1.General Principles

1.1 Task Origin and Project Background

Wufeng Tangjiahe(the river by the Tang's)llHydroelectric Power Station of Hubei is located in the lower reaches of Yuquanhe River. Yuquanhe River, also named Heitanhe River, is on the right bank of Siyanghe River, Wufeng. It is the largest tributary in Siyanghe River Basin and sub-tributary of Qingjiang River (a tributary of Yangtze River). The river shares the watershed with Wantanhe River, Tianchihe River; it is originated from Beifengya Forestry Farm(the largest state forest farm in Wufeng county), with an altitude of 2213 meter; it flows through Songjiahe (the river by the Song's), Tangjiahe(the river by the Tang's), Hongyuping(name of one of the 16 administrative village of Caihua Township, Wufeng County) and Kuzhuping(name of one of the 16 administrative village of Caihua Township, Wufeng County), and converges into Erchakou Reservoir (water lever: 420m) of Siyanghe River at Erchakou. The total length of the river is 18.26km, and overall elevation difference 1793m. Within the reach in plan, the catchment area measures 99.85km^2, the average annual precipitation is 1474.4mm, the average annual depth of runoff is 938.4mm, the average annual discharge is 3.25m^3/s, and the average annual runoff is 102 million m^3. The theoretical hydroelectric reserve is 13.8 thousand kW, and the corresponding annual hydropower is 121 million kWh.

In the light of the topographical and geological condition as well as the feature of the water cause, Qingjiang Design Institute of Water Conservancy and Hydroelectric Power of Yichang compiled ***Yuquanhe River Basin Hydro-energy Development Planning Report of Wufeng, Hubei*** in January, 2004, and the Bureau of Water Conservancy & Hydroelectric Power of Wufeng Tujia(a national minority in southern China) Autonomous County gave an official approval to the planning report in the Water Conservancy & Electricity Bureau of Wufeng Tujia Autonomous County, No.2 Document / 2004 in Feb 10, 2004. According to the report, the draft River Basin Cascade Development Plan is: Distributing six hydroelectric power stations and one reservoir on the main course of Yuquanhe River, i.e. at the 1400m point of upper stream elevation, the Hongpiao Bay mouth, a power house (elevation 1036m) is to be set up. It features a installation capacity of 2×320kW, and annual electrical energy

production of 2.6783 million kWh. It is to be named Xiejiazhai Hydroelectric Power Station. Spring water power generation is to be used in Liziping, the elevation of outcrop point of spring water is 1445m, and it is planed to channel water from spring opening, and to set up power house in Liziping (elevation: 1040m), with an installation capacity is 2× 400kW, average annual electrical energy production of 3.2173million kWh, and is named Liziping Hydroelectric Station. Water is channeled from Hongpiao bay mouth, which is at the upper reach of Yuquanhe River (elevation: 1036m), and power house is set up at Songjiahe (elevation: 865m), with an installation capacity 2×630kW, and average annual electrical energy production of 5.3876 million kWh, and is named Songjiahe I Hydroelectric Power Station. Water is channeled from Dixi Bay mouth (elevation: 865m), at the upper reach of Yuquanhe River, and power house is established at the end of Tangjiahe Reservoir (elevation: 800m), with an installation capacity of 2×400kW, and average annual electrical energy production of 3.3166 million kWh, and is named Songjia RiverⅡHydroelectric Power Station. There is a subsidiary stream on the right bank of Tangjiahe river reach, where the land form is broad and level, and the strata are all Silurian shale; it is planed to establish a small scale reservoir, whose height is 55m, and capacity 2.07 million m^3. It will impound and regulate water for hydroelectric power stations of all levels in the lower reach, and channel water from the reservoir to Hongyuping Terrace for power station establishment (elevation: 560m); the power station features a installation capacity of 5000+2000kW, and average annual electrical energy production of 23.3067 million kWh, and will be named Tangjiahe Reservoir Hydroelectric Power Station. Water is channeled from Hongyuping, at the lower reach of Yuquanhe River (elevation: 560m), and power house is established on Kuzhuping, the end of Erchakou Reservoir (elevation: 420m); the installation capacity is 2× 2500kW and average annual electrical energy production is 2.20242 kWh; It is named TangjiaheⅡ Hydroelectric Power Station.

To accelerate the development of hydroelectric power and take the lead of regional economic development, Wufeng Yiye Hydroelectric Development Co., Ltd decided to establish hydroelectric power stations along the river by stages. It is initially planned to develop Songjiahe I and Songjiahe Ⅱ Hydroelectric Power Station, Tangjiahe Reservoir

and Hydroelectric Power Stations in stage one. Development and Planning Bureau of Wufeng Tujia Autonomous County officially approved the hydroelectric power development program in the river reach on April 26th, 2004, in the Development Planning Bureau of Wufeng Tujia Autonomous County No.34 Document / 2004.

Environmental protection is a fundamental policy of the country, according to the requirements in ***PRC Environmental Impact Assessment Law*** and ***Administration Catalog of Construction Project Environmental Protection***, Tangjia River‖Hydroelectric Power Station comes under the first category, i.e., "Construction project that may have huge impact on environment", and therefore, environmental impact report must be compiled. On August 5th, 2005, Wufeng Yiye Hydroelectric Development Co. Ltd. commissioned Hubei Xiangfan Environmental Protection Research Institute to undertake the environmental impact assessment work of Hubei Wufeng Tangjiahe River□Hydroelectric Power Station in the form of Commission Letter. In view of the urgent time limit of the project, in the working process, the institute reported to Hubei Environmental Protection Bureau and Yichang Environmental Protection Bureau about the content, depth, focus points, range and standard of the assessment; with the consent of the bureaus' ecology department, the General Outline was permitted to be omitted, and report compilation was initiated directly. After assuming the commission, the institute immediately implemented field investigation, survey, data collection, etc., and carried out full discussion with construction units, design organizations and environmental protection authorities of project locality on issues concerning project and local environmental protection demands; while at the same time, Environment Monitoring Station of Wufeng Tujia Autonomous County was commissioned to conduct necessary monitoring toward environment status quo. In line with the demand of ***Technical Guidelines for Environmental Impact Assessment （HJ/T2.1～2.3-93、HJ/T2.4-95、HJ/T19-1997、HJ/T88-2003）*** and other technical demands, Environment Impact Report of Tangjiahe Ⅱ Hydroelectric Power Station of Wufeng, Hubei (for deliberation) was fully compiled in the end of October, 2005 (refer to as Report for short hereinafter). On Nov 23, 2005, the Report passed examination and appraisal of experts group organized by Hubei Environmental Protection Bureau. In response to their suggestions, the report was revised to submit for approval.

During the process of the Report compilation, energetic supports were given by Yichang Environmental Protection Bureau, Environmental Protection Bureau of Wufeng Tujia Autonomous County, County Environment Monitoring Station, Wufeng Yiye Hydroelectric Development Co., Ltd and other departments and units, we would like to express our gratitude here.

1.2 Assessment Purposes

(1)The construction of TangjiaheⅡHydroelectric Power Station is a commonweal project with notable social benefits, while also brings environmental problems at the same time. The assessment works will be based on the overall consideration of the range and extent of its impacts on ecological and social environment. Emphasis will be laid on rational prediction and qualitative analysis of the main environmental impact factors (including the favorable impacts and unfavorable ones). It will provide the departments in charge with evidences by presenting them the feasibility demonstration of project from the angle of environmental protection.

(2) Objective assessment was carried out on various impacts the project construction will exert on natural and social environment of reservoir area, construction zone and the downstream reach of the reservoir site, and earnest and feasible environment measures and countermeasures were proposed, so as to furthest control and alleviate negative impacts of project construction on environment.

(3)Investment evaluation and profit and loss analysis toward environmental protection measures have been conducted, in order that environmental protection construction and investment of the project can be integrated into project construction; while at the same time, plans of environment administration, monitoring and project supervision have been put forward for the construction and operation periods of the project, with an eye to provide information and scientific foundation for project design and social, economic and environmental plan of the region.

(4)Through environment impact assessment, binding document on environment administration will be worked out – ***Project Environment Impact Report on Tangjiahe II Hydroelectric Power Station of Wufeng, Hubei*** (subsequent to the examination and

appraisal of experts and the approval of environmental protection administrative department in charge), consequently, the environment responsibility of the proprietor of construction project will be specified and implemented, in order that ecological protection, compensation and restoration works will be done well during the construction and operation period, and the principle of "whoever develop must protect, whoever damage must restore, whoever utilize must compensate" will be effectively implemented.

1.3 Foundation of Compilation

1.3.1 Law and Regulation

1) ***Environmental Protection Law of the People's Republic of China (1989)***

2) ***PRC* Environmental *Impact Assessment Law (2002)***

3) ***Law of the People's Republic of China on Prevention and Control of Water Pollution (amended in 1996)***

4) ***Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution (amended in 2000)***

5) ***Law of the People's Republic of China on Prevention and Control of Pollution from Environmental Noise (1996)***

6) ***Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Wastes (amended in 2004)***

7) ***Water Law of the Peoples Republic of China (amended in 2001)***

8) ***Law of the Peoples Republic of China on Water and Soil Conservation (1991)***

9) ***The Law of Land Administration of the People's Republic of China (amended in 1998)***

10) ***Law of the Peoples Republic of China on the Prevention and Treatment of Infections Diseases (1989)***

11) ***Law of the People's Republic of China on the Protection of Wildlife (1988)***

12) ***Forest Law of the Peoples Republic of China (amended in 1998)***

13) ***Regulations of the People's Republic of China for the Implementation of Wild Aquatic Protection (1993)***

14) ***Regulations on the Administration of Construction Project Environmental Protection*** Promulgated by Decree No.253 of the State Council [1998]

15) ***Administration Catalog of Construction Project Environmental Protection*** promulgated by Decree No.14 of EPA

16) ***Forwarded by General Office of the People's Government of Hubei, Notice of Hubei Environmental Protection Bureau on the classification of environmental function of surface water in Hubei*** (No.10 Document of the Government of Hubei / 2000)

17) ***Notice of Improving the Environmental Protection of Hydroelectric Construction by EPA and NDRC No.13 / 2005***

1.3.2 Technical Guide and Regulation

1) ***Guidelines for Environmental Impact Assessment - General Outline, Atmospheric Environment, Surface Water Environment (HJ/T2.1~2.3-1993)***

2) ***Guidelines for Environmental Impact Assessment - Sound Environment (HJ/T2.4-1995)***

3) ***Guidelines for Environmental Impact Assessment - Non-Pollution Ecological Impact (HJ/T19-1997)***

4) ***Guidelines for Environmental Impact Assessment - Water Conservancy & Hydroelectric Project (HJ/T88-2003)***

5) ***Technical Regulation on Water and Soil Conservation Plan of Development and Construction Projects (SL204-1998)***

6) ***General Rule of Planning for Comprehensive Control of Water and Soil Erosion***

(GB/T15772-1995)

7) ***Technical Regulation for Comprehensive Control of Water and Soil Erosion(GB/T16453.1~16453.6-1996)***

1.3.3 Official Approval and Commission Documents of the Project

1) Wufeng Yiye Hydroelectric Development Co. Ltd ***Commission Letter for Implementing EIA for Tangjiahe Hydroelectric Power Station of Wufeng, Hubei*** (see attachment 1)

2) Environmental Protection Bureau of Wufeng Tujia Autonomous County ***Reply to the EIA Implementing Standard for Tangjiahe Hydroelectric Power Station by Wufeng Yiye Hydroelectric Development Co. Ltd No.8/2005*** (see attachment 2)

3) Water Conservancy and Hydroelectric Bureau of Wufeng Tujia Autonomous County ***Reply to the Planning Report of Hydroelectric Development in Yuquanhe River Basin of Wufeng, Hubei Document No.2/2005*** (see attachment 3)

1.3.4 Technical Documents

1) ***Planning Report of Hydroelectric Development in Yuquanhe River Basin of Wufeng*** (Qingjiang Design Institute of Water Conservancy and Hydroelectric Power of Yichang / Jan. 2004)

2) ***FS Report of Tangjiahe Hydroelectric Power Station of Wufeng, Hubei*** (Qingjiang Design Institute of Water Conservancy and Hydroelectric Power of Yichang / July 2005)

3) ***Report of the Water and Soil Conservancy Plan of Tangjiahe Hydroelectric Power Station Project of Wufeng, Hubei***

4) ***Social and Economic Development Plan of Wufeng Tujia Autonomous County***

5) ***Wufeng Tujia Autonomous County "the Tenth Five Year Plan" Environmental Protection and Long-term Planning***

1.4 Assessment Standards

According to the environmental classification of the project area and related regulations of Document No.8 / 2005 of Wufeng Environmental Protection Bureau, the EIA standards of the project are as follows:

1.4.1 Environmental Quality Standards

(1) Ambient air quality standard

Secondary standard of the national ***Ambient Air Quality Standard (GB3095 - 1996)*** will be complied with. See Table 1-1 for details.

Table 1-1 Ambient Air Quality Standard (Secondary) **Unit：mg/Nm3**

Pollutant	TSP	SO2	NO2	CO	Remarks
Annual Average	0.20	0.06	0.08	-	Assessment Period: Construction Period Assessment Object: Assessment Area
Daily Average	0.30	0.15	0.12	4.00	
Hourly Average	-	0.50	0.24	10.00	

(2) Environmental Quality Standards for Surface Water

Grade II Standard of ***Environmental Quality Standard for Surface Water (GB3838-2002)*** is observed. The constructions of the 3km lower reach of the dam conform to the Degree III Standard. Details are as follows:

Table1-2 Environmental Quality Standards for Surface Water (Class II) Unit：mg/L

No.	Class / Standard Value / Parameter	ClassII	Class □	Remarks

1	Water Temperature(℃)	Man caused environment water temperature variation should be limited as: Average week maximum temperature increase ≤1; Average week maximum temperature decrease ≤2		3km stretch of the lower reach of reservoir site follow class III standard during construction period
2	pH	6~9		
3	Total Nitrogen ≤	0.5	1.0	
4	Total phosphorus (By P)	0.1(Lake、Reservoir 0.025)	0.2(Lake、Reservoir 0.05)	
5	Permanganate Index ≤	4	6	
6	Dissolved Oxygen ≥	6	5	
7	Chemical Oxygen Demand (COD) ≤	15	20	
8	Biological Oxygen Demand (BOD_5) ≤	3	4	
9	Ammonia Nitrogen ≤	0.5	1.0	

(3) Sound Environment Standard

Standards in the national ***Standard of Environmental Noise of Urban Area (GB3096-93)*** will be complied with。For details see Table 1-3

Table1-3 Standard Value of Environment Noise Unit：LeqdB(A)

Applied Area	Daytime	Night-time	Remarks
Ⅰ	55	45	Assessment Period: Construction Period Assessment Object: Assessment Area

(4) Standards for Classification and Gradation of Soil Erosion

Standards in the national ***Standards for Classification and Gradation of Soil Erosion (GBSL190-96)*** will be followed.

1.4.2 Emission Standards

(1) Noise Limit Value of Construction Site

Regulations in the national ***Noise limits for Construction Site (GB12523-90)*** will be followed. See Table 1-4 for Details.

Table 1-4 Noise Limit Value at Various Stages of Construction Unit: Leq[dB(A)]

Construction Period	Main Noise Source	Noise Limit Value		Remarks
		Daytime	Nighttime	
Earthwork	Bulldozer, Excavator, Mechanical Loader, etc	75	55	Assessment Period: Construction Period Assessment Object: Construction Site
Pile Driving	Various Pile-driving Machine	85	No Construction	
Structure	Concrete Mixer, Vibrator, Electric Saw, etc	70	55	
Decoration	Crane, Elevator, etc	65	55	

(2) Integrated Wastewater Discharge Standard

Regulations in the national ***Integrated Wastewater Discharge Standard (GB8978-1996)*** will be complied with. For details see Table 1-5.

Table1-5 Integrated Wastewater Discharge Standard (First Grade) Unit：mg/L

No.	Class / Standard Value / Parameter	ClassⅡ	Remarks
1	Water Temperature(℃)	Man caused environment water temperature variation should be limited as: Average week maximum temperature increase in Summer ≤1; Average week maximum temperature decrease in Winter ≤2	Assessment Period: construction period Assessment Object: factory effluent, sanitary waste

2	PH	6~9	
3	SS	70	
4	animal and vegetable oil	10	
6	Ammonia Nitrogen ≤	15	
7	Chemical Oxygen Demand (COD_{cr}) ≤	100	
8	Biological Oxygen Demand (BOD_5) ≤	20	
7	Petroleum ≤	5	

(3) Integrated emission standard of air pollutants

Regulations in the national ***Integrated Emission Standard of Air Pollutants (GB12523-90)*** will be complied with. For details see Table 1-6.

Table 1-6 Integrated emission standard of air pollutants (Second Grade)

Unit：mg/Nm3

Pollutants	TSP	NO_x
Permitted Maximum Emission Density	120	240
Remarks	Assessment Period：Construction Period Assessment Object：Assessment Area	

For detailed corresponding standard values of the above mentioned standards see relevant chapters, and for those environmental factors without assessment standards yet, predictions and analysis can be carried out according to the following different condition: When relevant discipline has a generally acknowledged threshold value of relevance, the threshold value should be used for assessment; for those impact factors without both threshold value and reference standard, impact analysis should be carried out compared with current situation.

1.5 Degree of Assessment Works

In light of the characteristics of the project construction and the environmental feature of the construction area, as well as the relevant regulation of Document No.8 / 2005 of Wufeng Environmental Protection Bureau, it is been determined that the degrees of the project environmental impact works are as follows:

Table 1-7 Division of Assessment Degrees

Assessment Contents	Work Degrees	Foundation
Ecological Environment	III	According to the degree principle in ***Guidelines for Environmental Impact Assessment - Non-Pollution Ecological Impact (HJ/T19-1997)***, the reduction of biological species, biomasses and bio-diversity of the area cause by the construction is far below 50%, which by no mean will lead to disappearance of endangered species; although lands connection develops negatively, the reduction value is below 1/2, which basically will not bring about physicochemical properties degradation of water, soil and land, and there is not any sensitive spot within the area. The impact range of the project construction is less than 20km^2, therefore, it is been determined that the ecological impact EIA grade is III.
Water Environment	III	The main sources of effluent sewage are waste water from the rinsing of sand-gravel processing system, frequent drainage of concrete production system and footing groove; the source of sanitary waste is the domestic water of construction workers; the complexity degree of the quality of sewage ranks at middle level; the hydrological basin scale of surface water is small stream; the water quality conservation demand of construction related area is Class II water standard in ***Environmental Quality Standards for Surface Water (GB3838-2002)***. In line with the relevant grading criteria in HJ/T2.3-93, water environmental assessment grade is III.

Sound Environment	III	The current sound environmental condition of the construction area pertains to I Area, in light with the relevant grading criteria in HJ/T2.4-1995, after the project is complete, noise level will increase by 3~5dB(A), therefore, it belongs to large and medium scale project.
Ambient Air	Simplified III	According to the relevant grading criteria in HJ/T2.2-93, $P_i < 2.5\times10^8 m^3/h$

1.6 Focal Assessment Point

According to the characteristics of the project construction and the environmental features of the construction area, as well as the requirements for environmental protection, the EIA will focus on the ecological environmental impact assessment during the construction period and operation period, as well as the environmental impact during the construction period.

The assessment mainly consists of: project analysis, investigation of general situation of the ambient environment and current situation of the environment quality, surface water EIA, ecological EIA and other environmental impact analysis (such as ambient noise, solid wastes, etc.), prevention and control of pollution and alleviation methods for ecological impact. Besides, atmosphere EIA, environment risk analysis, public participation, environmental controlling and monitoring, and analysis of economic profit and lose of environment, etc. are discussed in the report.

1.7 Assessment Range and Period

According to project feature and the current environmental characteristics of the construction site, it is been determined that the assessment period and assessment range are as follows:

1.7.1 Assessment Period

The environmental impact assessment period of the project comprises construction period,

impoundment period and operation period. The main assessment period for construction area and construction roads is construction period, next is project operation period. The assessment year of status quo is set as 2004, and the assessment level year of prediction is 2008.

1.7.2 Assessment Range

The Tangjiahe Ⅱ Hydroelectric Power Station is a second cascade hydroelectric station regulated by Tangjiahe Reservoir. Hence, the content of the EIA includes Tangjiahe Reservoir, apart from Tangjiahe Ⅱ Hydroelectric Power Station.

The specific assessment range includes construction area, reservoir area and the downstream area of the dam, for the assessment range of various factors see Table 1-8.

Table1-8 Check List of Planed Project Assessment Range

Assessment factors	Assessment Range
Ambient Air	Construction area (consists of dam site, power house construction area, supporting project area, waste disposal area, stock ground quarrying area) and 200m's range of the periphery.
Water Environment	The river segment from the terminal of reservoir backwater to 3km down the dam of Tangjia River Second Cascade Hydroelectric Station, and the river reach of 1km downstream the power house
Ecological Environment	Centered by the project effected area, radiating 2km toward important environment sensitive spots
Sound Environment	1m from the construction site boundary and sensitive spots outside the area

1.8 Objective of Environmental Protection

The construction of the Tangjiahe ⅡHydroelectric Power Station, while generating vast social benefit, it also bring about unfavorable impact on the environment of the affected area.

According to field investigation, no fauna and flora under special state protection exists in the directly affected area of the project construction, but the surrounding distributes sensitive targets of ecological environmental protection that may be indirectly influenced.

Due to the project feature and environmental characteristics of the affected area, it is been determined that the primary damage control and protection targets are list in Table 1-9:

Table 1-9 Damage Control and Environmental Protection Targets

Protection Targets	Key Object	Explanation
Environmental Quality of Surface Water	The river segment from the terminal of backwater to 3.7km down the dam of Tangjiahe □ Hydroelectric Power Station	Maintain or better than Class II Water Quality
Land Resource	The project perpetually occupies river beach 21.25mu, tea plantation 2mu, barren mountain 16.6mu, cultivated land 4.68mu; temporarily occupies river beach 12.67mu, tea plantation 1.1mu, barren mountain 2.3mu, cultivated land 0.45mu	Logically allocate permanently occupied land and temporarily occupied land for construction, so as to furthest reduce occupation and influences, and prevent new water loss and soil erosion during the project construction and operation period.
Ecological Environment	Protect existing forest and farm land of reservoir zone	For the occupied and undermined cultivated land and forest land caused by project construction, earnest and effective ecological compensation and restoration measures should be adopted. The connectivity of landscape, bio-diversity, and the intactness of ecological system should be maintained.
	Aquatic life	
Atmospheric Environment	Air quality of project construction zone and the vicinity of transportation roads within or outside the zone.	Meet the demand of secondary standard of ***Ambient air quality standard (GB3095-1996)***
Water Loss and Soil Erosion	Project affected area	The usage rate of project waste top soil plough horizon is above 90%, the restoration rate of plants reaches 80% and water loss and soil erosion control rate goes as far as 90% in the

		construction zone, which control the water loss and soil erosion volume of the project zone to an extent that below that prior to project construction
Human Health	Residents neighboring the reservoir and construction workers	Prevent the outbreak of various infectious diseases, protect the health of residents neighboring the reservoir and construction workers

2. Project Overview

2.1 Overview: Water Resource Development Plan of Yuquanhe River Basin

Yuquanhe River (Heitanhe River) is on the right bank of Siyanghe River, Wufeng. It is the largest tributary of Siyanghe River Basin and sub-tributary of Qingjiang River (a tributary of Yangtze River). The river shares the watershed with Wantanhe River, Tianchihe River; it is originated from Beifengya Forestry Center (the largest state forest farm in Wufeng county), with an altitude of 2213 meter; it flows through Songjiahe (the river by the Song's), Tangjiahe (the river by the Tang's), Hongyuping (1 of the 16 AVs of Caihua township, Wufeng County) and Kuzhu Ping(name of one of the 16 villagers Committees of Caihua township, Wufeng County), and converges into Erchakou Reservoir (water lever: 420m) of Siyanghe River at Erchakou. The total length of the river is 18.26km, total difference of height 1793m. The upper reach originates from Congyuan Mountain and flows to Songjiahe Dixi Bay mouth, with a length of 6.7km, elevation from 2213m to 870m, difference of height 1343m, and river gradient 11.7%; the middle reach of the river is from Dixi Bay mouth to Hongyuping, with a length of 6.96km, elevation from 870m to 565m, and river gradient 6.3%; and the lower reach of the river is from Hongyuping to the end of Erchakou Reservoir, with a length of 4.6km, elevation from 565m to 420m, and river gradient 4.9%. The river reach flowing through Songjiahe area sees Ordovician limestone exposure, which occupies 1.3km of the channel. The river reach flowing through Yuquanhe area sees Permian limestone exposure that along 2.7km of the river course, limestone exposure area accounts for 30% of the river basin area. Within the reach in plan, the catchment area measures 99.85km^2, the average annual precipitation is 1474.4mm, the average annual depth of runoff is 938.4mm, the average annual discharge is 3.25m^3/s, and the average annual runoff is 102 million m^3. The theoretical hydropower reserve is 13.8 thousand kW, and the corresponding annual hydropower is 121 million kWh.

Yuquanhe River Basin is abundant in water resource. According to the development plan, the installed capacity of the power station in the river basin will reach to nearly 20,000 kW upon full development. At present, there are only three hydroelectric power stations that are planned to develop: they are Erchakou Hydroelectric Power Station (main stream), Baiyi

Ping Ⅰ Hydroelectric Power Station (tributary) and Baiyi Ping ⅡHydroelectric Power Station (tributary). Due to financial reasons, only Baiyi Ping Ⅱ Hydroelectric Power Station has been completed and put into operation, Erchakou Hydro Power Station and Baiyi Ping Ⅰ Hydro Power Station are now in the planning stage. In order to effectively make use of the rich hydropower resource of Yuquanhe River Basin, and meet the demand of national economic development, Hubei Wufeng Yiye Hydropower Development Co., Ltd. , according to the characteristics and conditions of the river, plans to develop the water resource on the main stream of Yuquanhe River and commissioned Qingjiang Design Institute of Water Conservancy and Hydroelectric Power of Yichang to compile ***Yuquanhe River Basin Hydroelectric Development Planning Report of Wufeng, Hubei*** in January 2004. The Water Conservancy & Electricity Bureau of Wufeng Tujia Autonomous County gave an official approval to the planning report in ***the Water Conservancy & Electricity Bureau of Wufeng Tujia Autonomous County, No.2 Document / 2004*** in Feb 10, 2004.

Yuquanhe River Basin Hydroelectric Development Planning Report of Wufeng, Hubei is based on topographical and geological condition of the Yuquanhe River Basin. According to the Report, it is to distribute six hydroelectric stations and one reservoir on the main stream of Yuquanhe River, i.e., at the 1400m point of upper stream elevation, the Hongpiao Bay mouth, a power house (elevation 1036m) is to be set up. It features an installed capacity of 2×320kW, and annual electrical energy production of 2.6783 million kWh. It is to be named Xiejiazhai Hydroelectric Power Station. Spring water power generation is to be used in Lizi Ping, the elevation of outcrop point of spring water is 1445m, and it is planed to channel water from spring opening, and to set up power house in Lizi Ping (elevation: 1040m), with its installed capacity is 2×400kW, average annual electrical energy production of 3.2173million kWh, and is named Lizi Ping Hydroelectric Station. Water is channeled from Hongpiao bay mouth, which is at the upper reach of Yuquanhe River (elevation: 1036m), and power house is set up at Songjiahe (elevation: 865m), with its installed capacity is 2×630kW, average annual electrical energy production of 5.3876 million kWh, and is named Songjiahe Ⅰ Hydroelectric Station. Water is channeled from

Dixi Bay mouth (elevation: 865m), at the upper reach of Yuquanhe River, and power house is established at the end of Tangjiahe Reservoir (elevation: 800m), with an installed capacity of 2×400kW, average annual electrical energy production of 3.3166 million kWh, and is named SongjiaheⅡHydroelectric Power Station. There is a tributary ditch on the right bank of Tangjiahe reach, where the land form is broad and level, and the strata are all Silurian shale; it is planed to establish a small scale reservoir, whose height is 55m, and storage capacity 2.07 million m^3. It will impound and regulate water for reservoirs of all levels on the lower reach, and channel water from the reservoir to Hongyuping, so as to establish power station (elevation: 560m); the power station features an installed capacity of 2× 3200kW, and will be named Tangjiahe I Hydroelectric Station. Water is channeled from Hongyuping, at the lower reach of Yuquanhe River (elevation: 560m), and power house is established on Kuzhuping, the end of Erchakou Reservoir (elevation: 420m); the installed capacity is 5000+2000kW and average annual electrical energy production is 2.20242 kWh; It is named Tangjiahe Ⅱ Hydroelectric Power Station.

According to the collection of relevant information and field investigation, the elevations of channels of all the hydroelectric power stations and the interval between stations on the Yuquanhe River Basin are as follows. See Table 2-1.

Table 2-1 Interval and Elevation Table of Various Power Station Along Yuanquanhe River Basin

No.	Name	Interval between Stations (m)	Distance to the inlet of Siyanghe River	Elevation (m)	Location of the River	Remarks
1	Xiejiazhai Hydroelectric Power Station	0	18450	1036	Main stream	Current Planning, 2nd Phase Project
2	Liziping Hydroelectric Power Station	600	18550	1040		Current Planning, 2nd Phase Project

3	Songjiahe □Hydroelectric Power Station	2750	17950	865		Current Planning, 1st Phase Project, Completed
5	Songjiahe □Hydroelectric Power Station	1000	15200	800		Current Planning, 1st Phase Project，in construction
6	Tangjiahe □Hydroelectric Power Station	5600	9600	560		Current Planning, 1st Phase Project, inbuilt
7	Tangjiahe □Hydroelectric Power Station	4600	5000	438		Current Planning, 2nd Phase Project
8	Erchakou Hydroelectric Power Station	5000	0	440(tail water motherboard)		Former Planning, to be built
9	Baiyiping□Hydroelectric Power Station		10100	570 (tail water bottom slab)	Tributary	Former Planning, Completed

Remark: The distance between stations on the tributary refers to the distance from the place where tributary runs into Yuquanhe River to Xiejiazhai Hydroelectric Power Station, and the distance to the inlet of Siyanghe River refers to the distance from the place where tributary runs into Yuquanhe River to the inlet of Siyanghe River.

According to the table above, the development plan, takes full advantage of the hydropower data, converges the heads and tails of the stations as much as possible when distributes the stations of different cascades. In order to speed up the progress of hydropower development and promote regional economic development, Wufeng Yiye Hydropower Development Co., Ltd. plans to divide the construction of hydroelectric power stations along the river basin into phases. In the first phase, the development of a Songjiahe Ⅰ Hydroelectric Power Station (diversion-type, non-regulation， completed), Songjiahe Ⅱ Hydroelectric Power Station (diversion-type, non-regulation, under construction), Tangjiahe Reservoir (proposed), and Tangjiahe Ⅰ Hydroelectric Power Station (diversion-type, partial yearly regulation, inbuilt) will be carried out. The project is in the second phase, the

second phase development includes Xiejiazhai Hydroelectric Power Station (diversion-type, non-regulation), Liziping Hydroelectric Power Station (diversion-type, non-regulation), Tangjiahe Ⅱ Hydroelectric Power Stations (diversion-type, runoff regulation hydroelectric power station). For details of the development and planning of the Yuquanhe River Basin see Table 2-1.

To sum up, while planning to build Tangjiahe Reservoir and Tangjiahe ⅠHydroelectric Power Station, the construction of Tangjiahe Ⅱ Hydroelectric Power Stations is carried out simultaneously, which is in line with the development planning of the water resource of the river basin.

2.2 Project Location

Wufeng Tujia Autonomous County of Hubei Province is located in the southwest mountain area of Hubei Province, a branch of Wulingshan Mountain. It extends from 110°17′ to 115°25′ east longitude and from 29°57′ to 30°25′ north latitude, with a length of 98km from the east to the west and 54.3km from the north to the south. It neighbors Yidu City and Songzi City on the east, Badong and Hefeng County on the west, Shimen County of Hubei Province on the south and Changyang Tujia Autonomous County on the north. No.125 National Highway runs through the county, and Wufeng township is 390km away from Wuhan, the capital of Hubei and 190km away from Yichang City.

Tangjiahe Ⅱ Hydroelectric Power Station Project is located in Kuzhuping, Caihua township, Wufeng Tujia Autonomous County, at the outlet of Yuquanhe River; it is the last cascade development of the hydroelectric stations on Yuquanhe River Basin, and the second cascade hydroelectric power station of the Tangjiahe Reservoir regulation process. Tail water from the station meets back water from Erchakou Reservoir (438m storage level). The dam is located at the 300m point downstream Baiyiping Hydroelectric Power Station, and 30km away from the Wufeng County. The power house is located in Kuzhuping downstream the Yuquanhe River, 35km away from Wufeng township, and has a very convenient transportation. The project mainly comprises water diversion works, diversion structure,

power house and booster stations, etc. For specific locations see Table 2-2.

2.3 Project Task, Scale and Mode of Operation

2.3.1 Project Task

The project is the second cascade hydroelectric power station regulated by Tangjiahe Reservoir. Its main function is to generate electricity and trap sediment to some degree and at the mean time, take the task of system peak regulation and emergency duty at the period of low water level. The installed capacity of the power station is 2×2500kW, and the designed multi-year average power generation is 18,270,900 kWh (including the additional electricity output of 5,232,400 kWh by reservoir regulation), with an annual utilization hours of 3654h, being the base load in the system. Upon the operation of the power station, it will meet the demands of industrial and agricultural production and people's life in the township, and at time of high water, the additional electricity will supply the Grid.

2.3.2 Project Scale

(1) Water-intake Project

The diversion structure includes bottom trash rack dam and detritus pit on the head of the canal. The designed diversion flow rate is 5.5m^3/s. It adopts gravity dam whose elevation is 560m. The top elevation of the bottom trash rack dam is 561.10m, the top elevation of the weir dam 561.45m, and the length of the dam block 37m. the crest overflowing depth is 5.55m , then the design flood level is 569.83m; in examination, the crest overflowing depth is 6.59m, then the examination flood level is 570.87m.

Supplement: The Planned Tangjiahe Reservoir (not a component of this project)

The dam type of Tangjiahe Reservoir is concrete face rockfill dam, with the top dam height of 54.44m, total storage capacity 2.3964 million m^3, and an installed capacity of 2 × 3200kW. According to national ***Standard of Flood Control (GB50201-94)***, the project is a small scale (I) reservoir project, a Grade □ project; The grade of main buildings is 4, and

the grade of secondary buildings and temporary buildings 5. The water retaining structure is a concrete face rockfill dam. The reservoir is designed for flood of "50 year return period", and examined for flood of "500-year frequency". The power house of the power station is designed for flood of "50-year frequency", and examined for flood of "100 year return period".

The storage capacity of Tangjiahe Reservoir at normal storage level is 2.0696 million m^3, storage at dead water level (774m) 113.6 thousand m^3, regulating storage 1.956 million m^3, storage coefficient β=3.63%. It is a partial yearly regulating reservoir.

(2) Diversion Project

① Diversion tunnel: The diversion tunnel is divided into seven parts, whose length is respectively 642m, 1230m, 396m, 1647m, 324m, 651m, 67m, with an overall length of 4957m and design diversion flow rate is 5.25m^3/s.

②Open channel: Open channel is divided into two parts: channel head section and channel tail section. The length of channel head section is 440m, channel tail section 225m ,and the design diversion flow rate is 5.25m^3/s.

③Pressure Forebay:

The pressure forebay is 2.2m in width and 8m in length, and its characteristic levels are as follows: the normal water level of former chamber is 562.50m, the top water level of the former chamber 563.60m, and the lowest level 560.50m. The coping elevation of the side wall of the former chamber, the intake chamber and the pressure wall is 564.10m, the button elevation of intake chamber 557.88m, and base plate elevation of the former chamber 557.38m. The intake chamber is 2m in width; the former chamber is 9.0m in width and 32.5m in length, and the intake chamber 4.3m in length.

④The main pressure pipe：the total length of the main pressure pipe is 256.08m, and the proposed pipe diameter is 1.25m.

(3)Powerhouse and Booster Station

①Powerhouse:

It is proposed to install two HL100-WJ-84 water turbines, two SFW2500-8/1730 horizontal shaft generator units, and two YT-1000 speed governors. The total installed capacity of the power station is 2×2500kW, and installed flow rate 5.25m^3/s, the multi-year average generation 18.7013 million kWh (including the additional generation value of 5.2324 million kWh by reservoir regulation). The annual utilization hours are 3654h, rated head 133.34m and power station tail water level 438.00m.

②Booster Station:

The booster station measures 20m in length and 10m in width, installed with a main power transformer of Model No. S9—6300/35.

(4)Main Project Quantities

For detailed project quantities of permanent buildings of Yuquanhe River Ⅱ Hydroelectric Power Station Project see table 2-1.

Table 2-2 Permanent buildings

No.	Items	Unit	Amount	Remarks
1	Open-cut Earth-Rock	m^3	2.96×10^4	
2	Cave-cut Earth-Rock	m^3	2.49×10^4	
3	Earth-Rock Filling	m^3	1.30×10^4	
4	Concrete	m^3	4.64×10^3	
5	Plaster	m^2	1.23×10^4	
6	Reinforcing Steel Bar	t	48.96	
7	Curtain Grouting	m	168	

2.3.3 Mode of Operation

Generally, the process for hydroelectric projects comprise impoundment---power generation---discharge.

(1)Storage and runoff regulation

Tangjiahe Ⅱ Hydroelectric Power Station is a second cascade hydroelectric power station of the Tangjiahe Hydropower Works Project. Its storage project is the proposed Tangjiahe Reservoir. Thus, after the construction of the whole works, Tangjiahe Ⅱ Hydroelectric Power Station will be regulated by the upstream Tangjiahe Reservoir. However, if Tangjiahe Reservoir is postponed, Tangjiahe Ⅱ Hydroelectric Power Station is actually a runoff-style hydropower station without storage function. Therefore, the project has respectively two operation modes before and after the completion of the Tangjiahe Reservoir:

□ Runoff Regulation Approach of Storage-Type Power Station

The storage capacity of the supporting Tangjiahe Reservoir at normal storage level is 2.0696 million m^3, storage capacity at dead water level 113.6 thousand m^3, regulating storage 1.956 million m^3, and storage coefficient β=3.63%. It is a partial yearly regulation reservoir. According to FS report, the runoff regulating flow rate (P = 85%) Q = 13.34m^3 / s.

□ Operation mode of Non-Regulation Hydroelectric Power Station

If Tangjiahe Reservoir is postponed, Tangjiahe Ⅱ Hydroelectric Power Station is a runoff-style hydropower station. In accordance with the recommended computing methods of Non-Regulation Hydroelectric Power Station from ***Regulations of Small Hydropower Design(SL76-94)***, the power generation flow (Q) at different frequencies is at 0.49~7.64 m^3/s when the loss of water assumed as 5%.

□ Flood Regulation and Flood Control Security

As there is no requirement of flood control on the lower reach of Tangjiahe Ⅱ Hydroelectric Power Station, and at the same time, the water intake dam of the station plays the role of retaining water, not flood control, with no limitation on the discharge volume of the flood, the dam has no function of flood regulation. Therefore, the flood control task of Tangjiahe Ⅱ Hydroelectric Power Station Project is: ensure the flood control safety of the project and the normal operation of the powerhouse.

According to national ***Standard of Flood Control (GB50201-94)***, this project is a Grade □ project, and the grade of main structures is five. The water retaining structure is a cemented masonry dam whose height is less than 15m, so it is designed for flood of "10 year return period", and checked for flood of "20 year return period"; the power house is designed for flood of "30 year return period", and checked for flood of "50 year return period".

The intake dam of the power station plays the role of water retaining, not flood control. There is no limitation on the discharge volume of the flood. The design flood level and the check flood level are in accordance with the condition of the weir dam. For the characteristics of its water level see table 2-2.

Table 2-3 The Characteristics of Water Level Unit: m^3/s

Name	Design Flow Rate at Flood Peak (m^3/s)	Design Flood Level (m)	Check Flow Rate at Flood Peak (m^3/s)	Check Flood Level (m)
Intake Dam	347	564.47	415	564.78
Powerhouse	558	441.50	808	442.00

(2) Power Generation and Tail Water

The installed capacity of Tangjiahe II Hydroelectric Power Station is 2×2500kW, and the multi-year average power generation is 18.2709 million kWh (including the additional power generation of 5.2324 million kWh by reservoir regulation), with an annual utilization hours of 3654h. The firm capacity when P=85% is 958kW.

The power house of Tangjiahe Ⅱ Hydroelectric Power Station is located at the end of the Erchakou Hydroelectric Power Station, with a water head of 114m, and it features a mixed-flow turbine. The normal water storage level of the Erchakou Hydroelectric Power Station is 440m. In order to take full advantage of the drawdown depth of the Erchakou Reservoir, the tail water level of Tangjiahe Ⅱ Hydroelectric Power Station should be furthest less than 440m.

2.4 The General Layout of the Project and the Main Structures

2.4.1 The General Project Layout

Tangjiahe Ⅱ Hydroelectric Power Station is a hydropower project concentrating on power generation. It comprises intake works, diversion structures, ground powerhouse complex (power house and booster station) and supporting projects, etc.

(1) Diversion Project Layout

The intake dam of the project is located at the place 0.3km upstream the Yuquanhe River Bridge (to the Baiyizhai Highway Bridge). The riverbed of the dam site is relatively narrow, with an elevation of 751 ~ 756m. The river flow direction is about 320 °, and the width of the river bed is around 7 ~ 10m, the valley has an asymmetric "V"-shape.

The diversion works consists of bottom trash rack dam and detritus pit on the channel head. According to topographical conditions, the bottom trash rack dam is positioned at 150m downstream of the Baiyizhai Mineral Water Factory Bridge, the right bank of the lower reach of the spring mouth. The bottom trash rack dam has a control gate which can collect tail water from Baiyiping Ⅰ&Ⅱ Hydroelectric Power Station and Tangjiahe Reservoir; The detritus pit is positioned on the stream terrace downstream of the left bank bottom trash rack dam. The bottom trash rack dam and the detritus pit are connected with a culvert of 73m

to prevent flood from entering the channel. As the water flow carries large amount of sediment, the longitudinal slope of the culvert is 1/500.

(2) Layout of Diversion Projects

The diversion structure comprises an open channel, a tunnel, a pressure fore bay, and pressure pipeline. It connects detritus pit of intake works on the upper side and powerhouse on the down side. The design of the channel system is mainly tunnels in accordance with the topographical and geographical characteristics of the project.

The water diversion project starts from the end of the detritus pit, with an open canal and six tunnels. According to geological conditions, all the tunnels use C15 concrete floor. To ensure the integrity and freshness of the surrounding rocks, the project design of the inlet and outlet of the tunnel utilized furrowed-landform and the axis of the tunnel is moved for about 30m closer to the mountain massif. The ventilation and waste disposal during construction will use construction branch tunnel.

The fore bay is positioned following the slope hypsometric curve, and forming a 47 ° 12'22 " angle with the axis of No.6 tunnel, piles number 4+016~4+035 are arc shaped transition section which extends from the bottom of the tunnel of 2.0m in width to the fore chamber of 4m in width. The bottom slope changes from 1/1500 to 1/5, and the elevation decreases from 554.286m to 550.500mm.

The pressure pipes that are used to connect the pressure forebay and the powerhouse are laid along the ridge. The arrangement of the pressure pipes is a joint water supply system. From the former basin to the powerhouse, the pressure pipes are arranged in a straight line. The pressure steel pipes of the power station are of complex pipe types. The branching pipes are crescent-rib reinforced wye piece, arranged 6° angle of spread against the main pipe.

(3) Powerhouse Complex Layout

The powerhouse is on the river beach of the lower reach to the Kuzhuping Bridge. The powerhouse is a diversion-type ground powerhouse, with an in stalled capacity of 5MW. The auxiliary powerhouse is positioned at the elevation of 439.05m, with a height of 4.65m.

There are eleven high voltage switch cabinets arranged in a straight line in the high voltage switch room, and the central control room is located on the right side. The booster station is close to the road and on the lower reach side of the powerhouse. The terrace elevation is 442.30m. For the general floor chart of the powerhouse see Chart 2-5.

2.4.2 Main Structures

Before the completion of the Tangjiahe Reservoir, Tangjiahe Ⅱ Hydroelectric Power Station is a runoff-style hydropower station with an installed capacity of 5000kW. According to the provision 6.1.1 of national ***Standard of Flood Control (GB50201-94)***, the project is a GradeⅤproject and the grade of supporting hydraulic structures is 5 (including intake hub, diversion structure, powerhouse and booster station, etc.). According to the grade of the project, the standards of flood control are as follows: the intake dam is designed for flood of 10 year return period, and checked for flood of 20-year frequency, the powerhouse is designed for flood of 30 year return period, and checked for flood of 50 year return period.

(1) Water-intake Structures

Water intake structures mainly consist of two structures: the bottom trash rack dam and the channel head detritus pit.

The bottom trash rack dam: the length of the dam is 37m, and the elevation of the top of the dam 561.10m, the elevation of the top of the weir dam 561.45m. The detritus pit is 50m in length, 2.5m in width and 3.4m in depth. It has a sand sluicing gate and the desalting canal is 8m in length.

(2) Diversion Structures

The diversion structures comprise open channel, tunnel, fore bay and pressure pipe, and so on.

Open Channel: It is 145m in length, with rectangular water carry section and stone blocks

structure with cement mortar. The water carry section is of cement-mortar plastering, with a roughness coefficient of 0.014. The water carry section is 2.5m in width, 1.5m in depth and the longitudinal slope is 1/1500. The ventilation and waste disposal during construction utilizes construction sub tunnel, which is 1.5m in width and 1.8m in height.

Pressure fore bay consists of arc shaped transition section, fore chamber, intake chamber, pressure wall, down flow weir, side channel, and sluice channel, etc. The curvature radius of the transition section R=15.562m, with arc length of 12.822m. The arc section is part of the fore chamber that has a overall length of 53.96m (including the transition section). The fore chamber is connected with the intake chamber whose bottom elevation is 551.00m, 0.5m higher than the bottom slab of the former chamber. The intake chamber is 2.5m in width, and it has a trash rack. There is a bulkhead gate on the pressure wall. The elevation of the top of the fore bay external wall is 556.8m and it is designed to be a practical weir crest which is used for overflow in the entire process. It is 50m in length and the depth of overflow stream is 0.14m. Outside the dike there is a side channel that collects the waste water from power generation process to the sluice channel, and then to river course. The sluice channel is 165m in length, 2.0m in width, 1.2m in depth and it has a stone blocks structure with cement mortar.

Penstock: The length of the penstock is 311.81m, diameter of the main pressure pipe 1400mm, and the design power generation flow is 5.35m^3 / s. The diameter of the pipe branch, conversing by "pipes equivalent method", is 1.13m; it has a length of 13.70m and calculated wall thickness of 8mm. The wall thickness of the branch taper pipe is16mm

(3) Powerhouse and Switching Station

The plant area consists of main and auxiliary powerhouse, booster station and flood wall, etc.

TangjiahellHydroelectric Power Station has two generators, and the installed capacity is 5000kW. The main powerhouse comprises a machine hall and an erecting yard, with a length of 30.4m and a width of 12.0m. The size of the auxiliary powerhouse is 14.91m×5.1m and the dimension of the central control room is 9.09m×5.1m.

A 6300KVA transformer is installed in the booster station whose dimension is 24.0m in

length and 18.0m in width.

(4) **Supporting Projects**

□Electricity

After voltage boostering, Tangjiahe II hydroelectric power station was connected to the 110kV Siyanghe electric power substation through 35kv transmission line. This substation adopted multi-generator-transformer unit connection, with two electric motors and one transformer, model number for the motors, main transformer and generator outlet are respectively SFW2500—6/1430, S9—6300/35 and YJV22—6 - 120. Equipped with a computer monitoring system, the station employs unattended operation and has few people on duty. The station has two transformers, each as the other's alternative, one connected to 35kv generatrix and the other 6.3kv generatrix, their models are S9—50/35 and SC-100/10 respectively. The substation uses 380V/220V tri-phase four-wire transformer system. The electricity of the dam area comes from Tangjiahe I Hydroelectric Power Station and is sent through a 380v wire.

②Metallic structure

According to project layout, bottom trash rack dam is adopted, the length of the rack bar is 1.4 m, and interval of the rack bars is 1cm. The area of pressure fore bay trash rack is 2.5×6.5, the rack bar is made of 50×8 flat steel and 56×56×8 angle steel, and interval of the rack bars is 30mm, cleaning by hands. The emergency gate is made of PGZ1.5×1.5m cast iron, with a LQ-10 headstock gear, 2.2kw power. Tail water gate's initial choice is SPZ-C2.4×2.1 plane cast iron sliding gate, two-way watertight, weighing about 2.40t. Equipped with a LQ-5 manual-electric worm-type open-close machine, total length of the worm is 5m; in order to save project investment, stainless steel cat ladder is set at the inner side of the flood wall as the passage for open-close machine.

□Fire Control

Power station architecture includes dam area, powerhouse and booster station. According to the priority of production place, risk of fire, the fire-resisting grade of the architecture is class D grade two. According to the relevant articles of ***Code for Fire Protection Design***

of Buildings, the utmost fire-resisting limit of architecture and components burning performance should meet the code. In accordance with the fire prevention interval and safe evacuation requirements, there are two exists in the generator hall, central control room and switch room each. The main passage should be wider than 1.2m, evacuation gate clear width is over 0.9m, with the gate open to the evacuation direction, excitation transformer and plant transformer are both dry-type. Integrating the lay-out of the generator hall of power station, there is single automatic direct current jacklight as well as evacuating signal in each main passage, fire control measures are adopted specific to the features of each architecture and equipment.

