life cycle stages of the indicating organisms.

(4) From May to August in 2017, timely start ecological regulation and carry out relevant observations.

(5) From September to November in 2017, analyze the regulation effect, and improve the regulation scheme.

5 Budget

The initial budget of this task is CNY 4.60 million, and it is proposed to select 2 DIs and scientific research units to perform the study on ecological regulation test and ecological regulation effect assessment, respectively, with the budget of CNY 2.8 million and CNY 1.80 million, respectively.

APPENDIX 8: WORK PLAN FOR EFFECT EVALUATION OF FISH PASS

Work plan for assessment of fish pass effect

As fishway is a complex project, it is difficult to make the design at one go which fully meets the requirements for long-term dam pass of fishes; if we want to give play to the best effect of fishway, we must track and monitor the practical effect after the fishway is put into operation, and make appropriate changes and improvement to local fishway according to the monitored results.

1 Monitoring method

For the main project, monitor the operation effect of the fishway, perform statistics of the number of passing fishes, identify the fish species, measure the specifications of passing fishes and other detailed parameters, and collect the fishes in the fishway. We can use a fish collection pool built near the fishway to collect fish. The arrangement of fish collection pool is shown in Figure 1.

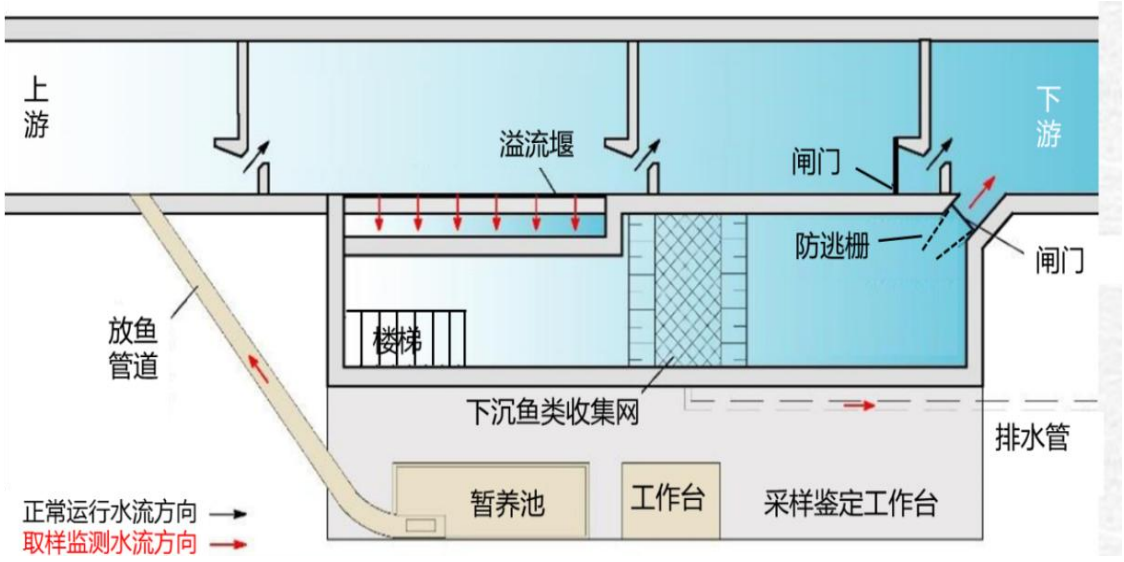


Figure 1 Schematic Diagram of the Fish Collection Pool

上游	Upper reaches
溢流堰	Weir
闸门	Sluice
下游	Lower reaches
放鱼管道	Fish release pipeline
楼梯	Stair
防逃栅	Anti-escape fence
闸门	Sluice
下沉鱼类收集网	Collection network for sunken fish
正常运行水流方向	Normal operation flow direction
取样监测水流方向	Sampling and monitoring flow direction

暂养池	Holding tank
工作台	Workbench
采样鉴定工作台	Sample identification workbench
排水管	Drain pipe

The actual effect after the fishway is put into operation during the trial operation period shall be tracked and monitored, and the monitoring items include: ① fish species; ② number of the fish; ③ size of the fish; ④ growth status of fish; fish passing law at day and night; ⑤ fish in various entrances; ⑥ fish in different operation conditions; ⑦ clusters and distribution of fishes in downstream of the dam.

After formal operation of the fishway, in addition to the above-mentioned monitoring, the behaviors of the fish sailing upstream in the reservoir area shall be tracked and monitored, and the change trends of the fish resources both in upstream and downstream of the dam shall be surveyed and calculated to get an objective assessment on the protection effect of the fishway.

According to the requirements of *Reply to Joint Ecological Operation Plan (trial) of Han River Navigation and hydropower complexes Downstream of Danjiangkou* (EZH [2015] No. 235, the monitoring of fish-pass effect shall be carried out from March to September. From March to May, the monitoring item will focus on up-going fish. From August to September, the monitoring item will focus on down-going fish.

2 Effect assessment

- Rationality of structural design of the fishway pond chamber;
- Rationality of main fishway inlet settings;
- Fish entering effect of the fish collecting and lure system;
- Rationality of fishway outlet settings;
- Other factors affecting the fish pass effect of the fishway?
- What is the relationship between the fish pass effect and the operating mode of the project?

3 Suggestions for improvement

- The structure of the fishway pond chamber shall be adjusted and improved according to the results of fish pass effect and hydraulics monitoring;
- The fishway inlet design and the local design of the fish collection and water

charging system shall be improved according to the results of fish behavior monitoring at the downstream from the dam and analysis on the fish lure ability.

- The operation, management and maintenance procedures for the fishway shall be improved according to the operation situation of the fishway.

4 Budget

The initial budget of this task is CNY 1.80 million