2.5 Project Construction Arrangement and Progress

2.5.1 Construction Condition

(1) Off-site transportation

Located in the Caihua village, Tujia Autonomous County of Wufeng, Wuniu Highway runs through the project area of Tangjiahe II Hydroelectric Power Station, the dam is situated 300m downstream of Baiyiping Hydroelectric Power Station, 30km off Wufeng town. The plant stands in the Kuzhuping of the lower reach of Yuqiuanhe River, boasts convenient transportation.

(2)On-site transportation

This project mainly relies on road transportation, external transportation utilize Wuniu Highway, since the dam and powerhouse are near the Wuniu road, there is no need for new road construction to meet the transportation requirements of the construction of retaining dam, powerhouse complex construction and equipment transportation.

Besides, temporary roads of 4km long will be built to the intake of each tunnel. (For more details, please refer to the transport map)

(3)Construction Water and Electricity Usage

Since the project scale is relatively small and hydraulic structures are dispersed, the construction of Tangjiahe II hydroelectric power station gives priority to machine and assisted by manpower.

The construction water for the intake dam is supplied by Baiyiping II Hydroelectric Power Station; other architecture construction water depends on water pump.

Construction electricity demand reaches the top load during the tunnel excavation period, that is 500kVA, voltage of 220/380V, which is supplied by the system.

(4)Conditions for Project Layout

The disposition of Tangjiahe Ⅱ Hydroelectric Power Station construction site is mainly 2 points linear layout, that is: The 2 points refer to diversion works construction area, fore bay, pipeline, powerhouse, construction area of booster station, and the linear layout stands for construction area of diversion tunnel. The construction from the diversion works to the exit of No.1 tunnel or the entrance of No.2 tunnel can utilize the sites of Baiyizhai Mineral Water Plant and Haiyiquan Hydroelectric Power Station to build warehouse, workshop and work shed, etc.; The exit of No.2 tunnel and entrance of No.3 tunnel can use wasteland to build work sheds; the exit section of No.3 tunnel and the water inlet of No.4 tunnel can also build worked shed taking advantage of slope wasteland; The exit of 4# tunnel and entrance of 5# tunnel may rent houses own by citizens in Zhujiatai; The construction of 6# tunnel's exit, fore bay, pipeline, powerhouse, and booster station can choose terrace that nears the pipe chase or at the powerhouse to erect work shed, material processing workshop or to rent surrounding houses own by citizens.

The construction of the project is small scaled and scattered, so the plants should not built in a concentrated manner. Thus according the construction layout, diversion works steel bar processing plant should be built at Baiyizhai Mineral Water Factory. The tunnel needs no steel bar. Steel bar processing required by the fore bay and powerhouse should be arranged in work sheds in powerhouse area, so the demand of project will be met, and end product transportation difficulty will be eased.

(5) Building Materials

①cement

This project totally needs 2122 ton's cement. Yuyangguan Cement Factory in Wufeng county can meet the requirements of both the quality and quantity.

②Raw Steel Material

The project needs only a small amount of raw steel material, which therefore can be supplied by county material department or purchase by the proprietor.

③Woods

The project area has abundant wood resources, the woods that project requires can be directly purchased from local processor.

④Fire Work Material, Oil and Electricity Supply

The dynamite, detonator, fuse the project requires can be supplied by the county chemical construction company or by the organization local police authority. And safety issues such as safekeeping and delivering should be in accordance with relevant regulations.

The oil required is mainly diesel fuel for construction machine, whose amount is small. And its can be purchased and stored by the construction units themselves.

⑤Electricity Supply

The construction area already have 10kV rural transmission network and Baiyiping II Hydroelectric Power Station Grid connecting network, therefore only by adding transformer can we meet the demand of electricity for construction. A 180kVA transformer arranged at the exit of No.2 tunnel and the entrance of No.3 tunnel, and the exit of 3# tunnel and the entrance of 4# tunnel positioned with a 180kVA transformer, the exit of 4# tunnel and the entrance of 5# tunnel equipped with a 180kVA transformer, and another 180kVA transformer for factory, fore bay and exit of No.6 tunnel will meet the demand of the tunnel excavation, ventilation, concreting and electricity required by construction.

2.5.2 Natural building material

According to the geological conditions of the intake dam site and the analysis on dam type, the amount of block stone aggregate and sand-gravel aggregate are small, which respectively are: block stone 5862m^3, pebble 4429m^3 , sand 5589m^3. Based on the suggestions from the designer and proprietor, the block stone for the hydroelectric power station still supplies by Yuquanhe Quarry, which is one of the planned stock ground for Tangjiahe Reservoir of last cascade, and supplementary reconnaissance and testing are necessary before the construction. This stock ground is about 1km from the dam site, so the transportation is convenient. For detailed natural construction material quarry distribution map see chart 2-6.

(1) Sand-Gravel Material

Yuquanhe River is a mountain river whose riverbed is developed narrowly in general, which is not conducive to deposition of sand and gravel, but by the dam site, the riverbed is about 26m in width, and are mainly composed of pebble interlay with boulders, with sand and gravel filling, and stockpiled a small amount of sand and gravel, since rocks are mostly limestone, quartz sandstone, the solidity is relatively high, after sediment screening, the quality can meet the requirement. According to the FS Report, sand and gravel materials are taken from the nearest riverbed of the dam site area; artificial aggregate can be adopted if the volume is not enough. Yuquanhe Quarry limestone f Qixia Formation can be used by the stock ground, the limetone features interlayer in parts of the area, and solid rocks, weak weathering.

(2) Block Stone

The stone materials are exploited from Yuquanhe Quarry, where limestone of Qixia Formation is extracted, it see a small amount of dolomite, solid rock, weak weathering, limestone's physical and dynamic parameters are as follows: natural volume-weight γ=26.8kN/m^3, Saturated uniaxial compression strength R_b=68.0MPa , Elastic modulus E_e=36.8GPa , Poisson's ratio μ=0.25.

2.5.3 Construction Diversion

(1) Diversion Standard

According to ***Specifications for Construction Planning of Water Resources and Hydropower Engineering (SDJ303-2004)***, the project is of V, and the diversion structure degree is □. The diversion structure employs a flood control standard for flood of "five year return period", taking the drought period from November to the next March, the maximum flow volume of the dam site is calculated as 52m^3/s.

The dam body quantities are relatively small, so it can be completed in drought season, and as a result, the issue of construction in flood season can be neglected.

(2) Diversion Method

The river reach is broad by the dam site, and the width of the valley is 37m, the sand and gravel covering thickness is about 0~15.1m. The project construction adopts the divisional cofferdam diversion method. Firstly, carry out the first phase construction on the left bank, the river water discharges from the narrow riverbed on the right bank. In the first phase of construction, the left bank dam body, water corridor, head gate, and sand sluice will be built. In the second phase construction, the river enters the open diversion channel through the corridor, and discharge to the riverbed through sand sluice at the open channel section.

(3) Construction Drainage

□ Intake Dam

For foundation pit displacement and equipment calculation, refers to the ***Organization, Administration and System Analysis on Water Conservancy and Hydropower Project Construction***.

Drainage equipments are 2 QX-type submersible pumps, with single flow rate of 15m^3/h , capacity of 2.2kW.

□ Powerhouse

As the powerhouse and tail water channel are higher than the water level in drought period, drainage work is unnecessary.

2.5.4 Main Works

(1) Diversion Project

The diversion project comprises bottom trash rack dam, water regulation sluice, detritus pit and scouring sluice, etc. The major quantities are: 14290m^3 of earth excavation, 592m^3 of rock chamber excavation, 227m3 of C20 concrete, and 1556m^3 of grouted block stones. The construction methods employ conventional methods and techniques.

During the first phase of the construction of the diversion works, the detritus pit, scouring sluice, water regulation gate and left bottom trash rack dam section will be under construction simultaneously. The construction approach of the dam body is to use a 1m^3 -excavator for foundation clearing, and manual stone blocks building with cement mortar, a 40L mobile mixer is adopted to mix the concrete on site, and inserting vibrator. Upon the completion of the first phase, the foundation grouting process will be implemented and the right section of the dam will be under construction. During the construction, earth and rock cofferdam will be built to direct the water into the diversion corridor and then enter the origin river bed through scouring sluice. The grate panels will be produced by the factory and built on site.

(2) Diversion Channel System

The diversion tunnel has five sub-tunnel openings which divide the tunnel into six: 1 # tunnel of 137m, 2 # tunnel of 1034m, 3 # tunnel of 781m, 4 # tunnel of 1292m, 5 # tunnel of 457m, and 6 # tunnel of 170m. Thus there are 12 driving faces in construction, in which 4 # tunnel is the longest one that bears utmost difficulty for construction, it requires single-sided excavation of about 700m, and therefore 4 # tunnel is the controlling part of the project. The ventilation inside the cave uses reversible axial fan (37kW) at 20m point of tunnel face to ensure adequate air supply. The electricity for construction is supplied by the transformers positioned in each construction point. The electricity safety management of construction should be strengthened.

Construction of concrete: the project of tunnel concrete mainly includes locking concrete in every tunnel opening, lining in area with unfavorable geological condition and cast-in-site concrete 1045m^3. The construction is conducted in a conventional way, i.e., mobile mixer is

adopted to mix the concrete, manual transportation and inserting vibrator employed, 100× 1500×55 steel mould selected, and assembled on site. The concrete at the bottom of the tunnel is 0.1m in thickness, mixed outside, and transported by 20 tractors, manually paved, solidified by flat vibrator, and smoothed manually.

The precast concrete blocks is produced on site, transported by 20 tractors, and built manually.

Cement mortar blowing: Cement gun utilized.

(3) Fore bay Construction

Fore bay excavation: the fore bay excavation use hand-held air drill for pole forming, and conventional blasting method. The waste disposed manually with the supporting of 20 tractors to waste disposal area.

Concrete works: 0.8m^3 imperative mixer is used to mix concrete, and needle vibrator for vibrating. 1500 × 150 × 55 steel mould assembled on site, and reinforcing steel bar installed manually.

Block stones cement mortaring: the quantity of masonry work for the fore bay is 1841m^3, with machines mortar mixing, and manual masonry work.

(4) Pressure Pipeline

The volume of earth and stone excavation of the pressure pipeline is 6477m^3. As the amount of excavation is relatively small, artificial pore forming by hand held air drill is advised and conventional blasting method. The waste is collected to the powerhouse area and then transported to waste disposal area.

Concrete Construction: the construction of concrete is divided into phases. After buttress and anchor blocks being processed with concrete in first phase and the steel pipe being fixed up, the concrete in second phase and the pressure wall of the fore bay will be poured, assembled a steel mould of the size of 1500 × 100 × 55, and the reinforcing steel bar is installed manually.

(5) Powerhouse and Booster Station

The excavation of the power house and booster station will adopt 80 DTH drill for hole-forming, and prespliting blasting method so as to produce a neat slope. The stone ballast is loaded on car with $1m^3$ pull shovel or shovel loader, and then transported to the waste disposal area with vehicles.

2.5.5 General Construction Layout

The project covers a large area with relatively dispersed structures. The enterprises are scattered in line with the actual condition of terrain. Water diversion works are centralized in upstream Baiyizhai Mineral Water Factory and the II power station dormitory quarter, so as to meet the requirements of land usage for living, accommodation, warehouses, maintenance of machines and processing factories, etc. And the construction sites should arranged the work sheds in near spots in accordance with the conditions and terrain. Moreover, sand-gravel aggregate system, concrete mixing system, air compressor plants are all arranged in close points, standard steel mould products and steel structure in project are provided and processed by specialized factories, and only maintenance sites are planned. The construction sites are only responsible for maintaining the sites. Concerning the short construction period, and aiming at reducing land requisition and temporary project expenses, dwelling houses for construction workers are out of consideration, but resort to houses leasing and temporary work shed erection.

(1) The project uses a small amount of concrete that concentrate on diversion section and the fore bay of the powerhouse, and the two are both neighboring Yuquanhe River, where boulders are abundant, thus making it possible to exploit and process artificial sand and gravel.

(2) Concrete mixing system adopts $0.8m^3$ mobile mixing machines, which arranged at the intake dams and the powerhouse, concrete lined on the bottom of the tunnel, which are supplied by the mixer at the diversion works, and transported to the paving ground with agricultural vehicles.

(3) Integrated processing and repair workshop, warehouse, etc.

Construction Buildings such as those for the purpose of processing, maintenance and warehouse, etc. are respectively arranged at the intake dam and powerhouse and other places, or it is also feasible to be centralized; it will be decided upon the actual condition of construction.

See Figure 2-7 for the general construction layout.

(4) Waste Disposal Area

The waste of the project amounts to $4.24\times10^4 m^3$. According to the geographic and topographical condition of the project, 6 waste disposal areas are set up, which respectively are: 1# waste disposal area locates in the left bank downstream of the dam, which is mainly for storing waste from the intake dam and 1# open channel excavation, amount to about $7600m^3$. 2# waste disposal area lies in the gutter of Hongyuping, namely, the left side of the powerhouse of Tangjiahe Hydroelectric Power Station, whose purpose is for stocking wastes from 1# tunnel and 2# tunnel entrance work section of about $8300m^3$. 3# waste disposal area sits at the exit of 2# tunnel, that is, the opposite side of Gongjiaping, the disposal area is based on the bed rocks. 4# waste disposal area locates at the exit of 3# waste disposal area, mainly for waste from 3# tunnel exit work face and 4# tunnel entrance work face. 5# waste disposal area is at the exit of 4# tunnel, mainly for waste from 4# tunnel exit work face and 5# tunnel entrance work face. 6# waste disposal area sits at the other side of the river behind the Tangjiahe Secondary Junior High School, mainly for waste of 5# tunnel exit, 6# tunnel, pressure fore bay and penstock, taking advantage of the deserted mountains beside the river. Details can be seen in Table 2-4 and Picture 2-5 Layout for the Spoil Fields.

Table 2-4 Waste Distribution and Spoil Fields Engineering Volume

Name	Waste Source	Waste Amount (1,000 m^3)	Area of the Spoil Fields Total Area (hm^2)	Notes
1# Spoil Field	Intake dam and1# open channel	4.8	0.08	The dam is 6m in height, 1m in

				width at the top and 4.2m in width at the bottom
2# Spoil Field	1# tunnel and waste from the working face of the entrance of 2# tunnel	5.3	0.083	The maximum height of the wall is 6m, and the baffle wall is 1.0m wide at the top and 4.2m wide at the bottom.
3# Spoil Field	waste from the working face of the exit of 2#tunnel and entrance of 3# tunnel	7.4	0.093	The height is 6m, and the baffle wall is 1.0m wide at the top and 5.6m wide at the bottom.
4# Spoil Field	dregs from the working face of the exit of 3#tunnel and the entrance of 4# tunnel	7.6	0.095	The maximum height of the wall is 8m, and the baffle wall is 1.0m wide at the top and 5.6m wide at the bottom.
5# Spoil Field	waste from the working face of the exit of 4#tunnel and the entrance of 5# tunnel	5.9	0.074	The maximum height of the wall is 8m, and the baffle wall is 1.0m wide at the top and 5.6m wide at the bottom.
6# Spoil Field	waste from the working face of the exit of 5# tunnel, 6# tunnel, pressure fore bay and penstock	11.4	0.285	The maximum height of the wall is 4m, and the baffle wall is 1.0m wide at the top and 2.8 m wide at the bottom.
Total		4.24	0.71	

2.5.6 Construction Progress

The project was planned to start in July 2006, put into operation in April 2008, and completes in June 2008, total construction period lasts two years.

The construction process is divided into three stages, namely the project preparation period, the major projects construction period, and construction finishing period. Project preparation period is from July to September in 2006; Construction period: from October 2006 to April 2008. Construction finishing period: from May to June 2008.

2.6 Submersion, Land Occupation and Migration Issues

The intake dam of TangjiaheⅡHydroelectric Power is a bottom trash rack dam, locating in the river channel, and there is no task of reservoir submersion treatment and resettlement, so this report will no longer elaborate on migration issues.

The land occupation of the project includes temporarily occupation and permanent occupation, covering a total ground area of 4.07hm^2. Among them permanent buildings is 0.67hm^2, and temporary buildings 3.403hm^2. Investigation shows the project mainly occupies river beach and a small amount of arable land which are not basic farmland.

2.7 Project Features, investment and economic indices

For the main structures, quantities of project, main technical and economical indices of Tangjiahe Ⅱ Hydroelectric Power Station see Table 2-5.

Table 2-5 Project Features of TangjiaheⅡHydroelectric Power Station

Number and items	Unit	Quantity	Remarks

1.Hydrology			
1.1 Water basin area			
Whole water basin	km^2	99.85	
Upstream from dam site	km^2	90.48	
1.2 Period of used hydrological document (reference hydrology	year	42	
1.3 Total volume of multi-year average runoff	$10.000m^3$	7301	Upstream from dam site
Multi-year average flow	m^3/s	2.32	
Design flood flow (P=10%)	m^3/s	418	Upstream from dam site
Check flood flow(P=3.33%)	m^3/s	569	Upstream from dam site
1.4 Investigated top flood level	m		
1.5 Multi-year average sediment concentration	kg/m^3	0.18	
2. Power generation benefit indices			
2.1 Installed capacity	kW	2×2500	
2.2 Firm capacity (P=90%)	kW		
2.3 Multi-year average electricity generation	10,000kWh	1870.13	
2.4 Annual utilization hours	h	3740	
3. Project permanent occupied land			
Tea garden	hm^2	0.21	
River plain	hm^2	2.26	
Waste land	hm^2	1.26	
4. Main structures and equipments			
4.1Water retaining structures			

Type		Gravity dam	
Earthquake basic intensity /fortification intensity	magnitude	Ⅵ/Ⅵ	
Altitude of dam crest	m	564.28	Weir dam section
Elevation of dam top	m	6	
Top dam height	m	20	
Total length of sand basin	m	25	
Type of sand sluice	PGZ2×2		
Type of open-close machine	QL-100		
4.2 Water diversion structures			
Design diversion flow	m^3/s	5.25	
Length of tunnel (mortaring sidewall , evening bottom)	m	4957m	
Length of channel(mortaring sidewall , evening bottom)	m	665	
Dimension of pressure fore	m	W2.2m , L8m	
Penstock type		United water-supply type	
Length of main pipe	m	256.08	
Internal diameter of main pipe	m	1.25	
Internal diameter of pipe branch	m	0.7	
Type of branch pipe		crescent-rib reinforced wye piece grid	
2.3 Powerhouse			
Type		Ground powerhouse	
Dimension of main powerhouse (length*width*height)	m	28.4×12.2×10	
Installation altitude of	m	421.85	
2.4 Booster Station			
Type		ground	
Area	m^2	200	

2.5 Main electromechanical device			
A. Type of turbine	HL100-WJ-84		
Number	unit	2	
Rated output	kW	2688	
Rated rotate speed	r/min	750	
Rated flow	m^3	2.33	
Rated water head	m	133.34	
Runaway speed	r/min		
B、Type of generator	SFW2500-8/173		
Number	unit	2	
Rated capacity	kW	2500	
Rated voltage	kV	6.3	
Rated power factor	cosφ	0.8（lag behind）	
Rated current	A		
C、transformer	unit		

Continued From Table2-5Project Features of Tangjiahe□Hydroelectric Power Station

Number and name	Unit	Quantity	Remark
Rated capacity	kVA	6300	
Voltage ratio	kV		
D、Type of feed valve			
Diameter	m	0.7	
E、Type of crane in powerhouse			
Span	m		
Hoisting weight	t		
6. Transmission line			
Voltage	kV	35	
Circuit	unit	1	
Transmission distance	km	2	
5. Construction			
1、Main quantities			
Earth open excavation	m^3	22928	
Rock open excavation	m^3	6640	
Stone blocks with cement mortar	m^3	8785	

Rock tunnel excavation	m^3	24939	
Plastering	m^2	12326	
House floor area	m^2	504	
Concrete	m^3	4641	
Curtain grouting	m	168	
Steel bars machining and setting	m^2	31	
2、Main building materials			
Cement	t	1800	
Steel bars	t	32	
Steel products	t	56	
Timber	m^3	20	
Dynamite	t	40.4	
Detonator	piece	55800	
Fuse	m		
Petroleum	t	15.20	
Diesel oil	t	15.30	
Concrete pipe	m		
Rock block	m^3	5862	
Pebble	m^3	4429	
Sand	m^3	5589	
3、Needed labor	Week days	130600	
4、Distance from site to external way	km	0.2	
5、Total construction period	month	24	
6、Economic indices			
1、Static investment	Million RMB	19.8061	
2、Total investment	Million RMB	20.2110	
Project Building	Million RMB	8.8729	
Electromechanical device and installation	Million RMB	5.3040	
Metal structures equipment and installation	Million RMB	1.2845	

Temporary works	Million RMB	0.7519	
Independent costs	Million RMB	0.9695	
Basic budget reserve	Million RMB	1.7183	
Price difference budget reserve	Million RMB		
Loan interests during construction	Million RMB	0.4049	
3. Main economic indices			
Investment/kw	RMB/kW	3961	
Investment/kwh	RMB/kWh	1.06	
Operation costs	RMB/kWh	51.18	
EIRR	%	15.28	
On-grid price	RMB/kWh	0.28	
FIRR before income tax	%	10.30	
FIRR after income tax	%	8.10	
Trace-back electricity price that meets base earnings ratio	RMB/kWh	0.317	
Pay back period of loan	a	9.3	

3. Project Analysis

3.1 Feasibility Analysis

3.1.1 Analysis on the Compliance of Industrial Policies

The project falls under the category of clean energy usage, an industry whose development, investment and promotion are encouraged by the country, not the project type whose development, investment are limited by the state industrial policy, and should be phased out. Tangjiahe Ⅱ Hydroelectric Power Station project provides inexpensive, clean and renewable energy for Wufeng County grid, and makes a ideal substitution for thermal power generation, it is a project of distinct economic and environmental benefit. The construction of the project will enhance the technical start point, adopt effective measures, utilize natural resources properly, prevent and control environmental pollution and ecological damage, which is consistent with the national environmental policy requirements.

3.1.2 Analysis on the Compliance of Planning

(1)Analysis on the Compliance of the River Basin Planning

According to the ***Hydropower Development and planning report on the Yuquanhe River basin of Hubei Province*** drawn up by Qingjiang Design Institute of Water Conservancy and Hydroelectric Power of Yichang in 2004, the main purpose on the development of the basin is to generate power and provide electric energy necessary for the local people's livelihood and production. According to geological and topographical conditions, six hydroelectric power stations and one reservoir will be established. From upstream to downstream are: Xiejiazhai Hydroelectric Power Station, Liziping Hydroelectric Power Station, SongjiahelHydroelectric Power Station, Tangjiahe Ⅱ Hydroelectric Power Station. The planning is divided into two phases, the preparatory work has been completed, and currently there are three status of in building, under construction and pending construction. This project is on the second phase, they are: Xiejiazhai Hydroelectric Power Station, Liziping Hydroelectric Power Station,

Tangjiahe Ⅱ Hydroelectric Power Station. The EIA report is targeting on Tangjiahe Ⅱ Hydroelectric Power Station; its construction is in line with the planning of the river basin water resource utilization.

(2)The "Tenth Five-Year Plan" of National Economic Development

Within the range of Wufeng, the towering mountains, beautiful scenery, mild climate and abundant rainfall, all brings ample water, forest, tourist and mineral resources to the place. The local government of Wufeng County, in order to accelerate the transformation of resource advantages into economic advantages, proposed a strategic goal of constructing a county with abundant hydropower resources, strong in forestry, famous for tea products and attractive in tourism. As the rapid development of national economy is going on, the electricity consumption on industrial and agricultural production and people's living will expand inevitably. The local electricity consumption is 149.4 million kWh, which is expected to grow into 176.2 million kWh in 2005 and 253.4 million kWh in 2010. ***The Tenth Five-Year Plan on National Economic and Social Development of Wufeng Autonomous County and the Target Planning Outline to 2015*** explicitly pointed out that due to the abundant hydropower resources, facilitating the exploit of the resources will be a necessity in reviving its development. In the past, present and future, hydropower resources are always the mainstay of all industries. Therefore, adjusting energy structure and vigorously develop the hydropower resources of the local area is a must. The Tangjiahe II Hydroelectric Power Station project meets its requirement.

(3)The Electricity Development Planning of Wufeng County

At present, the total electrical load of the Wufeng County has reached 100,000 kW, with the maximum simultaneous load of 38,000 kW, and average simultaneous load of 18,000, the annual electricity consumption of 134 million kWh. Seemingly the total electrical power exceeds requirement, while at the driest seasons, only 4,500 kW of electricity can be produced, accounting for 25% of the average load, which means 13,500 kW of electricity is lacked. The peak and bottom contradiction is prominent, resulting a farcry shortage in meeting the market demand. Meanwhile according to the Planning of National Economic Development of Wufeng, Hydroelectricity and Rural Electrification and the Ecological Protection Project Planning of Small Hydroelectric Power Station Replacing Fuel in Wufeng,

by the end of the Tenth Five-Year Plan, the whole county will reach a total electronic load of 125,000 kW, electricity consumption of 180 million kWh; 180,000kW and 270 million kWh in 2010; 250,000 kW and 460 million kWh in 2020. Therefore, speeding up the power source and power grid construction in Wufeng, especially developing reservoir and power station with regulation capability, blazing a trail of independent developing, adjusting and balancing road for hydropower industry has been a pressing cause.

Therefore, Tangjiahe Ⅱ Hydroelectric Power Station, as a hub in Tangjiahe hydroelectric development (incomplete annual regulation reservoir) renders a full compliance to the planning requirement.

(4)The Tenth Five-Year Plan on the Environmental Protection of Wufeng County

According to the tenth five-year plan on the environmental protection of Wufeng county, the county will further develop the mountain resources, improve the ecological environment in rural areas to realize sustainable development, enhance clean energy ratio, reduce forest resources cut and change air pollution conditions. Tangjiahe II Hydroelectric Power Station takes full advantage of the abundant local water resources to provide cheap, clean and renewable energy, featuring sustainable use and non pollutant emission. Meanwhile, it can substitute thermal power, reduce forest destruction, relieve the electricity demand and reduce air pollution resulting from the reduced use of coal. Therefore, the construction of Tangjiahe ⅡHydroelectric Power Station keeps in line with the planned environmental protection requirement of Wufeng.

3.2 Project Analysis in Construction Period

3.2.1 Construction overview

Tangjiahe Ⅱ Hydroelectric Power Station, covering a construction area of 1.753hm^2, combines the method of mechanization and manual work, with main equipment of pneumatic drill, excavators, vibrating roller and the dump truck.

The permanent covered area of Tangjiahe Ⅱ project includes project and management area.

Its power station lies on river shore terrace outside the highway, which is 20m downstream of Kuzhuping Highway Bridge. Its auxiliary powerhouse lies at the back of the main powerhouse; booster station plant is on the left side. The bottom trash rack dam functions as sand detaining and water diversion, it lies 200m downstream of the Baiyiping II Hydroelectric Power Station and also downstream of the spring opening of the right bank.

The temporary land occupation of the project includes construction facilities, stock ground, waste disposal area and temporary road, etc., covering a total 3.403hm^2 of land. Among them, concrete aggregate quarry takes up 0.47 hm^2, waste disposal area 2.46hm^2, entrance road 0.40hm^2, other temporary covering 0.073hm ^{2}. The total project duration will be 24 months, with peak personnel of 200.

According to the construction condition of the main project, the total volume on the excavation of earth and stone will be 6.03×10^4m^3 (among which the main project takes 5.45×10^4m^3, stones taken from the stock ground 0.58×10^4m^3). Among which the open excavation will be 2.96×10^4m^3, the cave excavation will be 2.49×10^4m^3, filling a 1.30×10^4m^3 volume of earth and stone, 4.64×10^3m^3 of concrete. The total waste volume is considerable as 4.24×10^4m^3, accounting for about 77.8% of the total excavation. Due to the features of the waste disposal of the construction, we plan to set up 6 waste disposal areas, namely:

No.1Waste Disposal Area (located at the left bank downstream of the dam)

No.2 Waste Disposal Area (located at the Hongyuping Canaliculous)

No.3 Waste Disposal Area (located at the small gully of the No.2 Tunnel exit.

No.4 Waste Disposal Area (located at the small gully of the No.3 Tunnel exit.

No.5 Waste Disposal Area (located at the small gully of the No.4 Tunnel exit.

No.6 Waste Disposal Area (located at the opposite bank of the Tangjiahell middle school)

In the construction period, 20 machinery equipments will be used, the total water usage is 105m^3/d; the construction personnel will reach 200 at peak time, a brief calculation of 120L of water will be used per person, the total domestic water consumption at the time will hit

$24m^3/d$.

3.2.2 Means, Modes, Intensity, Time and Range of Environmental Impact from Project Construction

The environment impact factors from project construction are mainly: construction arrangements, external transportation, machinery, land occupation, personnel activities, waste disposal, etc. The project will have impact on surface water, sound environment, ambient air, water and soil erosion, population health, ecological environment. Analysis on the impacts is as follows:

(1)Analysis on Water Supply & Drainage and Main Pollutant Emission in Construction Period

The water usage of the project in construction period mainly includes construction water and domestic water. Because all buildings of the project are located beside river bank, construction water can be extracted directly from the river, which has satisfactory quality and volume. According to our comparison to the data of similar projects, it is expected that at peak times, the project's water consumption and emission will be respectively $187m^3/d$ and $150m^3/d$. In construction period, the average daily water consumption and emission will be $42.1m^3/d$ and $33.7m^3/d$ respectively, with a total emission volume of $24601m^3$.

At the same time, the construction will also generate a large number of foundation pit wastewater, the original factors are: the excavation of the main project forms foundation pits, whose drainage is one important means that produce wastewater. Pit drainage can be divided into initial drainage and regular drainage, Initial drainage refers to the elimination of the water stored in the pit, namely the combination of original river water, leakage water and rainfall, due to the excavation of soil, stone cofferdam and the shore, the concentration of the SS in the water is likely to increase. Regular drainage is for pit water in the building excavation and concrete pouring processing period, combined by rainfall, leakage water and construction water. As a result of excavation and concrete pouring, washing, conservation and cement grouting, suspended solids PH may be increased, the PH of concrete conservation water may even reach 9~10, which, if directly discharged, will certainly affect the water quality of the river. For the above reasons, it is planned to set up pools, and more than 2 hours' static

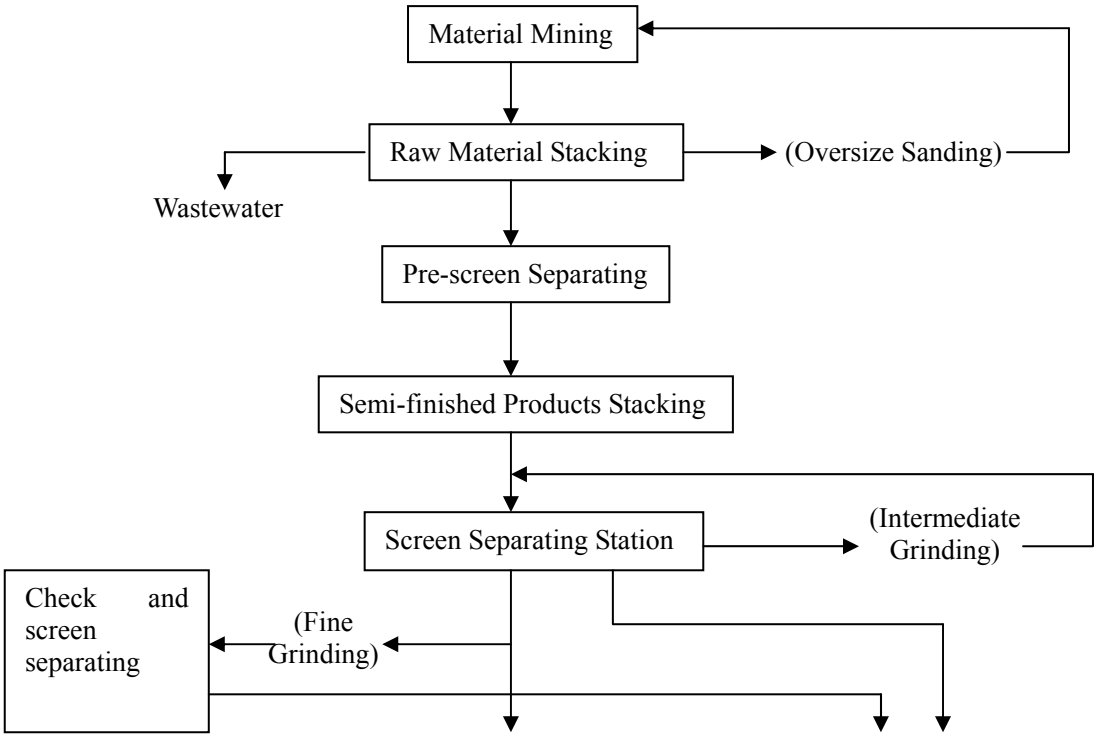
settlement is regulated to treat wastewater. After the concentration of the suspended materials has reduced to 300mg/L, the water pump is used to drain and discharge it. In that case, the affect to the surface water is reduced.

Corresponding wastewater discharge is shown in table 3-1.

① **Construction wastewater:** The total emission of the construction water is 19098m^3, mainly includes concrete pouring and conservation wastewater, sand and stone processing washing water, construction machinery and vehicle washing wastewater, etc.

Concrete pouring and conservation wastewater: originated from concrete pouring, conservation and cement grout. The suspended materials in this type of wastewater has high PH, even can reach 11~12.

Sand and stone processing system washing water: for the whole process flow see table 3-1. Regularly 2.7m^3 of water will be consumed from 1t of concrete aggregate. Calculating on the average sand content of 8%, according to the principle of material balance, the concentration of the suspended materials is 2.5×10^4mg/L. In the processing period, due to the surface water on material, evaporation and leakage, result in 20% of the total water consumption, the remaining 80% is production wastewater.



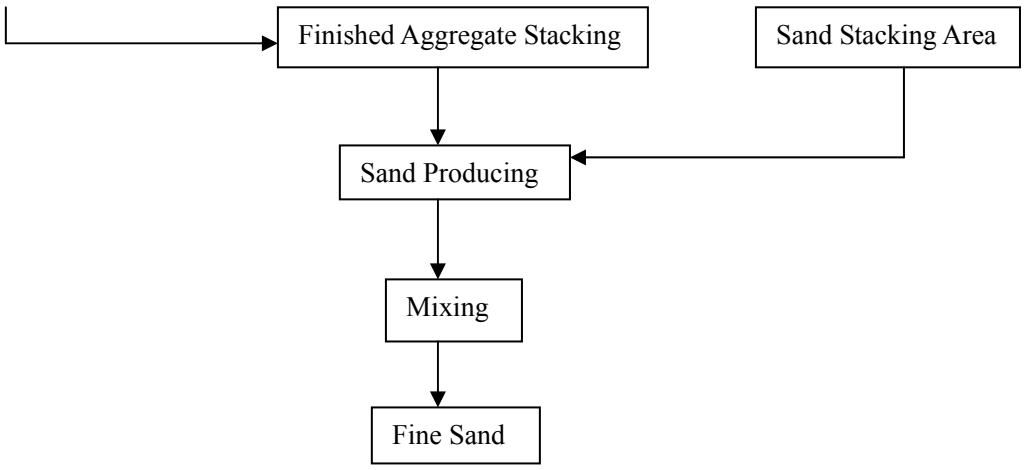


Table 3-1 Sand and Stone Processing System

Construction machinery and vehicles washing wastewater：According to the design of construction organization, there are 20 main construction machines and vehicles on the site, and were parked together, 0.6m^3 of wastewater will be produced for every car washing. Calculated by 50% of the total number, the daily oil-containing wastewater discharge will be 6$m^{3.}$

For Tangjiahe Ⅱ Hydroelectric Project construction wastewater and its main pollutants see table 3-1.

Table 3-1 Wastewater Discharge List in the Construction Period

No.	Type of wastewater	Daily discharge volume(m^3/d)	Total discharge in construction period (m^3)	Concentration of main pollutants	Pollutants emission intensity (t/d)	Treating measures	Discharge target	Discharge method
1	Sand gravel processing wastewater	17	12528	SS：2.5×10^4mg/L	0.27	setting	Yuquanhe River	Intermittent
2	Concrete pouring and conserv	3	2190	SS：5000mg/L	0.015	primary sedimentation	Yuquanhe River	Intermittent

	ation wastewater			pH：11~12		neutralization		
3	Construction machinery and vehicle washing wastewater	6	4380	petroleum：5mg/L	0.00003	Oil segregating settling	Yuquanhe River	Intermittent
				SS :300mg/L	0.002			
Total		26	19098	/	/	/	Yuquanhe River	Intermittent

②Domestic sewage: Mainly originates from construction personnel. The peak number of construction labors is 200, with an average of 80. According to their conventional water usage, the daily water discharge is approximately 120L per person, 80% of which will be discharged as sewage, so that the water discharge indicator is 96L/d, the maximum daily discharge is 19.2m^3 with an average of 7.68$m^{3.}$ The aggregate sewage discharge is $5.61\times10^3m^{3,}$ with the main pollutants of BOD_5, COD, and SS. The condition on the discharge of domestic sewage and its main pollutants，see table 3-2.

Table 3-2 Domestic Wastewater and Main Pollutants Discharge in Construction Period

Item	Water Consumption ($\times10^3$t)	Wastewater Discharge ($\times10^3$t)	Main Pollutants Discharge Density (mg/L)		
			COD	BOD_5	SS
Construction Area	7.01	5.61	300	200	250

Analysis from abovementioned conditions shows that: the project is of a relatively small scale, with dispersed layout, wastewater discharge is small in amount, yet if discharged untreated, will exert certain impact on the water quality of Yuquanhe River and Siyanghe River. As a result, the assessment put forward three-squared septic tank for domestic water treatment.

(2)Machinery, Equipment and Noise

Construction noises are mostly come from machinery operation, transportation, machinery processing and maintenance in excavation, drilling, blasting, aggregate crushing, and concrete pouring. The noise generated in the construction process can be broadly divided into fixed and continuous drilling noise, machinery noise, mobile traffic noise and short-term blasting noise. The former derives from the excavation of earth and stone, sand and gravel material processing system and concrete mixing system, featuring strong sound source, high sound level and constancy, causing huge effect to the on-site personnel. However, the latter derives from main part of the project foundation excavation and aggregate mining, featuring fixed timing, instant and highly controlled. Blasting will generate high level of sound, precautions on the method, amount and time control should be well organized for its hardly controlled impact and scale. Transportation noise mainly involves engine and horn sound when transporting. Its resulting noise level, see table 3-3.

Table 3-3 Tangjiahe‖Hydroelectric Power Station Project Main Noise Sources List

Sound Origin Type	Name	Specifications	Unit	Number	Noise level (dB)
Fixed sources	Hand pneumatic drill	/	unit	10	104
	Percussion drilling	CZ22	unit	1	100
	Mortar mixer	/	unit	1	85
	Jaw crusher	600×900m	unit	1	105
	Concrete pump	30m^3/h	unit	1	110
	Plug-in vibrator	HZ6X-70	unit	5	92
	Centrifugal pump	14kW	unit	2	95
	Welding machine		unit	2	92
Mobile sources	tractor	59kW	vehicle	12	89
	Truck	petroleum type 5t	vehicle	2	92
	Bulldozers	59kW - 74kW	unit	1	94
	Shovel excavator	Oil driven 1.0m^3	unit	2	96
	shovel loader	1.0m^3	unit	2	96

Because the construction site is located in valley, the spread of noise is hindered by the adjacent mountains, the affecting scale mainly limited in the nearby area. Construction layout and work schedule should be properly adjusted, avoiding using strong noise equipment or construction blasting during break time.

(3) Analysis on earthwork Balance, Construction Wastes and Living Garbage

① Excavation, Wastes

The gross excavation of the main project is 6.03×104 m³ (including earth excavation 2.29×104m³, stone excavation 3.16×104m³), which mainly comes from the excavation such as diversion tunnel , power tunnel , weir dam and so on , the earthwork Balance is shown on the schedule 3-4.

Table 3-4 Earth-Rock Balance Units: $\times 10^4 m^3$

Project items		Earth project (m^3)			Rock project (m^3)			Waste Disposal Project (m^3)		Remarks
		excavation	Use	waste disposal	excavation	Use	waste disposal	bank measure	compacted measure	
Intake dam		14290	8953	5337	521	176	346	5683	3006	
Diversion structures	Open canal	930	300	630	/	/	/	630	319	
	1# tunnel	/	/	/	994	/	989	989	853	
	2# tunnel	/	/	/	7507	/	7466	7466	6447	
	3# tunnel	/	/	/	5738	/	5707	5707	4928	
	4# tunnel	/	/	/	7869	/	7825	7825	6758	
	5# tunnel	/	/	/	2766	/	2752	2752	2376	
	6# tunnel	/	/	/	1029	/	1025	1025	883	
	Pressure forebay	3490	/	3490	942	/	938	4428	2580	
	Penstock	2000	470	1530	3939	398	3522	5052	3816	
Power house		2190	2190	/	440	438	/	/	/	
Pressure rise station		28	28	/	/	/	/	/	/	
Total		22928	11941	10987	31579	1009	30570	41557	31966	

We can conclude from the table above: large amount of waste will be generated during the construction process, which if not properly disposed, will give rise to the damage of the surface vegetation, water loss and soil erosion even the natural landscape destruction without the suitable treatment. Therefore, according to the project general arrangement plan and actual landform, the waste will be transported to the assigned waste disposal area.

② **Domestic Solid Waste**

The number of workers is about 200 per day during the peak time of project construction and about 80 workers per day in average in construction period. If calculated as 1.0kg per person a day, the max daily garbage amount is 0.2t and the average amount is 0.08t. The total generated garbage amount is around 58.4t, without any proper treatment it will cause mosquitoes, flies breeding and secondary pollution.

Therefore, the specialized area should be set up to classify the living garbage and deal with the garbage by compost method after recycling available component.

(4) Pollution Source of Waste Gas during the Construction Period

The project will mainly influence the quality of the atmospheric environment of construction area in the following aspects: the earth-rock excavation, the raised dust and bug dust produced by earth-rock backfilling, the raised dust of concrete batching in mixing system, the dust caused by crushing artificial sand and rock system, the raised dust and waste gas of fuel machines and means of transportation and the waste gas of domestic coal burning and dynamite blasting. The primary pollutants are as follows: TSP, SO_2、CO and so on.

①The main sources of raised dust are: the raised dust during the backfilling period of earth-rock excavation in the main project, the dust produced by tunnel excavation blasting, the raised dust caused by the loading and unloading during transportation of cement, coal ash and sand and stone, the dust brought about by exploitation and crush of aggregate and manufactured sand and rock , the dust produced by vehicle driving , as well as produced by concrete production process in mixing station.

According to the field data of Gezhouba hydro-junction project in construction period, the TSP emission concentration can reach 150mg/m^3 in the construction area. The floating dust concentration is 0.45~0.6mg/m^3 and the fall dust is 32t/km^2, which has exceeded secondary standard limit value of the ***GB16297-96 Integrated Emission Standard of Air Pollutants***. But it only has certain influence for the construction area and workers there, on account for the dispersion of different construction area and long distance away from living area. So we should adopt effective prevention measures to reduce the harm.

②The Pollution of Oil Consumption

The oil consumption is used for driving power of various mechanical equipments in construction period. On the basis of the analogy between this project design materials and that of similar projects, the oil consumption of construction machinery is estimated to be 15.3t (19125L) in construction period, while calculating as diesel oil (light diesel oil, first class). The estimated sorts and amount of the pollution caused by oil burning of this project are shown in Table 3-5.

Table 3-5 Amount of the Pollution Caused by Oil Burning

Items	Classification of pollutions			
	SO_2	NO_2	CO	Hydrocarbon
Amount of pollution per Unit(g/L)	4.4	21.4	14.2	4.2
Total discharge(kg)	84.2	408.5	270.8	79.6

The exhaust gas produced by the project will cause an adverse impact for regional environment and air.

③The Pollution and Impact of Domestic Coal Burning

The amounts of coal burning and construction workers are closely related in construction period. If the number of workers is 200 in peak period of this project, the estimated amount of used coal is 800t. Although the influence area is near the living area, the ventilation and living environment sanitation should be well done because of the weak diffusion capacity in the canyon area.

The influence of the project to the atmosphere is only effective in the construction period, and it will be removed automatically upon the project completion.

3.2.3 Possible Impact on Environment From Project Land Occupation

The construction of Tangjiahe II Hydroelectric Power Station will change the land use structure and type within the occupied area, in which permanent land occupation will alter

its original nature and temporary occupation land can be recovered to its original function or be developed.

(1) Temporary Land Occupation

The temporary building area of this project consists of temporary street, stock ground, waste disposal area, temporary processing factory, air compression station, parking lot, construction equipment warehouse, living material warehouse, cement warehouse, POL plants warehouse, offices and dormitories. The occupied lands are mainly river plain areas and a few tea gardens, amounting to 1.653hm^2. Please refer to Table 3-6 for detailed information.

Table 3-6 Situation of the temporarily occupied land of the project Unit: hm^2

No.	Name of areas	Types and amount of the surface ground				Total
		River beach	Tea garden	Barren hill	Farmland	
1	Intake dam	0.15	/	/	/	0.15
2	Mouth of the tunnel, open channel, and forebay	0.07	0.0067	0.047	0.017	0.14
3	pressure pipeline	/	0.07	0.03	/	0.10
4	Power house and booster station	0.04	/	0.03	/	0.07
5	Entrance Road	/	/	0.013	/	0.013
6	Waste Disposal Area	0.69	/	/	0.02	0.71
7	Stock Ground	0.47	/	/	/	0.47
Total		1.42	0.0767	0.12	0.037	1.653

(2) Permanent Land Occupation

Permanent land occupation of the project includes construction occupied land and project administration land occupation. The Tangjiahe II Hydroelectric Station project mainly covers barrage, diversion structures, power plant and booster stations of 0.67hm^2.

According to investigations, the above equipments take up mostly the river shore areas and a little cultivated land. Please refer to chart 3-7 for detailed information.

Table 3-7 Statistical Table of Project Land Occupation Unit: hm^2

No.	Item	type and amount of the surface land				Total
		River beach	Tea garden	Barren hill	Farmland	
1	Intake dam	0.103	0	/	/	0.103
2	Mouth of tunnel, open channel and fore bay	0.08	0.033	0.087	0.039	0.239
3	pressure pipeline	/	0.10	0.067	/	0.167
4	power house and booster station	0.04	/	/	0.107	0.147
Total		0.223	0.133	0.154	0.146	0.67

Construction land occupation, especially the permanent land occupation will certainly change the structure and distribution of the original vegetation types, even leading to the destruction of quantity and type of partial vegetation or damage to the habitat of existing animals within the scope. As a result, animals have to migrate to the other areas, causing the reduction of types and quantity.

Therefore, reasonable scheme and scientific layout should be attached great importance to and the impact on ecology should be reduced to minimum in the overall arrangement of the permanent structure like powerhouse.

After temporary land usage, the land should be well cleaned in time to recover vegetation and the original land use structure so as to avoid the water loss and soil erosion and the appearance of the other ecological problems.

3.2.4 Probable Influences on Ecology from Project Construction

During the construction, machinery, entering of the workers, the mining of the quarry and soil material yard as well as the arrangement of other construction sites has all destructed the habitats of wild animals with the progress of the project. The activities of amphibian and reptiles will be affected to a certain extent; birds and animals within the temporary land

occupation area will be kept away from the construction area because of the noise; therefore, animal number will decrease on a yearly basis. But, the construction activities will not exert distinct influence on the animal popularized structure.

The permanent highway and temporary road for construction have checked the passage of terrestrial organism to some extent. The impediment of the road will cast harmful impacts to terrestrial organism. But with the completion of the project, the vegetation will recover naturally, and the impediment to animals will disappear gradually.

During the construction, the discharge of waste water, waste residue and domestic waste will have certain influence on aquatic organism. However, if certain approaches are carried out during the construction, the project will have little impact to the environment of the surface water environment.

3.3 Project Analysis during Operation Period

As the construction of this project excludes the water storage project, the operation mainly includes water intake, power generation and water discharge. Therefore, during the operation period, the project itself basically discharges no wastewater or other pollutants, the main impact shows on the water regime changes, the ecological and environmental influences in the dehydration section, etc.

3.3.1 Influence toward Runoff Change

There is no measured runoff data for Tangjiahe II Hydroelectric Power Station, while in the Yuyangguan hydrometric station on the Yuyang River of the neighboring basin water, there are documents about the runoff data of 44 years dating from 1961 to 2004. These two river basins belong to the same hydrological and climate section, with similar natural, geographic, climatic and hydrological characteristics; hence the Yuyangguan hydrometric station could be set as a reference station for the runoff design of the Tangjiahe II Hydroelectric Power Station.

With the methods of hydrologic analogy and rainfall volume modification, we could work out the runoff design of the Tangjiahe II Hydroelectric Power Station. The control catchments area of the dam site is 91.0 km^2 , with an annual average flow of 2.31 m^3/s and a

total multi-year average runoff of 72,947,300m^3. To see the average annual and monthly flow of the dam site please refer to Table 3-8.

Table 3-8 Average Annual and Monthly Flow of the Dam Site Unit: m^3/s

Month	1	2	3	4	5	6	7	8	9	10	11	12	Annual Average
Monthly average flow rate	0.61	0.89	1.36	2.74	3.35	4.23	2.33	3.51	4.60	2.20	1.00	0.88	2.31
Runoff (10,000 m^3)	709.35	898.59	1095.51	622.85	939.34	1191.33	587.95	260.34	234.69	163.00	216.20	375.59	7294.73
Distribution rate (%)	9.7%	12.3%	15.0%	8.5%	12.9%	16.3%	8.1%	3.6%	3.2%	2.2%	3.0%	5.2%	100.%
Monthly average highest flow rate	0.96	2.37	2.93	11.44	12.01	24.04	18.41	24.78	24.53	9.68	3.80	1.81	11.39
Monthly average lowest flow rate	0.42	0.42	0.62	0.47	0.81	0.62	0.46	0.49	0.68	0.60	0.42	0.50	0.54

It could be learnt from Table 3-8 that the monthly runoff of the Tangjiahe dam site is between 0.42 and 24.78m^3/s with a relatively small flow during the dry season.

The completion of the project will cause certain downstream section dehydration in dry seasons. However, as the downstream reach of the Yuquanhe River is a coulee river course, limited by the terrain condition, ecological consumption and flood discharge are its main water functions? The runoff decrease and water level fall have mild influence on the present water function.

3.3.2 Influence toward Bank Slope Stability

The structural environment of the project site is relatively stable, where no active fault has

ever been found, the frequency of its seismic activity is low and the strength of which is small, and its basic seismic intensity is VI.

The holistic stability of the rock mass is good at the dam site and the diversion line area. Nevertheless, the intense local rock mass weathering, relative fracture development and the existence of weak interlayer intercalation have brought bad influence to the stability of some slopes, the whole body and the dam base. However, as the dam site of this project is a low one (merely 5.1m), the slope stability will not be quite influential after the completion of the project.

3.3.3 Influence toward Terrestrial Animals and Aquatic Organisms

This station is a runoff hydroelectric station with a height of 5.1m, the catchments area above the dam site is 91.0 $km^{2,}$ the catchments area above the powerhouse site is 99.8 $km^{2,}$ and the distance between the dam and the workshop is about 4.3km. According to the field reconnaissance and the introduction on relevant documents, there is a tributary converges 50m below the intake dam, and several tributaries flowing 150m downstream. The catchments area under the dam water level is 8.8 km^2. After the project is completed, the section 50m below the dam is dehydration section, and the downstream water could not be used for irrigation and drinking but only for ecological usage. Therefore, in this EIA we have pointed out that we must ensure the ecological water-use volume of the downstream section, not only ensuring the flow below the dam above or equal to 0.23m^3/s (10% of the annual flow). The specific measure is making overflow outlets at the top of the dam or preserving control water valves. While ensuring the implementation of above measures, the project will have smaller influence toward the terrestrial animals and the aquatic organisms during its operation period.

3.3.4 The Operation of Generator Unit

The project of Tangjiahe Ⅱ Hydroelectric Power Station itself did not discharge any pollutant during the operation. But in that period, lubricating oil will be used in the process such as the operation system of inlet valve, lubricating and cooling of unit bearing and the speed governor, so the generator units are inevitably give rise to leak, emit, drip and miss. And the main pollutant is petroleum. In addition, the transformer will drip and

miss when insulating oil is used with the main pollutant to be alkyl hydrocarbon. What is more, the power station is equipped with machines in repair room, such as lathe, milling machine and drilling machine which need cooling off and lubricating, too. So there is also some leakage and the main pollutant is lipid. If not dealt with, these petroleum pollutants will influence river water quality.

3.3.5 Maintenance Management of the Hydroelectric Power Station during Operation Period

During the operation, the maintenance of the Hydroelectric Power Station is by project management department Tangjiahe Ⅱ Hydroelectric Power Station Project, including eight members. If the daily domestic waste produced by the staff members is 0.5kg per person, then the daily waste is 0.004t, and the annual waste discharge is 1.36t. If not taken care of, these waste will influence the environment. If the water for life daily is 0.20m^3 and the coefficient of domestic sewage is 0.8, then the daily discharge is about 1.28m3/d. In the domestic sewage, if the BOD5 is 200mg/L, CODcr 300mg/L, suspended load concentration 250mg/L, then the discharge of these pollutant are to be: 0.26kg/d, 0.38k/d and 0.32m3/d respectively.

3.4 Conclusion for Engineering Analysis

According to the construction activities of the main structures and the primary analysis result of the probable influence of the project operation on the environment, the result can be seen in the following Table 3-9.

Table 3-9 Primary Analysis of Environmental Impact Analysis of Tangjiahe II-Hydroelectronic Power Station on Yuquan River

Time	Source of the Influence	Probable Impact
Operation Period	Blocking of the dam; Increasing of water surface;	1、Certain influences will be exerted on fishes and aquatic organisms. 2、Certain impact will be cast on the growth and distribution of territorial plants.

	Raise and fall of the water level at the submerging areas.	3、Certain influence will be caused on the species and population, distribution scope of wild animals; 4、Hydrology situation downstream will change; 5、Social economy will be influenced; 6、Damage to the vegetations will lead to new round of water loss and soil erosion.
Project Construction Area	Land occupation by the construction Spoils Waste water Noise Constructors	1、Damage to the vegetations will lead to new round of water loss and soil erosion; 2、Water quality in the river cause will be influenced; 3、Slight difference will be caused to the surrounding animals and plants; 4、Certain impact will be caused on arable land, transportation and social economy.

4. Environment Status

4.1 Basin Environment Status

4.1.1 Basin Briefing

Yuquan River (Heitan River), the largest tributary in the Siyang River basin and a sub-tributary of the Qing River, is located in the right bank of the Wufeng Siyang River Basin. The river shares divide with the Wantan River and Tianchi River. It originates from the Beifengya Forestry Farm at 2213m above sea level, flows through Songjiahe, Tangjiahe, Hongyu Ping and Guzhu Ping into Siyang River Erchakou Reservoir (water level at 420m above sea level) via Erchakou, forming a total length of 18.26km and a drop of 1793m. The upstream river section, from Congyuan to Songjiahe Dixiwankou, has a length of 6.7km, a drop of elevation from 2213m to 870m totaling to 1343m and a river slope of 11.7%; the midstream river section, from Dixiwankou to Hongyu Ping, has a length of 6.96km, a drop of elevation from 870m to 565m and a river slope of 6.3%; the downstream river section, from Hongyu Ping to Erchakou Reservoir, has a length of 4.6km, a drop of elevation from 565m to 420m and a river slope of approximately 4.9%. The Songjiahe section reveals Ordovician limestone deposits in the 1.3km of its stream way. The Yuquanhe Section possesses Permian limestone deposits in the 2.7km of its stream way. The limestone exposure area covers 30% of the catchments area. The river's length makes up for 21% of the total length of the rivers in the catchments. The River flows mainly across the Songjiahe anticline and the Baiyiping syncline, across land strata from Nanjinguan section of the lower Ordovician System to the lower Jiangling River section of the Triassic System. The catchments area of the planned stream is 99.85km^2 , and average annual precipitation is 1474.4mm, average annual flow depth 938.4mm, average annual discharge 3.25m^3/s and average annual total runoff is 102,000,000 m^3. The theoretical hydro energy reserve is 13,800kW and the corresponding annual hydro energy output would be 121 million kWh.

With generous precipitation and high storm intensity, Wufeng County is one of the country's storm centers. The highest annual rainfall was as high as 2578mm and the lowest annual rainfall was 965mm; the highest 24 hour rainfall was 422.9mm. A round of precipitation

from July 3rd to 7th 1935 reached 1318mm. In the past four decades, the county's average annual precipitation is 1588mm. Wufeng County has 6 relatively large rivers, i.e. Yuyang River, Siyang Stream, Nan River, Tianchi River, Wantan River and Baixi River. According to ***The Yichang City Water Resource Analysis***, the annual total runoff of all the river systems in the county is 2.44 billion m^3. The county's theoretical hydro energy reserve is 324 thousand kW, exploitable capacity would be 255.3 thousand kW and exploited capacity is 79 thousand kW. Abundant hydro energy resource has provided great advantages for the development of small scaled hydroelectricity plants in the county.

The catchments area is well forested, with forest coverage being over 73%. From river valleys to mountain tops, shrubs, trees, deciduous and evergreen plants thrive together and are lush all year round. Flourishing vegetation has effectively prevented soil erosion. The basin's riverbeds range from 20 to 60m in width, most of which are "U" shaped river valleys and a few are "V" shaped river valleys. Most of the river banks have fully outcropped rocks which provide great natural conditions for the construction of hydro electricity plants.

4.1.2 Climate and Hydrology

(1) Climate

The planned Tangjiahe Ⅱ Hydroelectric Power Station is located in the sub-tropical monsoon climate zone of the northern hemisphere, with its characteristics of distinct monsoonal and seasonal changes, sufficient sunlight, abundant precipitation, warm and changeable springs, rainy early summers, relatively dry autumns and cold winters. Meanwhile, as the catchments are located in high valley areas, the climate has mountainous climate characteristics. Due to characteristics of the topographic changes, hydrologic and climate factors show a clear vertical layout.

There are no meteorology stations in the catchments, hence its meteorological data are from the Wufeng County Meteorology Station. The Wufeng County Meteorology Station is located near midstream Tianchi River, at approximately 10km from the power plant. It was founded by the Hubei Provincial Meteorology Bureau in 1956 and started in February 1957 the measurement of ground meteorological factors such as air temperature, humidity,

air pressure, wind direction, wind velocity, sunshine, clouds, weather phenomena, visibility, and evaporation and ground temperature at various depths. The Wufeng Meteorology Station is one of Hubei Province's national primary meteorology stations; its measurement data is edited and published by the Provincial Meteorology Bureau. Its data is complete, precise and reliable and thus satisfies the requirements for the project construction. For details, see Table 4-1.

Table 4-1 Wufeng Meteorology Station Meteorological Characteristic Chart

Serial Number	Item	Unit	Unit	Notes
1	Annual Average Temperature	℃	13.1	
2	Extreme Highest Temperature	℃	37.1	
3	Extreme Lowest Temperature	℃	-15.0	
4	Annual Average Absolute Humidity	Pa	127.0	
5	Annual Average Relative Humidity	%	76.0	
6	Annual Average Wind Velocity	m/s	1.3	
7	Highest Wind Velocity	m/s	15.0	
8	Prevailing Wind Direction		SE	
9	Average Annual Duration of Sunshine	h	1533	
10	Average Annual Frost-Free Duration	d	247	
11	Water Surface Evaporation	mm	630	Yichang City Evaporation Contour Map
12	Land Surface Evaporation	mm	540	Yichang City Evaporation Contour Map

(2) Hydrology

There are no precipitation stations in the Yuquan River catchments. Adjacent are Wufeng Meteorology Station, Wantan Precipitation Station, Caihuaheping Precipitation Station, and Madu River Hydrology Station, located at 11km, 24km, 22km, and 22km respectively from the catchments centre. The four stations all have serial precipitation data of the past four decades. By calculation, average annual precipitation of the catchments area above the dam site is 1474.4mm. According to the Hubei Province precipitation contour map, the area's average annual precipitation is around 1500mm. The annual precipitation distribution is as shown in Table 4-2.

Table 4-2 Kuzhu Ping Hydroelectric Power Station Precipitation Analysis Chart

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Precipitation	27.6	38.5	72.2	138.6	196.1	225.6	266.9	178.4	131.2	110.6	60.5	26.5	1474.4
Distribution Rate	0.019	0.026	0.049	0.094	0.133	0.153	0.181	0.121	0.089	0.075	0.041	0.018	1

The annual and seasonal variance in precipitation is relatively great, with floods in rainy years and droughts in drier years. According to historical records, in Caihua Town, precipitation was as much as 2578mm in 1935 yet only 965mm in 1936, merely 37.4% of the former.

The characteristics of the annual precipitation distribution are: the average precipitation from April to October is 1247.3mm, accounting for 84.6% of the annual total and making this period the rainy season; the average precipitation from November to March of the following year is 227.1mm, accounting for 15.4% of the annual total and making this period the dry season.

The recorded highest 24h precipitation of Wufeng County was 422.9mm (3rd July, 1935); three day precipitation was 1076.1mm; seven day precipitation was 1318.0mm. Analyzing

from the precipitation statistics, on average there is 0.8 storms with a 24h precipitation more than 100mm, most frequent from June to August.

Calculating the runoff statistics, outcomes reveal that the average annual water flow at the Tangjiahe Ⅱ Hydroelectricity Station Dam is 2.31m^3/s with an average annual runoff of 72,947,300 m^3.

4.2 Regional Natural Environment Status

4.2.1 Topography

Wufeng Tujia Autonomous County is located in the southwest of Hubei Province. The county has a rugged landscape, with numerous steep cliffs and mountains. The relative height is between 800 to 1000m. In the project area, the tallest peak is 1255m tall and the lowest peak is 860m. The area is classified as mid-high mountainous region in structural erosion.

The strata in the region, belonging to the Huangling Section which is a sub-section of the Huanglingbamian Mountain, all consist of sedimentary rocks, more specifically clasolites and carbonate rocks. Clasolites are located in the southern part and the northwestern corner of the site; Carbonate rocks are located in the northern part and the southeastern corner of the site. Strata from Nanjinguan section of the Ordovician system to lower Wujiaping section of the Permian system and the Quaternary system all have been outcropped, from aged to new they are: 1. Sylurian system(S); 2. Devonian system (D); 3. Carboniferous system(C); 4. Permian system (P); 5. Quaternary system (Q).

Middle Shamao Section(S2s) of the Sylurian system: yellow ochre, yellowish green, greyish green colored argillaceous siltstone, siltstone, packsand and shale interbed, partially containing marlstone (deposited in stratoid or lenticular form), 700m in thickness.

Devonian system: immaturely formed in the region, only revealing the middle and upper seriess, variance in thickness is small, in para-unconformity with the underlying Sylurian system.

①Middle Series(D_2)

Yuntaiguan Section(D_2y) : Milky grey, pale grey with red tinge, medium seam of quartz-sandstone containing rattler, 26m in thickness.

②Upper Series(D_3)

Huangjiadeng Section (D_3y) : Upper layer is mudstone and quartz-sandstone, lower layer is greyish green and grey mudstone containing bio-limestone, 15 to 30m in thickness.

Xiejingshi Section (D_3x): Upper layer is a thin to medium seam of argillaceous limestone containing mudstone; lower layer is marlstone containing oolite haematite, 50m in thickness.

Carboniferous system: Partial exposure at the site, having only developed the upper Huanglong Section of the Carboniferous system, in conformable contact with the underlying Devonian system. Huanglong Section's (C_2hn) upper layer is grey deep-bed fine limestone; middle layer is grey coarse limestone, lower layer grey deep-bed dolomitize limestone, 24m in thickness.

Permian system (P): In parallel unconformable contact with the underlying Carboniferous system.

① Lower(P_1) Qixia Section : lower section is a saddle with coal deposit (P_1qm) , consisting of irony sandstone, clay stone, carbonic mudstone and coal layer, including 1-3 coal layers, 6m in thickness. The upper section is a limestone layer(P_1q) , the middle and upper parts consisting of carbonic argillaceous tumuli flint limestone and the lower part consisting of deep grey limestone containing a thin layer carbonic calcareous mudstone, 141m in thickness.

② Maokou Section(P1m) : In the upper segment, the upper section is mid thick carbonic limestone; the lower section is greyish black thin carbonic silicolites, 54.5m in thickness. The lower segment is grey mid thick fine limestone, containing flint nodules, karstified, and

70 to 100m in thickness.

Quaternary system (O_4): Alluvial deposits (O_4al), formed by river alluviation, mainly consisting of boulders and pebbles and also sand and clay, are along the river valleys. The pebbles are well rounded with a low sorting index. The usual thickness is from 1 to 6m. Proluvium, formed by flood activities, are mostly found along with alluvial deposits. The contents are diverse, including pebble soil, riprack rock and gravelly soil containing large rocks. The proluvium, in fan shapes, is found in areas around Guzhu Stream. Its thickness is mostly from 0.5 to 1.5m. Slope washes (O_4dl), formed after saprolite is carried by temporary flows of water, and mainly consists of gravel. Its common thickness in the area is 0.5 to 2.0m. Colluvium (O_4col), formed by the collapse of rock masses, mainly consists of large boulders and contains gravel. It is distributed under the steep ridges of bed rock where an unloading fissure is developing. Its thickness is 2 to 15m.

The project area is located in the folded mountainous regions of southwest Hubei Province, which are tectonic eroded mid low mountainous regions. Within the region, the east is higher than the west; the south is higher than the north. The mountains are steep, the valleys are cut deep, and hence the drop height is large. A little south from the area's centre is clasolite mounds. The north and the southeastern corner are mainly carbonate rock regions. These areas mostly form cuestas or caves along the strata. The river valleys are all "V" shaped and narrow, mostly between 6-25m in width with the widest approximately 25m wide.

For regional geology and the Tangjiahe Ⅱ Hydroelectric Plant Project geology, see the appended Figure 3.

4.2.2 Soil

According to the results of the ***Hubei Province Soil Survey*** and ***The Wufeng County's Second Soil Survey***, the soils in the project area fall into 6 categories: red earth, yellow earth, yellow brown earth, mountainous marsh soil, lime soil and rice soil. Red soil is found in the low-lying terraces and gentle slopes of the tourism areas which have good drainage; Yellow soil is found above the red soil; Yellow brown soil is found above the yellow soil and is a relatively common type of soil in the tourism areas; Mountainous marsh soil is found in the gentle slopes of mountain tops in the tourism areas; Lime soil can be

found from mountain bases to tops in the tourism areas; Rice soil is not widely found in the tourism areas, only in small spots on the sides of river valleys. Limestone soil is a lithologic soil formed from limestone parent material. It is usually thin in layer often containing gravel and is suitable for the growth of northern subtropical broadleaved deciduous trees and mixed forest of conifer species, such as pine trees, cedar trees, fern trees, oak trees, etc.

4.2.3 Hydrological and Geological Characteristics

Topographically, the planned project area is higher in the west than east and south than the north. Yuquan River is the area's only river system, flowing from south to north through the entire area, creating topographically a natural "corridor" and forming the natural topographic conditions great for the area's hydroelectric cascade development. The dividing crest in the area is tall, steep and wide, the underground watershed roughly coheres with that above ground, but as the area belongs to carbonate rock region, and the hydrological and topographical conditions are relatively complicated. According to prospecting, the complexity of carbonate rock hydrological and topographical conditions are manifested in the uneven rock water canal systems and small fissure systems that decide the distribution of underground water.

According to the area's lithology and permeable media, the area's underground water can be classified as clasolite fissure water, carbaonate rock karst water, friable rock fissure water, which is as follows.

a．Clasolite Fissure Water

It mainly accumulates in the mid-highly weathered rattlers of the Sylurian system and possessing a certain extent of water storage capability.

b. Carbonate Rock Karst Water

It mainly accumulates in the karstified crystallite limestone and carbonic argillaceous tumuli flint limestone of the Carboniferous and Permian systems. The karst water in the Qixia Section of the Permian System consists mainly of karst cave water with most of the rest being solution crack water within land strata. The karst water is unevenly distributed with

a high flow rate.

c. Friable Rock Fissure Water

Mainly accumulating in the alluvium, proluvium, slope wash and colluviums of the Quaternary system， lithologically belonging to pebble soil, riprack rock, and gravelly soil and is distributed loosely along the river valleys and stripping surfaces. Pebble layer and friable rock accumulation have a high permeability, but in the other accumulations of the rattler area, due to high argillaceous contents in the rocks, the clay formed through weathering has relatively poor permeability. The flow rate of fissure water is mostly less than 1L/s, but due to effects of precipitation, it changes with the season and perennial flow is little.

From the area's stratum lithology and underground water classification, the area's water-resisting layer includes the Sylurian system Luoreping section's grayish green, yellowish green and dark grey argillaceous siltstones, Shamao section's greyish yellow, yellowish green and greyish green argillaceous siltstone, siltstone and packsand; the Devonian system Yuntaiguan section, Huangjiadeng section and Xieshijing section's rock layers; the Permian system's harness including coal deposits. This area's carbonate rocks are all water-bearing or permeable strata.

The pattern of the formation and movement of the project area's underground water is: the water-bearing stratum of the earth's surface receives precipitation and first turns it into fissure water or pore space water. Part of the pore space water can permeate to supply the fissure water in the base rock. Special topographic and tectonic formations also have the fissure water of the base rock supplying the pore space water, such as the outlets of fissure water covered by the Quaternary system. However, in most circumstances, pore space water supplies fissure water. When the pore space water and fissure water meet karst supply zones or supply mouths**,** they form karst water moving towards the lowest karst erosion base level and change into surface runoff when discharged in various forms at the suitable locations onto land surfaces. The surface runoff also can, at specific karst conditions, supply the underground water through karst systems.

The area's carbonate karst area's underground water gradient is relatively complicated. According to past research on the changes in underground water level of the Nanjinguan

limestone valleys of the Yangtze River Three Gorges, the gradient of underground water level is low in the rock slopes near rivers, numerically 0.04-0.12, and gradient the hydro energy slopes of mountains further away from rivers are high, numerically around 0.3. It can be estimated that the patterns of underground water movements in this area's carbonate rock lying areas are similar.

4.2.4 Earthquakes

According to the State Bureau of Earthquakes, Hubei Province's related geological data and Shiyan City Bureau of Earthquakes' recent analysis on the trends of earthquake activities in the eastern Three Gorges regions, within 200km radius of the planned project site, there are 57 Ms≥4.7 earthquakes in recorded history. The basic characteristics of these earthquake activities are: small in magnitude, low in frequency with a shallow-lying focus. According to statistics, the intensity of the effects of these earthquakes on the planned plant is less than VI degree. By comparing the Madu River hydroelectric plant area's earthquake intensity and referring to ***The China Earthquake Intensity Zone Chart*** **(1995) and** ***The China Earthquake Index*** **(2002)**, it can be confirmed that this project area's degree of earthquake intensity is VI.

4.2.5 Soil Erosion Status

In 2000 the Department of Water Conservancy measured with remote sensor technology that the county's soil erosion area is 1058 km^2 , making up for 44.75% of the county's total area. Out of the soil erosion area, lightly eroded soils cover 380km^2 or 35.9% of the total; medium eroded soils cover 527km^2 or 10.6% of the total, and are mainly distributed in Yuguan Town, Wufeng Town, Renheping Town, Caihua Town; Severely eroded soils cover 39km^2 or 3.7% of the total, and are mainly distributed in Wufeng Town and Yuguan Town. The average annual erosion rate is 2695t/km^2 , the average total eroded soil quantity is 6.372 million ton.

The soil erosion of the project area in the Yuquan River catchments of Caihua Town is mainly water erosion and out of which surface water erosion is the main type. The total area of soil erosion is 2320hm^2 or 23.2 km^2 , taking up 23.17% of the total land area. Out

of soil erosion area, lightly eroded area is 1271hm^2 which is 54.8% of the total, medium eroded area is 793.44hm^2 and severely eroded area is 81.20 km^2 which is 3.5% of the total. The average annual erosion rate is 3031t/km^2 , the average total eroded soil quantity is 70.3 thousand ton.

4.3 Regional Economic and Social Status

4.3.1 Social Economy

Wufeng Tujia Autonomous County is located near the southwestern border of Hubei Province. Its original name was Changle County. It was renamed Wufeng County in 1914 and was authorized by the State Council in July 1984 to establish the Wufeng Tujia Autonomous County. Spanning across 110°17′-115°25′E and 29°57′-30°25′N, the county is part of a branch range of the Wuling Mountains. It is 98km from east to west and 54.3km from north to south, neighboring Yidu and Songzi Cities in the east, Badong and Hefeng Counties in the west, Shimen County of Hunan Province in the south and Changyang Tujia Autonomous County in the north. The total area of the County is 2372km^2.

The County administers 8 towns, 8 agricultural, wood and livestock farms, 104 villages and 857 villager groups, totaling to 62138 households and 206.7 thousand persons. Wufeng County is home to people of many ethnic groups, with Tujia as the most populous, followed by Han, Miao, Zhuang, Korean, Manchu, Mongolian and Hui. Out of these, Tujia makes up for 62% and Han 36.93%.

The County's GDP is 1,089.08 million RMB, out of which industrial output is 789.5 million RMB, agricultural output is 254.06 million RMB. Since the primary electrification of the rural areas, industrial production has increased at the rate of 15% per annum and agricultural production has increased at the rate of 8.9% per annum. The total fiscal revenue of the County is 88.96 million RMB. Currently the average net income of the County's rural population is 1,575 RMB.

According to *The Wufeng Tujia Autonomous County Domestic Economic and Social Development 10th Five Year Plan and 2015 Development Target Outline*, Wufeng's GDP

will increase by 12.6% per annum from 1.1 billion RMB in 2000 to 1.77 billion RMB in 2005 ; agricultural output will increase by 33.7% per annum from 280 million RMB in 2000 to 800 million RMB in 2005; industrial output will increase by 29.7% per annum from 600 million RMB in 2000 to 1.7 billion RMB in 2005; fiscal revenue will increase by 14.5% per annum from 60 million RMB in 2000 to 103 million RMB in 2005; and great improvements in science, education, culture, hygiene, ecology and environmental management will have occurred.

Caihua Town of Wufeng County, where the Tangjiahe Ⅱ Hydroelectric Plant Project is located, is one of the County's main tea producing areas. The Town administers 16 villages, 107 villager groups, 3014 rural households, 10,248 persons and 5,687 persons of agricultural labor force. In 2001, the total grain production was 5.445 million kg, grain yield per *mu* 311kg and agricultural production per capita 531kg. In 2001, agricultural economic income was ￥20.8297 million, out of which 14.0755 million RMB in cultivation, 705.7 thousand RMB in forestry, 5.8 million RMB in livestock raising and 248.5 thousand RMB in other sectors. Net agricultural income per capita was 1720 RMB.

Having numerous steep mountains, beautiful scenery, a mild climate and abundant precipitation, Wufeng County is rich in hydro energy, forestry, tourism and mineral resources. To accelerate the transformation of advantage in resources into economic advantage, the party committee and government of Wufeng County suggested the four goals of constructing a "county big in hydroelectricity", "a county strong in forestry", "a county renowned for tea", "a unique tourism county". In the past, present and the future, hydroelectricity will always be the lynchpin in the County's economic development.

Following the rapid development of the domestic economy, the agricultural, industrial and domestic demand for electricity will surely increase dramatically. In 2000 electricity usage totaled to 149.4 million kWh and it is predicted that this number will increase to 176.2 million kWh in 2005 and 253.4 million kWh in 2010. Wufeng County is rich in hydro energy resource and accelerating the exploitation of this resource is the vital condition for rejuvenating the county's economic development.

4.3.2 Regional Electric System Status

Wufeng's power supply system is based on self sufficiency, surplus power contributes to the power grid and shortages are met by the larger grids. Already established in the County are 45 hydroelectricity plants and 85 installed generating sets with a total capacity of 79.9 thousand kW and an annual output of 270 million kWh. The County's hydroelectricity assets are ￥368 million and the tax contribution of hydroelectricity firms is over ￥14 million. The County has 2 reservoirs with a total volume of 13.69 million m^3. The hydroelectricity industry has taken primary shape.

The County has 3 110kV transformer substations with a substation capacity of 52 thousand kVA, 8 35kV transformer substations with a substation capacity of 10.38 thousand kVA and a 10kV distribution capacity of 63.1 thousand kVA. The 8 towns and 104 villages of the County all have electricity supply with the percentage of households being supplied up to 99.54%. The length of 110kV high voltage transmission lines is 157.2km, 35kV transmission lines is 196km, 10kV distribution lines is 1,235km, forming the basic network of 110kV power lines of Suojinshan Power Plant – Wanmachi Transformer Substation – Yuyangguan Transformer Substation – large grid, with 35kV power lines as connection, with lines no higher than 10kV forming the transmission, distribution and supply network that cover the entire County. The total output of hydroelectricity lines per annum is 285 million kWh, out of which 134 million kWh is consumed locally, 135 million kWh is delivered to the large grid and 45 million kWh is purchased from the large grid. Of the electricity consumed locally, industrial usage is 106 million kWh, taking up 76%, household usage is 19.6 million kWh, taking up 14% and the rest is 14.4 million kWh, taking up 10%. In the decades of the development of small hydroelectricity network, Wufeng County's electricity consumption has risen steadily. According to statistics, from 1973 to 1985, increase rate per annum was 21%; from 1986 to 1996, increase rate per annum was 19.5%; from 1997 to 1999, due to effects from the industrial market, the numbers were steady; and from 2000 to today the increase rate per annum has been 8.4%. Out of these, the increase rate of household consumption has long remained about 8%. With the upgrade of rural electricity network of Wufeng County currently completed and striving for the development goals of a moderated well off society, Wufeng County's electricity consumption will yet have larger increases and the shortage in electricity supply will continue to exist. According to the Wufeng County 2005 to 2015 development sketch, exploitation of great amounts of hydro energy resources will take place during the period of time. The

insufficiency of electricity transmission is becoming severer by the day and has already become the primary restraint on the development of hydroelectricity.

4.4 Environment Status Evaluation and Major Environmental Problems

4.4.1 Environment Air Quality Status and Evaluation

(1) The Distribution of Monitor Points

To get information on the project area's environment air quality status, the Wufeng Tujia Autonomous County Environment Monitor Station monitored the area's air quality for five consecutive days from 2nd to 6th of September, 2005.

Taking into account of the area's climate characteristics, the distribution of environment sensitive spots and the trends of mountain valleys, two monitoring points were set up at the dam site and the plant site. For specific positions, see the appended Figure 1.

(2) Monitoring Items and Methods

The factors of environment air quality monitoring are sulfur dioxide, nitrogen dioxide and the amount of suspended particles. The sampling and analysis are all conducted in methods stipulated by the State Bureau of Environmental Protection. The determining of sampling spots and sampling height are conducted according to the ***Atmosphere Section of The Environment Monitoring Technique Standards***. For the sampling and analysis methods, see Table 4-3.

Table 4-3 Environment Air Pollutant Sampling and Analysis Methods

Pollutant	Daily Monitoring Time	Sampling Method	Sampling Apparatus	Analysis Method	Analysis Apparatus	Standards
TSP	≥12h	Filter Membr	Intelligence large volume suspended	Weight Measuring	TG328A Analysis	GB3095-1996

		ane Concentration Method	particle sampling machine TH-1000C model		Balance	GB/T15432-95
SO_2	≥18h	Liquid Absorption Method	Micro computer atmosphere pollution average daily concentration sampling machine TH-3000A model	Spectrophotometer Analysis	721(B)Spectrophotometer	GB3095-1996 GB8970-88
NO_2	≥18h	Liquid Absorption Method	Micro computer atmosphere pollution average daily concentration sampling machine TH-3000A model	Hydrochloric acid naphthalene ethylene diamine method	721(B)Spectrophotometer	GB/T15435-95

(3) Evaluation Standard

The evaluation of SO_2、NO_2、TSP follows the second grade standard of GB3095-1996 *The Environment Air Quality Standards*. For standard values, see Table 4-4.

Table 4-4 Environment Air Quality Evaluation Standard Values

Number	Pollutant	Standard Values(mg/m^3)		Standard Source
		Hourly Value	Daily Average	
1	SO_2	0.50	0.15	The second grade standard of GB3095-1996 *Environment Air Quality Standards*
2	NO_2	0.24	0.12	
3	TSP	/	0.30	

(4) Environment Air Status Monitoring Results

For the evaluated area's environment air quality monitoring results, see Table 4-5

Table 4-5 Atmosphere Environment Quality Status Monitoring Result

Monitoring Spot	Item	Hourly Value			Daily Average Value		
		Concentration Range(mg/m^3)	Exceeding Rate (%)	Maximum Exceeding Times	Concentration Range(mg/m^3)	Exceeding Rate (%)	Maximum Exceeding Times
1#Planned dam site	SO_2	0.015—0.020	0	0	0.014—0.015	0	0
	NO_2	0.019—0.025	0	0	0.020—0.022	0	0
	TSP	/	/	/	0.030—0.038	0	0
2# Plant site	SO_2	0.014—0.018	0	0	0.016—0.018	0	0
	NO_2	0.018—0.023	0	0	0.018—0.020	0	0
	TSP	/	/	/	0.032—0.036	0	0

(5) Environment Air Quality Status Evaluation Result

Table 4-5 shows: Evaluated area's SO_2、NO_2 concentrations are low, hourly and daily average values are coherent with the second grade standard of GB3095-1996 the ***Environment Air Quality Standards***; the daily average value of TSP is 0.032~0.036mg/m^3 , also coherent with the standard requirements, suggesting that the project area's air quality is good.

The evaluated area is located in remote mountainous regions, the main sources of air pollutants in the area are from the domestic use of high sulphur containing coal, char coal and fire wood and from motor exhausts and debris. As the area's population is small and transportation is not advanced, pollution discharge is very small, having a very small impact on the environment air quality and allowing the air quality to be at or above the second grade standard of GB3095-1996 *The Environment Air Quality Standards*.

4.4.2 Surface Water Environment Quality Status Evaluation

(1) Water Quality Monitoring Section Arrangement

Tangjiahe Ⅱ Hydroelectricity Project is an electricity production project. It is located in mountainous areas and the related catchments are the Yuquan River catchments. Taking into consideration of the reservoir's surrounding environment, water flow situation and

characteristics of the project, two monitoring sections are arranged in this evaluation, their water quality monitoring titles and positions are shown in Table 4-6 and the appended Figure 2.

Table 4-6 Water Quality Monitoring Section Table

Section Number	Monitoring Section Position	Notes
1	Dam site	Compare sections
2	Plant site water outlet	Control sections

(2) Monitoring Items

Monitoring items: water temperature, pH value, SS, potassium amount, permanganate index, nitrogen amount, dissolved oxygen, ammonia nitrogen, BOD_5 and faeces coliform bacteria.

(3) Sampling and Analysis Methods

The sampling and analysis are conducted according to the fourth edition of the ***Water and Wastewater Monitoring and Analysis Methods*** issued by the State Bureau of Environmental Protection. The analysis methods are shown in Table 4-7.

Table 4-7 Water Quality Analysis Methods

Number	Monitoring Item	Analysis Method	Standards and Norms
1	Water temperature	Thermometer method	GB13195—91
2	pH	Glass electrode method	GB6920—86
3	Permanganate	Permanganate methods	GB11892—89
4	Ammonia nitrogen	Spectrophotometric analysis	GB7479—87
5	DO	Iodine Amount Method	GB7489—89
6	Potassium amount	Spectrophotometric analysis	GB11892—89
7	Nitrogen amount	Alkalinity potassium persulfate dispels the ultraviolet spectrophotometric method	GB11893—89

8	SS	Weight Method	GB11901—89
9	BOD_5	Dilution and vaccination method	GB7488—87
10	Faeces coliform bacteria	Multiple tube fermentation method	The fourth edition of *Water and Wastewater Monitoring and Analysis Methods*

(4) Monitoring Time and Frequency

One period of water quality status monitoring during the dry season, twice during the period and the gap between the two times is 3-5 days.

(5) Evaluation Methods and Evaluation Standards

Evaluation method: Single factor index evaluation abiding by the HJ/T2.3-93 the ***Environmental Effect Evaluation Technique Instructions – Surface Water Environment Effect Evaluation***.

Evaluation standards: GB3838-2002□Category standards as shown in Table 4-8.

Table 4-8 Surface Water Environment Evaluation Standard Values

Item	pH	NH_3-N	DO	TP	TN	BOD_5	SS	Permanganate Index
Standard Value	6~9	≤0.5	≥6	≤0.025	≤0.6	≤3	—	≤4

(6) Monitoring Results and Evaluation

For water environment quality monitoring statistic results, see Table 4-9.

Table 4-9 Water Environment Quality Monitoring Statistic Results Unit：mg/L

Monitoring Section Number and Position	Monitoring Item	Average Value(mg/L)	Evaluation Standard Value(mg/L)	Standard Index	Exceeding Rate (%)

1# Rear end of the reservoir's backwater	pH	8.23	6~9	0.485	/
	Dissolved oxygen	9.48	≥6	0.411	/
	BOD_5	0.75	≤3	0.25	/
	Permanganate Index	1.44	≤4	0.36	/
	Ammonia Nitrogen	0.189	≤0.5	0.378	/
	Potassium Amount	0.005	≤0.1	0.05	/
	Nitrogen Amount	0.315	≤0.6	0.525	/
	Faeces Coliform Bacteria	230	≤2000	0.115	/
2# Dam site	pH	8.24	6~9	0.486	/
	Dissolved oxygen	8.86	≥6	0.384	/
	BOD_5	0.75	≤3	0.25	/
	Permanganate Index	2.06	≤4	0.515	/
	Ammonia Nitrogen	0.183	≤0.5	0.366	/
	Potassium Amount	0.005	≤0.1	0.05	/
	Nitrogen Amount	0.305	≤0.6	0.508	/
	Faeces Coliform Bacteria	230	≤2000	0.115	/
3# Plant site water outlet	pH	8.31	6~9	0.489	/
	Dissolved oxygen	8.71	≥6	0.377	/
	BOD_5	0.52	≤3	0.173	/
	Permanganate Index	1.48	≤4	0.37	/
	Ammonia Nitrogen	0.142	≤0.5	0.284	/

	Potassium Amount	0.005	≤0.1	0.05	/
	Nitrogen Amount	0.237	≤0.6	0.395	/
	Faeces Coliform Bacteria	230	≤2000	0.115	/

(7) Evaluation Conclusion

Table 4-9 shows: Evaluation the sections' various samples according to the status monitoring statistics and via the above evaluation methods, all the monitored items of the monitoring sections cohere with the II category of the GB3838-2002 the ***Surface Water Environment Quality Standards***, indicating that the basin's water quality is good.

4.4.3 Sound Environment Quality Status Survey and Evaluation

(1) Monitoring Points

Taking into account of the evaluation area's functions and the characteristics of the project's space arrangement, three noise monitoring points are arranged in this evaluation. Out of the three points, $1^{\#}$ and $3^{\#}$ are plant boundary noise monitoring points and $2^{\#}$ is the environment sensitive spot. The point positions are as shown in Table 4-10.

Table 4-10 Environment Noise Monitoring Table

Monitoring Point	Point Position	Notes
1	Dam site construction area	Construction area
2	Environment sensitive spot	Sensitive spot
3	Plant construction area	Construction area

(2) Monitoring Time and Frequency

The duration of monitoring is 3 days. Each monitoring point is monitored once at day time (6:00-22:00) and night time (22:00-6:00).

(3) Monitoring Methods

The noise monitoring at the sensitive spot and the planned construction site and the processing of the statistics are conducted according to the relevant requirements of the ***Industrial Firm Plant Boundary Noise Monitoring Methods (GB12349-90)*** and the ***Urban Regional Environment Noise Monitoring Methods (GB14623-90).***

(4) Monitoring Results and Standards

For environment noise status standards, see Table 4-11.

Table 4-11 Noise Evaluation Standards Unit：dB(A)

Item	Day	Night	Notes
Standard Value	55	45	GB3096-93 1st category

For environment noise status monitoring results, see Table 4-12

Table 4-12 Environment Noise Status Monitoring Results Unit：dB(A)

Point Number	Monitoring Location	Day		Night	
		Monitored Value	Exceeding Decibel Number	Monitored Value	Exceeding Decibel Number
1	Dam construction area	49	0	38.7	0
2	Sensitive spot	45.2	0	37.5	0
3	Plant construction area	45.3	0	38.9	0

(5) Evaluation Conclusion

The results of the plant boundary noise monitoring shows: the monitoring points of the

planned area at both day and night times all agree with the requirements of the GB3096-93 1st category of *The Urban Regional Environment Noise Standards*. The noise at the environment sensitive spot at both day and night times meets the evaluation standards, indicating that the evaluated area's noise status is good.

4.4.4 Major Environmental Problems

The region and catchment that the planned project is in is scarcely populated, and has no industrial firms and relatively little cultivation fields. The vegetation cover is in a good state and pesticide and artificial fertiliser usage is limited. Therefore, the effect of various types of pollution is small. The major problem at the project site is that the grade of roads in the area is relatively low, restraining transportation. The transportation needed in the construction of the dam and the electricity plant has to rely fully on the low grade roads of the rural areas or mountainous regions. The backward state of transportation severely hinders the region's economic development and affects the project construction to a certain extent also. Moreover, hydro energy exploitation projects now existing in the catchment has caused, in their processes of digging and refilling, a reduction of loss of the original topography and vegetation cover's ability of soil and water conservation, and thus increased the amount of soil erosion; Meanwhile due to the formation of the reservoir, there exists the risk of increasing the amount of soil erosion through landslides and collapses.

5 . Anticipation and Assessment for the Impact on the Eco-environment

5.1.1 Impact Analysis on Ecological Environment during Construction Period

5.1.1.1 Influence on terrestrial plant resources

Project construction will cast some influence on the vegetations and ecological environment within the construction areas. During the construction period, excavations of the stock grounds and spoil areas, reconstructions of transportation routes, constructions of water diversion and power generation work will definitely cause some damage to the vegetations to various extends. They are mainly in the following aspects:

(1) Influence of external transportations on plant resources

The water intake dam of Tangjiahe II- Hydroelectric Power Station is near Wuniu Road, thus, there is no need to construct a road particularly. The height difference between the pressure forebay (head tank) and Wuniu Road exceeds 100m, thus slide track will be set up for the transport of concrete aggregate, rubble, concrete reinforce bars for the fore bay and head conduit. As a result, there will not be any construction road in large scale for the construction of Tangjiahe II-Hydroelectric Power Station. According to the water and soil conservation plan, the temporary transportation road of the project will only covers an area of 0.013hm^2.

The lands temporarily occupied for the construction are composed of shrubs, brushwood and grassland. Vegetations within the road construction areas will be damaged and exposed surface will be left along the side of the road. Meanwhile, a large amount of waste will be produced, which, if left randomly without proper treatment, will surely bury the farmland and vegetations in these areas and block the surface runoff system. If heavy storms occur, soil erosion and water loss will definitely be aggravated along the route. The excavation in the mountainous areas will exert some influence on the stability of the slope. If we do not

pay much attention to the soil and water conservation, several problems, such as collapse and landslide will be caused.

The damage to the vegetations on the landscape, caused by the temporary road is reversible within short period. Two years after the construction, the adverse impact will terminate. In addition, there are no permanent road construction of the project, thus the external transportation will not cast large-scaled impact on the vegetations in the assessment areas.

(2) Impact of the overall construction layout on the plant resources

Land will be called into requisition for the main bodies of the project construction, such as the water intake dam, open channels and tunnels for water diversion, power house and its auxiliary systems (such as power supply, water supply, ventilation system, steel processing factory, wood processing factory, concrete batching plant and living quarters, etc.). Permanent land occupation for the project is 0.67hm^2, while another 0.71hm^2 is only for temporary usage.

During the construction periods, levering off the land and excavation will spoil the vegetations in the given areas, which will, to some extent, lead to exposed land surface and lower the vegetation coverage ratio in the construction areas. As a large portion of native vegetations in the construction areas have no longer existed, only some shrubs and forest plantations will be influenced. Project excavations and land occupation will ruin the vegetations in these areas, so as cause some fundamental changes in the original vegetation structures and distributions.

What's more, a large amount of waste will be produced due to the project construction. If they are not tackled properly, soil erosions and water loss will be escalated in the construction areas. Meanwhile, air pollutions and noise during the construction period will also affect the existence of the terrestrial creatures in the surrounding areas.

As the land occupation is relatively small and within the construction areas of the project, it will not exert significant impact on the forest coverage in the assessment areas. The occupied land of the project has not involved large native forests and rare plant species, so it will neither influence the rare plants and native forests conservation areas, nor cause significant impact on the reproduction and existence of species there. After the

construction work, it is planned to conduct forestation and vegetation restoration for most of the construction areas. Therefore, the construction activities will cast little direct impact on the terrestrial plants in the assessment areas, and this impact can be minimized through vegetation rehabilitation measures.

In sum, project construction will cause some influence on the vegetations in the areas, and the green areas of the regions will be fewer than before. Special distribution of the plants will be partially changed. However, as the scale is limited, no dramatic changes will take place in the regulatory function of the green areas on the environmental quality. What's more, with the termination of the construction, the vegetations in the given areas will be restored through levering off, backfilling, afforestation and forest planting, etc. in order to direct the ecological environment development into the positive direction.

5.1.1.2 Impacts on terrestrial animals

During the construction period, along with the progress of the construction, the approaching of construction mechanisms and constructors, excavations of quarry areas, soil material areas as well as arrangement of other construction sites all will damage the living environment of wild animals.

(1) Impact of main body construction on animals

Aves and mammals of medium-and-large size in the vicinity of the construction areas will leave their original habitats for a more appropriate environment due to the noise of the explosion and drilling during the construction process. As a result, the populations of the animals in these regions will decrease year by year. However, this adverse impact is only restricted in the construction period. After the termination of the construction work and restoration of the vegetations in the temporary occupied areas, the ecological environment can be restored and these wild animals will migrate back to their original habitats. What's more, due to the raise of the water level and source of food, the density of Myomorpha species will increase in the construction areas. Thus, local health and anti-epidemic departments should monitor the epidemic situation closely to prevent the breakout of natural focus diseases. There are no state-level protected animals living in the influenced areas of the project construction.

Construction activities will cause some influence on the amphibians and reptiles within the construction areas but will not pose great threats to their existence, because they have strong migration ability and will move to the non-constructing areas and non-overwhelmed areas spontaneously. After the entering of large number of constructors, strict measures will be adopted to prevent severe damages to the resources of amphibians and reptiles. The increasing density of serpentry in the construction areas will pose some threats to the security of the constructors, so prevention measures should be reinforced during the constructions.

Due to the raise of the water levels and expansion of the water areas, proper living environments are provided for amphibians in favor of still water. It will exert positive influence for the increase of the total species and will attract more waterfowls (palmipeds) and other Aves, resulting in a sharp rise in terms of species and populations.

After the construction periods, along with the implementation of various restoration and protection measures, the vegetations in the temporarily occupied areas will be restored and the living environment of wildlife will be improved, thus the animals can move back to their original habitats. So the construction activities will not cast significant influence on the population structures of animals in the assessment areas.

(2) Impact of road construction on terrestrial animals

The temporary construction road for external transportation will, to some extent, block the passage of terrestrial animals. Road will separate the natural environment into different sections, which will cause some negative impacts on the migration, foraging and moving around. After the termination of the construction work, the block effect will vanish along with the land rehabilitation and vegetation restoration.

5.1.1.3 Impact on hydrobios

During the construction period, waste water, residue and domestic sewage will be discharged into the river, which will cast some influence on the hydrobios in the river reach.

① Planktons

During the construction period, discharge of oil-bearing waste water, produced by leaked oil

during the machine maintenance and working, waste residues and domestic sewage will surely cause some pollution to the water body in the assessment areas, which will cast some negative impact on the population structure and dominant species population of planktons and zooplanktons in the given reach of the river. However, due to of the cosmopolitan feature of phytoplanktons and resemblance of the species, as well as the temporariness of the adverse impact of the water quality on the planktons, which will end shortly after the construction, the repercussions casted on the planktons of the assessment reaches are not very significant.

② Benthos

As stated above, because of the adverse impact on the water quality during the construction period and also resulting from the Ephemeroptera larvae's demand of clean water, the populations of these kinds of species will inevitably decrease as a result of water pollution. The benthonic organisms along the river reach, which can also be found in other similar environment, are not endemic species. Thus from the perspective of species conservation, project construction will not lead to the extinction of these species.

③ Fish

Fish density of the construction areas will decrease in response to the changes of their existing, growing and reproducing environment, which are caused by the deterioration of the water quality in the construction areas as well as the reduction of planktons and benthonic species and some organisms that fish feed on. Some disruptions caused by the constructors, such as fishing, will also cause some adverse influence on the fish resources. The river reach where the project locates is marked with torrential water flow and significant seasonal variation in volume of runoff. Thus, there is hardly any fish distributed there, let alone rare species. So the project construction will not cast severe influence on the fish of the river reach.

The waste water of project construction and domestic sewage, although small in amount, will go through water treatment process and then discharge into the river if they have reached the required standards. Thus the project construction will not cast severe damage to the hydro bios living environment, which will end when the construction finish. After

the completion of the project, the original hydrobios resources and their living environment will not change much if we can guarantee sufficient water flow and good water quality, and adopt certain protective measures.

5.1.1.4 Landscape

① During the construction period, the excavation of borrow areas and quarry fields will cause some negative impact on the landscape of the construction areas, making these regions look like a "scar" of the whole and disharmonious with the surrounding areas. However, after the conclusion of the construction period, the vegetation rehabilitation measures will be taken to diminish the side effects.

② The construction road layout may separate natural landscape and leave them in segments. Driving construction mechanisms away from the route at will for convenience will lead to deterioration of the vegetation of the land and ruin the landscape with the tracks of the vehicles. After construction, land rehabilitation measures will be taken, and these bad effects will vanish.

③ The environmental protection awareness differ from different constructors. Constructors and mechanisms may move randomly within the certain scope of the working site. Domestic sewage and rubbish may be discharged here and there or even cause direct damage to the vegetations. These bad habits and living pattern may be the direct cause for the deterioration and death of the vegetations in the areas, making defects for the landscape and driving wild animals away consequently. During the construction periods, we should enhance our management for the constructors; popularize the ideas of environmental and ecological protection in order to minimize this adverse impact.

5.1.2 Impact analysis of the ecological environment during the operation period

5.1.2.1 Impacts on terrestrial plants

(1) Impact of submergence on terrestrial plants

① Impact on plants within submerged areas

The most severe impact of hydropower projects on ecological environment is submerging some plant resources, which will directly lead to the loss of vegetations below the impounded level. Individual existence will lose its living environment. This impact is irreversible.

According to the project engineering analysis, the normal water level after the completion of the dam is one meter higher compared to the natural one. It will not lead to water impoundment of a reservoir, or resident's migration due to the rise of water level. The dam construction will cause submergence of vegetations in a certain areas near the dam. According to the survey, the plants submerged are mainly the cosmopolitan species in the assessment areas as well as in Hubei Province. Distributed in various altitudes, similar flora can be found in higher altitude along the submergence line. These species are endowed with strong adaptive ability, so there is no danger of species extinction due to the partially submergence. There is no protected plant of state level or provincial level under the impounded water level. The submerged area is limited because banks of river reach before the dam are stiff, and the water level rise is insignificant. As the vegetations of the area are mainly shrubs and prate, there will not be severe damage on the plant resources in the area.

② Impact of powerhouse construction on peripheral plants

In the wake of power station construction, with the investment inflow of project and improvement of transportation, more favorable conditions will be provided to the peripheral vegetations. Great efforts can be made to develop economic forests and special forest, which will exert positive impact on the growth and successions of forest vegetations.

(2) Impact of climate changes on vegetations

Tangjiahe II-Hydroelectric Power Station is a runoff power plant with no reservoir. Thus, its influence on regional climate is limited. Due to the artificial regulation for the good of power generation, in low flow period, the runoff in the lower reach of the dam will be larger than before. With more moisture, it is beneficial for the growth of vegetations in certain scope along the river reach and hygrophilous species of the flora will increase. Mesic and

hydric meadow vegetations and marsh plants will be further developed, which will also benefit from the maintenance of water quality in the lower reach of the dam.

5.1.2.2 Impact on terrestrial animals

After construction of the project, there will be one more obstacle on the original river ecosystems of Yuquan River. Combined with artificial regulation of the runoff, water division for power generation, changes in hydrology and climate, soil and vegetations as well as patterns and intensity differences of human activities, the species, populations and distributions of the terrestrial animals in these regions will surely be influenced.

(1) Influence assessment on Aves

After the construction, the fauna of the Aves will be more complicated, together with an increase in populations. Submergence, changes of food, difference of human productive and living patterns will all exert various influences on Aves faunae. There are from the following aspects:

①Changes of Aves fauna along the river and in the riparian areas

After the completion of the water-intake dam, the living conditions of the submerged areas along the river and in the river valleys will be destroyed. Whereas the changes of water areas are limited and these species can move to other habitats in a little bit higher altitudes, the influence on the Aves populations is not significant. The increase of runoff in low flow period will be favorable for the reproduction of species, so after a period, the species population will pick up. Meanwhile, as the aquatic insects increase and the water flow variation is moderated, more waterfowls and sub-waterfowls will be attracted, leading to a great increase in both species and population.

② Changes of Aves Fauna in farmlands

The project construction will not cause submergence of farmlands, but the main building will permanently occupy 0.146hm^2 cultivated lands. Thus, it will result in a moderate decrease of Aves fauna. However, with the inflow of the compensation investment and the intensifying of human activities, the Aves in farmlands will increase their size. Aves fauna,

such as magpie, sparrow and Large-billed Crow (Corvus macrorhynchos) will develop rapidly, especially the latter one.

③ Changes of Aves in forests

Vegetations are well conserved in the mountain area in the boundary of the regions, as there are few human activities there. Aves in these regions include: cuckoos, paridae, woodpecker, etc. As project operation only exerts small impact, Aves there will hardly be influenced.

(2) Impact assessment on mammals

The living environment of terrestrial animals is closely related to the vegetations. Vegetations of a region will determine the species components and populations of the terrestrial animals there. As the land is occupied and the scope of human activities is expended, the distribution areas of terrestrial animals are shrunk. All of these will lead to changes of living environments of mammals. Details are as follows:

① Along the river and in the riparian valleys

Mammals inhabit along the river and in the riparian valleys mainly are Rattus norvegicus and Arctonyx collaris, etc. As water level is designed to raise only one meter, the submerged area is limited, the mammals influenced are small in number. They can move to appropriate living environment in higher place. So the project will not cause living crisis for them.

②farmland and cultivated areas

Mammals live in these regions are small species of Rodentia and Insectivora, such as Lepus sinensis, R..novegicus, etc. These regions will become smaller due to the permanent land occupation by the project; the original living environment of these animals will also be reduced. What's more, with more frequent human activities there and the change of food sources, it is predicted that the population of them in the non-occupied regions of construction areas will increase, especially the Myomorpha species, which are often regarded as the source of natural epidemic focus diseases. Their frequent contact with

human beings may pose threats to the health of local residents. Among these Myomorpha species, Rattus flavipectus and R..novegicus, etc., are known to have some relations with Epidemic Hemorragic Fever(EHF) and Leptospirosis. These two epidemic diseases are the major ones of natural epidemic focus diseases in Hubei Province. Departments concerned should pay much attention to that.

③ Shrubs, prate and woodlands in low altitudes

Forest vegetations in these regions are mainly the secondary type after the damage to the native florae. Vegetations are sparse and mammals found there are Lepus sinensis, Hystrix hodgsoni (Porcupine), Arctonyx collaris, etc. After the completion of the project, the type of living environment there will decrease. Construction and operation of the project will increase the frequency of human activities there. Animals living in these regions will mainly be influenced by hunting and productive activities of peripheral residents, including reclamation of the land, which will reduce living environment of animals, and deforestation, which will ruin the habitats of the animals, etc.

(3) Amphibians and Reptiles

After the completion of the hydroelectric power station, the rise of water levels and expansion of water areas will provide appropriate living environment for amphibians in favor of still water. Thus, the species and population of the animals in these regions may increase. Reduction of water flow in the river can enlarge the riparian and gravel river beach. These dry apricus areas are suitable for lizard to stay and move around.

As most amphibians and reptiles, such as Rana limnocharis, Pelophylax nigromaculata, live in the vicinity of the river and brooks, the rise of water level near the dam will submerge their living environment. However, the rise of water level is limited, and they can move to higher places, so they will not be affected significantly. What's more, during the dry seasons, the increase of the runoff will benefit the living and reproduction of amphibians and reptiles in this river reach.

5.1.2.3 Impact on hydrobios

After the completion and operation of Tangjiahe II-Hydroelectric Power Station, the

hydrology, volume and velocity of water flow, as well as water levels have changed a lot. The change of water environment will directly or indirectly influence the growth of hydro bios. However, the hydro bios in the given water bodies are cosmopolitan species, which can easily be found in other similar environment. The environment change may lead to succession or disappearance of certain species in part of the water areas, but no severe damage will be caused in terms of species resource and species conservation.

(1) Influences on food organisms

In natural conditions, Yuquan River is canyon torrent living environment, which is marked with rapid water flow and sharp difference of water levels as well as great seasonal variations of water flow. The river bed is made of rocks, cobbles and sand, which is not favorable for the emergence of primary productivity force. After the completion of the Tangjiahe II- Hydroelectric Power Station, areas, depth and main body of the water before the dam will be enlarged; the water flow will be slowed; the mud and sand sediment will be enhanced; and the transparency of the water will be improved. What's more, submergence has led to increase of nutritious salt in the river reach, a rise in the primary productivity force and improvement of the food conditions. All these favorable conditions will lead to a rise in the species adaptive to still water environment and a drop of the existences getting used to rapid flow.

Phytoplankton

After the completion of the water-intake dam, the water flow before the dam will be slowed. The vegetations and organic substance stagnated from the external environment and dissolved from the soil being submerged will provide some nutrition to the water. Along with the change of hydrodynamic conditions and accumulation of nutrition, conditions have been prepared for the growth and reproduction of phytoplankton. Compared with original ecological environment, the species structure and populations will raise sharply after the dam construction, especially for Chlorella (green algae), diatom, dinoflagellate species, etc.

② zooplanktons

With the increase of bacteria and algae, as well as the slowing down of the water flow after dam construction, the zooplanktons which are feed on them will also thrive. The species

and population will increase. And rotifer, copepods and cladocera species will become dominant species.

At the beginning of the constructions, the biological nutrition will enhance as a large amount of organic substance and inorganic salt are dissolved in water. The zooplanktons population will reach a peak. But this summit is temporary. With time passing by, the physical and chemical elements and environmental factors will gradually reach a dynamic equivalence. And the population of zooplanktons, in response to that, it will also reach a relatively stable stage.

The development of zooplanktons does not follow the same pattern continuously. Vigorous at the beginning of the dam construction, the zooplankton development will reach a new equilibrium after a period of time, and a new complex fauna will be established consequently. The BOD_5 content will fall due to the long-time stagnation, slowing down of the water flow, dilution along the river and thorough decomposition by organisms. Population of colibacillus will reduce due to natural death. This has something to do with the replacement of the upstream water and environmental protection measures.

Due to water diversion of the power station, 4.3km upstream the river reach, with water flow reduced, will become creek with large riparian areas in dry seasons. The water flow reduction will surely lead to the shrink of living space of zooplanktons, which will cause a decrease in both biomass and species populations.

Benthic animals

After the completion of the dam, the water level in front of the dam will raise. Thus, the water exchange capacity of natural river will be changed. Soil sediment will reshape the substrate and ruin the habitats of benthic animals. The original cobble river bed will be covered with sand and mud. Along with the increase of mud, sand and organic matters, it is predicted that the community structure of benthic animals will experience a dramatic change. Species in favor of flowing water will gradually decrease. The community structure will mainly consist of mollusca, oligochaeta and Chironomus larvas, which will become the dominant species in the river reach.

The reduction of water flow in the 4.3 km river reach from the dam site and the factories may result in the disappearance of benthic animals in the river reach.

④ Impact on aquatic higher plants

After water division and dam construction, the water level is controlled be human beings. The variations no longer stay in conformity with the growth rhythm of aquatic higher plants, which obviously cast negative impact on their growth. In early spring, bourgeon and growth of higher plants will be affected and in summer, the growth and development will be restricted.

(2) Impact on fish

After construction and water diversion of Tangjiahe II-Hydroelectric Power Station, the water-intake dam has blocked the passage of fish in the river reach. The consequent changes in hydrological factors, such as substrate, volume and velocity of water flow, transparency, etc., will change the habitat of fish in various extend. The changes on ecological living environment of fish will cast significant impact on fish resources.

① Impact of power station operation on fish

In flood period, water rushes through the dam. Large amount of air will be engulfed by the running water, which will lead to supersaturation of nitrogen. This will exert negative impact on fish growth, as fish may die from air bladder disease. Besides, larval fish and some species of fish may get hut when passing through the water turbines during power-generation process. The casualty rate of larval fish depends on the depth of tail water, impact strength, mixture ratio, as well as water head, plate gate opening, etc. It is also related to the instantaneous differential pressure, cavitation degree and the operation of water turbines, etc.

② Impoundment impact of water-intake dam on fish

The project locates in the mountain area, with sharp drop height and rapid water flow. After the construction of the dam, the water flow will obviously slow down, which will lead to some sediment of sand, increase of food organism as well as a rise in nutritious salt and biomass. These changes will result in a rapid growth of omnivorous fish population, such as Cyprinus pekinensis (carps), crucian, etc. Fish species in favor of slow water flow or

still water will become dominant species.

The rise of water level makes the original gravel-bedded torrential water environment with sharp drop height into semi-still or still water environment. The fish species in favor of rapid water flow will lose their indispensable living environment. They are forced to migrate into some tributaries of Yuquan River. Thus population of these species may decline continuously and even gradually extinct. The fish species will become more simplified, which will cast some negative impact on fish diversity.

In sum, the faunal components of fish will develop from species in favor of running water into species preferring slow or still water flow. At present, the fish species in the upper reach of Yuquan River are cosmopolitan economic species, with no state-level or provincial-level protected rare species. What's more, fish inhabiting there are small in amount, so the project construction will exert little influence on fish. Instead, the fish population may tend to increase after the dam construction.

④ Impact of water-reducing reach on fish

After the project being put into operation, there will be a 4.3 meters long water-reducing reach. Thus, the water flow will be reduced in downstream of the dam to the power house, which will definitely cast some adverse impact on fish reproduction. On one hand, the necessary natural resources for the fish will reduce correspondingly, such as dissolved oxygen, algae, etc. Thus, aquatic plants and invertebrate animals will diminish in terms of population and total biomass, which will further lead to decrease of the primary productivity and the food for fish. On the other hand, the downstream reach of the dam will have limited water flow. Thus the quality of the water may deteriorate, which will cast negative impact on the reproduction and existence of the fish species in favor of clean water and rapid flow. What's more, the living space for the fishes shrinks, which will also result in the reduction of fish species and populations.

After field survey, we find the river reach between the water-intake dam and the power house is rich in water resources. There are abundant tributaries and springs, which are able to maintain the minimum ecological demand. Therefore, the project operation will cast relatively small impact on economic fishes with strong adaptability.

The lower reach of Yuquan River runs through deep canyon. Due to the terrain limitations, the major function of the water body is no other than to maintain the ecological environment. With sufficient water inflow, the lower reach of the dam still enjoys a minimum water flow of 0.23m^3/s, enough to satisfy the demand of the aquatic habitat. Whereas, in dry seasons, proper measures should be taken to maintain the ecological base flow in the lower reach.

5.1.2.4 Impact on landscape

After project construction, the corridor effect of human landscape is obvious. It will not only serve as the passage for material transportation and energy transmission, but also change the original isolated situation of the peripheral regions of the power station. There were only narrow mountain paths along coastal area of Yuquan River, or simply no road at all, which gives much inconvenience to villager who goes outside, thus results in sparse inhabitation. Upon power station completion, line corridors identified by roads will be further improved, whose large traffic flow will promote material and information exchange with outside regions. However, the increase of the stream of people will also disrupt the ecological environment of the forests. Thus, we need to intensify the management, especially strengthen the protection for the biological diversity and ecological integrity.

5.1.3 Assessment for the integrity of ecological environment

As the Tangjiahe Reservoir and Hydroelectric Power Station (I) have already gone through the environmental impact assessment, this assessment will not take them into consideration. This project will not cause submerged land occupation. After the completion of Tangjiahe II-Hydroelectric Power Station, permanent land occupation will be 6.7hm^2, most of which are for construction purpose. The project construction will cause some influence on the landscape integrity, resulting in productivity and stability changes of the organisms in the natural system.

5.1.3.1 Spatial structure analysis of the regional natural biological system

After the construction of the project, new landscape will be formed in the assessment areas. The project greening, such as the planning of the street trees, the introduction of foreign

species, will substitute the original patches and matrixes with new water sceneries and human landscape. Expansion of water areas and shrink of land areas will be good for the existence and reproduction of aquatic animals and plants. It also provides favorable water resource conditions for growth of peripheral plants and introduction of artificial forests. Meanwhile, more water fowls and amphibians will be attracted to live and reproduce here. The diversity of the ecological system will be enhanced along with clearer structure-layers of the landscape. In vicinity of the dam, new villages may take shape, thus the regional ecological structures will be changed indirectly.

5.1.3.2 Integrity and stability analysis of ecological system in the assessment area

The major influence on the integrity of the regional natural system is attributed to the permanent land occupation, with a total area of 0.67hm^2, which is a clear manifestation for the influence of the power station construction and operation on the integrity of the ecological system in the landscape. It mainly embodies the changes of the productivity and stability within the assessment areas.

(1) Variations of the productivity of natural systems

The productivity of the landscape ecological system will be influenced by the project land occupation, which leads to the changes of the total areas of different patches. Farmlands, shrubs and prate will diminish their total areas under the impact of the submergence and land occupations. The total productivity will drop in short-term. The changes on land utilization layout can be seen in Table 5-1. While the variations of natural productivity of landscape systems in the assessment areas are demonstrated in Table 5-2.

Table 5-1 Variations of Land Utilization Layout within the Engineering Areas of Tangjiahe II-Hydroelectric Power Station (Unit：hm^2)

Land types	Utilized areas at present	Occupied by the project	Land utilization during the operation period
1.Forest land	7289	0	7289
2.shrubs and prate	690	0.133	689.867
3.Woodlands	121	0.154	120.846

4.Cultivated lands	1080	0.146	1079.854
5.river and riparian areas	203	0.223	202.777
6.others	602	0	602
Total	9864	0.502	9683.498

Table 5-2 Variations of Natural Productivity of Landscape Systems in the Engineering Areas of Tangjiahe II-Hydroelectric Power Station (Unit：t/a)

Land types	Biomass at present	Expected biomass	Variations of total productivity
1.Forest land	80689230	80689230	0
2.shrubs and prate	6210000	6208803	-1197
3.Woodlands	968000	966768	-1232
4.Cultivated lands	9720000	9718686	-1314
5.river and riparian areas	203000	202777	-223
Reduction of average natural productivity within the assessment areas ($g/m^2.a$)			0.07
The productivity of the natural systems in the assessment areas after the project operation ($g/m^2.a$)			979.30

From Table 5-1 and Table 5-2, we can clearly find out that after the operation of the power station and the expropriation of the forests, shrubs and prate, the utilization function of lands will change correspondingly, leading to a decrease in the natural productivity of the landscape system. As reservoir impoundment is not an issue here, and the area of permanent land occupation is small, only taking up 0.0067% of the total, the natural productivity of the natural system in the assessment regions is 979.30g/m^2·a after the project is put into operation, only 0.07g/m^2·a lower than before. Thus the influence of construction and operation of power station is still within the bearing capacity of the ecological environment, which is tolerable for the natural system in the assessment regions.

(2) Stability variations of landscape ecological system

There are two characteristics of landscape ecological stability, namely resilience stability

and resistance (persistence) stability. Resilience refers to the ability to restore back to the original state, while resistance stability stands for the resisted or rebellion ability when the environment changes or being disrupted. The measurement of resilience is using plant biomass as the yardsticks, while the parameter for resistance stability is the extent of matrix variation of the landscape.

The permanent land occupation takes up only a small portion (0.0067%) of the total influenced area. Thus, the resistance stability will not lower to the next grade merely because of the small amount of shrubs, prate and farmland being occupied by the project. The construction of the hydroelectric power station will not cast great influence on the landscape ecological stability. Thus, the construction and operation of the power station is within the baring capacity of the ecological system, and is tolerable for the regional natural system.

Although the terrestrial ecological system within the engineering areas has partially been occupied, the green lands still maintain its dominant position as the occupation areas are small. So the project construction will not change the regional matrix status and only cast little impact on the quality of the landscape system of the assessment areas.

(3) Comprehensive quality assessment of the landscape ecological system

In the wake of the implementation and operation of Tangjiahe II-Hydroelectric Power Station, the land utilization layout in the areas has changed, but the changes are not significant in terms of the dominant degree of various land types. As the permanent land occupation is only 0.67hm^2, while the regional landscape ecological system is far beyond the variations, the forest and prate remains the matrix of these region. It suggests that the implementation and operation will not cast severe influence on the landscape quality of the natural system within the assessment areas.

5.2 Assessment of Water Regime and Sediment Influence

5.2.1 Impact Assessment of Water Regime Variation

After the completion of Tangjiahe ⅡHydroelectric Power Station, an intake dam of 5.1m will be established at 300m downstream the Baiyiping Hydroelectric Power Station, thereby transforms the original condition of the natural watercourse of the reach. To meet the demand of hydropower and flood regulation in flood season, the water storage and

discharge amount of the low dam and the Tangjiahe Reservoir will undergo appropriate regulation. Moreover, sediment under the dam will accrete year by year, which shall incur relevant changes of water level, flow volume, velocity and other hydrological condition along reach of the dam zone.

1) Impacts on Water Regime Shift along the Water Basin

Runoff

Before the construction of Tangjiahe Ⅱ Hydroelectric Station, Yuquan River, the project area, is classified as a typical mountain river, whose runoff mainly rely on rainfall supplement, while rainfall volume fluctuates dramatically throughout the year, which results in huge runoff variation of the river. Floods are influenced by rainstorm intensity and landform, featuring fluctuation in different seasons, frequent rainstorm with great intensity.

The major characteristics of rainfall amount throughout the year are manifested on the uneven distribution of rainfall: the average rainfall amount from April to October is 1,247.3mm, this high flow period contributes 84.6% of the total rainfall within a year; from November to the next March, and the average rainfall goes as low as 227.1mm, this low flow period makes up 15.4% of the yearly rainfall. The largest single 24-hour-rainstorm recorded in Wufeng's history was 422.9mm (July 3, 1926), and largest 3-day-rainfall 1,076.1mm, 7-day-rainfall 1,318.0mm.Statistic analysis of precipitation shows there is 0.8 rainstorms whose daily rainfall amount exceeds 100mm, which appear most frequently from June to August. Due to the great rainstorm intensity of the river basin, and steep slope of riverbed, short convergence time of flood, the floods tend to rise and fall sharply and suddenly.

TangjiaheⅡHydroelectric Station is a runoff hydroelectric station which basically has no regulating capability, and as a result, exerts little impact on the runoff amount of the river. During low water period, the intake dam can intercept the tail water of BaiyipingⅠ,ⅡHydroelectric Power Station and TangjiaheⅠ Hydroelectric Station (planed). In addition to the power generation demand of the station, the Tangjiahe River Reservoir, which belongs to the same company, can regulate the runoff, therefore, the flow volumes of high, medium and low water period tend to be at level. Those are beneficial to flood

regulation and ecological development of the river basin for the river that rises and falls sharply.

Water Level

The top height of the intake dam of TangjiahellHydroelectric Station is only 5.1m, and the normal elevation in front of the dam is 561.45m, merely 1.0m above natural water level in average .Consequently, the impact of dam construction on elevation and yearly elevation shift along the reach of the dam area is relatively small.

Because of the regulating effect of the Tangjiahe Reservoir and its intake dam, the runoff of the upper reach will become relatively stable; the flow will be increased during low water period, which is favorable to the water and ecological environment of the watercourse. The enlarged flow in low water period enhances the diluting capacity of the water body, and the change of the water regime is favorable to the improvement of water quality. In the case of high water period, since the intake dam has no capacity of blocking flood peak and impoundment, it exerts little impact on water regime.

Flow Velocity

Analysis based on riverbed configuration of the river basin, diversion and regulating methods of the project, sediment accumulation, the river flow velocity of the reach of the dam area will be changed after the dam construction. Due to the blocking effect of the intake dam, the flow velocity of the dam reach will be decelerated, and since the intake dam is a weir dam of 5.1m, the velocity and flow relate to the magnitude of floods. In non-flood season before normal water level, flow in front of the dam basically tends to be sub-critical flow.

Physical Continuity of River

After the Tangjiahe □ Hydroelectric Power Station is built, an obstruction will be formed in the Yuquanhe River Basin, which undermines the natural continuity of the main course of the reach, the variation from flood to drought will be completely subject to artificial regulation. Yuquan River is a typical mountain river with rapid flow, featuring fluctuated distribution of runoff throughout the year and a small number of species within the basin,

therefore, no sharp reduction of aquatic organism within the basin is expected as the result of dam construction. And because of the regulating effect of power generation by the hydroelectric power station on flow volume, the flow volumes of high, medium and low water period tend to be level, which is favorable to the ecological improvement for aquatic lives.

According to the Water Resource Assessment Report, there are six tributaries injected to the river between the dam site of Tangjiahe II-Hydroelectric Power Station and the outlet of tail water. They are Xujiayan River, with a water flow of 0.03m^3/s, Jianjiawan River, 0.05 m^3/s; Yaochangpo River, 0.03m^3/s; Xiangjiagou River, 0.09 m^3/s, etc. The total water flow volume exceeds 0.3m^3/s. It is sufficient for the need of minimum ecological demand. However, at the non-water discharge period, the river section between the dam site and the injection of the first river is still short of water for ecological maintenance. Thus, this environmental impact assessment will apply the result from the Water Resource Report that the ecological water reserve should be 0.1 m^3/s, which is calculated by the minimum average water-flow within 10 years. According to the survey, there are few villagers (15 in total) living on the mountain slope along the water-reduced and diminished sections. The irrigation of the farmland and drinking water are mainly from the springs on the mountain, rather than from Yuquan River. Thus, water in the water-reduced and diminished sections is mainly for flood discharge and ecological system maintenance, rather than for irrigation or drinking. After the completion of the power station, the water-reduced section is about 4.3km long, including 50m water-diminish section. The annual ecological water consumption is around 3.1536 million m^3. To ensure that the sections between the dam site and the first river injection will have water flows, suggestion is raised in this environmental impact assessment that water valve should be maintained at the foot of the dam. Once the measures have been taken, the impact during operation period on aquatic-organisms and territorial animals will be limited.

2) Impacts on Water Regime Shift on the Lower Reach of the Dam

Runoff

According to the feasibility study of the project, preceding to the dam construction, average multi-year flow in flood season (April to October) is 3.28m^3/s in the dam zone, making up 82.8% of the yearly total; during low water period (November to next March), average

multi-year flow goes as low as 0.95m^3/s, accounts for 17.2% of that of the whole year. Tangjia □ Hydroelectric Station's designed water diversion flow is 5.5m^3/s.The hydroelectric station, after it is construction, will exert certain impact on the runoff of the lower reach of the dam.

The water diversion of the project, in addition to the natural runoff, will also use the tail water of Baiyi Terrace □,□ Hydroelectric Station and Tangjia □ Hydroelectric Station, furthermore, during low water period, Tangjia River Reservoir will also contribute to the regulation. (The project is the second cascade hydroelectric station regulated by Tangjia River Reservoir) The runoff of the project river basin mainly rely on rainfall supplement, the average multi-year rainfall volume in the dam zone is 1,474.4mm, considerable rainfall supplement is available on the lower reach of the intake dam. Besides, incoming water (tributary streams and springs) is also abundant within the area, which provides certain regulating effect. After the dam is built, the extent of monthly average flow variation in the reach downstream of the dam is, on the whole, within the extent of the natural condition. Hence, the operation of the station basically does not affect the annual runoff of the downstream reach of the dam. The tail water of the power generation of the hydroelectric station connects with the backwater of Erchakou Hydroelectric Station (planed) in the lower reach.

Flood Regulation and Characteristic Water Stage for Flood-control

The intake dam of the Tangjia □Hydroelectric Station bears only the function of the blocking and channeling water, it does not shoulder any flood control responsibility, and no limit will be set on the discharging amount during flood period, therefore, no flood control calculation will be carried out. The designed flood level and check flood level will be defined upon the working condition of the spillway dam. The total length of the intake dam is 37m, and the crest elevation is 564.28m. For the calculation result of stage-discharge relation curve, see table 5-3

Table 5-3 Dam Site Stage-discharge Relation Curve Table of Tangjia Hydroelectric Station

Water Stage Z(m)	Catchments Area A (m^2)	Wetted Perimeter of Flow Cross	Hydraulic Radius R(m)	Discharge Q(m^3/s)

		Section X (m)		
562	10.0	13.0	0.77	43
563	24.5	18.0	1.36	134
564	43.0	22.0	1.95	275
565	66.0	27.0	2.44	541
566	94.0	32.0	2.93	693

Note: n=0.04，i=21‰

Seen from table 5-3, during flood period, the in intake dam of Tangjia River Second Cascade Hydroelectric Station exerts no flood storage and blocking function, hence, the flood discharge volume in flood period will not be effected by it.

5.2.2 Impacts Analysis on Water Regime

1) Favorable Impacts

Improve Energy Structure

The average multi-year electricity production of Tangjiahe □ Hydroelectric Station is 18.2709 million kWh. After the station is built, the energy structure of local residents will be changed, providing firm foundation for replacing firewood with electricity, which is beneficial to forest protection and the reduction of water loss and soil erosion.

Adjust Flow Volume, Prevent water loss and soil erosion

After the Tangjiahe □ Hydroelectric is built, river flow returns to the river course through tail water; little difference will emerge on the yearly runoff distribution and total water volume within the area before and after the construction; the construction and operation period of the project will exert approximately zero impact on the water regime. However, during the operational period, as a consequence of water regulation for power generation, flow volume downstream the dam in low water period can be enhanced, then the water quality shall be improved, which will prevent the occurrence and spreading of infectious diseases, thereby, benefit the economic development of the local society, the improvement of people’s working conditions and living standards.

Improve Biotope of the River Basin

Because of the water regulation of the station for power generation, runoff volume of the river basin will distribute more balanced throughout the year. Particularly in low water period, because of the tail water supplement from Baiyi Terrace □,□ Hydroelectric Station and Tangjiahe □ Hydroelectric Station and the regulation by Tangjia River Reservoir (after it is been built), the reach runoff volume of the dam zone will increase to some extent compared with what it was before the construction, and the biotope shall be improved within the river basin.

2) Unfavorable Impacts

Impact on Water Quality

Upon the completion of the dam, upstream water level of the dam before normal intake water level is reached, 1m higher than the natural water level. When the hydroelectric station is in operation and undergoes normal water diversion, soil and plants within certain range of the two banks will be submerged. Following the decomposing of dissolved soil material and submerged plants, water quality upstream the dam may also be affected. A reducing reach of 4.3km will be formed between the intake dam and the power house. Since the water volume is decreased in the reach, river's diluting and self-purifying capacity will be weakened.

Hydrological Impact of Sediment

According to calculation, suspended sediment concentration in the dam site is 0.18kg/m^3, the multi-year average suspended load is 10.1 thousand, and multi-year average bed load 1.7 thousand m^3 (the dry density of suspended load and bed load are respectively calculated as 1.3t/m^3 and 1.5t/m^3) The Tangjiahe □ Hydroelectric Power Station practically comprises no reservoir, whereupon no sediment accumulation is expected. The top height of the intake dam is only 5.1m, which enables a convenient cleaning of sediment accumulation. Besides, clear river water will results in small amount of sediment accumulation, therefore, station operation will not be affected. In addition, the project employed bottom trash rack dam for water diversion, with the support of sand basin, the contradiction of water taking and sand prevention shall be solved.

5.2.3 Sediment Impacts

1) Impact on Intake Dam Functioning

Upon the completion of intake dam, the water velocity upstream the dam will be decelerated, and the moving capacity of stream will also be diminished, hence, the bed load and part of suspended load in the stream will deposit before the dam. Besides, due to the rise of water level in front of the dam (about 1m in average), after the intake dam completion, much cultivated land, quaternary deposit and rock weathering product that were originally above water level will enter the river. During the operation process of the power station, as a result of seasonal and operational water level fluctuation, some loose accumulative material that within the fluctuating water levels will enter the river, which gives rise to the increase of sediment concentration of the river.

The deposit accumulates in front of the dam, and the total amount of sediment accumulation increase with the escalation of the dam's service period; although to some extent, the accumulation serves as a natural bedding that prevents intake leakage, large amount of accumulation will lower the water level in front of the intake dam, which will affect the power station operation, and reduce its serviceable period. Moreover, Tangjiahe □ Hydroelectric Power Station is a run-of-river hydroelectric station, which means overtop sediment concentration will pose harm to generator units.

The source of the solid runoff that causes sediment accumulation relates to the lithology, geomorphy and dynamic geological process of the area. Those are mainly constituted by sediment, debris flow upstream the dam and deformation failure as well as the sheet flow erosion materials of bank slope. Accumulation issue of the project intake dam is less prominent because: 1. water and soil conservation of Yuquanhe River Basin is relatively good, the stream brings less sediment, and its upstream already has development project of multi-level, especially the fact that the main dam construction of Tangjiahe Reservoir will block 55% sediment of upstream river basin area, so that sediment volume brought by the river will be significantly reduced; 2. In the catchments area of the reservoir, carbonatite is the principle type, and no developing area of debris flow can be found; 3. the reservoir bank is relatively stable, no large scale deformation failure is expected.

Along the river reach upstream the dam site, human activities exert fairly small impact on

environment. Towering mountains and steep slopes reside both banks, it is a remote mountainous area with high altitude and few human inhabitancy. And the ecological environment is favorable, with a forest coverage rate of about 73%. River water keeps clear throughout the year, and sediment concentration is relatively small. Sediment in front of the dam primarily derives from flood period, sediment concentration from July to September makes up over 90% of the yearly total. Since the project intake dam is a spillway dam, sediment that brought by short lasting flood that form by rainstorm in the upstream gully of the dam site does not have enough time to silt, therefore, most of it will be brought to downstream reach by the flood. And because the intake dam is small in scale, the top dam height is 5.1m, the little amount of sediment can be disposed by direct sediment dejection measure.

To solve the contradiction of water diversion and sediment prevention, the project intake dam will be designed as bottom trash rack dam for water diversion, and sand basin will be set up between the dam and the entry of the No.1 open channel, and sand sluice will be installed to prevent the entering of small particles to the channel. The sand basin will be set up between the exit of bottom trash rack dam and the entry of the No.1 open channel; it will be formed by partly deepening the channel. By considering the small scale of the power station, shutdown for sand washing poses little influence on the electric network; the project will adopt sand basin of linear type intermittent sand washing, power generation will be stopped during sand washing operation.

Concluded from above analysis, water loss and soil erosion should be given top priority during the operational period of the project, and water and soil conservation must be strengthened to minify sand introduction to the front of the dam, so the efficacy of the station will be given full play.

2) Impact on Scouring and Silting of Reach Downstream of Dam

In the operational period of the Tangjiahe Second Cascade Hydroelectric Power Station, since no flood storage and blocking function can be produced by the low intake dam, during the flood period, its diverted water volume is virtually neglectible compared with the runoff volume of the 4.3km reducing reach from intake dam to power house, so the construction of the intake dam does not affect the scouring and silting of the reach downstream of the dam. In low water period, thanks to the regulating effect of the station, runoff downstream will

have certain increase compared with that before the dam completion, scouring and silting will also be improved in comparison with natural condition.

Tangjiahe Reservoir (planned), blocks 55% of sediment from upstream river basin, greatly reduced sediment that entering the end of the downstream Erchaokou Reservoir, channel aggradations is not critical, so it will not silt the tail water exit of Tangjiahe □Hydroelectric Power Station.

5.3 Land Environment and Land Resource

5.3.1 Land Environment, Land Resource and Occupation Profile

According to project design, the intake dam of Tangjiahe □ Hydroelectric Power Station is categorized as bottom trash rack dam, which is located on the river course, thus inundation treatment and resettlement are not required. Project land occupation is mainly temporary occupation for construction and permanent occupation by buildings. For details see table 5-4.

Table5-4 Project Land Occupation Table Unit：hm^2

Division Name	Temporarily Occupied Land				Permanently Occupied Land				Total
	River Shoal	Tea Garden	Barren Hill	Cultivated Land	River Shoal	Tea Garden	Barren Hill	Cultivated Land	
1.Intake Dam	0.15	0	0	0	0.103	0	0	0	0.25
2.Tunnel Outlet, Open Channel and Forebay	0.07	0.0067	0.047	0.017	0.08	0.033	0.087	0.039	0.38
3.Pressure Pipeline	0	0.07	0.03	0	0	0.1	0.067	0	0.27
4.Power House and Booster Station	0.04	0	0.03	0	0.04	0	0	0.107	0.22

5.Access Road	0	0	0.013	0	0	0	0	0	0.01
6.Waste Residues Site	1.31	0	0.97	0.18	0	0	0	0	2.46
7.Material Field	0.47	0	0	0	0	0	0	0	0.47
Total	2.04	0.0767	1.09	0.197	0.223	0.133	0.154	0.146	4.08

In line with the related agreement drew up by proprietors and local government on the development and construction along the Yuquanhe River Basin, township and county governments are responsible for organization and other related works. Township governments are responsible for the completion of the compensation of project land occupation in the first construction year. The compensation for the requisition of land will be carried out in line with the compensation standards and plans as following:

The cultivated land will be compensated as 6 times of the annual output value of 1000yuan/mu; the forestland will be compensated as 5 times of the annual output value of 500yuan/mu; besides, in line with national regulation, Wufeng County belongs to Yangtze River sheltering belt range. The area, whose fee of the forest re-vegetation is charged as 5.00yuan/m^2. For detailed compensation condition for land requisition, see table 7-3.

Table 7-3 Compensation Condition for Land Requisition

No.	Item	Temporarily Occupied Land （hm^2）				Permanently Occupied Land （hm^2）				Total
		River Shoal	Tea Garden	Barren Hill	Cultivated Land	River Shoal	Tea Garden	Barren Hill	Cultivated Land	
1	Occupied Area	2.04	0.0767	1.09	0.197	0.223	0.133	0.154	0.146	4.08
2	Compensation Standard(10,000yuan)	0	0.75	0.45	0.75	0	10.00	3.15	18.75	/
3	Compensation Amount(10,000yuan)	0	0.06	0.49	0.15	0.00	1.33	0.49	2.74	5.25

Note: River shoal falls in the domain of the common land, which will not be compensated. Farmland occupation fee is charged at 4,000yuan/mu, farmland of 2.19mu will be compensated for 8,760yuan. Managerial fee of land requisition will be charged as 1.1% of gross land compensation investment, totaling 1,400yuan. Overall compensation is 61.9

thousand yuan.

Upon the completion of project, the temporarily occupied land will be reused after restoration, and the permanently occupied land will exert certain influence on land resource and agricultural production. The reduction of land resource will bring about certain economic loss to the project construction area and pose certain influence on the life quality of local residents. Nevertheless, because of the fine current environmental condition of assessment area, it is considered suitable for human residence and activities. Power generation and other comprehensive functions of the project will greatly mobilize the development of local economy, enhance the capacity to withstand drought and other natural disasters, and also improve water supply, transportation, communication and other infrastructure and public utilities. Project construction will facilitate the improvement of the general life quality of local residents, and the losses and impacts will be compensated.

5.3.2 Impact Assessment on Land Environment and Land Resource

Because of the fact that the temporary occupied land of the project will be restored to its original functions or receive rational development in line with the practical situation upon completion of construction. As a result, impacts of project construction on land resources are mainly permanently occupied land. After the project has been carried out, the permanently occupied land will cover about 0.67hm^2. The soil textures and fertility in the occupied area take on damages of various forms and extents, much soil of ground surface tillage layer or vegetation growing layer has been undergone digging damage, stripping, crush or bury, which result in rapid weakening and loss of land production force. According to field reconnaissance, the assessment area is a mountainous glen area and requisition land is primarily shrubbery and grass growth, and has a relatively low land production grading, therefore, unfavorable impacts of project land occupation on land resource are comparatively small.

While the project land occupation brings unfavorable impacts on local land resource, it also presents precious opportunities for rational development and utilization of land resource as well as the enhancement of soil quality, as long as prudent guidance are provided, favorable impacts will crop up for land resource. For example, local farmers that are subject to the impacts of the project land occupation shall be encouraged to take advantage of land submersion compensation, which is to be used on the remained farmland for the

improvement of land quality, land efficiency and unit yield of agricultural products. At the same time, the construction of planned project will create better irrigation condition for the remained farmland of some villages in assessment area, thus provides better means for land structure adjustment. Hence, while the project land occupation brings unfavorable impact of land resource reduction, it also creates favorable conditions for the improvement of rational development and utilization and the enhancement of land quality.

5.4 Impact Prediction on Water Environment

5.4.1 Impact Prediction on Water Environment during Construction Period

Tangjiahe □ Hydroelectric Power Station Project was planned to start on July 2006 and implement no-load operation on April 2008 and will complete on June 2008, totaling construction period of 2 years. According to project analysis, the total wastewater emission of the two-year construction period is 24.6 thousand m^3. Probable impact on surface water environment by the construction activities is brought about by wastewater in construction and production, sanitary waste by construction workers in living quarters and scattered cement and sand during construction process.

The sources of construction effluent are washing wastewater from aggregate processing system, construction machines and vehicles, concrete depositing and curing waster water. The main pollutants are suspended substance, petroleum and substances with high pH. Sanitary wastewater here mainly indicates daily domestic water emission by construction units and construction personnel, which comes with over proof BOD_5 and COD indices.

1) Impact Analysis on Construction Waste

According to the arrangement and plans of construction site, water consumption by aggregate processing, curing of concrete and construction workers, it is estimated that the total construction wastewater emission during construction period is 19.1 thousand m^3, among which concrete depositing and curing waster water, wastewater from aggregate processing system and construction machines and vehicles are main components.

□Wastewater from Aggregate Processing System

Construction technique of Aggregate Processing comprises screening, assorting, etc; screening technique applies water adding for dust reduction, the added water, except for the part that consumed during producing process, most of it are emitted as wastewater. The construction requires aggregate material of about 15.9 thousand m^3, and during peak time of construction, wastewater emission volume can go as much as $11m^3/d$. In the aggregate washing part of aggregate processing system, mud fluid and sand particles that are smaller than 0.15mm in diameter in the unprocessed material will be brought away by water current, and SS density in washing wastewater is high, the sediment content in aggregate material used by normal material field ranging from 2.26~13.6%. In this assessment, the sediment content will be calculated as 8%, and according to production balance theory, and the SS density in the wastewater of aggregate material washing is 2.5×10^4mg/L.

The SS density of wastewater from sandstone aggregate process plant far exceeds the class I standard 70mg/L of maximum emission density of class II pollutants in *Integrated Wastewater Discharge Standard (GB8978-96)*, if left untreated, the suspended load density in river will gain a increase of large margin compared with natural condition, which exerts a strong impact on river, therefore, only treated wastewater that reach standard should be allow to emit.

□Concrete Depositing and Curing Wastewater

By analogy with similar project, this kind of wastewater bears a pH value of 11 – 12, suspended substance density of about 5000mg/L, exceeds allowed emission density of 70mg/L, the wastewater is characteristic of high suspended substance density, small water amount, intermittent and centralized emission, therefore, needs to be treated.

□Oily Wastewater

In project design, a machine maintenance station will be setup in water supply section (in the living quarter of Baiyiping □ Hydroelectric Power Station), which is primarily responsible for the regular maintenance of construction machines and transportation vehicles and the replacement of common parts. The sources of oily wastewater are the machine shop wastewater and vehicle cleaning wastewater, and main pollutants are petroleum and suspended substances. If the oily wastewater was left untreated, the followings will be been emitted to water, the oil film formed on the surface will impede

reoxygenation of water, and thereby produce unfavorable influence on the water quality, therefore needs to be treated.

For the detailed emission of main pollutants from production wastewater during construction period, see table 5-6

Table5-6 Construction Peak Period Wastewater Production Table

No.	Item	Peak Water Emission	Main Pollutant	Produced Density	Emission Density
1	Waste Water From Aggregate Processing	$3m^3/h$	SS	25000mg/L	70mg/L
2	Concrete Depositing and Curing Wastewater	$1m^3/h$	SS	5000mg/L	70mg/L
			pH	11~12	6~9
3	Construction Machines and Vehicles Cleaning Wastewater	$2m^3/h$	SS	300mg/L	70mg/L
			Petroleum	5mg/L	≤5mg/L
Total		$6m^3/h$	/	/	/

Observing from table 5-6, the waste water from this project will be discharged into the natural ditches nearby, and inject into Yuquan River. The main characteristics of the project construction wastewater are high suspended substance concentration and high pH with a small amount of oily wastewater emission, if no corresponding treatment was to be adopted, certain pollution will be caused on Yuquanhe River – the pollutants admitting river.

Due to the small scale of the project, the high period of construction produces wastewater by only $6m^3/h$, compared with the flow volume $0.95m^3/s(3420m^3/h)$ of the dam site in low water period, the dilution ratio is 1:570. It can clearly be seen that, the production volume of wastewater in peak period of the construction compares with no flow volume of the Yuquanhe river reach besides project construction site, and the emission of construction wastewater is only temporary, which will end with the completion of the construction period, thus poses no evident influences on the water quality of Yuquanhe River. In this assessment,

corresponding wastewater treatments are worked out for different types of construction wastewater, the rigorous implementation of such treatments shall distinctly alleviate pollution to pollutants admitting water.

2) Sanitary Waste

The planned period of Tangjiahe Second Cascade Hydroelectric Power Station Project lasts 2 years, in peak period, there are 200 construction workers, and the average daily workers are 80. Sanitary waste mainly comprises the emission of domestic water and excrement by construction managerial personnel and workers, the total emission of construction is 5.6 thousand m^3, and generation of sanitary waste in construction peak period is about 6.4m^3/h, converts to wastewater emission flow 0.0018m^3/s. As a result of the small scale of the project, sanitary waste emission is small in amount, so this assessment does not make quantitative prediction for the pollutants in sanitary waste but analysis.

The average flow volume of the planned dam reach of Yuquanhe River, the pollutants admitting water body for the project, measures up 0.95m^3/s in low flow period, multi-year average flow reaches 2.31m^3/s. Dilution ratio average 1:1283, and 1:528 in low water period. Even in low water period, sanitary waste generation in peak construction period is still far less than the flow volume of Yuquanhe River reach along the construction site, thus will not bring evident influence on the water quality of Yuquanhe River.

In the project sanitary waste, the density of BOD_5 and COD are respectively 200mg/L and 300mg/L, higher than the maximum allowed emission density ($BOD_5$20mg/L and COD100mg/L) of class II pollutant in the standard of ***Integrated Wastewater Discharge Standard (GB8978-96)***. The assessment suggests that after sanitary waste is treated by septic tank, it can be used as greenery water or of other purposes, but must not be emitted into water body.

5.4.2 Impact Prediction on Water Environment during Construction Period

1) Impact on Water Quality

Water Quality in front of the Dam

In the initial period of power station operation, as a result of the blocking function of the intake dam, normal water level in front of the dam will be elevated by 1m compared with natural water level. With the release, bleeding and resolution of various organic matters in the submerged soil and vegetation, water quality in front of dam will suffer unfavorable influence.

According to field survey, both banks of Yuquan River are steep, so the submerged area after dam completion will be rather limited, and in submersion area, present vegetation types are shrubs and thin conifer and broad-leaf mix forest. During the clearing work before dam construction, trees and most of fuel wood are cleared, leaving only herbs, fallen leaves and others of such kind. By reducing the amount of organic matters, the bleeding and resolution of organic matters on the submerged land will also decrease in amount, thus exerts less influence on the water quality. Resolved substance in soil is the main source of influence, and the result of the influence is the probability of water quality aggravation in front of dam. According to the monitoring data from constructed reservoirs home and abroad, dissolved oxygen in water, mineralization rate nourishment and plant overgrowth are related to the water storage rate of reservoir. Tangjiahe □ Hydroelectric Power Station is a runoff-style hydropower station, bearing practically no reservoir capacity and with frequent current replacement in front of the dam, therefore, project operation will exert a relatively small influence on water quality in front of the dam.

Water-reducing Reach

A water-reducing reach of 4.3km will be formed from station dam site to powerhouse and the water amount of the river reach will be reduced, which results in certain drop in self-purification and dilution capacity of the river water. But there is not any industrial organization distribution along the river reach, which results in low pollution load, in addition to tributary ditch development and much incoming water in the area, big stream gradient, rapid velocity and fully aerated water, all give rises to prominent degradation. Especially in high water period, since the top dam height is 5.1m, which enables no blocking and storage capacity, the regulating effect on the river reach runoff from the station dam site to powerhouse is negligible. Therefore, water diversion and power generation of the hydroelectric station influences little water quality in water-reducing reach.

On account of the considerable watercourse depth of the river reach at the dam site,

irrigation by pumping is a daunting task. Assessment area enjoys abundant rainfall and wide spring distribution, local residents are used to drinking from mountain spring, and agricultural irrigation by pumping is quite rare, for which reason, power generation by water diversion exerts little influence on agricultural irrigation and drinking water resource along the water-reducing river reach.

Eutrophication of Water Body

Tangjiahe □ Hydroelectric Power Station Project is a second cascade hydroelectric station regulated by Tangjiahe Reservoir, it has no reservoir. Except for natural runoff, the power station relies on the tail water of Baiyiping □,□ Hydroelectric Station and Tangjiahe □ Hydroelectric Station and the water regulation by Tangjiahe Reservoir for power generation. The intake dam of the power station serves only the function of water blocking and diversion, water level in front of dam is elevated only 1m above that of nature, and has practically no reservoir capacity. Moreover, because of sparse population along the river reach between the dam site and its upstream area, and low pollutants emission, after the dam is built, although river depth increases, and velocity decreases, eutrophication is unlikely to happen. It is deductible that under current nutrient loading level, Tangjiahe □ Hydroelectric Power Station will not cause a water quality transition of the reach to eutrophication, i.e. total nitrogen<0.25, total phosphorus<0.02mg/L.

2) Water Temperature Predication

The release flow temperature is related to the position of reservoir outlet, reservoir water velocity, inflow current temperature, and temperature of the time and locality, etc; according to the actual measurement data of Xinjiangkou, Danjiangkou and other reservoirs, watercourse temperature downstream dam bears a fine corresponding relation with the water temperature of certain depth in reservoir. Tangjiahe □ Hydroelectric Power Station is a diversion type hydroelectric power station, which has reservoir capacity; although an intake dam is included, the normal water level is only 1m higher than the natural one before dam construction, top water level in front of dam is 5.1m (intake dam is spillway type, top dam height 5.1m). Stream current in front of the dam is fast, with strong blending throughout the year, but water temperature undergoes no vertical or horizontal change; water temperature in front of the dam is evenly distributed and carries no distinct difference with temperature in natural water course in the same period. Since water is diverted through a

tunnel of 3.87km, tail water after power generation from the station will be 2~5□ lower than natural watercourse temperature (related with the external temperature).

According to survey, stream current is rapid along the project controlled river section, and no spawning site of large commercial, rare or endangered fish distribution was found, there is also no demand for process and domestic water; therefore no obvious unfavorable influence will be brought on the growing and reproduction of fishes in the reach, water quality below the dam, aquatic lives and agricultural irrigation.

3) Influence of Upstream Hydroelectric Station Operation on Water Quality in front of Dam

Influence of Suspended Load in front of Dam

Before the completion and operation of Tangjiahe □ Hydroelectric Power Station, Tangjiahe Reservoir and Tangjiahe□Hydroelectric Power Station (planned) will have been put into use. Most sediment that once entered the Tangjiahe Reservoir with surface runoff will be blocked in upstream reservoir (Tangjiahe Reservoir blocks 55% sediment of upstream river basin area), as a result, the river reach of Tangjiahe □ Hydroelectric Power Station will enjoy much improvement on water quality which demonstrates in the pureness and transparency than that before reservoir construction. Consequently, the operation of the upstream reservoir will, to some extent, reduce sediment accumulation and density of suspended load in water of the project, and produce favorable influence on the water quality in front of the dam.

Baiyiping □,□ Hydroelectric Power Station (tributary power generation) are the kind of power station without regulating and reservoir capacity, therefore exert no influence on water quality downstream.

Influence on Water Environmental Capacity of Downstream River Reach

Tangjiahe Reservoir is a incomplete annual regulating reservoir, because of the regulating and storage effect of the reservoir, and the own power generating regulation of Baiyiping □ , □ Cascade Hydroelectric Power Station and Tangjiahe □ Hydroelectric Power Station, the flow volume of down stream river reach will undergo redistribution in time. The low

volume, velocity and water volume below the dam of Tangjiahe Reservoir will undergo different changes, which however, will not affect the diluting and purifying capacity of the river reach of Tangjiahe □ Hydroelectric Power Station. Besides, the volume entering Tangjiahe Reservoir is still from natural incoming water, volume that leaves the reservoir equal that flows in, so the impoundment of Tangjiahe Reservoir does not affect upstream incoming water volume of Tangjiahe □ Hydroelectric Power Station. To sum it up, flow regulation of Tangjiahe Reservoir will not affect the water environment capacity of the river reach of Tangjiahe □ Hydroelectric Power Station.

4) Influence of Hydroelectric Station Operation on Water Environment of Downstream Erchakou Hydroelectric Power Station

Influence of Power Station on Suspended Load of Erchakou Hydroelectric Power Station

Erchakou Hydroelectric Power Station was planned downstream the Tangjiahe □e Hydroelectric Power Station, the power house of current project closely connects the terminal of backwater from Erchakou Reservoir. To solve the contradiction of water diversion and sediment prevention, and protect generator units the project intake dam will be designed as the bottom trash rack dam for water diversion, and sand basin will be set up between the dam and the entry of the No.1 open channel, the sand sluice will be installed to prevent the entering of smaller particle into the channel. Large amount of sediment will be blocked for Erchakou Reservoir, consequently, and both transparency and water quality of the reservoir will be increased. Therefore, the operation of Tangjiahe □ Hydroelectric Power Station will considerably reduce sediment accumulation and suspended load density of Erchakou Reservoir and will produce a relatively strong favorable influence on the quality of Erchakou Reservoir.

Influence on Water Environment Capacity of Reservoir Area of Erchakou Hydroelectric Power Station

Tangjiahe □ Hydroelectric Power Station is a runoff type hydroelectric station, which possesses no regulating capacity; its power generation does not affect the incoming water amount upstream of Erchakou Reservoir area. But it will be regulated by Tangjiahe Reservoir upstream, and utilize the tail water of Baiyiping □,□ Hydroelectric Power Station

and Tangjiahe □ Hydroelectric Power Station to generate electricity. Because of the artificial regulating effect of the station power generation, flow volume of downstream of the station river reach will undergo redistribution in time – in low water period, flow volume, velocity and water amount will be increased, which will enlarge the Water Environment Capacity of Reservoir Area of Erchakou Hydroelectric Power Station; in high water period, as a result of no blocking and storage function of the project intake dam, the flow volume and velocity will by and large equal what it is in natural river reach, therefore will not affect the diluting and purifying capacity toward pollutants by the downstream Erchakou reservoir area. Conclusion has it that the water diversion and power generation of Tangjiahe Second Cascade Hydroelectric Power Station will not affect the Water Environment Capacity of the Reservoir Area of Erchakou Hydroelectric Power Station.

5.5 Impact Analysis on Local Climate

For the reason that Tangjiahe □ Hydroelectric Power Station is a runoff-style hydropower station, bearing practically no reservoir capacity, it will not affect local climate. According to the analogical analysis of climate effect done on established diversion type hydroelectric power station of the same river basin in recent years, tributary ditch development and water reduction in watercourse which stretch from station dam site to power house bring just slight influence on valley climate. Since groundwater converges from slope to gully one-sidedly, the situation in which river valley supplies mountain slope does not exist, vegetation on both banks of the river valley will basically remain its original condition. However, dam construction slightly elevates water level, which humidifies the air and provides favorable condition for the growth of trees along the river reach in front of the dam.

5.6 Impact Prediction and Assessment on Environmental Geology

5.6.1 Regional Stability

According to geological investigation report of the project, geological references of Hubei and Seismicity Trend Analysis Made by Shiyan Earthquake Bureau on eastern region of Three Gorges, within a range of 200km of Tangjiahe □ Hydroelectric Power Station, since the beginning of historical records, there has been 57 earthquakes with magnitude equals or more than 4.7. These earthquakes feature low intensity and frequency, shallow earthquake center. Statistics shows that response intensity on the area are all less than VI degree, for details see table 7 – 5.

Table 7 – 5 Near Field Region Earthquakes Magnitude & Frequency Statistics

Earthquake Magnitude	4.7~4.9	5.0~5.4	5.5~5.9	6.0~7.0	Remarks
Frequency	19	24	12	2	Dating from 743 B.C. to 1995 A.D., Ms≥4.7

Known from table 7-5, earthquakes exert little impact and damage on project area. Changmaosi fault zone located in the NNE of the western area of near project region, although polyphase activities were recorded, no noticeable movement has been come to attention. Project field region of Wufeng Tangjiahe □ Hydroelectric Power Station was situated on a relatively stable tectonic setting of earth crust, no active fault has been found, the frequency and magnitude of seismic activities are low, only tectonic and supergene joints are fairly developed, the exposed fault bears a small scale, shallow cutting depth, which is disadvantageous to strain energy accumulation.

In the light of the abovementioned condition and drawing an analogy of the field region seismic intensity between the project and Maduhe (house crossing river) Hydroelectric Power Station (intensity of the sites that the probability of seismic risk that exceeds 10% in 50 years is 5.83 degree), also according to ***National Seismic Zoning Map of China (1990)***,

by analogy with ***The Zoning Map of Earthquake Ground Motion Parameters in China (1990)***, it is been determined that seismic basic intensity of the project area belongs to VI degree area, situated in micro seismic area with stable regional structure. Conclusion has it that project architecture design of Tangjiahe □ Hydroelectric Power Station can employ VI degree anti-seismic measures.

5.6.2 Water Intake and Diversion Leakage

Seeing from topography and geomorphology, the western part of the project area is higher than eastern part, and south higher than north. Yuquan River is one and only river system within the area meandering through from south to north, forming a natural "corridor" topographically, thus providing a favorable natural topographical condition for cascade development of Hydroelectricity within the area. Surface watersheds within the field region are elevated, steep and wide, ground watersheds are practically uniform with surface ones, but since the dam site is categorized as carbonate rock area, its hydrogeological condition is fairly complicated. According to this survey, the complexity of hydrogeological condition in carbonate rock area is manifested in inconsistent channel aquifer petrofabric and small size channel-fissure-pore interactive aquifer petrofabric, controlling its own groundwater distribution.

According to lithologic characters and permeable media of the field region, groundwater types of the field region are classified as three major types of Clastic rock type fissure water，Carbonate rock type karst water、Loose rock type pore water.

□Clastic rock type fissure water: Mainly exists in intense and medium weathering rock mass of Silurian System arenaceous shale, with certain water storage capacity.

□Carbonate rock type karst water: Mainly exists in Carbonic and Permian karstic micrite, argillaceous warty chert limestone. In Permian Qixia Formation, karst water is mainly cavern water, and in other strata, mainly interstitial water, karst water is unevenly distributed with large flow volume.

□ Loose rock type pore water: Mainly exists in quaternary alluvial-diluvial, eluvium talus and colluvial deposits, lithologically are pebble soil, erratic boulder soil and rubble soil, thinly scatter on both banks of river valley and top soil of all levels. Gravel stratum and

loose deposits is permeable, but in other deposit body of arenaceous shale, since argillite content is high in rocks, clay that formed after weathering is less permeable. Pore water flow volume is normally less than 1L/s, but when affected by rainfall, it is evidently undergone seasonal variation, and perennial water flow is small in amount.

Considering from the lithology of strata and ground water type of the area, its aquifuge comprises celadon, olivine and dark grey silty mudstone and argillaceous siltstone of Silurian Luoreping formation; isabelline, olivine and celadon argillaceous siltstone of Shamao formation; various lithological sections of Yuntaiguan formation, Huangjiadeng formation and Xiejingsi formation of Devonian system; Maan coaly section of Permian system. Carbonate rock in this area all formed as aquifer or permeable stratum.

The common generation and migration pattern of the groundwater of the field region is: surface aquifer receives water supplement from the atmosphere, which firstly turns into fissure water or pore water, part of pore water infiltrate into bedrock for fissure water supplement, it also happens in some special landform and structure that part of bedrock fissure water supplies pore water, as in the quaternary covered fissure water discharge opening. However, in most cases, it is still that pore water supplement fissure water. When fissure water and pore water meet karst recharge zones or recharge ports, they turn into karst water and migrate to the lowest karst erosion base level, and is discharged to ground surface and becomes surface runoff at suitable location in various forms, while the surface runoff supplement groundwater through karst under certain karst condition.

In the field region, groundwater gradient of the carbonate rock karst area is relatively complicated, according to prior study on the groundwater level variation in the Nanjinguan limestone gorge area of the Three Gorges, in places that neighboring rivers and rock slopes, has relatively gentle groundwater gradient, at 0.04~0.12, while in other places that far from river and mountain body, groundwater gradient is relatively steep, at about 0.3. It is estimated that carbonate rock distributed area in this region, groundwater migration pattern resembles what it is above. Analysis shows that, the project river reach features high and wide watersheds, and river reaches without parallel reservoirs have deep and steep gullies, without geological origin of leakage.

5.6.3 Project Geological Stability of Dam Site and Water Diversion Line

Within the assessment area, according to topographic, geomorphologic and geologic condition, as well as the external geological effects, the four physical and geological appearance of weathering, karst, collapse and landslide are determined, by which Project Geological Stability of Water Diversion Line is to be analyzed and assessed.

Weathering

In line with the stipulation in Annex E of GB50287-99, various rock masses in the field region can be categorized as three weathering strata, i.e. intense weathering stratum, medium weathering stratum and weak weathering stratum. Rock masses of different lithological character that distributed in different sections bear rather apparent inconsistency in terms of weathering depth, and their influences on all buildings differ in extent.

Shale, silty mudstone, argillaceous siltstone combination: these rock massed appear in the region in a sandwich structure, and outcrop weathered with depth variation, those with high argillaceous content suffer deeper weathering, and those with high quartz content, and whose cement is dominated by ferrous silicon and calcium suffer weaker weathering, micro-weathered layer measures only 0.5~2m, while intense and medium weathered layers of argillite series may go down as deep as dozens of meters.

Thick-bedded quartz siltstone, silty mudstone and shale combination: the last two of the three rock masses appear in sandwich structure in the region, and ground surface shows varied weathering, normal quartz siltstone bears very thin micro-weathering, the weathering depth of silty mudstone and shale that imbedded in this rock mass subjects to their own exposed depth, the greater depth exposed the greater depth of formed intense-micro weathering layer there will be.

Medium thick-thick bedded micrite, calcareous mudstone and carbonaceous mudstone combination: the last two of the three rock masses appear in sandwich structure in the region, and ground surface shows varied weathering, and normal has medium-thick weathering layer of 2~15, micro-weathering layer of 1~6m develops under accordingly. When calcareous mudstone and carbonaceous mudstone are denuded to ground surface, their weathering show medium to intense level, and the depth develops according to the own depth of the rock masses, normally 0.5~2m.

□Karst

Karst is the final outcome of continuous karst effect over a vast span of geological development, karst in the field region mainly developed in the Qixia formation of Permian system and Huanglong formation of carboniferous system. Karst of Permian system Qixia formation is characteristic of interlayer karst, which develop along the bedding plane, outcrops appear 50m upstream of the dam site; karst of Carboniferous system Qixia formation is characteristic of fissure karst, which is small in scale ,and no outcrop appear on ground surface.

□Collapse

At scarps and cliffs in the field region, when stress-release crack and vertical joint or crack are developing, small scale collapse will accompany. Cliffs by the dam site are composed of thick-huge thick entire rock mass, a few huge stones piled up down slope; according to field survey, few stress-release cracks developed in the region at present, and no collapse mass of influence has been found.

Landslide

In the dam site area, by the right bank 50m downstream the dam, resides of water floating rocks can have an ancient slide, which comes under accumulative slide, the surface of slide is the top surface of coal bearing ferruginous sandstone of Qixia formation, with sliding direction of 179°, the sliding mass is colluvial slope, whose front measures 150m in width (elevation: about 550m) , and the rear measures 10m in width (elevation: about 580m), the sliding mass bears a loose structure, the rock masses placed disorderly, with many isolated blocks imbedded, gravel and clay fill its periphery, currently its front is cut by stream, and sliding body bears a thickness of about 5~20m, the total volume goes as much as 5 thousand m^3, and according to survey, the sliding body features a fine stability, no movement was recorded in history.

According to borehole and geophysical exploration data, rock masses at the dam site is relatively complete, without large scale development of karst cave, only a fraction of upper part sees karst fissure development, and both banks bear similar attitude, that come under uniclinal structure, without fault fracture zone passing by, therefore the dam base enjoys fine stability. The rock mass of the dam site and water diversion section is of better general stability, yet since weathering casts a relatively intense impact on part of the rock masses,

fairly developed fissure and the existence of weak interbed, bring unfavorable influence on the stability of part of side slopes, caves and dam base, on which attention should be paid in design and construction.

5.6.4 Earthquake Inducement

Project construction area features uncomplicated geological structure, no large scale fault has been found, it comes under micro-seismic area where the regional structure is stable. Seismic activity of the region is weak, and basic earthquake intensity comes at VI, karst slightly develops, and no large scale cave can be found. Moreover, the project is a runoff type hydroelectric station, which practically possesses no reservoir capacity. Even if earthquake is induced by air explosion or tunnel collapse happens in part of karst conduit during water filling upstream the dam, magnitude will be fairly low, thus pose little harm. In light of the abovementioned geological condition, conclusion has it that the possibility of earthquake inducement is rather low. As a result, earthquake inducement shall not be something that to be considered alone in project design.

5.7 Impact Analysis of Project Construction on the Atmosphere, Sound Environment and Solid Waste

5.7.1 Impact Analysis on Atmospheric Environment during Construction Period

The impact of the project on the atmosphere is limited to construction period, which shall automatically be cleared up after project completion. Three types of pollutants sources on the atmosphere will be produced by project construction as following:

Point Source: including air-borne dust produced by the concrete batching of mixing system, and dust produced by the grinding of artificial aggregate processing system, waste gas generated by excavator and explosion, as well as the exhaust gas from coal combustion for daily use.

Linear source: including air borne dust and exhaust gas produced by communications and transportation, dust generated by cement and fly ash transportation.

Surface source: mainly dust from excavation in construction.

1) Impact Analysis of Project Construction on the Atmospheric Environment

During the construction period, dust and air borne dust generated by foundation excavation, earthwork refilling, and aggregate processing of the main works; air borne dust and vehicle exhaust gas produced during construction machinery operation, internal and external communications and transportation; waste gas produced by excavator operation and gunpowder explosion, and combustion gas emits during daily coal burning in live quarters; and the restoration of highways that submerged in construction area or because of the construction, etc, will all cast influence on the ambient air, and the main pollutants in the waste gas include TSP, SO_2, NO_2, CO, hydrocarbon and plumbous compounds and so on.

The small scale of the project gives rise to a small volume of average daily earthwork excavation; the main construction machinery and equipments, 83 vehicles of various types; whose operation points are rather dispersed, and exhaust gas emission is relatively small; cement mixing and aggregate processing have unorganized emission of construction air borne dust, which will pose certain influence on neighboring residents. While at the same time, certain influence will be extended to part of the area and field personnel, thus anti-measures should be adopted to lower the harm.

2) Impact Analysis of Domestic Pollution Sources during Project Construction on the Atmospheric Environment

Domestic pollution sources in construction area on the atmospheric environment are principally daily coal combustion gas, the volume of the waste gas is closely related to the number of construction worker. During the peak time of the project construction of Tangjiahe □ Hydroelectric Power Station, construction workers number 200, daily worker number averages 80. It can be concluded that emission volume of daily coal combustion waste gas is low, and the influence area mainly covers living sectors. However, because of the weak diffusing capacity of the gorge area, exhaust stack should be elevated to a proper height, so as to enhance diluting and diffusing capacity and ameliorate regional air quality.

To sum it up, although some operation points are situated in the vicinity of environment sensitive points, because of the medium scale of the project and few construction worker residences inside the construction area, as well as the limitation in time and space of the influence on ambient air quality, once the construction is complete, such influence shall cease.

5.7.2 Impact Analysis on Sound Environment during Construction Period

The influence of the project on sound environment is focused in the construction period, the main noise sources are from blasting, drilling, concrete placing and excavation and construction machinery operation and vehicles transportation in the process of construction, they can be categorized as three types of static sound source, mobile sound source and blasting sound source.

1) Determination of Source Intensity

Actual measurement data from the constructed hydroelectric project shows that: machinery and equipments used in hydroelectric project produce fairly loud noise during operation, for detailed construction machinery and equipments and noise value see table 5-8.

Table 5-8 Summary Table of Main Construction Machinery and Equipments

Type	Equipment Name	Specification	Number(Unit)	Noise Volume(dB)
Loading Unit	Shovel Dredger	Oil Driving 1.0m^3	2	96
	Mechanical Loader	1.0m^3	2	
	Bulldozer	59kW-74kW	1	
Rock Drilling Unit	Air Drill	Hand Holding	10	104
	Air Drill	Air Leg	18	
	DTH Drill	Type 100	1	
	Fiber Repairing Equipment		6	
Drilling and Grouting Unit	Percussion Drill	CZ22	1	104
	High-low Voltage Grunt Pump		1	

	Mortar Mixer		1	
Processing Unit	Jaw Breaker	600×900mm	1	115
	Heavy Jigging Screen	1500×3000	1	
	Disk Feeding Machine	DB-1600	1	
Concrete Construction	Concrete Mixer Discharge	$0.8m^3$	1	103
	Concrete Pump	$30m^3/h$	1	
	Mortar Ejection Machine		1	
	Wind(Sand) Hydraulic Gun	Wind Energy Exhausted in the Sand 2-$6m^3$/min	1	
	Immersion Vibrator	HZ6X-70	5	
Transportation	Truck	Petroleum Type 5t	2	103
	Tractor	59kW or Agricultural Vehicle	12	
Other Machinery	Centrifugal Pump	14kW	2	100
	Diving Pump		2	
	reversible axial flow fan	37kW	8	
	Arc Welder		2	

During project construction period, 83 (unit or set) machinery and equipment of various types will be used, among which 45 (unit or set) produce loud noise, they are mainly distributed in main works construction area, stock ground, aggregate processing area, etc. It is therefore clear that it is the construction area where noise pollution is fairly intensive. Environment sensitive points near construction area will be evidently affected.

2) Prediction Mode

Static Sound Source

During the construction, static construction noise sources with high intensity mainly come from aggregate processing system, foundation pit excavation, concrete mixing building, comprehensive processing, etc. According to the concerning demands in Technical

Guideline for Environmental Impact Assessment – Sound Environment (HJ/T2.4-1995), following prediction formula is adopted.

$$L_{A(r)} = L_{wA} - 20\lg r - 8$$

In formula: $L_{A(r)}$ represents sound level A (dB) which is r (m) from the sound source

L_{wA} represents sound power level A (dB)

r represents the distance (m) between measuring point and sound source

Mobile Sound Source

Noises produced by communication and transportation of trucks of various types or by bulldozer can all be considered as mobile sound source, the loudness of the sound is related to elements such as traffic flow, vehicle types, speed and road condition, etc; following model is adopted to calculate the decrement.

$$Lm = 10\lg(N/r)+30\lg(v/50)+64$$

In formula: $L_{A(r)}$ represents the sound pressure level (dB) which is r (m) from the sound source

N represents traffic flow (vehicle/hour)

v represents speed (km/hour)

r represents the distance (m) between measuring point and sound source

3) Impact Analysis

Static, Continuous Point Source Noise

Consider in the worst scenario, i.e. adopt maximum source intensity, source intensity of aggregate processing system takes 110dB, concrete mixing system 88dB, steel-wood processing plant 105dB, foundation pit 112dB, for range of influence see table 5-9.

Table 5-9 Tangjiahe Hydroelectric Power Station, Construction Area Static and Continuous Noise Source Point Prediction Unit: dB(A)

Distance / Noise Source	Sound Source Value	0m	20m	30m	40m	50m	80m	100m	120m
Aggregate Processing	110	82.0	76.0	72.5	70.0	68.0	63.9	62.0	60.4
Steel-wood Processing Plant	105	77.0	71.0	67.5	65.0	63.0	58.9	57.0	55.4
Concrete Mixing System	88	60.0	54.0	50.5	48.0	46.0	41.9	40.0	38.4
Foundation Pit	112	84.0	78.0	74.5	72.0	70.0	65.9	64.0	62.4

It can clearly be seen that the in the dam site area, foundation pit excavation, artificial aggregate processing system make a relatively high noise source, which cast unfavorable influence on construction workers in short distance.

There is no residential area near the construction area, thus noise only exerts influence on workers in the construction living quarters. According to influence exerted by different noise source and sound environment background, prediction can be made on the influence extent of workers in construction living quarters by different noise sources. For calculation result see table 5-10 and Table 5-11.

Table 5-10 Influence Value of Construction Activities of Tangjiahe Hydroelectric Power Station on Sensitive Points

Item	Aggregate Processing System	Dam Site Area Foundation Pit Excavation
Closest Distance to Noise Source (m)	400	600
Noise Influence Value dB (A)	50	48.4

Table 5-11 Influence Value of Construction Activities of Tangjiahe Hydroelectric Power Station on the residents living in Kuzhuping Village

Item	Aggregate Processing System
Closest Distance to Noise Source (m)	100
Noise Influence Value dB (A)	50

It can be seen from table 5-10 that influence of noise pollution on workers in construction and living area is fairly small, noise values are all below the daytime standard class I standard (daytime 55dB(A), night time 45dB(A)) in Standard of environmental *noise* of urban area (GB3096-93). While, from Table 5-11, the residents from Kuzhuping Village will be influenced to some extend. The noise of sand and stone processing system is abide by the daytime standard, but fails to meet the nighttime standard. But due to the mountain barrier effect, actual sound environment is slightly lower than the prediction. To avoid noise to the residents, the time of construction should by carefully chosen. Night time construction should be avoided and relative noise prevention measures should be taken.

2) Mobile Noise

Daytime traffic flow of the main communication line of the project construction is considered 20vehicle/h, speed 35km/h; and night time traffic flow 5vehicle/h, speed 20km/h. For influence range of communication noise see table 5-12

Table 5-12 Influence Range Prediction of Noise on both sides of the Main Communication Line of Construction

Period of Time	Noise Value Prediction of Various Distances to Sound Source (dB)								Attainment Distance (m)
	5m	10m	20m	30m	40m	50m	60m	70m	
Daytime	65.4	62.4	59.4	57.6	56.3	55.4	54.6	53.9	10
Night time	52.1	49.1	46.0	44.3	43.0	42.1	41.3	40.6	10

It can clearly be seen from table 5-12 that daytime noise level meets the standard in a distance of 60m, and 30m in night time. Because construction living quarters are sited by the entrance road, it could more seriously be affected by noise.

3) Blasting Noise

Blasting noise features short duration, determined time and space, noise intensity can reach as high as 130~140dB(A), main blasting points include left and right abutment of the intake dam, powerhouse and block stone stock ground. Blasting casts certain influence on construction workers, thus safety protection should be attended to.

5.7.3 Environmental Impact Analysis on Solid Waste during Construction Period

1) Project Waste Residues

According to project excavation-fill balancing analysis, earth-rock excavation volume of the project totals 54.5 thousand m^3, which mostly comes from the excavation of water diversion tunnel, power tunnel and spillway dam, 12.9 thousand m^3 is used for backfilling. Construction works produces waste residues totaling 41.6 thousand m^3, among which earth takes 11 thousand m^3, and stone 30.6 thousand m^3, making up 76.33% of excavation volume of main works, which is considered a large amount.

If the waste residues of construction are improperly disposed, once they are washed into watercourse, they will not only increase the difficulty of construction, hinder construction progress, but also lead to natural and ecological environment destruction, induce water loss and soil erosion, thus result in ecological disorder in certain area of the region. In the initial project design, six waste residue ground was planned, covering an area of 2.46hm^2.Upon project completion and water residue disposed, occupied land will be returned to farmland and forest, maximally control the impact of water loss and soil erosion on environment.

2) Domestic Waste

In peak time of the project construction, the workers will number 200, assuming the daily domestic waste production is 1kg/person, so in peak time of the project daily domestic waste production will reach 0.2t; with average 80 construction workers, total domestic waste production will be 58.4t during construction period.

Although domestic waste production in construction period is relatively small, if not

disposed in time according to environmental and sanitary demand, mosquitoes and flies shall breed in large amount, viruses and bacteria multiply, and rats rampage, which will not only affect landscape, pollute air, under certain climate condition, various insect transmitted diseases will arise and spread, even become epidemic in densely populated construction area, pose harm to the health of construction workers. In the meantime, inappropriate storing up of domestic solid waste shall undermine the soil structure or pollute it with pathogenic bacteria, thus lead to secondary pollution. Meanwhile, subsequent to the entering into surface water by all sorts of pollutants and bacteria in domestic waste with rainwater and runoff, river water will be polluted, which poses harm on the surrounding ecological environment.

5.7.4 Drinking Water Condition Analysis of the Project Construction Water Tunnel Area

According to *The Geology Survey Report*, the construction area's surface water crest is tall, steep and wide with the underground water crest in a similar state; however, as the dam site is in a carbonate rock area, its hydrological and geological conditions are rather complicated. According this round of survey, the complexity of the carbonate rock area's hydrological and geological conditions are manifested in the unevenness of the water containing rock channels and small fissures that control the underground water distribution.

The common pattern of the formation and transfer of the plant area's underground water is: the water-bearing surface layer receives water from precipitation and transfers the water into fissure water or pore water; part of the fissure water permeates to supply the base rock fissure water; in special topography and formations some of the base rock fissure water also supplies the pore water such as in the fissure water outlet covered by the Quaternary System, but in most circumstances pore water supplies fissure water. When pore water and fissure water meets a karst supply band or supply mouth, they would transfer into karst water flowing towards the lowest karst erosion layer. They would then transfer into surface runoff when released onto ground surfaces in various forms at the suitable places, and the surface runoff would again, when under specific karst conditions, supply the underground water through karst rocks.

According to the on-spot survey, there are sparsely populated several village households

between the dam site and plant area (15 persons). These households all live on cultivation with their drinking and irrigation supplied by mountain spring water. The project construction water channeling tunnel is relatively long (4957m). The construction area's hydrological and geological conditions are complex while the water resource is bountiful. Under normal circumstances, project construction will not harm the underground drinking water source, but if managed or constructed improperly, harm can be done to the underground water source. Once such a situation occurs, construction must be stopped immediately and emergency measures be taken to ensure the villagers' production and domestic use of water. We have communicated with the proprietors and they expressed the will to build a set of water pipes near the villagers' farm land and another set near their houses with the pipes' other ends connected to unaffected mountain spring water to ensure the drinking and irrigation water being unaffected by the construction.

5.8 Human Health

5.8.1 Impact Analysis on Human Health during Construction Period

In peak time of construction period, workers number 200 per day. Construction workers come from all over China, so local and outside workers contact with each other frequently in works and life, due to the complicated composition of staff and their varied custom and constitution, diverse immunocompetence, pathogen carrier may exist, susceptibility of population increases, various diseases transmission routes exist simultaneously. Moreover, service facilities and living condition in construction area are relatively poor; in addition that high strength consumption of construction workers will impair their immunity and add to the probability of catching diseases. Therefore, if health protection work has not been properly done in construction area, it may lead to (digestive tract, respiratory tract, entomophilous) transmitted disease, or even cross infection and epidemic, which will pose harm to human health, thus adequate attention should be paid to.

In construction period, there is also risk of accidental injury, so effective security measures should be adopted to prevent and avoid industrial accident in field construction, communication and redevelopment of electricity transmission facilities.

5.8.2 Impact Analysis on Human Health in Operational Period

Upon completion of the project intake dam, water level will be slightly elevated from natural level. Rats will migrate to higher altitude area, which results in the density increase of rats in surrounding area, and higher possibility of human-rat contact; although it is not the epidemic area of hemorrhagic fever and leptospirosis, there is still the possibility of the emergence of new focus of natural infection, which makes surrounding residents susceptible population, if effective prevention measures was not adopted, there will be the possibility of epidemic of natural focal infectious disease.

Upon project completion, water area increases, wetland grows in number, which is favorable for water weed growth, in addition that humid ecological environment of reservoir banks, provides conditions for the multiply of mosquito vector, the density of media mosquitoes may also increase in surrounding area, if effective prevention measures was not to be done, diseases incidence of malaria, encephalitis and other insect-borne infectious diseases may increase shortly after project completion.

Project construction casts certain influence on the health of surrounding population, but with the adoption of effective disease prevention measures, the risks will all be removed, and no evident unfavorable influence shall be produced.

5.9 Social Environmental Impact Assessment

The Tangjiahe □ Hydroelectric Power Station in plan is situated in the township of Caihua, Wufeng and belongs to Yuquanhe River – right tributary of Siyanghe River- Cascade Development Hydroelectric Power Station. Yuquanhe River Basin is a relatively under-developed area in terms of economy, with weak industrial and agricultural basis. Since the reform and opening up, with the improvement of communication, the strength of national economy has been gradually enhanced, however, due to the limit of natural condition, its economic development grows more slowly compared with other areas in Hubei, the National Economy Index has been in a relatively backward position for a long term.

It can be seen from the electricity load of Wufeng that with the accelerated development of industry and agriculture, electricity demand will keep increasing, the current electricity

capacity can not meet the demand of production and living, the conflict of electricity load between high and low period are becoming increasing salient, which has turned into a bottleneck that impeding the economic development of Wufeng. Wufeng County enjoys abundant hydro energy resource, and accelerate hydro energy resource development is a prerequisite of vitalizing local economic development. Therefore, the people's government of Wufeng Tujia Autonomous County decided to build Tangjiahe □ Hydroelectric Power Station by attracting investment.

The development of Tangjiahe □ Hydroelectric Power Station will bring considerable social and environmental benefit. Project construction will enormously promote the development of local and rural industry and enterprises, and plays a prominent role in the promotion of local gross national product. The main task of the project is electricity production, so as to provide electric energy that is in urgent demand by living and production of the area. Tangjiahe □ Hydroelectric Power Station has a installed capacity of 2×2500kW, and multi-year average electricity production of 18.2709 million kWh (including the additional 5.2325 million kWh by reservoir regulation), it is principally responsible for peak load and waist load in the electricity system. It is also of positive and practical meaning for the development of forestry, pharmaceutical industry, special raising and mineral industry, and also for the increase of rural income, the gradual realization of "Electricity Replacing Firewood", and for solidifying the achievement of "Closing Hill for Afforestation" and "Grain for Green".

From environmental and ecological aspects, the top environmental effect is the supersedure effect. The electricity provided by Tangjiahe □ Hydroelectric Power Station every year can replace the role of a thermal power plant that annually burns 7.7 thousand tons of standard coal, thus reduce the emission of harmful gases of CO_2, SO_2, etc. While the power generation benefit brings taxes and other direct economic income for Caihua Township, huge project investment will also become a propeller driving forward local economic development.

Currently, most project areas are in a closed state to outside, there has never been any infrastructure construction project with considerable scale carried out here. Project construction will greatly improve the external communication of the area and provide favorable condition for local development.

Project construction will improve regional communication, promote the development of construction material industry, and is beneficial to the development of the second, tertiary and agricultural byproducts processing industry, and the increase of rural income, improvement of people's living standard as well as general level of health. Hydroenergy is a renewable clean energy source; replacing firewood with electricity will reduce logging in forestland and avoid atmospheric and solid waste pollution from coal combustion, which are favorable to environmental protection and water and soil conservation.

5.10 General Environmental Impact Analysis of Cascade Development in River Basin

5.10.1 Yuqianhe River Cascade Development Plan

According to *Yuquanhe River Basin Hydroenergy Development Planning Report of Wufeng, Hubei*, six power stations and one reservoir are planed to be placed by the main course of Yuquanhe River. Respectively, Xiejiazhai Hydroelectric Power Station (elevation:1036m，installed capacity:2×320kW), Liziping Hydroelectric Power Station (elevation:1040m，installed capacity:2×400kW), Songjiahe □ Hydroelectric Power Station (elevation:865m，installed capacity:2×630kW), Songjiahe Second Cascade Hydroelectric Power Station(elevation:800m，installed capacity:2×400kW), Tangjiahe □ Hydroelectric Power Station (elevation:560m，installed capacity:2×3200kW), Tangjiahe □ Hydroelectric Power Station (elevation:420m，installed capacity:2×2500kW)，and Tangjiahe Reservoir(dam height: about 55m，reservoir capacity: 2070 thousand m^3).

Tangjiahe □ Hydroelectric Power Station in this assessment is located in the center of Yuquanhe River Basin development, a □ Hydroelectric Power Station regulated by Tangjiahe Reservoir, with a high drop from upstream Baiyiping□,□Hydroelectric Power Station and Tangjiahe□Hydroelectric Power Station (installed capacities are all 2×630kW, generating electricity with tributary), and there is no other outlet in Yuquanhe River Basin, only flowing from top to bottom is possible. As a result, the upstream power stations will

not exert any unfavorable influence on Tangjiahe □ Hydroelectric Power Station in this assessment; but it's development will bring even larger benefit to downstream power station. Tangjiahe □ Hydroelectric Power Station embodies certain interdependent relationship with Tangjiahe Reservoir, Baiyiping □, Ⅱ Hydroelectric Power Station and Tangjiahe □ Hydroelectric Power Station, thus favorable influence is even larger. The tail water of Tangjiahe □ Hydroelectric Power Station flows into downstream rivers (elevation: 438m) and connects with the backwater of Erchakou Reservoir (elevation:440m) downstream the station. Therefore, Hydroelectric Power Station in this development no only cast no influence on downstream Erchakou Hydroelectric Power Station, it is also in line with the comprehensive utilization and development plan of the river basin.

5.10.2 Impact Analysis of Cascade Development on Overall River Basin Environment

Yuquanhe River Basin enjoys abundant hydroenergy resource and has huge potential in development and utilization, cascade development in river basin provides energy security for alleviate the electricity strain and power supply guarantee rate of the area and the sustainable development of local economy. According to ***Planning Report of Hydroenergy Development in Yuquanhe River Basin of Wufeng, Hubei*** by the Water Conservancy and Electricity Survey and Design Institution of Qingjiang, Yichang in January 2004, combines with the status quo of nature and society in the river basin as well as project features, initial analysis shows that the main environmental impacts of the cascade development of Yuquanhe River are as following:

1) Impact on Ecological Environment

The impacts on land ecological system are principally that reservoir submerges the former forest, and land plants lost because of submersion and project permanent land occupation, also the habitat and activity range of terrestrial animals shrink. Data from the status quo survey shows that thin conifer-broad leaf mix forest, grass and shrubbery cover most of the reservoir submersion area, and those affected vegetations are common species that spread widely and with strong adaptability, thus the situation that submersion in part of the area causes plant species group to disappear could not happen. There is no rare or endangered animal or plant species. Impact on animals is mainly in construction period, when they are

disturbed by construction activities and are forced to migrate, which increase the risk of being caught and killed. In the river basin range, there is no nationally or provincially protected animal.

Survey shows that fishes in Yuquanhe River Basin are mostly widely spread commercial fished, and no nationally or provincially protected rare or endangered fished was found. Upon the completion of the cascade development of the river basin, the water depth of the reservoir area increased and velocity slowed, which make the formerly flowing water body become still or semi-still, and those fished adapted to still water will gradually dominate.

2) Environmental Impact of Water Loss and Soil Erosion

Water loss and soil erosion happens primarily in construction period, construction activities lead to land form disturbance, land damage and vegetation destruction, which all result in water loss and soil erosion. The power stations of various cascade all feature large amount of excavation, besides, water diversion tunnel spans a long distance, for which excavation amount will also be large, thus lead to wide disturbance on ground surface. Water and soil conservation plan must be strictly followed in construction and administration, then the range and extent of the impact of water loss and soil erosion will be limited to minimum level.

3) Water Regime

Viewing from Yuquanhe River Basin, after the cascade development of the river, there will be a layout of series power station stringing together, which will transform the complicatedly shaped winding river of nature to cascaded hydrologic basin of series of levels, thus results in the discontinuity of stream. Meanwhile, the water body forms a relatively still water in reservoir, major changes take place in terms of velocity, depth, water boundary. Because all the cascade power station in this river basin are water diversion type, water-reducing reach may appear between the dam site and power house of all power station, in the project, a water-reducing reach of 4.3km will appear. The outcome of river form discontinuity is the decrease of bio-diversification, in term of fishes, those fishes inhabit in the river basin that are more adapted to high stream velocity will decrease in number since they can not adapt to the environment transformation.

The impact that caused by the discontinuity of natural rivers is turning dynamic water

biotope into still water biotope, those two respectively correspond to dynamic water biocoenosis and still water biocoenosis. Since the water in reservoir is far deeper than river, the radiation function weakens as it goes deeper. In deepwater condition, photosynthesis becomes relatively weak, therefore, the ecosystem of reservoir biotope is a relatively closed system, which is more fragile compared with river ecosystem, and the fact is demonstrated in inferior stress resistance and self restoration capacity. After the reservoir is formed, the winding shape in the up, middle and downstream area of the river will disappear in reservoir area, the diversified biotope of main course, tributaries, river bends, swamps, torrents and shoals, etc, will be replaced by a relatively uniform reservoir biotope, biocoenosis diversity will be affected to different extent.

4) Impact of Water-reducing Reach on Water Regime

The cascade development of Yuquanhe River exerts an evident impact on water regime; on one hand, water depth undergoes a leap in reservoir area, stream turns from torrents to still water; on the other hand, the water-reducing reach resulted from the cascade development of hydroelectricity receives great runoff reduction, channel shrinkage and water inception in certain area, therefore produces considerable impacts on aquatic ecosystem, which is even more critical in normal flow and drought period. Reservoirs and power stations of all cascades should improve coordinated regulation, so that certain discharge flow downstream of intake dam will be ensured, and eventually the risk of flow interception is to be reduced.

5) Impact on Social Environment

Yuquanhe River Basin is situated in the southwest mountainous area of Hubei, an area with weak economic basis and low living standard of people. The substantial investment of capital, material and techniques in river basin development and project construction plays a positive role in the development and construction of local society and economy. A development mode for the abundant hydroelectricity resource in Yuquahe River Basin that is adapted to local conditions will not only directly increase economic benefit and fiscal income, but also provides security for industrial development and rural electrification and lays a foundation for the rapid growth of local economy, which are positive influence to social environment.

It can be clearly seen from above analysis, the most obvious environmental impact from the hydroelectric cascade development on the main course of Yuquanhe River Basin is vegetation submersion and the impact on water regime, those impacts are irreversible, and the impact on water regime will transfer to the impact on aquatic lives. Other influences are slighter or easily restorable or controllable.

6. Soil and water conservation

6.1 soil erosion and water loss in the project areas

According to the ***Public Notice on Division for Soil Conservation Pivot Control Region by the People's Government of Hubei***, the project locates in one of the eight key prevention districts—Qingjiang River Basin. The specific water loss and soil erosion situation can refer to ***Chart of Soil Erosion and Water Loss Situation of Tangjiahe II- Hydroelectric Power Station of Wufeng County, Hubei Province***.

In accordance to the satellite remote sensing materials in 2000, the total water loss and soil erosion areas in of Wufeng County, where the Tangjiahe II-Hydroelectric Power Station locates, amounts to 1058km^2. Table 6-1 presents the situation of water loss and soil erosion of the areas concerned.

Table 6-1 Water Loss and Soil Erosion Situation of the Project Construction Area

Target Region	Survey area (km^2)	area and extent of soil erosion and water loss									
		Area of soil erosion and water loss		Slight		Moderate		Severe		Annual average	
		Area (km^2)	Proportion (%)	Area (km^2)	Proportion (%)	Area (km^2)	Proportion (%)	Area (km^2)	Proportion (%)	Soil erosion modulus	Erosion Amount kt
Wufeng County	2364.2	1058.0	44.8	380.0	35.9	527.0	49.8	39.0	3.7	2695	6372
Construction Area	100.1	23.2	23.2	12.7	54.8	7.9	34.2	81.2	3.5	3031	70.3

From the water loss and soil erosion intensity, the slope non-cultivated land whose gradient is below 25° and slope cultivated land with a gradient lower than 15° mainly have slight water loss and soil erosion. Non-cultivated land whose gradient is higher than 25° and cultivated land whose gradient is between 15° and 25° are featured with severe water loss and soil erosion. Moderate loss and erosion occurs in Yuguan, Wufeng Town, Renheping Town, and Caihua County. Extreme water loss and soil erosion happens in Wufeng Town

and Yuguan Town.

Water loss and soil erosion in Yuquan River of Caihua Village, Wufeng County, where the project construction locates, are mainly caused by water erosion. As the vegetation along the river reach are well preserved (the forest coverage amounts to 73%), the type of water loss and soil erosion are mainly caused by surface erosion, with coverage of 23.2km^2. Gully erosion and gravitational erosion also happen from time to time. Surface erosion mainly occurs in weathering shale sandy slope and red sand stone. Gravitational erosion mainly happens in canyons with steep cliff, while gully erosion occurs in 低山平坝沟垄地带.

6.1.1 Reasons for water loss and soil erosion

① Natural factors

Terrain of Wufeng County is uneven, with high mountains, steep slopes as well as plenty of gullies and ravines. Once heavy storm occurs, the surface runoff immediately collected, which are prone to water loss and soil erosion. The county enjoys abundant and concentrated rainfalls and frequent storm occurrence. What's more, Qingshuiwan and Wantan of Yuyangguan are places with the heaviest rainfall in Hubei; the washing effect is strong and it is easy to be escalated to disaster and severe water loss and soil erosion is also seen here.

② Human factors

Due to the rapid growth of total population and in order to solve the food problem, large scales of reclamation has been conducted on slope with high gradient, together with excessive tree cuttings, which directly resulting in vegetations damage. In recent years, vegetations have been destroyed during road construction, quarrying process, etc. while no measures have been taken, which are also the causes for large amount of the soil erosion and water loss.

6.1.2 Harm of water loss and soil erosion

（1） lowering the soil fertility

After continuous washing by the surface runoff, the soil layer becomes thinner; the fertility also goes down; the ability to prevent drought also worsened; which all together lead to the low and unsteady crop production.

(2)damaging the integrity of the land

The widening and further extension of the gully will erode the soil, reducing the cultivated land available and increasing the rock exposure.

(3) filling up lower reach of the river

The water level of reservoir will be escalated and the flood disaster in lower reaches will be aggravated. As the holding and stocking ability of the land surface is weakened, mountain torrents may occur when heavy storm happens, and in some places, debris flow may occur. This may lead to devastation of farmlands in lower reaches and great loss of houses, lives and livestock, etc.

(4) blocking lower reaches of the river

Water resource facilities and transportation facilities will be destroyed. The mud and sand caused by water loss and land erosion will sedimentation in lower reaches, reservoir and ponds and dams, which will definitely shorten the duration of these facilities. As a side effect of the sediment, the river bed will be raised, with water level rise simultaneously, posing great flood threat on transportation and water resource facilities.

6.2 situations of water and soil conservation in the project areas

Changing the slope into contour cultivated land has been the focus of water and soil conservation work of Wufeng County. Especially after mid-1980s, comprehensive control has been implemented with Changpu Brook, under provincial administration, Baiguo Bay,

Qianping Reach as small units. Project and biological measures have been taken, such as mountain and land management, closing the hill for forestation, vegetation conservation, etc. What's more, closely cooperated with forestry, mining, land management departments; strict forbiddance has been put on forest devastation for reclamation, inappropriate mining excavation, vegetations damage, unplanned land requisition for production, etc.

The three villages where the project locates, Tangjiahe, Hongyuping, Songjiahe, are enjoying good forest and grass coverage and low level of water loss and land erosion. However, the situation is much more severe where the power house locates. Thus, People's Government of Wufeng County strengthened the reform of the farmlands on slopes; take the measures of further developing forestry, creating water and soil conservation forest on barren hills and slope land, planting economic forest and fruit trees in line with the local situations. In the countryside, fuel (wood)-saving kitchen place, methane tank will be popularized; plant fertilizers will be used and stalks and strews will be put back into the farmland as a fertilizer. And through series of water and soil protective measures, water loss and land erosion areas of 1500hm^2 have been controlled, including 80hm^2 of fundamental farmland, 200hm^2 for water and soil conservation, 420hm^2 of forest for economic purpose and 800hm^2 forests being nurtured by closing the hill. All the above measures are mainly composed of some invested programs, such as annual infrastructure construction programs of farmlands, Yangtze River Protection Forest Project, comprehensive development for agriculture, etc. Local ecological environment has been improved a lot.

6.3 Predictions on new water loss and soil erosions caused by the project

6.3.1 Prediction foundation

According to the project layout and construction features of Tangjiahe II-Hydroelectric Power Station, surveys should be conducted on disturbed areas of land surface, vegetation damaging degree and areas, amount of waste soil, stone and debris. According to the piling position and patterns, and in line with original erosion modules of the project location,

the erosion modules during the construction period can be reached through comprehensive analysis. Then the possible new soil erosion and water loss as well as their possible damage, if with no proper measures being taken, can be deduced, so as to lay the foundation for prevent water loss and soil erosion scientifically.

6.3.2 Features of soil erosion and water loss in project areas

The project areas enjoys sub-tropical monsoon climate, with abundant rainfalls. Thus the exogamic forces are sufficient for water loss and soil erosion. Besides, the project is near to the flood flowing zone of the river, so wastes are prone to get into the river. What's more, the river valley is deep; bank collapse is frequent; and terrain there is disintegrated. All of these are vulnerable topography conditions for water loss and soil erosion. The project will involve excavation, filling and building, construction road, excavation of quarry, piling and burying of waste. This will destroy the vegetations on the land and lower the anti-washing and anti-erosion ability, which will accelerate the erosion and further aggregate the water loss and soil erosion. Meanwhile, the excavation for the main body, quarry, and construction road will enlarge the areas being high up in the air and move the temporary erosion line backward. Gradient will be enhanced, which will destroy the original stability of the mountain and make the collapse, landslide and gravitational erosion possible. Large amounts of waste, produced during the excavation will provide rich source of loose materials, which are easy to be move into the river and form a sand transportation in large scale. As the project locates in mountain area, it will cast adverse impact on agriculture production, and may lead to reclamation on slope with high gradient, which will further enhance the loss amount.

6.3.3 Prediction period

According to the ***Technological Guidance of Water and Soil Conservation for Project Development and Construction, (SL204-98)***, the prevention of water loss and soil erosion prediction should be carried out in two periods—construction period and operation period. The infrastructure construction of the project will inevitably cause some adverse impact on the water and soil resource as well as the ecological environment along the river. While all the factors of water loss and soil erosion caused by construction during the early phase of operation period will vanish after the implementation of various soil and water conservation

measures. With time passing by, the functions of water and soil conservation will give a full play, resulting in the rehabilitation and improvement of ecological environment. Then new landscape will be formed and the erosion amount will be reduce will a new stable amount.

The prediction period covers two phases: fundamental construction period and trial operation period—two years of the construction period (from June, 2006 to June, 2008). The duration of prediction will apply different time periods according to various land erosion situation due to different specific construction periods. While influenced period refers to forest and prate rehabilitation period, the time for the vegetation to rehabilitate into their original water storage and soil conserving ability after human intervention is eliminated, which may last for two or three years, but no more than five years. Taking the situation of different districts into consideration, this prediction will regard the influence period as three years. Details of prediction duration of all construction districts can be seen in Table 6-2.

Table 6-2 Soil Erosion and Water Loss Prediction Duration Unit：year

Project		Predicted duration		
		Construction period	Influenced period	total
1	Main construction area	1.25	3.00	4.25
2	Borrow fields and quarry	1.83	3.00	4.83
3	Spoil areas	1.25	3.00	4.25
4	Temporary occupation areas	2.00	3.00	5
5	Construction road	0.25	3.00	3.25
6	Submerged areas in reservoir	2.00	3.00	5
7	Electricity transmission areas	0.25	3.00	3.25

6.3.4 Method and content for prediction

The main content of prediction are the water loss and soil erosion during the project construction, including: devastation areas of the original landscape, total amount of the waste, demolishment of the water and soil conservation facilities, possible loss amount, possible harm of water loss and soil erosion, etc.

According to the construction features and real situation of the project, as well as analysis on the influential factors of water loss and soil erosion, the prediction contend and methods have been formulated, in line of ***Technological Guidance of Water and Soil Conservation for Project Development and Construction, (SL204-98)***. Details can be seen in Table 6-3.

Table 6-3 Prediction Content and Methods

No.	Prediction Target	Prediction aim	Prediction content	Prediction methods
1	Area of original landscape disruptions, destroyed land and vegetations	Provide basic data for the prediction of loss amount	Prediction of the land disruption, land occupation, as well as area and number of damaged forest and prate	Conduct research on project design materials and design drawings; carry out field survey and get relevant materials for all parts of different sections
2	Stones, earth and waste residues	Provide foundation for project measures layout	Predict the excavation amount, utilization amount, waste source and amounts according to the construction work of the project	Conduct research on project design and estimation; get separate statistics of all parts of different sections.
3	Species and areas of damaged water and soil conservation facilities	Provide foundation for calculation of compensation fees	Predict damaged areas and numbers of forest and prate, contour cultivated land, and soil dams, such facilities for water and soil conservation.	Carry out field survey and gather relevant statistics, confirmation letter from local water administration managers on total areas of water and soil conservation facilities
4	Possible areas and amount of water loss and soil erosion	Provide foundation for specific measures arrangement and profit calculation of water conservation	Get sufficient information for the disruptions of vegetations on land surface, understand the composition piling places and pattern of the waste; predict the loss amount of	Carry out field investigation and analysis

			soil and water	
5	Analysis of the harm of water loss and soil erosion	Provide foundation for the project feasibility and measures formulation	Impact and influential degree of water loss and soil erosion on project, land resource and ecological environment, etc.	Analyze according to the real situation of the project

According to the principle of "the one develop should take in charge of the protection, the one being responsible for the water loss and soil erosion should tackle the problem", the water loss and soil erosion prediction areas of Tangjiahe II- Hydroelectric Power Station is also the scope for the problem prevention and tackling.

6.3.5 Area of original landscape disruptions, destroyed land and vegetations

Land disruptions refer to all kinds of excavation, occupation, piling and abandoning, cutting activities during the development and construction of the project, which will damage the land surface, lower the water storage and soil conservation ability. This is counted by vertical projected areas.

Statistics of total areas of land disruption, occupation, and damage to the forest and prate vegetations during the construction period should be gathered through researching the water conservation materials of the project, use the design drawings and combine field surveys together. The total disruption area of the project amounts to 4.08hm^2. Details can be seen at Table 6-4

Table 6-4 Statistics on Land Disruption Unit：hm^2

No.	Name of the district	Types of the land and the total amount				Total
		River riparian	Tea plants areas	Barren hills	Cultivated land	
Temporary land occupation	1.Land occupation for construction	0.26	0.0767	0.107	0.017	0.460
	2.road for approaching	0	0	0.013	0	0.013
	3.spoil areas	1.31	0	0.97	0.18	2.46
	4.borrow areas	0.47	0	0	0	0.47

Total		2.04	0.0767	1.09	0.197	3.403
Permanent land occupation	1.water-intake dam	0.103	0	0	0	0.103
	2.tunnel mouth, channels and fore bay (head tank)	0.08	0.033	0.087	0.039	0.239
	3.penstock	0	0.1	0.067	0	0.167
	4.power house and step-up substation	0.04	0	0	0.107	0.147
Total		0.223	0.133	0.154	0.146	0.67

6.3.6 Predictions of stones, earth and waste residues

This item mainly covers the waste (stones, earth and residues, etc), industrial and living trash produced in the construction process of main body, temporary project, affiliated facilities (including transportation, water and electricity supply, living facilities, etc.), quarry and borrow areas construction, etc. Though research on the technical materials and field survey and prediction, information can be gathered in exaction amount, filling-back amount, stripping ratio, and waste per unit product, etc. so as to predict the total amount of the waste.

The total amount of the waste during the construction period may reach 42,400 m^3, including 11,200 m^3 of earth, 31,200 m^3 of stone, which equals to 97,700 tons. (Calculated by assuming the bulk density of earth is 1.75t/m^3, of stone is 2.5t/m^3)

6.3.7 Areas of damaged water conservation facilities

Due to construction excavation and waste burying within the project construction areas, damages of various extent will be done on the original terrain, rock composition, and vegetations on the land surface, leading to the diminishing or eliminating of the original water storage and soil conservation functions and accelerating the development of water loss and soil erosion. For instance, the forests and prate may loose their abating ability for the damage, and natural meadow and wild meadow with good vegetations may loose its holding capacity due to the suppression and occupation. (Trees cutting along the electricity transmission route will not be counted as damage on land surface, as it hardly ruins the vegetations on the land surface.) This type of land surface destroyed by the project will be categorized into water conservation facility areas. The statistics of damaged water

conservation facility can be seen in Table 6-5.

Table 6-5 Areas of Damaged Water Conservation Facilities

Content / Item	Type of land occupation (hm^2)				Total (hm^2)
	Riparian areas	Tea plants garden	Barren hills	Cultivated land	
1.land occupation by main buildings	0.223	0.133	0.154	0.146	0.67
2.road of approaching	0	0	0.013	0	0.013
3.spoil areas	1.31	0	0.97	0.18	2.46
4.borrow areas and quarry	0.47	0	0	0	0.47
5.temorary construction land occupation	0.26	0.0767	0.107	0.017	0.460
Total	2.263	0.21	1.244	0.343	4.08

6.3.8 Predictions on possible loss amount

(1) Background value of water loss and land erosion

Background value of water loss and soil erosion refers to the loss amount of original terrain without project construction, which can be calculated by construction disruption and its influential area, as well as corresponding average soil erosion modules. The construction disruption area of the project amounts to 4.08hm^2. As the construction areas locate in a relatively concentrated way, field surveys can be adopted to investigate the situation of water loss and soil erosion.

According to the classification standard for soil erosion and surface erosion in ***Chart of Soil Erosion and Water Loss Situation of Tangjiahe II- Hydroelectric Power Station of Wufeng County, Hubei Province*** and ***Classification Standard of Soil Erosion (SL190-96) ,*** and taking into consideration the experience of water and soil conservation experience along Qingjiang River for years, the original soil erosion module of the land occupied areas are: 1000t/km^2·a for the places free from water loss and soil erosion, 1000~2500t/km^2·a for the place with slight problem, 2500~5000t/km^2·a for the places with medium water loss and soil

erosion, while 5000~8000t/km^2·a for the place with severe water loss and soil erosion, 8000~15000t/km^2·a for the extreme areas. The water loss and soil erosion situation can be seen in Table 6-6.

Table 6-6 Soil Erosion and Water Loss Situation

Content / Item	Total (hm^2)	Soil Erosion and Water Loss (hm^2)					Total Amount(t)
		Little	Slight	Moderate	Severe	Extreme	
1.land occupation by main buildings	0.67	0.1	0.12	0.32	0.08	0.05	18.8
2.road of approaching	0.013	0	0	0	0.013	0	0.65
3.spoil areas	2.46	0	0.14	1.25	0.55	0.52	102.45
4.borrow areas and quarry	0.47	0.42	0.02	0.03	0	0	5.25
5.temorary construction land occupation	0.460	0.1	0.11	0.2	0	0.05	11.65
Total	4.08	0.62	0.39	1.8	0.643	0.62	138.8

Thus the background value of water loss and soil erosion in the construction areas can be calculated. Without construction of Tangjiashan II-Hydroelectric Power Station, the water loss and soil erosion of the original landscape amounts to be 138.8t.

(2) Prediction for the possible water loss and soil erosion

Water loss and soil erosion areas include the areas caused by project productions and constructions as well as original erosion areas within the occupied land which haven't reach the requirement of the permitted level. Possible water loss and soil erosion areas refer to the significantly changed places caused by excavation, burying, excessive tree cutting and other production and constructions. The possible water loss and soil erosion areas can be seen in Table 6-7

Table 6-7 Possible Soil Erosion and Water Loss Caused by the Project (Unit：hm^2)

Content	Type of land occupation				Total
	Riparian	Tea plants	Barren hills	Cultivated	

Item	areas	garden		land	
1.land occupation by main buildings	0.223	0.133	0.154	0.146	0.67
2.road of approaching	0	0	0.013	0	0.013
3.spoil areas	1.31	0	0.97	0.18	2.46
4.borrow areas and quarry	0.47	0	0	0	0.47
5.temorary construction land occupation	0.26	0.0767	0.107	0.017	0.460
Total	2.263	0.21	1.244	0.343	4.08

(3) Predictions on possible loss amount

water loss and soil erosion amount caused by land surface disruption

a. field survey and soil erosion classification methods

According to the investigation result on land occupation, terrain and landscape, vegetation and water loss and soil erosion features, different water loss and soil erosion degree will be identified. In accordance to the classification standard of soil erosion and classification index of surface erosion in ***Classification Standard of Soil Erosion (SL190-96),*** the original water loss and soil erosion, degree and amount will be calculated. Then according to the possible water loss and soil erosion degree during construction in different areas, loss amount will be reached. The difference between the two are the newly-added water loss and soil erosion of the project (The losing amount of earth and waste residues are excluded.)

b. experience-based formula (accelerated erosion coefficient method)

According to the survey and calculation, the excavation and filling back of the project will lead to compact structure changes, due to various looseness of the soil. The conglomeration of the waste, viscosity, internal friction angle will also change a lot. Thus, the ability to stand weathering and washing will be weakened, while the erosion force is stronger than before, thus the erosion modules will increase correspondingly.

The prediction of water loss and soil erosion can be calculated in the following formula:

$$Ms=F\cdot A\cdot P\cdot T$$

$$M= Ms-Mo=F\ (A-1)\cdot P\cdot T$$

In this formula：

Ms—Predicted amount of water loss and soil erosion (t)；

Mo—Original amount of water loss and soil erosion(t)；

M—Newly added amount of water loss and soil erosion (t)；

F—accelerated erosion areas (hm^2)；

A—erosion acceleration coefficient；

P—erosion modules of original erosion on land surface($t/km^2 \cdot a$)；

T—predicted time (a)。

According to different features of water loss and soil erosion caused by construction method and technology, predictions will be carried out on the basis of various situations of the project areas.

After field investigation, and taking into consideration of the erosion force of rainfalls, soil vulnerability of erosion, gradient and slope length of the failure surface, vegetation left after damage, the coefficient of erosion acceleration of different districts will be identified. On this basis, further check and adjustment will be conducted on the erosion acceleration coefficient of different districts through field survey and erosion classification methods. Finally, it is decided to apply 3 to 6 as the coefficient. The prediction time of different project districts should be arranged in accordance to the construction process of the main body design report. The possible water loss and soil erosion of the project construction will amount to 1,800 tons, newly added water loss and soil erosion during the predicted period is 1,200 tons.

Table 6-8 Water Loss and Soil Erosion Prediction of the Project District

Items	Accelerated erosion areas (hm^2)	Erosion modules ($t/km^2 \cdot a$)	Original amount of water loss and soil erosion (t/a)	erosion acceleration coefficient	Predicted annual amount of water loss and soil erosion (t)	predicted time (a)	Total predicted amount of water loss and soil erosion (t)	Predicted newly added amount of water loss and soil erosion (t)
1.land occupation by main buildings	0.67	3104	18.8	5	79.90	4.25	441.93	362.03
2.road of approaching	0.013	5000	0.65	6	3.14	4.83	18.84	15.70
3.spoil areas	2.46	2400	102.45	3	435.41	4.25	752.76	317.35
4.borrow areas and quarry	0.47	3930	5.25	4	26.25	5	369.42	343.17
5.temorary construction land occupation	0.460	3000	11.65	4	37.86	3.25	179.40	141.54
Total	4.08	/	138.8	/	582.56	/	1762.35	1179.79

Loss amount of waste residues

The waste earth, stone and residues produced during the construction are the basis of water loss and soil erosion. Instead of counting on all the waste, only the part being effectively transported into the river will be considered as part of erosion. Bellow is the formula to calculate it:

$$WS_2=\Sigma DeiWi$$

In this formula：

WS_2——loss amount caused by waste release (t)

Dei——the total amount of waste in the spoil areas(t)

Wi——loss coefficient of different spoil areas.

There are several factors influencing the losing coefficient of the waste, mainly including

the terrain of the waste piling place, impetus conditions, such as heavy storm and runoff, composition of the waste as well as prevention measures. According to field investigation, the waste residues are mainly composed by earth and stone, piling on the mountain areas and riparian areas. Combined with the rainfalls of construction areas, the loss coefficient of waste is 0.2. The total amount of the waste during the construction period may reach 41,600 m^3, including 11,000 m^3 of earth, 30,600 m^3 of stone, which equals to 95,800 tons. The calculation indicates that the loss amount caused by the waste amounts to 13,300 m^3 (loose measure), equaling to 21,600 tons. Thus we can reach the conclusion that large amounts of waste earth, stone and residues, piling loosely without any disposition, will lead to large-scaled loss.

Prediction of the loss amount

Combining the increasing erosion amount caused by waste release and newly-added erosion amount caused by land surface eruption during the project construction, the total water loss and soil erosion amounts are 23,400 tons in the prediction period, with an added water loss and soil erosion of 22,800 tons.

Thus, it is of great importance to ensure simultaneous design, construction and putting into production of the water and soil conservation project and the main project in the process of construction. Through water and soil construction work, the aggravated ecological environment will be improved a lot, laying a solid foundation for the sustainable development of this region. The emphasis of water and soil conservation would be the tackling of waste, rehabilitation of the forests and prate and the control of water loss and soil erosion.

6.4 Impact analysis on water loss and soil erosion

During the project construction process, land surface will be destroyed of various extents within land requisition areas, with dramatic changes taken place in some part of the areas. If left without any water and soil conservative measures, the newly added water loss and soil erosion will amount to 22,800 tons, which will exert various influences on regional land productivity, regional ecological environment and the scour-and-fill effect of rivers in the region.

6.4.1 direct harm and influence caused by the project

The project construction will cause severe harms and impact on the project areas:

(1) The disruption areas amounts to 2.31hm^2, together with damage occurred in 1.643hm^2 riparian areas, 0.21hm^2 tea plants garden, 0.27hm^2 barren hills and 0.183hm^2 cultivated lands. Damaged water and soil conservation facilities cover an area of 2.31hm^2.

(2) The natural volume excavated and cleared for the project amounts to 54,500m^3, in which 12,900 m^3 being utilized, leaving 42,400 m^3 been deserted. This includes 11,200 m^3 of earth, which equals to 19,700 tons; 31,200 m^3 of stone, which equals to 78,000 tons. The poor terrain conditions cause a lot of difficulties of the conservation work, leading to a rise on water and soil conservation investment.

(3) The possible accelerated erosion areas during the construction period amounts to 2.31hm^2, and the total amount in prediction period is 1,800 tons. Newly added water loss and soil erosion amounts to 1,200 tons, and the waste reaches 22,000 tons. The total amount of water loss and soil erosion caused by the project construction is 23,400 tons with a newly added water loss and soil erosion of 22,800 tons.

6.4.2 possible harm of water loss and soil erosion

(1) lowering the fertility and reduce land resources

As the project construction disrupts the original landscape and leads to land surface vegetation damages. A large amount of tillage layer on the surface of cultivated land and plants growth layer have been excavated, stripped or buried. Exposed land surface will lead to water loss and soil erosion under the scouring of rainfalls, loosing the nutritious on the front layer of the soil, lowering the fertility of the soil. Thus the growth of crops and woods will be influenced with a rapid reduction or elimination of the productivity, which will trigger erosion acceleration and lower the utility of the peripheral land, posing adverse effect on land resources.

Meanwhile, the waste earth, stone and residues, filling backs, if left without proper protective measures, will intrude into peripheral areas, carried by the surface runoff, and influence the growth of surrounding plants.

(2) Influence the landscape of surrounding mountains and forests

The forest coverage of assessment areas is relatively high before the project construction. If the water loss and soil erosion, caused by construction along the project is left without any control, the land productivity will be lowered, posing adverse impact on peripheral forest growth. It will also damage local ecological environment, casting long-term negative impact. What's more, water loss and soil erosion will, to some extent, damage natural environment and reduce the landscape value.

(3) Impede the construction and operation of the project

Water loss and soil erosion will impede the construction and operation of the project. The waste earth produced in the construction areas, if left without proper measures, will be washed into the construction site, influencing the progress and production safety and posing a threat to the security of working staffs there.

(4) Block the river and impede flood running, causing side effect on water quality in lower reaches

The water loss and soil erosion caused by the project will be washed into the brooks, river nearby through surface runoff, sedimentation and silt the river, which will raise the river bed and diminish the flood running ability of the river. What's more, waste earth and stones, industrial and domestic trash will contaminate the water in lower reaches and cast adverse effect on production and living environment of people along the river. In addition, if water and soil conservation measures are not adopted simultaneously, the waste will be flowed into the Maduhe Reservoir in lower reach (planned) and silt.

6.4.3 Influence analysis and evaluation of water loss and soil erosion of project divisions

Tangjiahe II-Hydroelectric Power Station project covers an area of 4.08hm^2, including 0.67hm^2 for permanent building, 0.46m^2 for temporary usage, and 2.46hm^2 for spoil areas. Permanent land occupation accounts for 16.4% of the total.

(1) Key project of water intake

The overburden layer of water intake key project is large in depth. According to geological report, the river bed sediment on the project site is composed by common and erratic boulders, filled with large amounts of sand and stone. The maximum depth of drilling is 15.1m. The main body of the project is designed to adopt bottom-grating pattern, with smaller total volume of dam. Thus we can lower the excavation amount, together with the waste, which will reduce water loss and soil erosion in return. The main project will be constructed with impervious drapery of sand and cobbles. On one hand, it can lower permeation. And on the other hand, it reduces the excavation on large-scale, so as to reduce water loss and soil erosion. The water intake key project will disrupt the land surface when the base is excavated. But when the construction ends, the form of the dam is favorable for water and soil conservation.

(2) water diversion channel and tunnel construction

The water diversion building of Tangjiahe II-Hydroelectric Power Station is composed by a 145m-long water diversion channel, six free-flow water diversion tunnel (3871m long in total), fore bay and head conduit.

Water diversion channel locates in the head of the building, with plain terrain. Drainage system has been designed for the channel in order to prevent water loss and soil erosion, which is also good for the stability of the channel.

Free-flow water diversion tunnel will be favored in layout of the diversion building. Compared with open-channel, it can reduce disruption of land surface and damage to the vegetations. Stone waste will be lowered, leading to less water loss and soil erosion, which are beneficial for the water and soil conservation. The intake and outlet tunnel will use block stone with plasma as the protective project to lower soil erosion and water loss.

(3) Fore bay and penstock

The terrain of fore bay is of slope type, thus it is not favorable for water and soil conservation, and is vulnerable for water loss and soil erosion. The design and excavation of the main building will follow the principle of satisfying the needs for project layout while minimizing the excavation volume. It can lower the project investment and prevent mass water loss and soil erosion. After the excavation of fore bay, backfill should start immediately after then.

Penstock locates in a place with moderate gradient but long length. According to the design of the major building, drainage ditch will be set along the long with cement C10(2), in order to reduce the wash of mountain torrents on the penstock, to prevent water loss and soil erosion and also get rid of the threat on concrete frusta and rest pier. After the construction, the excavation surface should be sprayed and protected, with proper arrangement of scuppers. After the construction work, there will be no more water loss and soil erosion.

(4) plant area project

The plant area of Tangjiahe II-Hydroelectric Power Station includes the power house and the booster station. The terrain of the plant site is gentle. Thus the impact on water loss and soil erosion during the construction period will not be very severe, except temporary land occupation for the spoil disposition. The design of the plant site has already taken into consideration the balance of excavation and utilization. During the construction period, attention should be paid to temporary protection on spoil, in order to prevent new water loss and soil erosion. A large portion of plant site will be covered by permanent architectures, so there will be no more new water loss and soil erosion caused by the construction.

(5) Temporary architectures

Temporary architectures of the project include facilities in the living and production areas, such as their temporary residence. Certain extend of water loss and soil erosion will be caused during the construction. After putting into use, there will be no more new water loss and soil erosion at large-scales as a considerable portion of land has been covered. After the project construction, vegetation rehabilitation will be launched, so as to prevent further water loss and soil erosion.

(6) Spoil areas and borrow fields

□ spoil areas

The design and layout of the main structure have already taken into consideration the balance between excavation and backfilling as well as the pilling place for the spoil. However, little light has been shed on the protection measure, which entails special attention

in this regard.

□borrow fields

Yuquan River Quarry which stands at one kilometer up steam from the water intake dam, will be used as the borrow field for Tangjiahe II-Hydroelectric Power Station. The design for the main structure didn't pay much attention to the protective measures for the borrow field, thus the designed program and vegetation measures from water and soil conservation plan should be put into place.

6.5 protective measures for water and soil conservation

6.5.1 Requirements for the protective measures

During the construction process, the protective measures are closely related to the water and soil conservation. New water and soil loss mainly occurs during the construction period, thus the following requirements for the period should be raised from water and soil conservation perspective:

(1) Construction plan should be made in line with the water and soil conservative measures stipulated in the water and soil conservation plan so as to ensure no new water and soil loss will be caused.

(2) During the excavation of the foundation and slope, it is prone to create new source of water and soil loss. However, water and soil conservation functions will be available after the completion of the construction. Thus effective measures should be taken during the construction period, such as temporary blocks and water drainage gully in peripheral areas, etc., so as to minimize the water and soil loss.

(3) large amount of waste, produced during the construction and excavation, will provide rich loose material for water and soil loss. They are prone to be washed into the river course by the heavy shower. In that case, large amount of sand transfer will be caused, exerting adverse impact on the ecological environment down steam. Thus special attention should be paid on the location of the spoil areas and protection of the waste, to prevent further adverse impact.

New water loss and soil erosion are mainly made up be the spoils of the project. Thus protection work should focus on the construction site of the main structure, transfer venue of the spoils and spoils fields. From the perspective of the intensity of water and soil loss, protective measures combined with vegetation measures should be adopted. The temporary piling place for the spoils and materials should be equipped with drainage systems to prevent the rain-wash and materials loss. Seen from the intensity and the loss amount, the key monitoring period should be construction period, while the key spots should be temporary piling site and spoil areas.

(4)from the prediction of the water and soil loss, we can find that the key period for water and soil conservation should be construction period. And the major place for new water loss and soil erosion should be excavation site, quarry, and temporary piling places and most importantly, spoil areas. These places will be key areas for water and soil conservation in this plan.

6.5.2 Overall layout for water and soil conservation measures

Water and soil conservation should be based on the prediction result and take into consideration types, features and utilization intention after the work, so as to establish a whole prevention and treatment system. Various kinds of water and soil conservation measures should be applied comprehensively so as to form integrated water and soil prevention system combining key measures and overall work, permanent and temporary project, construction measures and vegetation approaches, as well as construction and rehabilitation.

In specific prevention and treatment measures, we should make full use of the efficiency and control of the project, and give into full play the continuity, long-term and ecological effect. According to the terrain, geological and soil conditions, considering water loss and soil erosion situations, we can combine the features, layout of construction and short-term and long-term development plan of these areas together. Given the impact and prevention goals of water loss and soil erosion, we can adopt different plans in accordance to specific situations of different sub-districts.

Water and soil conservation should focus on the spoil areas, excavation fields in large scale and geographically unstable regions. A conservation plan combined project and vegetation

measures together should be adopted to deal with the problem. The whole system can be seen in the picture 6-1 below:

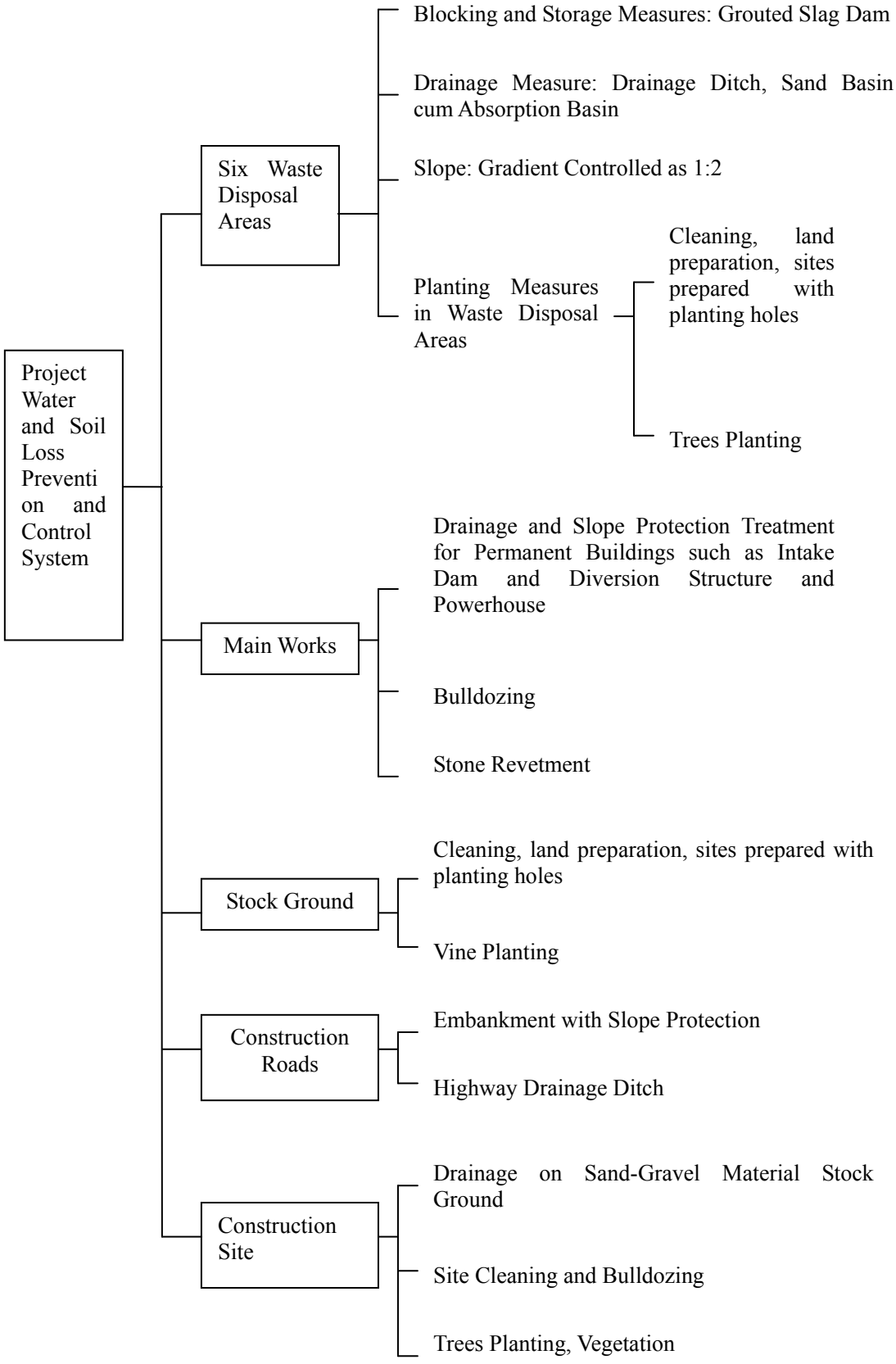


Chart 6-1 Prevention and Control System on Project Water and Soil Loss

6.5.3 Protective measures for different regions

In the implementation of water and soil conservation measures, measures of "three-simultaneousness" should be conducted. They are: making construction phase as the emphasis and pay attention to the operation period at the same time; take prevention as the first step and in the same time, apply the project and vegetation measures in order to intensify the construction management; establish district prevention system at the same time according to the specific features of water loss and soil erosion.

(1) spoil areas

To reduce ecological environment damage and water and soil loss caused by misplacement of spoils, the spoils should be transported to specific fields. It is strongly forbidden to disperse them along the road or dump them into the river. The vehicles should not be overloaded, preventing spoils falling along the road.

project measures

The total amount of spoils is 42,400 m^3 in loose measures, equals to 32,600 m^3 in compacted measures. According to the original plan, there will be six spoil fields covering an area of 0.71hm^2. the location and project volume can be seen in the table 6-9 below:

Table 6-9 Spoils Amount and Construction Volume of the Field

Name	Source	Spoils Amount (thousand m^3)	Areas of the Spoils field (hm^2)	Project volume(m^3)	
				Earth amount	Wet masonry retaining walls
$1^{\#}$	Water-intake dam & $1^{\#}$ Channel	6.3	0.21	525	1890
$2^{\#}$	$1^{\#}$ tunnel & inlet of $2^{\#}$ tunnel	1.0	0.23	200	480
$3^{\#}$	Outlet of $2^{\#}$ tunnel & inlet of $3^{\#}$ tunnel	7.5	0.30	240	768
$4^{\#}$	Outlet of $3^{\#}$ tunnel & inlet of $4^{\#}$ tunnel	5.7	0.37	150	480
$5^{\#}$	Outlet of $4^{\#}$ tunnel & inlet of $5^{\#}$	7.8	0.21	100	307

	tunnel				
$6^{\#}$	Outlet of $5^{\#}$ tunnel, $6^{\#}$ tunnel, fore bay and penstock	13.3	1.14	520	2052
Total		41.6	2.46	672	5977

During the construction work, locations of spoil areas should be decided according to terrain, geographic conditions as well as project and construction layout. They should be arranged close to the work sites so as to shorten the transportation and lower construction disruptions. Excavation spoils should be fully utilized by means of combining construction and backfilling, so as to reduce final amount of spoils and lower the cost. Spoils areas should be situated in the place with favorable terrain and geographic conditions so as to prevent large scales of water loss and soil erosion, as well as landslide. Locations of spoils fields should try to avoid cultivated land occupation, reduce the impact on surrounding ecological environment so as to diminish the adverse impact on people's lives and works. At the foot of the spoil fields, retaining walls should be made by cement masonry stones, to prevent surface erosion and falling of the waste piles. By controlling the slope gradient, the stability of the spoils can be maintained and partially landslide can be avoided. Drainage system should also be considered in prevention of washing by water.

design of vegetation measures

After the spoil piling, the fields should be leveled and plant trees on it. According the overall plan and considering the soil type of the prevention and treatment areas of the spoil fields, Black Locust (Robinia pseudo acacia L.) is chosen to be planted on the fields and purple medic will be chosen as the grass.

Table 6-10 Density of forestation

District	Trees and grass	Density at plantation	unit	Distance (m)
Spoil areas	Black Locust	2500	Per hm^2	2×2
	Purple Medic	22.5	kg/hm^2	0.3

The total plantation areas of the spoil field's amounts to $2.46hm^2$, on which 6150 Black Locust will be planted, and 55.35kg of purple medic seeds will be sowed.

(2) borrow fields

According to the feasibility report, Yuquan River Quarry which stands at one kilometer up steam from the water intake dam, will be used as the borrow field for Tangjiahe II-Hydroelectric Power Station. It covers an area of 0.47hm^2.

① project measures

During the excavation period, stable slope should be borne in mind so that the slope after excavation can maintain stable, and gravity erosions caused by dispersing, collapsing and landslide will be avoided. According to the geographical conditions, the slope after excavation should be 1:0.5 ~ 1:0.75. And excavation should follow the natural layers of the rocks. Movable stones on the surface should be cleared in time. The width of excavation should be decided by the excavation amount. And the excavation should start from above and gradually come downwards, leaving a smooth surface after excavation. So the holes along the mountain side should be arranged in accordance to presplitting blasting, while the others should abide by bench blasting. After the project construction, there should be no spoils left. The wastes should be transported to the spoil fields if there are small amounts left.

Besides, during the early period of excavation, retaining walls and drainage systems should be set around them. After excavation, the site should be cleared (quarry should be backfilled by earth from borrow fields), and proper measures should be adopted to rehabilitate the vegetations.

② vegetation measures

After excavation, plants should be rehabilitated on the site, with a total area of 0.47hm^2. The plants types are same with that on the spoil fields. The total plantation areas amounts to 0.47hm^2, on which 1175 Black Locust will be planted, and 10.58kg of purple medic seeds will be sowed.

(3) Main structure of the project

This region belongs to permanent land occupation areas, thus it is prone to excavation and

tree falling. In the light of project security, a relative high standard of protection has already been set, such as the wet masonry to protect the bottom, wet masonry retaining walls, C25 cement-masonry tunnel and wet masonry retaining walls of the tunnel transportation construction. Thus here, we are going to point out some protective measures and temporary water and soil conservation measures for the construction, to beautify the exposed conduit of the water-intake tunnel and to conduct vegetation protection on the excavation and disruption surface after the work.

(4) Construction road

The water intake dam of Tangjiahe II- Hydroelectric Power Station is near Wuniu Road, thus there is no need to construct a road in particular. The height difference between the ore bay (head tank) and Wuniu Road exceeds 100m, thus slide track will be set up for the transport of concrete aggregate, rubble, concrete reinforce bars for the fore bay and penstocks. Thus the cost of the project can be lowered and new water loss and soil erosion can be prevented. As a result, there won't be any construction road in large scale for the construction of Tangjiahe II-Hydroelectric Power Station.

① Road for excavation

For the road for excavation, different slope standard will be set in accordance to the specific geological conditions. The slope along the road to the factory will be made of rock or rubbles with earth. The gradient of the rock slope should be 1□0.1~1□0.75, while the one for rubbles and earth should be 1□0.5~1□1.5. thus the stability of the slope can be maintained.

drainage system of the road surface

The drainage system should be set along the road to the factory. For the rock section of the road, square side trench with cross-section of 50cm×50cm should be arranged.

Besides, during the road construction, efforts should be made to balance excavation and backfilling. Drainage systems should be set along both sides of the road, and retaining wall will be built on the slope of high gradient. Meanwhile, vegetation measures should be adopted, which mainly refers to the greening along the influenced areas along the road.

(5) Construction site

Besides a relatively small area for living quarters and production offices, the construction side of Tangjiahe II-Hydroelectric Power Station also includes piling areas for sand and stones, storages, maintenance factory, part lot, reinforcement yard, wood processing factory, laboratories, etc., covering an area of 0.46hm^2. the temporary living and production facilities are arranges at the original site of Baiyizhai Mineral Water Factory, 100m up steam from the water-intake dam.

Project measures

The sand and earth piling sites of Tangjiahe II-Hydroelectric Power Station are located near the permanent buildings. The project is small in size but the working areas cover a long range. In accordance to the terrain of the site, two piling sites will be set. One is at the water-intake dam, mainly for the sand and stones of water intake conjunctions, water diversion channels and free-flow tunnels. The other will be situated near the plant, mainly for fore bays, penstocks and plant sites. The project measures of the piling site should include drainage ditches surrounding them. These ditches should be square in size, with a cross-section of 30cm×30cm, the thickness of the wet masonry is 30cm.

The total length of the drainage around the piling site is 200m, and the excavation volume amounts to 140m^3. The M5 masonry amounts to 62m^3. besides, the piling sites should reduce their storage so as to diminish the chance of water loss and soil erosion. The land occupation of the piling sites is 0.12hm^2, while the total land occupation of the construction site is 0.46hm^2.

② vegetation measures

After project construction, the waste should be cleared up and transported to the spoil areas and vegetation measures will ensue. The temporary land occupation, with an area of 0.46hm^2 will be cleared up, leveled and cultivated. The plants types are same with that on the spoil fields. The total plantation areas amounts to 0.46hm^2, on which 1150 Black Locust will be planted, and 10.35 kg of purple medic seeds will be sowed.

Total workloads for water and soil conservation can be seen in table 6-11

Table 6-11 Total workloads for water and soil conservation

Item		Excavation volume (m^3)	Earth backfilling (m^3)	M5 wet masonry (m^3)	Grass cultivating (hm^2)	Black locust	Purple medic seeds (kg)
Spoil areas	Retaining walls	672		5977			
	Drainage tunnel	1037	716	1321			
	Drainage gully	1064		650			
	Vegetation measures					6150	55.35
	total	2773	716	7948	2.46	6150	55.35
Borrow areas					0.47	1175	10.58
Construction site		140		62	0.46	1150	10.35
total		2913	716	8010	3.39	8475	76.28

7. Environmental Comparison and Selection on Project Plan

7.1 Brief Description on Comparison and Selection Plan

Tangjiahe Second Cascade Hydroelectric Power Station is on the midstream of Yuquanhe River, it should be closely linked in term of water level with upstream and downstream cascade hydroelectric power station, and rationally utilize main course and tributary water source (including spring).

On the upstream of Tangjiahe Second Cascade Hydroelectric Power Station, there is a built Baiyiping Second Cascade Hydroelectric Station (power generation by tributary) on the right bank, and a planned Tangjiahe Reservoir Regulating Hydroelectric Power Station (power generation by main course) on the left bank, and a planned Erchakou Reservoir downstream. Three restrictive conditions should be considered in the plan of dam site selection of the project: (1) the intake port of Tangjiahe Second Cascade Hydroelectric Power Station is linked with the tail water of Baiyiping Hydroelectric Power Station; (2) The intake dam of Tangjiahe Second Cascade Hydroelectric Power Station is positioned at the downstream reach of spring vent to lead in the spring water to channel, and it is considered to link the tail water of power generation from Tangjiahe First Cascade Hydroelectric Power Station with the spring water confluence level; (3)the tail water of Tangjiahe Second Cascade Hydroelectric Power Station is linked with the normal water level of Erchakou Reservoir, it is considered to slightly utilize the drawdown depth of Erchakou Reservoir, while do not overly add to the work load of the flood control project of the power house of Tangjiahe Second Cascade Hydroelectric Power Station, and the power house will advisably move from downstream of the end of Erchakou Reservoir. Since Erchakou Reservoir is not responsible for flood control, the reservoir maintains a normal water storage level for a relatively long time, and it is initially planned to utilize the drawdown depth of 2m of Erchakou Reservoir, the tail water level of Tangjiahe Second Cascade Hydroelectric Power Station will drop from the normal water level of 440.00m of Erchakou Reservoir to 438.00m.

Three Plans: Left Bank Upstream Power House Plan (assume I water diversion line), Right

Bank downstream Power House Plan (assume II water diversion line), Right Bank Plan (assume III water diversion line), all water diversion lines are mainly constituted by water diversion open channel and water diversion tunnel. This report will combine the selection of the sites of dam and power house, and water diversion open channel and power tunnel to carry out a comprehensive comparison on dam site and the three plans, and conduct comparison and selection analysis on the possible impacts that may be brought about on environment.

7.2 Comparison and Selection Analysis on Plans

7.2.1 Plans Comparison and Selection on Dam Site

According to feasibility study report, two comparison and selection plans were raised, i.e. 150m down the bridge of Baiyizhai Mineral Water Plant (assumed as I Dam Site) and about 500m down the bridge of Baiyizhai Mineral Water Plant (assumed as II Dam Site); in line with the feasibility study report and geological prospecting report, two dam sites will be compared and selected, for details see table7-1.

Table 7-1 Dam Site Comparison and Selection Table

Item	Dam Site Position	Pros	Cons
Dam Site I	150m down the bridge of Baiyizhai Mineral Water Plant, riverbed downstream of the right bank spring vent measures a width of 15m, sand and pebble covering layer measures a width of 15.1m, and riverbed elevation 560.00m	1. Relatively complete rock mass, and fine dam base stability; 2. Stable side slope of dam abutment; 3. low dam building cost; 4. Relatively small submersion loss.	1. Dam base leakage issue exists
	About 500m down the bridge of Baiyizhai Mineral Water Plant, 430m to upstream dam site,	1. Topographically and geologically,	1. High dam building cost. 2. Dam building in that

Dam Site II	situated at the pedestrian bridge, riverbed extends 7m in width, bedrocks of riverbed and both banks expose, which are lithologically sandstone, riverbed elevation is 533.50m.	downstream dam site is preferable. 2. low quantities, reliable leakage proof.	position will lift water level to the elevation of 560m, which shall jeopardize the power house stability of the left-sided upper cascade Tangjiahe Reservoir. 3. Undermine the normal communication of the right-sided Wuniu highway. 4. Submerge three upstream residences and their farmland.

It can be seen from table 8-1 that upon project completion, there are many negative elements on downstream dam site project plan whether it is from geological condition, submersion loss or project investment; consider in the prospective of social and economic development, since downstream dam site will lift up water level, and expand submersion area, its shall lead to a relatively large social and economic impact, and a fairly considerable destruction on ecological environment. Conclusion has it that consider from environmental aspect, upstream dam site is preferable to that of downstream.

7.2.2 Plans Comparison and Selection on Power House Site

1) Geological Comparison and Selection on Power House Site Plan

The tail water of Tangjiahe Second Cascade Hydroelectric Power Station must be linked up with the normal impounded level of downstream Erchakou Reservoir, therefore different power house position takes from the same tail water level of the power station. In this feasibility study report, base on the established decision of adopting upstream dam site plan, three powerhouse sites are open for selection corresponding to three water diversion lines, i.e. Left Bank Upstream Powerhouse Site Plan (assumed as Water Diversion Line I), Left Bank Downstream Powerhouse Site Plan (assumed as Water Diversion Line II), Right Bank Plan (assumed as Water Diversion Line III). Because of the similarities of the these water diversion tunnels in terms of topography, geomorphology, stratum lithology, geological appearance, geological structure, etc, they will be recount here together; the topography, geomorphology, stratum lithology, geological appearance, geological structure and other

aspects of different powerhouse site plan will be elaborated respectively, and environmental comparison and selection will be carried out. For details see table 7-2, table 7-3.

Table7-2 Project Geological Conditions of Diversion Lines

Item		Diversion Line I	Diversion Line II	Diversion Line III	Remark
Diversion Open Channel	Topography and Geomorphology	No.1 open channels in both left and right bank plans are located in dam site area, with a relatively level terrain, which comes under river valley colluvial deposits and alluvial-diluvial landform; in left bank plans, No.2 and No.3 open channel are situated in powerhouse area, with a relatively level landform, which falls in the category of lower and middle mountain area slope eluvium talus landform.			Diversion line is consisting of diversion open channel and diversion tunnel. Diversion tunnels in the three diversion lines are divided to left bank diversion tunnel and right bank diversion tunnel.
	Stratum Lithology	In left and right bank plans, No.1 open channel is located in quaternary colluvial deposits, alluvial-diluvial covering layer, lithologically comprises gravel, rubber soil, and interlayer pebble and erratic boulder, and the base covering rocks below are composed of limestone and coal bearing member of Qixia Formation and limestone of Huanglong Formation.In left bank plans, No.2 and No.3 open channels are located in quaternary eluvium talus covering layer, lithologically comprises gravel, rubbles and clay, and the base covering rock below is argillaceous siltstone of Luoreping Formation.			
	Geological Appearance	Geomorphologically, all open channels are situated on level areas of field region, only No.1 open channel on right bank goes through floating rocks ancient slide, and north end of No.1 open channel on left bank is piled with a few collapsed huge rocks; No.2 and No.3 on left banks see no collapse, landslide and other geological appearance.			

Diversion Tunnel	Topography and Geomorphology	Diversion tunnel is situated in tectonic denudation area of lower and middle mountain, landform tends to become lower from south to north, appears as cuesta and ridge hillock geomorphologically.	
	Stratum Lithology	Among left bank diversion tunnel, No.1 tunnel goes through Permian Qixia Formation coaly section of stratum, other diversion channels on the left and right go through stratum of Huanglong Formation, Devonian system Xiejingsi Formation, Huangjiadeng Formation, Yuntaiguan Formation of carboniferous system, Shamao Formation and Luoreping Formation of Silurian System.	
	Geological Appearance	Left and right diversion tunnels go through Duizhuangya anticline whose axial heading to approximately southeast, and is of Transpressional quality, no fault and other geological structure is seen.Part of sections along diversion tunnel sees karst, collapse and other geological appearance.	

Table7-3 Geological Condition Comparison Table for the Three Plans

Powerhouse Site	Left Bank Upstream Powerhouse Site	Left Bank Downstream Powerhouse Site	Right Bank Powerhouse Site
Topography and Geomorphology	The fore bay is situated on a slope tableland with fairly level landform, generally incline from south to north, with an angle of 10~20°, its pressure pipeline is on the slope, the landform is uneven, generally incline from southwest to northeast, the powerhouse resides on farmland and riverbed down	The fore bay is situated on a slope with uneven landform, generally inclines from west to east, the pressure pipeline is on the slope with uneven landform, generally inclines from west to east, the powerhouse is located at the inner side of a	The fore bay is located on a slope with uneven landform, generally inclines from east to west, the pressure pipeline is on the slope with uneven landform, generally inclines from east to west, uneven landform, generally inclines from east to west, half on base

	the slope, fairly level landform with grading angle < 10°.	highway down the slope, landform is uneven, and the foundation is built on excavated rock masses.	rock and half on riverbed.
Stratum Lithology	The fore bay is covered with quaternary eluvium talus covering layer, and the underlying bedrock is argillaceous siltstone of Luoreping Formation, the attitude of rock is 33°∠25°, its pressure pipeline is covered with quaternary eluvium talus covering layer, and underlying bedrock is argillaceous siltstone of Luoreping Formation, the attitude of rock is 33°∠25°, the powerhouse ground is covered with quaternary eluvium and alluvial-diluvial covering layer, measures 6.3m maximum in thickness, the underlying bedrock is argillaceous siltstone of Luoreping Formation.	The fore bay is covered with quaternary eluvium talus covering layer, and the underlying bedrock is argillaceous siltstone of Luoreping Formation, its pressure pipeline is covered with quaternary eluvium talus covering layer, and underlying bedrock is argillaceous siltstone of Luoreping Formation, the attitude of rock is 33°∠25°□, the powerhouse stratum is bedrock after mountain excavation, the bedrock is argillaceous siltstone of Luoreping Formation, the attitude of rock is 33°∠25°.	The fore bay stratum is the bedrock after mountain excavation, the bedrock is argillaceous siltstone of Luoreping Formation, bedrock at the pressure pipeline exposes, and is argillaceous siltstone of Luoreping Formation lithologically, rock attitude same as above, the powerhouse is half on bedrock argillaceous siltstone, half on pebble and erratic boulder interlayer.
Structure Condition	Stratum come under uniclinal structure, no trail of fault was found, slope top south of pressure pipeline see small scale collapse, no other negative geological appearance was seen.	Stratum come under uniclinal structure, no trail of fault was found.	Stratum come under uniclinal structure, no trail of fault was found.

Proceed from the project geological condition of all powerhouse sites, the three have respective pros and cons: landform of left bank upstream powerhouse site features gentle slope, which is apt to pressure pipeline extension and stability afterward, however the slope top on the south sees small scale collapse, and pressure pipeline is relatively long; left bank downstream powerhouse site has a relatively steep slope and thick covering layer on part of the area, which is unfavorable for pressure pipeline extension, and the powerhouse is on highway, the construction will need step-slope excavation on southern mountain to form free surface, whose stability directly affect the stability of the powerhouse; right bank powerhouse site is on a relatively steep landform, pressure pipeline is short, rock stratum is of reverse gradient, stability is favorable, and bedrock is exposed, but part of powerhouse is placed on riverbed, and on the convex bank of the river, during rainy season, flood will directly wash the foundation of powerhouse, which is unfavorable to powerhouse stability, so the prefer ability of the three powerhouse sites is: right bank powerhouse site > left bank upstream site > left bank downstream site.

2) Comparison on Powerhouse Site Construction Plan

For Construction Plan Comparison for Tangjiahe Second Cascade Hydroelectric Power Station see table 7-4.

Table 7-4 Comparison Table on Powerhouse Site Construction Plan

No.	Comparison Item	Unit	Left Bank Upstream Powerhouse Site	Left Bank Downstream Powerhouse Site	Right Bank Powerhouse Site
1	Normal Water Level of Water Intake	m	561.45	561.45	561.45
2	Normal Tail Water Level of Upstream Power Station	m	559.307	559.307	559.996
3	Fore Bay End Normal Water Level	m	556.740	556.278	556.274
4	Normal Water Level of Downstream Reservoir	m	440.00	440.00	440.00
5	Design Water Head	m	115.35	116.00	116.50

6	Design Flow Volume	m^3/s	5.21	5.21	5.21
7	Installed Capacity	kW	5000	5028	5050
8	Annual Electricity Production	10,000kWh	1827.09	1837.39	1845.31
9	Length of Culvert	m	73	73	100
10	Length of Open Channel	m	145	283	340
11	Length of Non Pressure Tunnel	m	3871	4364	4315
12	Length of Aqueduct Bridge	m			35
13	Length of Gound Fore Bay	m	52	52	
14	Length of Fore Bay inside the Culvert	m			50
15	Length of Pressure Steel Pipe	m	312	214	168
16	Length of Entrance Road	m			320
17	Total Investment	10,000 Yuan	2317.58	2366.71	2359.26
18	Electricity Generation Margin	10,000kWh	/	10.30	18.22
19	Income Margin	10,000 Yuan	/	2.60	4.60
20	Investment Margin	10,000 Yuan	/	49.13	41.68
21	Differential Internal Rate of Return	%	/	0.55<10	9.1<10
22	Conclusion		Preferable Plan	Least Preferable Plan	Less Preferable Plan

It can be seen from table 7-4 that total project investment in left bank upstream powerhouse is lower than left bank downstream powerhouse and right bank powerhouse, from the view point of the length of excavated culvert, open channel, non-pressure tunnel, excavation on left bank upstream powerhouse site is the shortest, therefore, taking all abovementioned elements into consideration, left bank upstream powerhouse site is preferable to left bank

upstream powerhouse site and right bank powerhouse site.

3) Comprehensive Comparison on Powerhouse Site Plan

After a comprehensive comparison on three powerhouse site plans, for their pros and cons see table7-4.

Table 7-4 Main Comparison on Three Plans

Plan		Composition	Building Position	Pros	Cons
Plan I (recommended plan)	Left Bank Upstream Powerhouse Site	Diversion open channel 145m, non-pressure tunnel 3871m, main pipe of pressure pipeline 312m, ground fore bay 52m.	The outer side of a highway 10m downstream the left end of Kuzhuping highway bridge, pressure pipeline goes through the highway to powerhouse	1. Geomorphologically gentle slope, apt to pressure pipeline extension and pipeline stability. 2. No serious riverbed sedimentation at the end of Erchakou Reservoir and the tail water outlet of Tangjiahe Second Cascade Hydroelectric Power Station will not be sifted up. 3. Spacious area on the bank on which the powerhouse resides, so the positioning demand of the powerhouse and booster station will be met. 4. Ground elevation is close to main	1. Part of the south slope top sees small scale collapse. 2. Relatively long pressure pipeline.

				powerhouse terrace elevation, infrastructure quantities for powerhouse are relatively small.	
	Diversion Open Channel	No.1 open channel (400m), left bank No.3 open channel (about 50m) and left bank diversion tunnel (3859m)	No.1 Open Channel in dam site area, No.2 and No.3 in powerhouse site area	1. Directly lead the tail water of reservoir and power station to tunnel.	1. Reduces diversion tunnel excavation of about 500m in water diversion line. 2. Save costs
	Diversion Tunnel		Left Bank		
Plan II	Left Bank Downstream Powerhouse Site	The Line is 98m shorter than in upstream powerhouse site, non-pressure diversion line is 631m longer than in upstream powerhouse site.	350m to upstream powerhouse site, situated at the inner side of the original line of Wuniu Highway.	/	1. Relatively steep slope, and part of covering layer is comparatively thick, unfavorable to pressure pipeline extension 2. Powerhouse is on highway, the construction will need step-slope excavation on southern mountain to form free surface, whose stability

					directly affect the stability of the powerhouse. 3. Undermine the normal communication of the right-sided Wuniu highway, and submerge three upstream residences and their farmland. 4. high dam building cost.
	Diversion Open Channel	No.1 Open Channel (400m), left bank No.2 open channel (about 200m) and left bank diversion tunnel (4,339m).	No.1 Open Channel in dam site area, No.2 and No.3 in powerhouse site area.	1. Directly lead the tail water of reservoir and power station to tunnel.	1. Add to diversion tunnel excavation of about 500m in water diversion line. 2. Increase costs
	Diversion Tunnel		Left Bank		
Plan III	Right Bank Powerhouse Site	Open channel 340m, non-pressure tunnel 4315m, fore bay inside culvert 50m in length, with 2 aqueduct bridges with total length of 35m, pressure	Right bank powerhouse site is selected on the opposite bank of a position between two left bank powerhouse	1. steep slope, short pressure pipeline. 2. Rock stratum is of reverse gradient, with good stability. 3. Bedrock exposed.	1. Part of powerhouse is on riverbed, and on the convex bank of the river. 2. During rainy season, flood will directly wash the foundation of

		pipeline 168m.	sites.		powerhouse, which is unfavorable to powerhouse stability.
	Diversion Open Channel	No.1 Open Channel (400m), right bank diversion tunnel (about 4348m).	No.1 Open Channel is in dam site area.	/	1. An aqueduct of 150m will be built between diversion tunnel and Tangjiahe Reservoir. 2. Right bank No.1 Open Channel goes through floating rocks ancient slide, although the slide is basically stable, building open channel on it may lead to a hidden danger of instability. 3. Add to diversion tunnel excavation of about 500m in water diversion line. 4. Increase costs
	Diversion Tunnel		Right bank		

It can be seen from the comparison analysis in table7-4 that, left bank upstream powerhouse site plan is preferable to left bank upstream powerhouse site plan and right bank powerhouse site plan.

7.3 Brief Summary on Plans Comparison and Selection

（1）As the rock at the dam site I is relatively integrated, with solid foundation and slopes at the dam abutments. Submergence loss are relatively small, thus the chance for dam collapse is rare. Water loss and soil erosion has been reduced and the ecological environment has been protected.

Meanwhile, as the water level raise at the dam site II, the submerged areas will be enlarged. This issue will concern the migrant residents in submerged areas and the investment will be increased. The environmental pressure at the relocation areas will be intensified, which will exert negative impact on the ecological environment indeed.

(2) All the three options for the site of the power house, namely the upper steam at left bank, the downstream at the right bank, the right bank, will change the present characteristic of the soil to some extend, and cause a certain damage to the mountain and the vegetations. The upper steam at left bank will make full use of the wide riparian field at the bank and minimize the occupation of the forest land and arable land. Meanwhile, the elevation of the power house is near to the elevation of the floor of the main plant. Thus the foundation construction is relatively small in scale and will not cause fundamental change to the characters of the land. Also the influence on the mountain and vegetations are small. The downstream at left bank will be located on the road. It will excavate the west side of the slope of the mountain so as to construct the plant, thus the stability could not be fully guaranteed. What's more, along with the enlargement of the submerged areas, some farmland and household are included in the area, which will all lead to vegetation devastation and aggravation of water loss and soil erosion.

In conclusion, the project site is decided to be 300m downstream from the Baiyiping Hydroelectric Power Station. Combined the tail water from Baiyiping and Tangjiahe I-Hydroelectric Power Station, the power house is located at the outside of the road 10m downstream from the bridge of Kuzhuping Road. Penstocks will cross the road and run

into the power house. This plan can reduce water loss and soil erosion; alleviate the damage to the surrounding vegetations, so as to protect the ecological environment. However, 50m downstream from the dam will be water-reduced section. Thus during the operation period, the water flow downstream must be ensured to be larger than 10% of the average annual level. To sum up, from the perspective of environmental protection, the locations of the dam site and power house are reasonable.

8. Environmental Rationality Analysis on Occupation and Construction Layout Plan

8.1 Environmental Rationality of Project Permanent Occupied Land and Main Buildings Layout

8.1.1 Environmental Rationality of Project Permanent Occupied Land

The main buildings of the project cover an area of 0.67hm^2. Project dam is a low sand dam (height: 5.1m), and submersion loss will be small. The project land occupation mainly covers river shore, a little cultivated land and tea garden, project construction area sees no cultural relic and mineral resources that worth exploiting, and practically no farmland. The project occupied tea garden and cultivated land will lead to water loss and soil erosion, and then cast certain negative influence on ecological environment; it can be clearly seen that the main project land occupation does not exert large social, economic and ecological influence on local residents; generally speaking, it is environmentally reasonable.

8.1.2 Environmental Rationality of Project Main Buildings Layout

The recommended general layout of the project is as following: dam site is at 300m downstream the Baiyiping Hydroelectric Power Station, its powerhouse is located on the outer side of a highway 10m downstream the left head of Kuzhuping Highway Bridge, the pipeline goes through the highway to powerhouse. Its tail water directly connects with the tail water of the downstream Erchakou Reservoir. The Project intake dam is a bottom trash rack dam located in the river course, no reservoir submersion treatment and migrate resettlement is required. Water diversion line layout is mainly on the left bank of the river shore; left bank layout comprises successively a pressure diversion tunnel and a powerhouse. According to field survey, left bank layout is dominated by river shore, bare hills, a few tea gardens and cultivated lands; without massive occupation of farmland, forestland and other ecological land, and barren ground surface is better utilized, no large influence is cast on the production and lives of local residents. However, the construction of water retaining dam and connection structure breaks the connectedness between upstream and downstream river

shore wetlands of dam site, and may lead to short range sectional dehydration downstream, which is possible to cause certain influence on river shore wetland organism.

Generally speaking, the main layout buildings of the project are environmentally reasonable.

8.2 Layout of Abandoned Dreg Site and Construction Road and Environmental Rationality of Land Occupation

According to field reconnaissance, vegetation condition is good on both banks of the project, except for a few barren hills, the project follows the principle of minimizing forestland and farmland occupation, in light of geomorphologic features, to maximize the usage of river shore and barren land and alleviate the influence of waste residue transportation to the side along the route. As a result, in the initial design of the project, 6 abandoned dreg sites are considered in plan, and make a full use of river shore and barren land. Abandoned dreg sites, construction roads and camps are all positioned on left bank.

The main sources of waste residue are the excavation of permanent buildings, water diversion canals and diversion tunnel, the total residue amount is $4.24\times104m^3$. After a comprehensive consideration of various elements, in construction, waste residues will be stacked on the river shore and in gulley nearby, covering a total area of $2.3hm^2$. In the EIA, it's been raised that dreg retaining dikes should be built outside the abandoned dreg sites, and a small amount of abandoned dreg to be used to fill up small gulley on both banks. Dreg abandoning plan is: After adopting this layout plan, abandoned dreg stacks cast little influence on upstream and downstream water level, while at the same time, the situation that water from high beach flows to water release gate opening following slope, the construction of dreg retaining dikes can also prevent dreg from being washed into water and then cause new pollution. Because abandoned dreg sites occupy part of the cultivated land, proprietors must pay land occupation compensation of the same value to farmers, and meanwhile, after the completion of construction activities, abandoned dreg sites must be bulldozed and cultivated. On the basis of that, abandoned dreg sites layout is environmentally rational.

8.3 Environmental Rationality of Construction Temporary Land Occupation

In line with the project layout feature, dam area construction site layout of the project adopted two construction areas layout plan of two banks with left bank prioritized. Left bank main construction site features a two points linear layout, two points refer to water intake works construction area, fore bay, pipeline, powerhouse and booster station construction area, and the line refers to diversion canal construction area, which cover an area of 3.403hm^2, those are all temporary occupied land (requisition land). The project works are distributed in a linear shape, buildings are relatively dispersed, and according to actual landform condition, decentralize construction enterprises, work sheds are established according to site condition near construction points, and sand-gravel aggregate system, concrete mixing system, air compressor plant and others are all positioned nearby, project related steel molding plate standard products, steel structure and others are all supplied and processed by specialized factories, only maintenance grounds are planed in fields. In construction temporary occupied lands, river shores, barren hills, tea gardens and cultivated lands respectively accounts for 59.9%, 32.0%, 2.3%, 5.8%, among which river shores make up a large proportion (59.9%), in construction period, certain damage on local ecological environment is expected. But since the lands are only temporarily occupied, after construction completion, former ground surface mellow soil can be covered on the temporarily occupied lands, and carried out re-cultivation, grass and trees can be planted to recover local ecological environment; or crop planting, part of non-irrigated lands can be recovered as cultivated lands. Therefore, in an overall and long term view, construction temporary land occupation is environmentally rational.

8.4 Environmental Rationality of Stock Ground Arrangement and Land Occupation

According to project characteristics and geological conditions, stock grounds arrangement includes earth stock ground and natural sand stock ground. The project stock ground is planned to choose Yuquanhe River Quarry – one of the planned stock ground of Tangjiehe Hydroelectric Works, the stock ground covers an area of 0.62hm^2. The stock ground has

abundant reserve, and it is both convenient for exploiting and transportation. The occupied area is the river shore, so no environmentally sensitive target in surrounding area.

Generally, the arrangement of stock ground considered both the convenience for communications and transportation, and the avoidance of large impact on surrounding environment, thus it is environmentally rational. However, subsequent to stock ground excavation, the remained waste residues and deep pit will lead to certain hidden security danger, and damage on local ecological environment to some extent. Therefore, the suggestion is: once stock ground excavation has been stopped, refilling and corresponding treatment should be done immediately, to recover it to its original status to the best of ability.

8.5 Environmental Rationality of Construction Road Layout and Land Occupation

Tangjiahe □ Hydroelectric Power Station Project is situated in Caihua Township of Wufeng Tujia Autonomous County, and Wuniu Highway goes through the project area, the dam is located 300m downstream the Baiyiping Hydroelectric Power Station, and 30km from Wufeng County. The powerhouse is in Kuzhuping which by the downstream reach of Yuquanhe River, 35km from Wufeng County, communications condition is convenient.

The intake dam located by the side of Wuniu Highway, and since the intake dam site is quite close to Wuniu Highway, no construction road is required; pressure fore bay has a 100m elevation difference with the Wuniu Highway, so the concrete, aggregate, block stones and steel bars for pressure fore bay and pressure pipeline will be transported with a slide line extended along pipeline, therefore, new water and soil loss shall be prevented. As a result, Tangjiahe□ Hydroelectric Power Station does not need large scale construction roads.

Because the project mostly uses current roads, over occupation of lands is avoided, the greening on both sides of roads with grass to reduce water loss and soil erosion, therefore, the roads layout and land occupation of the project are environmentally rational.

After integrating Environmental Rationality of Project Permanent Occupied Land and Main Buildings Layout, Construction Temporary Land Occupation and Construction Site Arrangement, the land occupation and construction layout plan is environmentally rational

from a general point of view. However, the project construction produces large amount of abandoned dreg mostly from excavation, therefore, proprietors are suggested to invite departments in charge to examine dreg composition and recycle dreg that meets quality standard, in this way, while the amount of abandoned dreg is reduced, the occupation area of the abandoned dreg sites is also contracted, and then the amount of water loss and soil erosion will be decreased, and land resource is also protected.

9. Environmental Risk Analysis

Hydroelectricity is clean energy, and the water conservancy and hydroelectricity project itself will not give rise to pollution accidents, but the hidden danger of other accidents still exist. Once happened, they may lead to ecological or environment harm to various extents. This report integrates the environmental condition of Yuquanhe River Basin where Tangjiahe II Hydroelectric Power Station resides, on the basis of analyzing and checking the environmental risk of similar projects, the risks in the project and the composite environment system will be identified, estimated and analyzed, and measures and countermeasures will be raised to avoid risks according to certain standards.

9.1 Risk Identification

The environmental risks of the Tangjiahe II Hydroelectric Power Station are to be analyzed on the probability and possibility of disaster outbreaks in future caused by project construction and operation. The environmental risks of the project construction are only a potential, its harm produced only when risks break out in the form of unexpected and disastrous accidents.

Having no reservoir of its own, the power station is regulated by the upstream Tangjiahe Reservoir, the top of which is only 5.1m, and it is of spillway style, therefore, there is no risk of dam overtopping or collapse. Besides, according to the project's geological reconnaissance, conclusion has it that there is only slight possibility of earthquake occurrence, additionally, the fact that the project does include a reservoir prevents the risk of a dam collapse, therefore, in this risk assessment, above mentioned risk factors will not be assessed or analyzed.

According to the development undertaking, scale, project layout of Tangjiahe Ⅱ Hydroelectric Power Station and the design, utilization means of the main buildings, geological environment, climate conditions, landscape, vegetation, water regime, sediment condition, water environment quality, aquatic organisms of the project region and other environmental conditions, integrating the environmental prediction and assessment of the project construction, it can be concluded through initial risk identification that the project

environmental risks are primarily flood risks and the risk of unexpected accidents in the construction of the diversion tunnel.

9.2. Environmental Risk Analysis on Flood

9.2.1 Risk Identification

If a catastrophic flood strikes the Tangjiahe ⅡCascade Hydroelectric Power Station of Yuquanhe River Basin, powerhouse construction and operation shall all be in the jeopardy and this may lead to project investment wastage, salient local electricity shortage and even the possibility of unforeseeable casualties. Losses beyond measure would be brought to the area.

9.2.2 Risk Analysis

1) Rainstorm Characteristics and Causes of Flood

The origin of floods in the Yuquanhe River Basin is rainstorms. The time of floods corresponds to that of rainstorms. Rainfall within a year mainly focuses from April to October; annual maximum peak flow appears mostly from June to August, with high frequency. High mountains and steep slopes rest in the river basin. The valleys are deep and the rivers narrow. Turbulent flood waters swell and relieve quickly, bearing the characteristics of mountain floods. The top annual precipitation ever recorded from on-the-spot survey in the river basin reached 2579mm (1935), and top 24h rainstorm actually measured is 423mm; annual minimum precipitation is to 965mm (1936). Rainstorm variation over the years is not much, annual maximum 24h and 72h rainstorm variation coefficient go within 0.37~0.38. According to the Hubei Precipitation Contour Map, annual average rainfall over many years in this area is about 1500mm. For yearly precipitation distribution see table 9-1.

Table 9-1 Tangjiahe II Hydroelectric Power Station Precipitation Table

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Precipitation Amount	27.6	38.5	72.2	138.6	196.1	225.6	266.9	178.4	131.2	110.6	60.5	26.5	1474.4
Distribution Ratio	0.019	0.026	0.049	0.094	0.133	0.153	0.181	0.121	0.089	0.075	0.041	0.018	1

The rainstorms within the river basin are dominated by cyclone rain and frontal rain. Sometimes typhoon rain directly or indirectly influences the river basin. The earliest rainstorm appears in April and most storms end in October, making up 85% of the annual precipitation amount. Most rainstorms are concentrated in July and August, and more appear in the upstream river basin; In July west wind circumfluence reduces, south western monsoon wind strengthens, temperature is high and vapor is abundant, precipitation intensity prevalently increases; from late July to early August, subtropical high moves north, equatorial convergence zone distinctly moves north, at which time the typhoon, easterly wave and other tropical systems can all directly or indirectly influence the river basin, causing rainstorms or heavy rainstorms; in mid and late August, subtropical high continues to strengthen and move further north, the river basin is controlled by subtropical high, so precipitation is less, but exceptions also exist. For example, the typhoon in August 1975 formed torrential rain in part of Huaihe River Basin of Henan Province and later passed the Qingjiang River Basin. The rainstorm's center, town of Duzhengwan, suffered a 12h precipitation of 545.6mm and a maximum 24h rainstorm 630.4mm. A relatively large flood was generated.

Flood origins in the basin are formed mainly by rainstorms of cyclone rain and frontal rain systems. It can also be formed by rainstorms of typhoon rain systems, so the flood magnitude is larger than the neighboring river basins. Because both banks of the river basin have steep slopes and features short confluence time, floods tend to rise and fall quickly, floods process are mostly single peak, come under high peak angular type, i.e. even if the flood process is multi-peaked, the minor peaks are small in terms of peak and volume, and lasts a very short time. A whole flood process lasts normally 1 to 3 days. This is typical of a mountain river.

2) Flood Risk Analysis

There is no flood control requirement downstream from the project, so risk assessment primarily considers the flood control security of the project itself. Tangjiahe Ⅱ Hydroelectric Power Station is a runoff hydroelectric power station. The project's installed capacity is 2×2500kW. According to ***The PRC Standard for Flood Control (GB50201-94)***

Provision 6.1.1, it is been established that the planned project scale, grade and main buildings grade are: project is of grade V, main buildings (including intake works, diversion structure, powerhouse and booster station, etc) are of class 5.

According to the project grade, the corresponding flood control standard is: water retaining structure is masonry dam, with a height of less than 15m, thus designed for "Ten Year Return Period" flood and peak flow of 347m^3/s, and checked for "Twenty Year Return Period" flood and peak flow of 415m^3/s; powerhouse and booster station design for "Thirty Year Return Period" flood and peak flow 558m^3/s, checked for "Fifty Year Return Period" flood and peak flow of 808m^3/s.

The intake dam of the Tangjiahe Ⅱ Hydroelectric Power Station bears only the function of the blocking and channeling water and does not shoulder any flood control responsibility. No limit is set on the discharging amount during flood period, and therefore no flood regulation calculation is to be carried out. Design flood level and check flood level will be decided upon the working conditions of the spillway dam. The powerhouse is located at the forks of the Erchakou Reservoir. Its flood control characteristic is affected by the design flood level and check flood level of the Erchakou Reservoir. According to The Siyanghe River Hydropower Development Revised Plan, flood level is 441.50m when p=3.3% and flood level is 442.00m when P=2%. For project flood control characteristics and water levels see table 9-2.

Table 9-2 Table of Characteristic Water Level Unit:m^3/s

Project Name	Design Peak Flow (m^3/s)	Design Flood Level (m)	Check Peak Flow (m^3/s)	Check Flood Level (m)
Intake Dam	347	564.47	415	564.78
Powerhouse	558	441.50	808	442.00

The terrace outside the powerhouse has an elevation of 438.35m, which is under the check flood level. Rain water collects through the drainage ditch around the powerhouse, is discharged into the collecting well inside the powerhouse and is finally discharged onto the riverbed. Those with an elevation above 442.50m will use the drainage ditch behind the retaining wall for discharge, water will be discharged into the river through the slope at the bottom of the ditch, whose gradient is 2%. Booster station neighbors the Wuniu Highway,

water standing above the road surface can be discharged downstream with side drains. Beneath the road surface, water will run through the ground to the river course through the slope of the ground whose gradient is 1%.

It is considered that after the implementation of the upstream Tangjiahe lHydroelectric Power Station and Reservoir Project, downstream floods will be reduced and therefore enhances the flood control standard of the second cascade project; in terms of the consequence of building destruction, no critical loss is expected. In terms of feasibility, the Tangjiahe Second Cascade Hydroelectric Power Station is a small scale project, of which the construction period is relatively short and its structures are mostly constructed in a low flow period, and therefore requires no calculation on design flood in high flow period with only the design flood volume in the construction period from November to next March needing to be calculated. Flood does not exert much influence during the construction period.

3) Risk Relief Measures

Effective prevention and emergency measures should be adopted during the reconnaissance, design, construction and operation period to nip any dangers in the bud. As a result, the security of the project dam and reservoir can be ensured, benefit is promoted, harm is eliminated, disaster risks are avoided and advantages will be given full play. The Following suggestions will be raised in the assessment:

□High frequency rainstorms and flood rage at the Yuquanhe River Basin, where mountains are high and slopes steep, little time is required for convergence and the floods are typical mountain river floods, which tend to rise and fall rapidly. Flood control standard in the project design is not high; no flood detention capacity is borne. For the safety of the junction and a full play of the power station's efficacy, timely upstream rainfall regime information is needed to provide a reliable foundation for the implementation of optimum project flood control regulation plan.

□ Flood forecast works have to be improved and exceptional alert must be given to floods that exceed the design security standard, so that more time will be gained to overcome that kind of flood. For the torrential rainstorms that exceed standard, preparation of extreme flood discharge measures should be taken beforehand and the downstream reaches are ought

to be informed of the preparation of emergency flood fighting.

□Operational superintendents should manage strictly in line with scientific regulation plans and pay close attention to the regional weather forecast and hydrological forecast of the river basin so as to carry out rational analyses. Ordinary security maintenance should be strengthened for the main structures, thereby problems and hidden dangers can be dealt with in time. Formulated management system, operational rules and regulations must be enforced stringently. Supervision and management should also be improved. Meanwhile, various emergency pre-proposals should be formulated to avoid or reduce environmental loss.

□Automatic hydrological forecast system established during operational period will provide accurate and in-time flood forecasts, effectively enhance the precision, forecast in time so as to provide the foundation for flood regulation plans and ensure that the hydroelectric project get safely through the flood period with enhanced economic returns. It is a greatly important non-project measure.

□Improve the comprehensive monitoring on landslides, rock falls, mud slides, karst collapses and other natural disasters in part of reaches during the construction period, particularly during rainstorm and flood, so as to minimize the environmental risk.

□Emergency Plans

The Tangjiahe ⅡHydroelectric Power Station is subject to the runoff regulation of upstream Tangjiahe Reservoir and is also affected by the risk of dam breach of the reservoir. The dam breach risk of the Tangjiahe Reservoir is small, but in the case of an upstream reservoir dam breach, corresponding emergency plans must come to existence. The situation of dam breach will be experienced by downstream area as an extraordinary flood, but the scenario of dam breach is not exactly the same with that of an extaordinatry flood as it produces a large discharge during a short duration. Therefore, emergency plans aimed at the above situation should be included in the existing flood control plans of the project. The plans should be better designated to the characteristics of dam breach.

For ordinary measures such as emergency organization and duty, emergency facilities, equipments and materials, emergency safety, protection and paramedic rescue, evacuation,

drill, a flood control manual is available for reference. Security pre-alarm system and defense measures should be established, mainly for the instant-on pre-alarm system and measure when the possible or once dam breach incident of the Tangjiahe Reservoir happens. It will be drawn up by the project security panel together with administrative department in charge. The main contents should include the following:

 establish an early warning system for dam breach incidents of the upstream Tangjiahe Reservoir due to catastrophic floods or other factors.

 define communication means and the alarm signal with the downstream population center once an dam breach incident happens to the reservoir.

 define the method, venue and approach of resident evacuation in the case of a dam breach incident.

 define temporary flood defense measures and flood division plans.

9.3 Outburst Incident Risk in Diversion Tunnel Construction

9.3.1 Hazard Identification

Project diversion line distributes on the left bank of the river valley and consists of the Left Bank No. Open Channel (145m) and the Left Bank Diversion Tunnel (3871m). In terms of the mentality of the plan and design, diversion tunnels are used for converging river water from open channels and tail water from the upper cascade Tangjiahe Reservoir. Project designed diversion line can lead directly the tail water of the reservoir and power station to the tunnels. In the process of tunnel construction, risks of collapse and karst water inflow exist, which may cause a relatively large risk on construction.

9.3.2 Risk Analysis

The project diversion tunnel has a length of 3871m and is situated in the tectonic denudation area of the lower and middle mountain. The landform tends to become lower from south to north and appears as cuesta and ridge hillocks in topography. Within the left bank

diversion tunnel, No.1 tunnel goes through the Permian Qixia Formation coaly section of the stratum, others successively go through the stratum of Huanglong Formation, Devonian system Xiejingsi Formation, Huangjiadeng Formation, Yuntaiguan Formation, Shamao Formation and Luoreping Formation of Silurian System. Project diversion tunnels go through the Duizhuangya anticline, whose axis heads roughly to the southeast, and are of transpressional quality. No faults or other geological structures are seen. Part of the sections along the diversion tunnel sees karst, collapse and other geological appearances.

According to ***The Code for Water Resources and Hydropower Engineering Geological Investigation***, the geological classification of rocks surrounding the project uses the five factors of rock strength, rock integrity degree, structural plane status, groundwater status and attitude of structural plane as essential facts. The rocks are classified as Class □~□. According to the practical experience of similar projects, lining is basically not required for Class II ~ III surrounding rock tunnel, but leakage prevention, roughness decrease and discharge capacity are considered to reduce section excavation in tunnel.

Possible geological problems in the project diversion tunnel are:

(1) The Stability of Tunnel Entrance and Exit

Rocks at the entrance and exit of the tunnel are medium weathered with their cracks and joints relatively developed. Quaternary colluvial deposits and the surrounding rocks that cover part of the tunnel mouth are fairly thin, which make for unfavorable conditions for the tunnel's formation with tunnel top collapses likely to occur. To ensure stability of the tunnel mouth, it is recommended to go in early and go out late and avoid having an overly high head and side slopes at the tunnel mouth. Moreover, support should be strengthened and the lining in time.

(2) Water Permeability

Stratum at the north end of the tunnel comes under the carbonate rock of Huanglong formation stratum of the Carboniferous System, karst fissure is well developed, with a small amount of karst fissure water. The possible karst water permeability may affect construction. Therefore, water drainage should be done before construction.

The rock cracks at both the entrance and exit of the diversion tunnel, joint development and

colluvial deposits make for poor tunneling conditions and rock permeability affects the processes of construction.

But generally speaking apart from these unstable factors, the rocks surrounding the tunnel are new mid-soft and mid-hard rocks, the tunnel's axis is diagonal to the stratum alignment and the main body of the tunnel is deeply buried with the exception of its entrance and exit all make this diversion tunnel stable.

9.3.3 Suggestions for Reinforcement and Prevention Measures

The left bank layout of the diversion tunnel will inevitably go through the karst water system, so prevention for collapse or karst water inflow must be prepared to avoid jeopardizing construction. In the process of tunnel construction, collapse and karst water inflow need to be prevented when crossing the karst section, if water inflow is incurred, construction must be stopped in time, workers evacuated and inflow volume observed, reinforced concrete lining treatment carried out towards the water inflow before construction continuance and safety of workers ensured in construction. Construction should be stopped when an underground river is encountered and construction scheme should be made in accordance with the type and dimension of the underground river. However, it has to be guaranteed that the construction of the diversion tunnel must not block the flow of an underground river and cause water interception to downstream river section.

Ordinary measures such as emergency organization and duty, emergency facilities, equipments and materials, emergency safety, protection and paramedic rescues, evacuations and drills also need to be done. Detailed investigation needs to be done in the next initial design period and to take appropriate prevention measures as well as to draw up emergency preplan.

9.4 Other Environmental Risks

9.4.1 Blasting Risk in Construction

Construction means that may provoke collapse such as large charge blasting should be avoid in project construction. Furthermore, the personal safety of bystanders and construction workers should be paid special attention to so as to avoid accidental injury.

9.4.2 Population Health Risk

During the construction, unfavorable environmental and sanitary conditions of the site, frequent in and out of people from other places, relatively concentrated construction workers and high population density may lead to the incurrence and epidemic of certain diseases. Therefore, sanitary conditions should be improved, drinking water pollution avoided, strict sterilization of drinking water carried out and sanitation in living quarters improved, disease prevention administered and domestic wastewater, garbage and excrement treated, in a view to reduce or eliminate places where disease producing mosquitoes multiply. Thus epidemic can be avoided.

10. Public Participation

10.1 Objectives and Foundation of Survey

Public participation is a kind of mutual communication between project construction plan and general public, its objective is to earn full public approval and support on the project, so as to enhance its environmental, social and economic benefits. Hence, it is of great necessity the decision making and smooth implementation of construction plan. Public participation is a vital part of the environmental impact assessment on planned project. It can directly reflect the impacts of the Tangjiahe Ⅱ Hydroelectric Power Station project construction on surrounding environment. Because public participation in the EIA can enhance efficiency of the decision making and the construction project, as well as public recognition on decision making an construction activities, it bears the functions of extensively receiving information and pooling the mass wisdom. The objective of public participation is to enabling the public to fully understand project directly participate in the comprehensive decision making of the environment and development raise advantageous opinions on the feasibility of environmental protection measures, alleviate environmental pollution and ease the loss of environment resources. Through local public participation, early discovery of environmental problems from the planned project is possible, so the depth and extent of the problems can be found out, local environment-vital points will be known and then solutions shall be acquired early. The problems discovered after decision making will be avoid and the situation of dilemma and resources wasted in vain will be prevented.

Public participation is a vital part of EIA. Its objective is to enable the pubic to fully understand the significance of the construction of Tangjiahe Ⅱ Hydroelectric Power Station Project, gain their support and cooperation in project construction and further remove or alleviate the unfavorable environmental impacts brought by construction, so that the project design and plan will be more reasonable and complete and the comprehensive benefits of the project will be brought into a full play. According to No.324 Document/1993 issued by EPA and other 3 units, in this assessment work, in September 2005, under the energetic support of concerned local departments, public participation had been carried out.

10.2 Participatory Target and Means

10.2.1 Participatory Target

1) Administrative Departments

Mainly Wufeng County Government, Caihua Township Government, **County Water Resources and Aquatic Products Bureau, Forestry Bureau**, **Environmental Protection Bureau, Bureau of Land Administration**, sanitation and antiepidemic station, etc.

2) General Residents

Residents living in areas neighboring the project construction area

10.2.2 Means of Participation

The means of public participation survey is to deliver questionnaires (***Tangjiahe Second Cascade Hydroelectric Power Station Project Public Participation Questionnaire***) in the project construction affected areas. This random sampling survey is carried out through individual, household and group interviews. The questionnaires are filled by the surveys themselves or their dictation is recorded and filled in by surveyors.

The contents of the questionnaire are as following:

Attachment:

Tangjiahe Second Cascade Hydroelectric Power Station Project Public Opinion Questionnaire

1. Project Profile

Tangjiahe Second Cascade Hydroelectric Power Station Project is located in Kuzhuping Village of Caihua Township in Wufeng Tujia Autonomous County, the outlet position of Yuquanhe River. It is a hydroelectric power station of the final cascade of Yuquanhe River Basin, a secondary hydroelectric power station regulated by the Tangjiahe Reservoir. The project mainly includes: water intake works, water diversion works, and power house and booster station. The principle responsibility of the project is electricity production. It is

planned to install two generators in this project, with a total installed capacity of 2×2500kw and designed multi-year average electricity production volume 18.2709kWh (including additional electricity production of 5.2325kWh by reservoir regulation).

Tangjiahe Ⅱ Hydroelectric Power Station is a Grade Ⅴ project. The corresponding hydraulic structures are on Level Ⅴ. According to the project grade, the corresponding flood standard is: intake dam designs for “Ten Year Return Period" flood, being checked according to the “Twenty Year Return Period" flood standard; Powerhouse designs for “Thirty Year Return Period" flood, being checked according to the “Fifty Year Return Period" flood standard.

The project construction temporarily occupies an area of 3.403hm^2 and permanently occupies an area of 0.67hm^2.

The construction period of the Tangjiahe ⅡHydroelectric Power Station is 2 years, and in the peak time, construction workers will number 200.

Main works will have open excavation earth and stone of 2.96×10^{4}m^3, tunnel excavation earth and stone of 2.96×10^{4}m^3 and concrete 4.64×10^{3}m^3.

During project construction, over 20 sets of various machinery and equipments will be used and the daily production water consumption is 25m^3/d.

The project construction, particularly during the construction process, may bring certain influence on environment. For a full consideration of public opinion in EIA, we sent you this questionnaire, please select the answers in line with your opinion, thank you for your cooperation.

2. Surveyee Simple Profile

Name_____Gender_____Age_____

Ethnic Group_____Occupation_____Household per capita income_____Yuan

Address_____

3. Survey Content (Please tick your choices)

1) Education Level

□Associate degree and above_____□Senior high school_____□Junior high school □Elementary School_____□Uneducated_____

2) Do you support an immediate start to the project?

□Support_____□Neutral_____□Oppose_____

3) If the power station was constructed, your current dwelling is at:

□Construction area____□By construction road____□Other areas____

4) What do you think is the largest influence on you from power station construction?

□Noise_____□Dust ____□Communication inconvenience_____□Landscape destruction □Transmitted diseases____

5) Will the project construction improve your life?

□Yes____□Don't know____□No____

6) Do you understand the term "environment"?

□Yes____□A little____□No____

7) Do you think project construction will improve surrounding environment?

□Improve____□Not much____□Worsen____

8) What is the role of the project upon completion for improving local environment?

□Positive____□Not much____□No effect____

9) What is the role of the project upon completion for propelling local economy?

□Positive____□Normal____□No effect_____

10) Between the economic benefit and environmental expense from the project, which do you think is the priority?

□Environment____□Environment and benefit____□Benefit____

4. Do you have any reasonable suggestion on the project construction?

_____

_____

_____

10.3 Survey Result

10.3.1 Surveyees Composition

Local public of different ages, ethnic groups, occupations and education levels positively participated in our survey. We designed 100 samples and actually received 95 valid samples, reaching a sample retrieving rate of 95%. For basic profiles of public participators see table 10-1.

Table 10-1 Tangjiahe Second Cascade Hydroelectric Power Station Project Public Participation Basic Profiles Statistics Table

Item	Type	Number	Percentage (%)
Gender	Male	67	70.5
	Female	28	29.5
Age	Below 20	8	8.4
	20~35	40	42.1
	36~50	38	40
	Above 50	9	9.5
Occupation	Farmer	61	64.2
	Worker	11	11.6

	Cadre	4	4.2
	Teacher	4	4.2
	Doctor	1	1.1
	Others(student, merchant unemployed, etc)	14	14.7
Ethnic Group	Han	46	48.4
	Tujia	49	51.6

10.3.2 Public Participation Survey Result

After the public understood the general profile of the Tangjiahe Second Cascade Hydroelectric Power Station Project, they enthusiastically participated in the survey as masters of society and expressed their opinions, ideas and views on the project construction in a truth seeking spirit. The survey reflected the public passion in participating social activities and the results fully reflected the aspirations of the general public.

The results of the public survey are as follows:

Table 10-2 Tangjiahe II Hydroelectric Power Station Project Public Participation Survey Result

No.	Survey Content	Option	Number (person)	Percentage (%)
1	Education Level	□ Associate Degree and Above	6	6.3
		□ Senior High School	14	14.7
		□ Junior High School	52	54.7
		□ Elementary School	23	24.3
		□ Uneducated	0	0
2	Do you support an immediate start of the project?	□ Support	85	89.5
		□ Neutral	10	10.5
		□ Oppose	0	0
3	If the power station was constructed,	□ Construction Area	35	36.8

	your current dwelling is under:	□ By the Construction Roads	53	55.8
		□ Other Area	7	7.4
4	What do you think is the largest influence on you from power station construction?	□ Noise	75	78.9
		□ Dust	11	11.5
		□ Communication Inconvenience	6	6.4
		□ Landscape Destruction	3	3.2
		□ Transmitted Diseases	0	0
5	Will the project construction improve your life?	□ Yes	67	70.5
		□ Don't Know	9	9.5
		□ No	19	20
6	Do you understand the term "environment"?	□ Yes	24	25.3
		□ A little	49	51.6
		□ No	22	23.1
7	Do you think project construction will improve surrounding environment?	□ Improve	64	67.4
		□ Unchanged	31	32.6
		□ Worsen	0	0
8	What is the role of the project upon completion for improving local environment?	□ Positive	68	71.6
		□ Not Much	27	28.4
		□ No Effect	0	0
9	What is the role of the project upon completion for propelling local economy?	□ Positive	60	63.2
		□ Average	35	36.8
		□ No Effect	0	0
10	Between the economic benefit and environmental expense from the project, which do you think is the priority?	□ Environment	14	14.7
		□ Environment and Benefit	42	44.2
		□ Benefit	39	41.1

	Do you have any reasonable suggestion on the project construction?	Common request on accelerating project progress and early construction is expected.

10.3.3 Greatest Public Concerns

Analyzing from the information feedback from public participation of various forms, we can see that the most public concern is over the following aspects:

1) Concerns about Reservoir Area Land Compensation Issue. It is hoped that government and construction units will formulate compensation plans and the related implementation plans in line with state policies. About land requisition compensation, reasonable land requisition prices should be decided according to state policies and standards and local practical situation should also be taken into consideration. Staff should be sent to the reservoir area to understand the idea and demand of villagers. This issue must be addressed earnestly and leftover issues must be prevented.

2) Concerns about the quality of project construction. Quality is of vital and lasting importance. The public repeatedly mentioned that "it is not allowed to build this project into a jelly-built project".

3) Concerns about development and utilization after project completion. In other words, issues about the long term planning of taking advantage of the project to develop the local economy. There is a public opinion that the government should formulate construction plans of infrastructure (e.g. highway and communication) and support welfare facilities that marching the project and plans that accelerate local economic development, improve people's living standards and raise construction fund.

4) Concerns about the timeliness of flood discharge and flood discharge capacity after project completion. Concerns about water loss and soil erosion. It is hoped that the government takes these issues into consideration, earnestly inspects technical measures and countermeasures that address such issues in design and environmental assessment.

10.3.4 Public Participation Survey Result

1) 6 of the surveyed have associate degree or above, making up 6.3% of the total; 14 had senior high school education, accounting for 14.7% of the total; 52 went to junior high school, taking up 54.7% of the total; and 23 received elementary school education, constituting 24.3% of the total.

2) 100% of public expressed their support on the immediate start of the project, none was against it.

3) If the power station was being constructed, 35 people's residences are in the construction area, taking up 36.8% of the total surveyed; 53 live by the construction roads, making up 55.8% of the total; and 7 people's dwellings are in other area, constituting 7.4% of the total.

4) 75 people think noise would be the influence on them from power station construction, accounting for 78.9% of the total surveyed; 11 people chose dust, taking up 11.5% of the total; communications inconvenience is chosen by 6, that is 6.4% of the total; and landscape destruction is the concern of 3, constituting 3.2% of the total.

5) 67 people believe the project construction shall improve their lives, for 70.5% of total surveyed; 9 chose "don't know", making up 9.5% of the total; and 19 don't think it will improve their lives, accounting for 20% of the total.

6) 24 people understand the term "environment", taking up 25.3% of total surveyed; 49 know a little, that is 51.6%; and 22 don't understand, making up 23.1% of total.

7) 64 people believe the project construction will improve surrounding environment, which is 67.4% of the total surveyed; and 31 don't believe there will be much change, accounting for 32.6% of the total.

8) 68 people believe the project construction will play a positive role in improving local environment, which is 71.6% of the total surveyed; and 27 don't believe there will be much change, accounting for 28.4% of the total.

9) 60 people believe the project construction will mobilize local economy, which is 63.2% of the total surveyed; and 35 don't believe there will be much change, accounting for 36.8%

of total.

10) Viewing from economic benefits and environmental costs brought about by the project, 14 prioritize environment, taking up 14.7% of the total surveyed; 42 value both environment and benefits, accounting for 44.2% of the total; 39 lay stress on benefits, making up 41.1% of the total.

Reasonable suggestions on project construction: Public generally ask for acceleration of project progress and are looking forward to early construction.

10.4 Conclusion on Public Participation

The reasons that public and offer their support is primarily:

10.4.1 Tangjiahe Second Cascade Hydroelectric Power Station is mainly responsible for power generation, which will meet the electricity demand of Wufeng County. Electricity supply quality and guarantee probability will be enhanced for the city of Yichang.

10.4.2 Current communications situation will be improved after project completion, thus providing better transportation conditions for the production and livelihood of the people in mountain areas. In the future, the transportation of production materials and agricultural products will be more convenient.

10.4.3 Project construction is favorable of changing the backwardness of infrastructure in the mountain areas. After project completion, hydroelectric energy shall improve the living conditions that lag behind the times in the mountain areas, enabling improvement of electricity and water supply for people in the mountain areas.

Results of the Public Participation Survey show that the chief concerns of the general public towards the construction of Tangjiahe Ⅱ Hydroelectric Power Station are: water loss and soil erosion, vegetation protection, pollution prevention is the river basin how to minimize the impacts of project construction on environment and ensuring the sustainable development of the area. Through the proprietors' publicizing and communication with

the local people, public concerns are settled. Proprietors stated that public opinions would be given top priority. The issues that the public concern about shall be settled from design to construction. While the project construction progress is maintained, ecological environment construction and water and soil conservation will also be emphasized. Project quality must be ensured and various environmental protection measures raised in the report shall be implemented, thus truly minimizing the project impacts on environment.

11. Measurements and Recommendations of Environmental Protection

11.1 Measurements on Surface Water Environmental Protection

The main structures of the project include the intake dam, hydropower tunnel, and powerhouse and booster stations. In the construction process of the project, many water pollutants affecting the water quality of the segment will be created by large-scale, high-intensity excavation of cubic meter of earth and stone, waste stacking, multi-type of machinery and equipment operations, transportation of numerous outside materials and the large-number residence of construction personnel. In addition, power plant operations will also bring about a series of hydrological changes, making it of high necessity for construction units to take effective measures on environmental protection in an attempt to minimize the adverse effects.

11.1.1 Water Environmental Protection Measures During Construction Period

According to the analysis of the project, the total wastewater discharge during the construction period will be 24,600 m^3, mainly including wastewater in concrete pouring and keeping, ballast processing system, construction machinery vehicles washing, and foundation pitch during construction period and personnel sanitary wastewater.

(1) Wastewater in Concrete Pouring and Keeping

This type of wastewater is low in quantity (the total emission is 2190 m^3 during the construction period) and is emitted intermittently after each washing. The concentration of the suspended solids in wastewater is 5000mg/L, with the PH value of 11~12. The using of intermittent natural sediment method to eradicate sediment-vulnerable grains of sand is recommended. As a result of the relatively high PH value, an appropriate amount of acid can be used for precipitation before further sediment. The specific design is as follows:

□Setting basin: It is divided into two compartments, one for preparation and another for use. The washing water has quiescence sediment for more than 6 hours between each emission period, making its concentration less than 70mg/L.

□Neutralization sediment basin: 2 segregation walls will be constructed, with a PH value determinate equipped at the exit. Using sulfuric acid to neutralize and ensure the out coming water is in the 6~9 PH range.

(2)Wastewater for Ballast Processing System Washing

During the construction period, the total emission of wastewater for the ballast processing system washing is 12,500m^3. Its main pollutant, SS, has the concentration of 25,000 mg/L. Due to the implementation of *Environmental Quality Standard for Surface Water* (GB3838-2002) and its requirement in the second class quality, the pollutant receiver, **Yuquan River**, should keep a high water quality. In addition to the bad trail conditions on both straits of the project, the limited construction area and selective area for wastewater, with the effective (the main suspended substance of the wastewater is inorganic particles, featuring fast sedimentation speed) method of coagulating sedimentation in operation, the adding of flocculating agent can fast and effectively remove the suspended substance of less than 0.035 mm's grain diameter. Thus, the removal rate of SS can amount to more than 90%. For brief procedure of the measurements, see the Illustration 11-1.

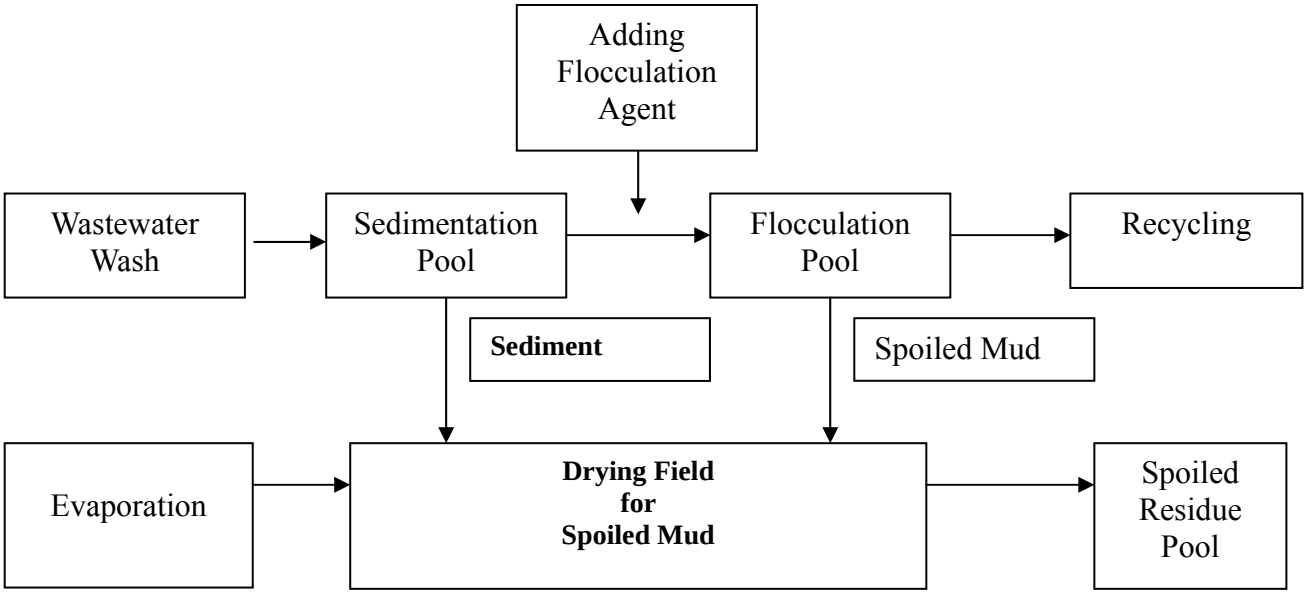


Figure 12-1 Technical process of the sewage treatment in the processing system of substance stone material

After operating the washing wastewater stem from the screening and sand producing system, further pouring is needed for ballast washing. The spoiled soil from the distilling pool and flocculating agent sedimentation pool will be sent to the drying pool and then to the spoiled residue pool.

(3)Wastewater For Construction Machinery Vehicle Washing

Throughout the construction period, 4380 m^3 of the machinery vehicles will be produced. In order to prevent the pollution of soil and water by the wastewater for construction machinery maintenance and washing, gullies are planned to build in the machinery automobile repair and maintenance area to collect, wash and repair the oil-contained wastewater. The measurements are: arranging drainage pitch under the inspection rack, gullies around the parking space to complement the wastewater washed in the pitch. Steel plate is arranged at the rear of the gullies for oil segregation, thin barrier shields are arranged at the exit of the gullies to reduce the floating water. Timely remove the waste oil at the steel plate, clean the silt at the bottom. The norm of the gullies, see the Table 11-6.

Table 11-6 Norm of the gullies

Place	Peak volume of wastewater (m^3/d)	Detention (d)	Designed volume (m^3)	Norm (m)
Parking Place	6	1	20	5×2×2

(4)Wastewater in the Foundation Pitch

Due to its small scale and absence of a cofferdam, the project will produce little water in the foundation pitch. The main pollutants in this type of wastewater are SS, pH and the petroleum spilled by machines. The concentration of suspended substances is around 2000mg/L. The substances constitute of rock soil particles, cement mortar and can easily cause sedimentation. Handling the foundation pitch wastewater can adopt the method of manually cleaning floating oil, adding a defined amount of acid to neutralize the PH value (using acid-based indicator for testing), and extracting and discharging the post treated water after 2 hours of quiescence sedimentation. During construction time, the monitoring of the wastewater also needs to be stressed. If the SS or Ph of the segment is abnormal, or the suspended substance in the foundation pitch is overly high, quiescence time should be prolonged.

(5) Control Measures of Sanitary Wastewater

During the construction period, the maximum daily discharge of sanitary wastewater is 19.2m^3, totaling 560019.2m^3. The main pollutants include BOD_5, COD, SS and ammonia nitrogen.

The handling of sanitary wastewater can adopt measures such as burying, using septic tanks, oligodynamic procedures and methane tanks. The former three have their own advantages while the post treatment wastewater can hardly be discharged above standard. As for the method of using methane tanks, for its extreme large volume, arrangement is hard to achieve.

The construction area is located in the barren hills far from the residential and urban area. Considering the status quo of the construction area and the regional environment conditions, building temporary restrooms and facilitated cesspools can match the local conditions as

well as the skill requirements. The purification efficiency of a normal cesspool is around 50% to 90%, with COD and BOD_5 accounting for 60% and SS for 70%. It is difficult for COD、BOD_5 and so forth to achieve the first emission concentration level, while analyzing from the project itself and its estimation on environment, the influence is limited to a certain time and area.

In order to ensure the effectiveness of the sanitary wastewater treatment, wastewater from temporary construction canteens should be treated through oil separation tanks. The project waste and solid waste discharge to surface water is prohibited. In addition, the proposed water intake for construction production and living use should be located in the upper reaches of the river segment. Judging from the environmental protection requirements, in order to minimize the pollution and effects by the sanitary wastewater, dry toilet is recommended, other wastes can be regularly sent to the neighboring farmers for fertilizing.

(6) clear-up for the submergent areas

After the construction of the intake dam, the upstream water level will be 1m higher than the average. A certain scale of the flooding area will be formed at both sides of the river banks. In order to prevent deterioration of the water quality during the early operation period, a thorough clean-up in this area should be proceeded in accordance with *The Hydropower Project Reservoir Inundation Treatment Planning and Design Specification* (DL-T5064-1996), namely the clean-up and removal of weeds, trees, branches, leaves, pits, rubbish, debris and other structures. The height of the structure and herb remains should be limited respectively to 0.5m and 0.3m above ground. Flush the ground if possible for hewing herbs and trees. The potential contagious pollutants should be cleaned under the guidance of the local health and epidemic prevention departments. Sterilization and purification are carried out in place. Strict operation is implemented to prevent proliferation. Due to the limited flooding area, little cleaning work is needed.

11.2.2 Water Environmental Protection Measures during Operation Period

(1) The power plant should be equipped with facilities such as oil-water separators and oil processors for operating an amount of oil-contained wastewater during power inspection. Among them, reuse work can be carried out by the oil processors. The operation should be strictly regulated to avoid leakage of oil into water. In addition, the reservoir should be set

up around oil reserve equipments and transformations for preventing accidental leakage.

(2) The main pollutant after the running of the project is domestic sewage with the total emission of 467.2t/a. The number may seem small but is still above required standard if without proper treatment. It is required to erect equipment for domestic sewage treatment. This evaluation recommends the adoption of ecological dry toilets to prevent external discharge.

(3) Strengthen the operation on the source of the pollutant at the segment. In order to reduce the adverse effects of the unbearable load source water, local water conservancy, and agriculture and forestry sectors should enhance and speed up the soil erosion operations at the upper reaches of the dam site and the surrounding areas. Level terrace of farmland should be implemented. Land above 25° of slope should be reforested. Project construction units should take greening measures to ensure the forest coverage rate of up to 40% in the affected areas. To strengthen the management on the use of pesticides and chemical fertilizers, scientifically and effectively fertilize according to the soil types, crop features and seasons in an attempt to reduce water pollution caused by particles and fertilizer erosion.

(4) Regularly monitoring and forecasting the water quality of the dam to provide scientific evidence for water environment management of the construction region.

11.3 Other Environmental Protection Measurements at the Construction Region

11.3.1 Acoustical Environment Protection Measures

(1) Strengthen the control of the construction noise sources. The constructing units should select machines in line with the state standards. Low noise equipment is recommended and so is the enhancing of its maintenance and repair work.

(2) Sand and stone screen separation system uses rubber mesh and plastic plate and is coated

in order to reduce noise. Shock absorption base can be used for vast vibration equipment.

(3) Use forestation at the construction site and along main transportation roads to reduce noise pollution. Construction transporting vehicles should limit speed. Traffic flow should be controlled. Loud horning should be prevented when passing residential and living areas.

(4) Properly arrange the construction time. High-noise construction equipment should be avoided when the crowd breaks. Demolition should be avoided during the time between 22:00p.m to 7:00a.m the next day and the lunch break.

(5) Strengthen the labor protection of the construction personnel and improve their working conditions. For high-noise working personnel, the working time should be limited to less than 6 hours. Dispensable anti-noise earplugs, earmuffs, anti-noise helmets and other protective supplies also need to be distributed to the noise-affected personnel.

11.3.2 Air Quality Protection

(1)Cut and Control Policies of Excavation and Explosion Debris

The construction companies should adopt the machines and transportation tools in accordance with the state sanitation standards and should discharge the fumes following the state standards. When explosions happen in the open air, a grass bag should be used to cover the explosion area in order to reduce the debris caused by explosion. In the dam areas, material fields and other construction sites where there are plenty of diggings and explosions, water should be sprinkled to reduce the debris as well as the polluted areas. A dust-removal device should be attached to the drill. According to the experience when constructing the Gezhouba Dam, the density of the debris can reach 317mg/m^3 when drilling. With the help of the device, it can be reduced by 99.4%. When digging underground, we should spray water and set up ventilation equipment in order to improve the conditions for pollution to spread and thus reduce the debris density in the working sites.

As for the workers working in areas with a higher production of debris, we should provide dustproof products such as dustproof masks.

(2) Cut and Control Policies of the Sandstone Aggregate and Concrete Powder

In the processing of the sandstone aggregate, we prefer to adopt the low-dust-producing method, which involves wet crushing in order to reduce the production of powder. Concrete and coal ash should be transported in an enclosed way to reduce the ways of spreading. Sprinkle water to each processing system to reduce the powder.

(3) Cut and Control of the Fuel Exhaust Gas

Enhance the management of the large construction machines and vehicles. The machines of the constructors should be equipped with the relevant dust-removal devices and transportation vehicles, using high-quality and low-polluting fuel and installed with exhaust purifiers. Inspection and maintenance should be carried out at regular intervals to ensure that the various indices of the machines and vehicles are consistent with the regulations of the exhaust gas emission.

(4)Cut and Control Policies of Transportation Debris

When building new roads, asphalt pavements or concrete pavements should be adopted to reduce the dust caused by the transportation on the earth or gravel roads. Maintain and clean the roads regularly for the smooth functioning of the roads. Use watering carts in the construction period and sprinkle water two to three times a day on sunny and windy days in order to reduce the flying dust.

When carrying the materials with much dust, humidify them or cover them with canvas. Storage tanks of the vehicles carrying concrete in bulk should be sealed. Concrete in bags should be covered and the vehicles should be cleaned regularly.

(5)Health Protection

The working and living areas of the workers in the working period should be arranged in the windward direction of the working sites and stoves to avoid the pollution from the powder and flying dust.

The workers who may be greatly influenced by the pollution should adopt personal measures such as wearing dustproof masks and so on. Plant trees and grass at the both sides of the roads in the working and living areas to reduce the dust. Set a time limit for the vehicles running through the working and living areas with a speed of no more than 15km/h.

11.3.3 Dealing with Solid Waste

(1)Domestic Waste

The production of domestic waste at the peak time of construction can reach 0.2t/d with a total number of 58.4t. Dustbins should be set in the construction and living areas to collect the garbage and then garbage should be moved to the nearest dumping sites promptly. There should be space for the constructing garbage to be piled up in the dumping sites and a groundwork treatment should be carried out. When the garbage is piled up, insecticides should be sprayed to prevent flies from spreading diseases, which will reduce negative influences from the domestic garbage on the water in the construction sites as well as the living environment for the workers. After the construction, close the site in a proper way and cover the ground with a certain amount of soil together with the planting of vegetation.

(2) Construction Dregs

Construction dregs should be used to backfill and utilized in a comprehensive way as much as possible. The construction garbage, waste stones, mud and sand left in processing the dirty water, which all cannot be used, should be moved to the dumping sites to be treated properly. The bottomland occupied by the construction dregs should be built with protection walls to prevent the waste stones from flowing into the river along the surface runoff, thus polluting the water. Those unoccupied areas and bottomlands in the construction sites should be cleaned and flattened as soon as the construction ends. The exposed land should be filled and afforested in time to avoid the soil erosion and water loss and the landscape destruction. For more details, please refer to the chapter of maintaining water and soil.

11.4 Risk and Accident Prevention Measures

As the **TangjiahellHydroelectric Power Station** is a river-run one without a reservoir. There is no risk of a dike-break. According to the analysis of the reasons of environmental risks in this project and referring to the research achievements of safety both home and abroad, we put forward the following measures for the possible main causes for accidents.

11.4.1 Prevention of Fire

(1) Implement the principle of "prevention comes first and actively put off the fire". Count the forest fires and establish a fire archive. In the prevention period in the forests, fire in open air should be forbidden. If there should be a special need for fire, follow strictly the regulations.

(2) In the construction period, give publicity of the forest fireproof knowledge and enhance management. Properly arrange workers' living areas and forbid the workers from using naked fire in vegetation-covered areas.

In the operation period, enhance the publicity of the forest fireproof knowledge and manage it properly. Visitors should be inhibited from using naked fire. Enhance the management on the firewood of the villagers.

(3) Once discovering a forest fire, put it off immediately and reports the fire to the local government or the forest fireproof headquarters. Award those who contribute to the forest fireproof work. As for those who break the fireproof regulations, the police can arrest them according to *The Law of the People's Republic of China on Public Security Administration Punishments.* If the plots and the consequences are serious enough to constitute crimes, they should bear criminal responsibility judged by the judicial departments.

11.4.2 Prevention Measures for Accidents in Diversion Tunnels

The total length of the diversion tunnel is 3871m, which is located at the **right bank**. According to the feasibility program, part of the tunnel is karst with the risks of collapsing. Besides, the southern part of the layer of the tunnel is carbonate with grown karst cranny. Thus, in the process of construction, water may break through the karst and the construction may be influenced.

Thus, in the construction process, we should prepare to prevent collapsing and water gushing from the karst layer to avoid relatively serious damages to the construction. To

ensure the stability of the portal, we had better entered the cavity early and got out of it late. The heading slope and the side slope of the portal should not be too high. Besides, in construction, the supporting should be enhanced and the tunnel lining should be made in time. In addition, when crossing the karst zone, special attention should be paid to the collapsing and the water surging from the karst. If the water surges, the construction should be stopped immediately and the workers should withdraw in time and observe the volume of water surged. After lining the water with concrete, construction can go on and the safety of the workers should be ensured. If there is an underground river, the construction should be stopped and then a proper constructing plan in accordance with the type and size of the river should be adopted. However, keep in mind that the construction of the diversion tunnel should not block the flow of the underground river, which may cause the zero flow in downstream.

11.4.3 Prevention of Other Accidents

(1) Strictly follow the relevant regulations in ***National Safety Regulations of Blowing Up*** (GB6722-88) and adopt prevention measures before the explosions. Avoid the harms of the various effects in the blowing up, including vibration, noise, bow wave, dust and flying subjects on the surrounding people and creatures. It is suggested that after mining the dynamite, a shelter with a certain width, such as a used blanket, should be covered on the rocks in the blowing up point and then be fired to blow up.

(2) If we use places to temporarily store inflammable, explosive or toxic substances, such as dynamite warehouse and oil tank, a special warehouse should be set up for the potential risks of oil burning, fire and explosion. A 120-meter-long safety prevention zone should be set up and be kept by some people. Carry out relevant regulations according to the management of dangerous substances. Adopt accident prevention measures and constitute emergency plans for accidents. In the plan, we should prohibit fire, control the leak of inflammable, explosive and toxic substances and improve the systems of supervision, checking, warning and protecting. We also need to install scientific and modified devices for fireproofing, explosive-proofing, calling the police when there is fire and leak of oil and for putting off the fire. Furthermore, we still need to supervise the system to erase the potential risks of oil leak, fire and explosives. In addition, in the dangerous zones and places in the construction sites, a sign of danger should be set up and safety measures be

taken.

11.5 Protection of Land Resources and Soil Environment

After the setting up of the **TangjiahellHydroelectric Power Station**, the structure and type of the land in the occupied areas have changed. To deal with the relevant problems in full use of the land resources and protecting the soil, the following suggestions are put forward.

11.5.1 Protect and Fully Use the Land Resources in Existence

In the exploitation and construction, we should save the land and control strictly the use of the plow land. Increase the investment in labor, fund, science and technology in plow land to boost the grain production and increase the population carrying capacity of the land.

As for new hollows caused by waste soil fields and stone fields in the construction, we should make full use of the waste soil and stones to backfill and flatten the land. Covering the surface with soil, we can use the land for agriculture and forestry judging from the factual conditions. If possible, the hollows in some places can be built into water cisterns or other forms.

11.5.2 Reconstruction of Dumping Site

The temporary dumping site occupies an area of 2.46hm$^{2.}$. Furthermore the protection slopes around the side slope of the garbage, a water-blocking geng and a drainage system should be built along the outer circle. After finishing the project, the top of the dumping site should be flattened. Then a layer of clay should be spread and then pressed tightly to form an anti-osmosis layer. Later, spread soil and plant trees on the surface and increase the areas of forests.

11.5.3 Reclamation of Temporarily Occupied Land

The temporarily occupied land, after the construction, can be restored to its original function or developed properly according to the actual conditions. After the completion of the project, the garbage from the temporarily occupied land, domestic garbage in the construction period and construction garbage should be removed in time or be mustered to be dealt with,

together with the land reclamation. Thus, the original landscape can be restored or it can be used for other plans.

11.5.4 Use of the Land after the Reclamation

Having relatively good soil after reclamation, the ground and the gentle slope(less than 15°) can be used for farmland with a certain water conservancy condition. Those slopes having a gradient of more than 15° or those with relatively bad soil can be used for forestry and animal husbandry. Formed trees, shrubs and grasses should be allocated properly to restore the vegetation to maintain the water and soil as soon as possible.

11.6 Protection Measures for People's Health

11.6.1 Health Protection Measures for People in Construction Period

(1) Disinfecting the Fields

Clean and disinfect mainly the following areas: construction fields, places with a muster of people, original washrooms, cesspits, stockyards, graveyards and the demolished temporary living areas after the construction, temporary washrooms and dumping sites. Carbolic acid should be used together with mechanical sprayers, following the requirements in the ***The Criterion of Antisepsis Technology***. Remember to clean the castoff while disinfecting.

(2)Killing Nocuous Vectors

In the construction period, kill mainly the mice, flies and mosquitoes in spring and autumn every year to control the source of infection of various diseases and cut off the ways of spreading. Use rat-nips and poison to kill mice. Use insecticide to kill mosquitoes and flies. Distribute drugs and tools to workers to spread or use under the guidance of epidemic prevention workers.

(3)Hygiene Quarantine

Hygiene quarantine should be carried out on workers in the local medical and health

institutions before they enter the fields. Detect and control the carriers and new diseases which may enter the fields, thus to prevent the cross infection and spread between workers and local residents. Do the sample quarantine according to the survey with the items including viral hepatitis, hemorrhagic fever and malaria. All the workers and managers should have physical checks before entering the construction fields. Once contagious diseases were discovered, the patients should be quarantined and treated in time to prevent the spread of the disease. Afterwards, conduct spot checks twice of about 20% of the workers in the construction period. Carry out a survey about the health conditions of the workers regularly and thus establish the archive of the disease. Those with contagious diseases should be forbidden to enter.

(4)Physical Check

After the beginning of the project, the environmental conditions in the construction sites will be changed gradually. Due to the high intensity of labor and the workers' different health conditions, new contagious cases may emerge. Observe and carry out a physical check to the workers to have an idea about the health conditions of the workers in different periods of construction. Thus, the emergence and spread of various diseases can be prevented and controlled in time. Treat the sick workers or wounded workers in time to ensure the formal operation of the construction. Physical checks should be determined by the actual conditions. For those catering workers in the construction sites, those who are exposed to dust and loud noise and those who are engaged in work with relatively large harm on people, physical checks should be carried out annually and an archive should be established according to the results.

(5) Preventive Immunity

Because of the high pollution intensity and high intensity of work, the workers need to have preventive immunity to increase the workers' immunity against diseases and prevent the contagious diseases such as typhoid, hemmorhage fever and malaria from infecting and spreading. According to the features of the epidemics and the rules of diseases in the water conservancy projects, measures like taking pills and vaccination can be adopted. Furthermore, the medical units in the construction areas should have enough storage of lockjaw immunity preparations and the medicine against viper bites to save those infected by lockjaw and those bitten by the vipers.

(6) Publicity of Sanitation and Management

The construction and construction units should be clear about the person in charge of sanitation, who will have responsibility for the publicity of people's health and management. A network for reporting diseases should be established, modified and should report the diseases to superior departments in time. Supervise and check the food in the construction areas regularly and check the health certificates of the catering workers in the construction areas. Enhance the purifying and disinfection of drinking water in the living areas. The drinking water should meet the requirements in ***The Rules of Drinking Water*.**

(7)Public Sanitation Facilities

The arrangement of the public sanitation facilities should be determined by the general arrangement of the construction, the actual management and the distribution of the workers.

The requirements for temporary public washrooms: Have a distance of 30m from the canteens with the consideration for its convenience. The setting of the squats should follow the requirements in ***The Sanitation Standards in the Design of Industry and Enterprises*** (TJ35-79). The number of washrooms and the number of the squats in each washroom should be determined by the population intensity. According to the distribution of workers and allocation of living areas, dustbins should be set in both construction areas and living areas. Domestic garbage should be cleaned in time and carried regularly. Pouring waste into the rivers or drains is forbidden to prevent the water contamination. An emergency medical unit should be set up in the construction sites, equipped with medicine and tools for common contagious diseases and injuries.

11.6.2 Measures of Protecting People's Health

Establish a relevant health care system in the local towns to strengthen the ability of dealing with and controlling possible diseases. Enhance the publicity of sanitation in the local residents and publicize the knowledge of preventing and curing various contagious diseases and the knowledge of vaccination in order to increase the local's knowledge of sanitation and the awareness of health protection. Protect the sources of drinking water and manage the food safety.

According to the spread of the existed diseases in the local regions, a sample check should be carried out in diseases such as infectious diarrhea, viral hepatitis, malaria and phthisis. Prevent and cure mainly the hemorrhage fever and leptospira. According to the results of the spot check, the residents in the surrounding areas should have vaccinations or take pills.

After the completion of the project, kill the mosquitoes and mice in the shallow water areas of the river tributaries and drawdown areas. The work can be carried out in cooperation with the local sanitation departments. Based on the survey of the mice and its intensity, insecticides like “Shatazhang” or “Dalong” can be used to kill mice. Remember to recheck after killing the mice.

The change in the flow in the tail water areas and low-water-level areas when T**angjiahe**|**Hydroelectric Power Station** adjusts may threaten people’s lives. Thus, caution boards should be set up in the downstream of the sluice, bottomland near the power station and the downstream of the factories. The board should tell clearly to residents to avoid safety accidents. At the same time, carry out safety education to the local residents two years before the construction, letting them have a basic understanding of the operation features of the power station and raise their attention.

12. Environmental Management, Supervision and Inspection

12.1Plans for Environmental Management

Environmental management is an important and integral part of environmental protection. The basic task is to protect the environment and enhance the environmental management on constructions in the construction and operation periods.

12.1.1 Goal of Environmental Management

Through strict environmental management, ecological destruction and environmental pollution can be prevented and controlled effectively. Thus, the negative effects on the environment in the construction and operation periods can be reduced to the least in accordance with the principle of "three meanwhile". Endeavour to fulfill the unification of the economical, social and environmental effects from the construction of the **Tangjiahe|Hydroelectric Power Station**.

12.1.2 Duties of the Environmental Management Departments

The construction units should set up environmental protection management organs to supervise and manage the environmental protection in the construction and operation periods. The environmental management organs should include the organs for environmental management and supervision with 1 or 2 personnel. The duties of environmental protection organs at various levels are as follows:

（1）Implement the national and local environmental protection policies, principles and regulations. Assist to formulate and carry out the environmental protection plans of the reservoir. Cooperate with relevant departments to check the completion of the environmental protection facilities and carry out the plans of environmental protection.

（2） Organize and coordinate various tasks in this report and the approved opinions. Put the entire fund in ecological compensation and pollution prevention into effect. Establish and improve the environmental protection system and principles. Ensure the responsibility system of environmental protection and ways of awarding and punishing.

（3） Do the following work in the construction period: Organize environmental supervision and inspection, formulate a report on the environment quality in the construction site regularly and submit it to the superior department; prevent ecological destruction and pollution in the construction period and make emergency measures for emergency accidents. In the later part of the construction, organize the environmental restoration and improvement in the construction sites, such as restoring the project slash and greening the construction areas. Manage the sanitation of the environment in the reservoir and deal with the waste dregs before the junction stores water.

As soon as the completion of the Tangjiahe Reservoir matching this project, do the following work in the operation of the reservoir: Protect the water source in the reservoir and the water quality; inspect the living organisms water quality, hydrology and mud; coordinate to solve the ecological and environmental problems in flood prevention, electricity generation, irrigation, tourism and aquiculture; deal with accidents of water contamination and ecological destruction.

（4） Collect and manage information on environmental regulations (especially in ecological environmental protection) and environmental protection technology and supervision and establish an environmental protection archive.

12.1.3 Plans for Environmental Management Protection in the Project

Table12-1 Plans for Environmental Management Protection in the Project

Environmental Problems		Measures	Conducting Organs	Organs in Charge
Construction Period	1. Air Pollution	① All the proper measures including spraying water to reduce the extend of air pollution ② The material fields should be at the leeward of the living areas. Places storing materials should be covered to prevent the pollution of flying dust. The vehicles carrying the materials should be covered with canvas. ③Effective cover for stirring device. ④Properly plan the driving routes	Contractor	Yiye Hydropower Development Ltd. in Wufeng
	2. Pollution and soil erosion and water loss	①Enhance the management on the workers' living areas. Adopt necessary measures to prevent pouring construction and living sewage in the surface water and river directly. ②Make construction plans properly to protect the existed natural vegetation to prevent soil erosion and water loss ③Adopt necessary measures to prevent abandoned dregs from blocking the river	Contractor	Yiye Hydropower Development Ltd. in Wufeng

	3. Noise	□ Strictly follow the criteria for noise in industry and enterprises. The workers close to the sources of loud noise should take protective measures and limit working time. ② Large machines should be forbidden to work from 22:00 to 6:00 ③ Properly plan the routes for vehicles to avoid sensitive zones ④ Enhance the management of the machines and workers to reduce the influence of noise Carry out the system of approving the blowing up. Blowing up is forbidden at the top of the mountain when constructing.	Contractor	Yiye Hydropower Development Ltd. in Wufeng

Construction period	4. Protection of Ecological Resource	① Do not set up dumping sites randomly ②Enhance protection for the existed original secondary forests. No destruction or digging. For those needing to be transplanted, follow the plans if there are. ③Workers should not randomly enter the original secondary forests, the mountaintop woods, shrubs and the inner parts of the grass. Digging natural plantation and killing wildlife are forbidden. ④ No random harm to the surface vegetation and surface soil in the surrounding areas. The dealing of dregs should not harm the surrounding natural environment. Refer to the environmental protection departments for advice for the places.	Contractor	Yiye Hydropower Development Ltd. in Wufeng
	5. Water Pollution	Clean thoroughly the left twigs, leaves, buildings and domestic garbage	Contractor	Yiye Hydropower Development Ltd. in Wufeng
	6.Protection of cultural relics and landscape	Stop construction upon discovering cultural relics and report it to the department. Resume construction only under the permission. Meanwhile, the facility of the construction should accord with the tourism plans	Contractor	Yiye hydropower development Ltd. in Wufeng

	7. Construction sites	Dustbins and sanitation facilities should be set up in the construction sites. Garbage in the dustbins and dregs should be dealt with regularly. Drinking water should meet the state requirements for drinking water. Prevent the domestic sewage and solid waste from polluting the environment.	Contractor	Yiye Hydropower Development Ltd. in Wufeng
Operation period	1. Ecological environmental protection	□ Adopt orderly tourist activities to prevent the damage to the original secondary forests □ No buildings in the river way or on the banks	Contractor	Yiye Hydropower Development Ltd. in Wufeng
	2. Water pollution	New source of pollution if forbidden	Contractor	Yiye Hydropower Development Ltd. in Wufeng
	3.Noise and solid waste	□ Set up dustbins and a solid waste collecting system □ Deal with the solid waste around the warehouse. Clean every day.	Contractor	Yiye Hydropower Development Ltd. in Wufeng
	Environmental Monitoring	Formulate monitoring plans and carry it out according to state regulations	Contractor	Yiye Hydropower Development Ltd. in Wufeng

12.1.4 Environmental Protection Management Organs and Duties

According to the responsibilities and duties in the environmental protection work, the duties of the management organs and supervision organs are as follows in table 12-2

Table 12-2 Environmental Protection Management Organs and Duties

Period		Organizations	Supervision organs	Duties
Feasibility study period	Feasibility report	Design Institute of Hydro Power in Qingjiang, Yichang	State Ministry of Construction	Feasibility demonstration of the environment, economy and technology of the project

	Report on environmental influence	Environmental Protection Institute, Xiangfan, Hubei	Bureau of environmental protection in Hubei province, Bureau of environmental protection in Yichang, Bureau of environmental protection and construction in the autonomous county of Tu minority group in Wufeng	Make sure about the environmental influence. Demonstrate the feasibility of the environment in the project and put forward suggestions for environmental protection
Construction period	Protection measures of all environmental protection elements and soil and water conservation	Construction units	Bureau of Environmental Protection in Hubei province, Bureau of Environmental Protection in Yichang, Bureau of Environmental Protection and construction in autonomous county of Tu minority group in Wufeng	Construct according to the environmental protection facilities to make sure that the environmental protection measures be fulfilled. Carry out the “three meanwhile ”
	Environmental Inspection	Owner, qualified supervision organs	Bureau of Environmental Protection in Hubei province, Bureau of Environmental Protection in Yichang, Bureau of Environmental Protection and construction in autonomous county of Tu minority group in Wufeng	Supervise the fulfillment of all the environmental protection measures and ecological protection projects. Report the fulfillment of the measures, the existing problems and suggestions for improvement.

	Environmental supervision	Environmental supervision station in autonomous county of Tu minority group in Wufeng	Bureau of Environmental Protection and construction in autonomous county of Tu minority group in Wufeng	Complete the task of environmental supervision in the construction period
	Acceptance check of environmental protection	Owner, acceptance check units of environmental protection	Bureau of Environmental Protection in Hubei province, Bureau of Environmental Protection in Yichang, Bureau of Environmental Protection and construction in autonomous county of Tu minority group in Wufeng	Check all the fulfillment of environmental protection measures
Operation period	Daily management of environmental protection	owner	Bureau of Environmental Protection in Hubei province, Bureau of Environmental Protection in Yichang, Bureau of Environmental Protection and construction in autonomous county of Tu minority group in Wufeng	Maintain the normal operation of all environmental protection facilities and make sure the concentration of the discharging pollutants meet the requirements for local environmental protection
	Environmental supervision	Environmental supervision station in autonomous county of Tu minority group in Wufeng	Bureau of Environmental Protection in Yichang, Bureau of Environmental Protection and construction in autonomous county of Tu minority group in Wufeng	Complete the supervision tasks in the report of environmental evaluation

12.2 Plans for Environmental Monitoring

Environmental monitoring is an important work for environmental protection and management. It can be organized and coordinated by the environmental management organs to take full use of the local organs, technology and devices, including the environmental monitoring office in the county, hydrology office, epidemic prevention station and weather station. Thus, a complete environmental monitoring system for the project can be formed and the environmental monitoring tasks can be undertaken together. Within the monitoring system, a contracting system can be adopted to ensure the rights and duties of each partner.

12.2.1 Main Duties of Monitoring Organs

(1) Inspect the water, air quality and noise in the reservoir as well as the sources of pollution. Deal with and inspect pollution accidents.

(2) Examine and report the hydrological observation, water situation and rainfalls in the reaches including the upstream of the reservoir, the reservoir areas and the downstream of the dam.

(3) Examine and report the meteorological factors relevant to the weather in the warehouse area, including temperature, rainfalls and speed of wind.

(4) Inspect the status of soil erosion in the reservoir area.

(5) Inspect and predict the happening and development of various diseases relating to the project.

12.2.2 Plans for Environmental Monitoring

The construction period of the hydropower station is long and the operation period is even longer. Both the construction and the operation may have extensive and far-reaching influences on the natural and social environment. Some potential environmental risks may not be fully recognized in the feasibility research and the

early stage of construction. Thus, long-term monitoring for the areas influenced is needed.

(1) Environmental Monitoring Plans in Construction Period

① Supervision of Water Quality

A, Supervision of Water Quality in Rivers

Set of the section: Due to the separation of the construction sites, set a section both in the major construction sites in the dam and the factories in the **Tangjiahe Ⅱ Hydroelectric Power Station.**

Items for monitoring: 11 items including water temperature, pH、SS、BOD_5、DO、index of permanganate, petrol, total phosphorus, total nitrogen, ammonia nitrogen and fecal coliform.

Method of monitoring: carry out monitoring according to the methods in ***The Regulations of the Supervision Technology in Surface Water and Dirty Water.*** (HJ/T91-2002)

Time and frequency of monitoring: one year before the storage of river water. Three years for the cross section in construction sites. Three times a year in rainy, normal and dry seasons.

B. Monitoring of Drinking Water

Arrangement of monitoring stations: arrange a monitoring station in drinking water intake point in the construction sites.

Items for monitoring: According to the requirements in ***The Regulations for the Water Quality for Drinking Water*** [2001]161 issued by the Ministry of Sanitation, the 10 items include the color of the water, turbidity degree, smell, visible substances with naked eyes, pH, total hardness and $CaCO_3$, anionic synthetic detergent, total coliform group and fecal coliform.

Time and frequency of monitoring: once a year. Three consecutive years in the construction period

C. Supervision of the Sewage Outlet

Arrangement of monitoring station: arrange a monitoring station for sewage in the outlets of various sewage processing device (including the sedimentation tank and oil-separating tank), the outlet of foundation pit waste water and the outlet of domestic waste water

Items for monitoring: Waste water in construction: pH、SS, petrol; Domestic sewage: SS、BOD_5、COD。

Time and frequency of monitoring: three times a year. Three years in the construction period together with the monitoring of water quality.

Method of supervision: carry out supervision according to the methods in ***The Regulations of the Supervision Technology in Surface Water and Dirty Water.*** (HJ/T91-2002)

② Monitoring of Air

Arrangement of supervision station: arrange a monitoring station in both the construction sites of the dam and the construction sites of the power station factories in order to know the environmental conditions in the sites. Thus, effective measures can be taken to erase the dust and ash to reduce air pollution.

Items for monitoring: For the massive use of machines and the characters of the burning coal in life, NO_2、SO_2、TSP are chosen.

Method of monitoring: carry out monitoring according to ***the Standards of Air Quality*** (GB3095-1996) and ***Standards of Monitoring Technology of Environment*** (the part of air).

Time and frequency of monitoring: once for each quarter of the year and five days

consecutively for one time. Three years for monitoring in the construction period. Report the environmental monitoring in the construction every quarter and every year. After the editing of the report, submit it to the local department of environmental protection regularly. The construction units can entrust the local environmental monitoring station to finish the report.

③ Noise in the Area

Arrangement of monitoring station: In order to know the influence of the construction noise on the surrounding environment, arrange five monitoring stations, respectively one station in the construction sites of dam, sandstone material fields, construction field of the factories, the living areas of the workers and the roads leading to the factories.

Items and time for monitoring: the equivalent sound level dB(A) both in the daytime and at night

Frequency of monitoring: twice a year in the construction period respectively in autumn and summer. For every monitoring, supervise for 24 hours and the period of monitoring is 3 years.

Methods of monitoring: carry out the methods according to ***the Method of Measuring the Noise in Urban Areas*** (GB/T14623) and ***Method of Measuring the Noise in the Construction Sites*** (GB12524).

④ Monitoring of Aquatic Organisms

Supervise the production of fishery in the warehouse, the species and number of fish. The period of monitoring is three years.

⑤ People's Health

Contents of monitoring: The general health inspection of people mainly depends on the three-tier medical networks' monitoring of the change of disease in the construction sites; so that the relationship between the pollution produced in the

construction activities and human health can be understood. The focus should be the monitoring on the contagious epidemics including the natural source diseases, waterborne diseases and the arbo infectious diseases. In those areas that witness the high frequency of the spread of diseases, do a spot check of the workers and vaccinate them. Meanwhile, set up a reporting system of epidemic situations. Once discovering the contagious diseases, report it to the superior departments and cope with it to ensure the health of the workers.

Target of monitoring: all the workers in the construction area

Time for monitoring: once at the peak time of construction and once at the end of the construction. Carried out by the local epidemic prevention department, the requirements of the Ministry of Sanitation should be followed.

⑥ Soil Erosion

Elements of monitoring: rainfall, wind, ground slope, the length of the slope, composing substance of the ground, the density, features and harms of the soil erosion in construction, the growth of the vegetation, coverage of vegetation, the loss amount of soil, the nutrient of soil, the number of facilities for soil and water conservation and the change of the facilities' quality.

Contents of the monitoring: the loss amount of water and soil, damage of the soil erosion, the effects of the project of maintaining the water and soil

Methods of monitoring: fieldwork survey, inspection at fixed points

Arrangement of monitoring station: arrange respectively one observation point in the dumping sites and in the material filed. Choose two typical sections for monitoring in the constructive road and each section can be set with 1 or 2 observation points.

Time and frequency of monitoring: once in the construction period

⑦Observation of Terrestrial Animals and Plants

Set one observation point in each construction section, altogether two points. Observe

and protect the terrestrial animals and plants.

(2) Plans for Environmental Monitoring in Operation Period

The monitoring plans for the operation period mainly focus on this project and the monitoring plans of the reservoir after the completion of the Tangjiahe hydropower complex.

① Monitoring of Water Quality

Setting of the cross section: the key point of the water quality monitoring in the operation period is the areas around the reservoir. Thus, set a regular section respectively in the end part of the backwater in the reservoir, the place 200m in front of the dam and the place 100m downstream away from the outfall of the power station and a signal should be set. Each side of the section should be set with one vertical line. Set two points to sample in each line and thus altogether 12 points.

Items for monitoring: water temperature, pH, permanganate index, dissolved oxygen, ammonia nitrogen and total phosphor.

Frequency of monitoring: Supervise twice each year, one in the normal seasons and one in dry seasons after the storage of water.

Methods of monitoring: the arrangement of the sample positions should follow the requirements in the ***Regulations of Supervision Technology (surface water)*** and the method of analysis of examining should follow ***the Standards of the Quality of Surface Water.*** (GB3838-2002)

②Soil Erosion and Water Loss

Elements of monitoring: rainfall, wind, ground gradient, the length of the slope, composing substance of the ground, the density, features and harms of soil erosion in construction, the growth of the vegetation, coverage of vegetation, the loss amount of soil, the nutrient of soil, the number of facilities for soil and water conservation and the change of the facilities' quality.

Contents of the monitoring: the amount of soil erosion, damages of the soil erosion, the effects of the project of maintaining the soil

Methods of monitoring: fieldwork survey, inspection at fixed points

Arrangement of monitoring station: arrange respectively one observation point in the abandoned dregs sites and in the material filed. Choose two typical sections for monitoring in the constructive road and each section can be set with 1 or 2 observation points.

Time and frequency of monitoring: Monitor once before the flood and after the flood and in winter every year within three years in the operation period of the power station.

③ Aquatic Organisms

Cross section for monitoring: set a monitoring section respectively at the end part of the reservoir backwater, 200m in the upstream of the dam and 500m downstream the dam.

Contents of monitoring: zooplankton, phytoplankton, benthos, aquatic advanced plants and fish.

Time and frequency of monitoring: in April in the third year after the reservoir stores water.

④ Hydrological Observation

Set a hydrological observation point respectively in the outfall of the dam and the end of the reservoir. Follow the requirements in ***The Standards for Hydrological Test*** and examine the water level, the flow and the content of sand and mud.

⑤Observation of People's Health

Do a survey of the people's health in the reservoir areas and a spot check in typical areas.

⑥Weather Observation

Set 2 or 3 observation stations in or around the reservoir area to measure the temperature, speed of the wind, direction of the wind, frequency of the wind, rainfall, humidity and fog.

⑦ Programs such as the use of biological resources and the land have a long changing period with great difficulties. It is suggested that remote sensing materials or satellite photographs should be used to analyze them.

12.3 Plans of Environmental Inspection

The major influence on the environment in the construction period is ecological influence. Once destructed, it is hard or impossible for the environment to recover. Thus, in the construction, it is more important to preserve than to restore later.

According to the requirements of environmental protection, the environmental monitoring of the project is an important integral part of construction monitoring, which should run through the whole process of the construction. The construction units should entrust those qualified construction monitoring organs to supervise, examine and manage all departments, which carry out the environmental protection programs, and the environmental protection work of the constructors. The construction units should also deal with and solve the emergent environmental problems. Before the operation of the project, according to the environmental protection plans, they should examine the dealing and recovery of all the construction sites, such as the dumping sites, the occupied fields for construction, the recovery ecological environment and the implementation of environmental protection measures. Thus, it can reduce the negative influences on the environment as much as possible.

12.3.1 Purposes of Environmental Inspection

Personnel in the environmental inspection organs should follow the laws, regulations,

policies and design documents, bidding documents and inspection contract of the nation and the departments in charge to fulfill their duties of inspecting the environment according to the scope and content of the environmental inspection service. They also should strive to make the project meet the environmental protection requirements in the design, construction and operation. The work goals for environmental monitoring are:

(1) Make sure the environmental protection design and the environmental protection work in the monitoring documents be properly carried out and the environmental protection requirements in the report of environmental influence be fulfilled. This is the core goal of environmental inspection and the basic requirement for various environmental policies and regulations.

(2) Consider the actual conditions of the project, assist the owners with the environmental management and publicize environmental knowledge to increase the environmental protection awareness. This is a goal for the actual situation in our country: the common awareness of protecting the environment in the construction in our nation is not strong and the environmental protection management is not good enough. It aims to increase the owners' abilities of managing environmental protection through active work on environmental inspection.

(3) Units supervising the construction should take effective measures to limit the negative influence from the construction on the environment to an acceptable level. They should also improve the work of protecting the environment and protect the rights of construction units. The environmental inspection units, entrusted by the owners as an independent "third partner" into the construction, should be scientific and fair between the owners and construction units to coordinate the mutual relation. They should supervise and manage strictly the construction units on the one hand. On the other, they should take the actual difficulties in the construction into consideration and carry out the environmental protection measures flexibly according to the actual conditions.

(4) Gather complete materials of inspection work which reflect the working process and provide the basis for the acceptance check of the environmental protection of the

project. Environmental inspection is a bridge linking environmental evaluation and environmental acceptance check in the environmental management of the construction. Full and accurate working materials of environmental management can serve as a solid foundation for the smooth operation of the acceptance check of environment.

12.3.2 Working Contents of Environmental Management

In the three periods of the project, namely the preparation, the construction and the acceptance check, environmental management have different tasks for different periods.

(1) Preparation

Organize an environmental inspection-clarifying meeting to put forward the sensitive environmental elements deserving special attention, the requirements of protecting the environment and the working procedures of environmental inspection. Check the contents of environmental protection from the construction units' plans in the whole project and the branch project of construction and check the preparation of environmental protection of construction units.

(2) Construction

Check the organization and operation of the environmental protection organs of the construction units. Check the implementation of the environmental protection issues in the contract carried by the construction units and the fulfillment of the environmental protection measures. Host meetings about environmental protection in the construction sites and collect opinions about environment. Look through the measures put forward by the construction units, coordinate the relations of various partners about environmental protection and negotiate with the partners about the disputes on environmental problems. Compile written materials of environmental management.

(3)Acceptance Check

Supervise and check on site the construction units' dealings with the leftover environmental problems. Pack up the materials of environmental inspection needed for acceptance check. Conduct a comprehensive evaluation of the actual situations and effects of carrying out and fulfilling the environmental protection measures. Participate in the acceptance check of the project and subscribe the opinions of environmental inspection.

12.3.3 Setting of the Environmental Supervision Organs

As the project is small, it is suggested that 1 or 2 environmental inspection engineers are assigned who should be responsible for the owners.

13. Estimation of Environmental Protection Investment and Analysis of Economic Profits and Losses

13.1 Estimation of Environmental Protection Investment

According to economic theories and regulations as well as the basic principles, “Those who harms the environment should be responsible for management”. In order to avoid the massive loss on the environment from the designed project and the ecological degradation, and to stimulate a virtuous circle of economy and ecology and fulfill sustainable development, it is very necessary to reduce the environmental risks to the lowest, predicting the possible influence on the ecological environment and estimating the budget of investment against the risks.

13.1.1. Principles for Investment

(1)The principle of “Those who pollute the environment should be responsible. Those who exploit the environment should protect the environment”. As for those programs, which protect the environment, serve the major project and aim to reduce the negative effects on the environment from the projects, measures like environmental protection, environmental supervision and environmental project management are needed. The investment needed should be determined by the features of the projects. As for those projects, which are not suitable to be included in the main project, or projects of maintaining the water and soil, the investment on them should be listed as environmental protection investment.

(2) The principle of “Giving prominence to the key points”. We must carry

out special protection on those environmental elements in the projects, which have a relatively wider influence, an extensive public attention and a higher level of protection, and we must also give preference in fund.

(3) The principle of "Recovering the function". Make necessary compensation for the negative effects from the construction of the projects. The added investment resulted from improving the criteria by moving and rebuilding or enlarging the scale should be paid by the local government or the relating departments and the property owners.

(4) The principle of "Lump sum compensation". As for the negative environmental influence on the substances that are hard to recover or be rebuilt, and the loss of ecological environment caused by the construction, measures of substitute compensation and ecological recovery can be adopted or lump sum compensation can be paid according to the standards of compensation.

13.1.2 Basis for Estimation

(1)***Calculation methods and Standards for the Design of Hydropower Project*** **(**2002, No. 78, State Economic and Trade Commission)

(2) ***The document of standardizing the charge of the consultation about the environmental influence issued by State Environmental Protection Administration*** ***(***National development and planning commission, State Environmental Protection Administration, Price (2002) No.125)

(3) Design of the environmental protection measures for TangjiaheⅡHydroelectric Power Station

(4) The price of the designed material should be consistent with the market price of the second quarter in 2005.

(5) The temporary charging regulations of the Industry of Environmental protection in Hubei Province and the Methods of managing the charge of environmental supervision.

13.1.3 Division of Investment Project

According to the ***Regulations of the Design of Environmental Protection on Construction Projects***, all the equipment, device, supervising methods and construction facilities belong to environmental protection facilities used for pollution treatment and environmental protection, which should be included in the investment estimation of environmental protection facilities.

Those project facilities, device and supervising methods aiming at reducing the negative environmental effects on the ecological environment from the hydropower station in the report should be listed as special environmental protection investment, which mainly invest on the environmental protection, supervision, and management in the construction period.

13.1.4 Investment Estimation of Environmental Protection

Judging from the environmental influence of TangjiahellHydroelectric Power Station, the environmental protection measures and the foundation unit price and comprehensive price of fulfilling related measures, the total investment of the environmental protection on this project is 2.19million yuan (see Table 13-1) calculated by the principle listed before. Among the total investment, the investment on environmental protection measures in pivot project is 1.19 million yuan, accounting for 54.34% of the total. The independent fee is 200,000 yuan, 9.16% of the static investment and the total investment on maintaining the water and soil in the project is 800,000 yuan, 36.5% of the static investment.

Table 14-1 The Estimation of Investment of Environmental Protection on Subentry of TangjiahellHydroelectric Power Station (unit: 10,000)

Period	Subentry of the project	Elements	Measures for environmental protection	Executive Units	Investment estimation
Construction periods	The dam	Protection of water quality	1. Recycle the drainage of the foundation pit after being tested as reaching the standards in the sedimentation tank.	Construction units	10.0
			2. Recycle the drainage from the sandstone after sedimentation in the sand basin and being tested as reaching the standards.		
			3. The temporary domestic drainage in the construction sites should be dealt with in the septic tank before being used for other purposes. Discharging is not allowed.		
			4. Domestic water can be used after being dealt with and being disinfected. Construction dregs and garbage are forbidden to be discharged directly into the water.		
		Air	1. The construction materials should be transported in hermetization and covered.	Construction units	5.0
			2. Spray water on the dust-prone or construction roads. The frequency should be determined by the situation of the flying dust.		
			3. Install dust-removal equipment in mixing plant.		
		sound	1. Device with a loud noise should be put away from the construction encampment together with some noise proof products distributed to the workers in the sites with loud noise.	Construction units	1.0
			2. Install noise-eliminating and vibration-insulating device in the machines with loud noise.		
			3. Properly arrange the time and not to use loud machines near the sensitive parts during the rest period.		
		Protection of ecological environment	1. The construction of the dam should avoid the reproduction season of aquatic organisms.	Construction units,	15.0

			2. Enhance the patrol and protection of the animals in the reservoir. Poaching wildlife is forbidden.		
			3. Clean the bottom of the reservoir and transplant the transplantable plants as much as possible. Cut and use those which cannot be transplanted.		
			4. Recover all the plants after cleaning the dregs in the dumping site.		
		Aquatic ecology	The construction, completion and operation of the Fish Protection Station should be simultaneous with the major construction	Construction units, department of fishery	2.0
		Protection Fund of Animals and Plants	Survey and evaluate the national key protected animals and plants and set up Protection Fund of Animals and Plants.	owners	2.5
		People's health	1. In the construction site, a comprehensive disinfection should be carried out in all the original toilets, cesspits and stockyard. Anti-mosquito, fly disinfestations and rodent control activities must be launched in the construction period.	Local medical department of the construction units	4.0
			2. Build latrines in the construction sites and disinfect them always.		
			3. Conduct health quarantine to all the workers preparing to enter the construction site and do physical check to all the workers regularly. Carry out epidemic prevention work according to the rule of epidemic spread.		

			4. Domestic garbage should not be piled up randomly. Instead, it should be mustered to pile up and cleaned in time to be coped with together. The garbage can is coped with together with waste soil. Dustcart for exclusive use should be purchased.		
		Geological Environment	1. Protect those places which leaking from the reservoir may occur, with measures like grouting, covering, blocking and reducing pressure by discharging water.	Construction units	5.0
			2. As for the farmlands and buildings which may be submersed, measures like constructing drainage system, changing the crop structure to enhance the base of buildings should be adopted.		
		Environment at the bottom of the reservoir	1. Clean the toilets, madden, garbage sites, corral and sewage ditch. Those, which can be used as organic fertilizers can be used as in the garden, and those, which cannot be used, should be transported to the dregs sites to be coped with all together.	Construction units	3.5

			2. After the demolish and clean of the buildings, the garbage should be transported to the landfill site to be dealt with. Wall foundation and wall feeting should not be 0.3m above the ground.		
			3. Clean all the plants in the reservoir before the storage of the water. Those fruit trees which are transplantable should be transplanted as much as possible and those which cannot be transplanted should be cut off. The wood should be used as much as possible and those cannot be used should be burnt on the spot, using the wood ash as fertilizer.		
	Material fields and Transportation of materials	Protection of water quality	1. Construct temporary intercepting drain and barrel drain in the break stone sites. Build sedimentation tanks in the places below the break stone sites where there is water flow.	Construction units,	4.5
			2. Enhance management in the exploitation of the sandpit and avoid producing many suspended substances, which may influence the water quality.		

		Air environment	1. When carrying materials with much dust in bulk, cloth should be used to cover the materials to prevent the flying of the materials. When carrying sandstones and abandoned waste, the vehicles should not be overloaded to prevent the dropping on the road. If there is dropping, it should be cleaned immediately.	Construction units,	3.0
			2. Spray water on the materials to remove the dust on the road. The frequency should be determined by the flying ash on the site.		
			3. Build stone-breaking shed to prevent the spread of the dust.		
		Sound environment	1. The blowing up of the stone pit should be carried out at 11：50 a.m. and 5：50 p.m. In addition, assigned workers should be in charge.	Construction units,	0.5
			2. Control the time of transportation. Stop the transportation vehicles from running through the residents' zone in period of rest.		

		Ecological environment	Level digging should be adopted in the material sites. The surface soil should be piled up together and the cut surface be covered with waterproof cloth. After the digging of the soil, the surface soil should be recovered ecologically.	Construction units,	12.0
	Road project	Protection of water quality	1. Build septic tanks to treat domestic sewage in the construction sites. 2. The domestic garbage, domestic sewage should have harmless treatment. Discharge into the water is forbidden.	Construction units,	4.5
		Air environment	1. Construction sites that are easy to have flying dust should be sprayed with water to reduce the dust. 2. The mixing plant of asphaltum should be set in the clearing, 300m away in the leeward direction from the sensitive sites.	Construction units,	3.0
		Sound environment	Large machines and sites should be away from the sensitive sites with a distance of less than 200m. Construction should be stopped from 22：00 to 7：00 next morning.	Construction units,	0.5
		Ecological environment	1. Properly design the trend of the road to make full use of the original pavement instead of the farmland to reduce the ecological destruction by digging the roads. 2. The temporary occupied forests and farmlands should be recovered and plowed.	Construction units,	10.0

Operation period	Dam project	Water environment	1. Set colleting pool for leaked oil in the factories and pool for treating accidents. In addition, oil water separator should be equipped to deal with all the leaked dirty water with oil.	Department in charge	4.5
			2. Ecological dry toilets should be set up in the management station.		
		Ecological environment and soil and water conservation	1. Enhance the construction of the systems of the ecological preventive forests around the reservoir and manage effectively all the plants in the reservoir bank and green area. Replant once discovering the dead ones.	Department in charge	3.0
			2. Control the exploitation scale of the land and prevent the expansion of the farmland and the shrinking of woodland.		
			3. Recover the vegetation on the river shoal. Prohibit the reclamation of the wasteland for farmland to prevent the riverbank slide and the collapse.		
			4. Strengthen the protection of wildlife in the reservoir area and arrange personnel for patrol and protection, in order to prevent the poaching of wildlife.		
			5. Enhance the inspection of the fish species in the reservoir area. If necessary, put a certain amount of local fingerlings to maintain the balance of fish species in the reservoir area.		

			6. Reinforce the work of greening in the work sites and living zones.		
		Ecological environment	Test and maintain the stability of the reservoir bank in the protection zone of the project regularly. Deal with the places with dangers immediately.	Department in charge	3.0
		Inspection of the stability of reservoir bank	Monitor the landslide body in the reservoir.	Department in charge	12.0
	Material sites	Ecological environment	1. Maintain the vegetation in the waste material sites annually.	Department in charge	3.0
			2. Reinforce the maintenance and conservation of all the measures of maintaining water and soil in the waste material sites until the stability of the ecological environment.		
	Electricity generation		Sound-insulation device should be set up in the factories of the power station and the maintenance of the device should be carried out.	Department in charge	2.0
	Road project	Water environment	Test and maintain the drainage system on the road to make sure the smoothness of the system.	Department in charge	0.5
		Air environment	Spray water on the roads to reduce dust according to the weather.	Department in charge	0.5
		Sound environment	Protective measures should be taken in places sensitive to superscale noise according do the results of the test.	Department in charge	1.5
		Ecological environment	1. Test the grass and trees in line at both sides of the roads and replant once discovering the dead ones.	Department in charge	2.0
		Traffic safety	Set up safety warning boards in those traffic accidents-prone roads.	Department in charge	1.0
Other fees			Supervise the fees for construction management,		20.0

	environmental supervision and quality of construction.		
Total Static Total investment for maintaining water and soil			80.0
Total estimation of investment for environmental protection measures		219.00	

The total investment of the project is 24.1522 million yuan, among which 2.19 million yuan is special investment for environmental protection, accounting for 9.07% of the total investment. In the bidding documents of the project, the investment of environmental protection should be listed in the investment estimation clearly and should be ensured to be used as special investment for protecting the environment in its implement, which truly fulfill the environmental protection in the project.

13.2 Analysis of the Economic Profits and Losses of the Environmental Influence

13.2.1 Purpose and Principle

(1)Purpose

The purpose of the analysis of economic profits and losses of the environmental influence is to use the principles of ecology and environmental economics. Under the premise of considering the continuance, sustainability and coordinated development between the construction and ecological environment as well as the regional economy, the benefit analysis of the expense in use is to carry out a comprehensive analysis of the environmental benefits and the loss of the project. It also will provide scientific references for the policies of the leaders to reduce the negative effects on the environment and the comprehensive economic assessment of the investment on the measures, which aim to reduce the negative influences from the project on environment.

(2)Principle

There is no standard regulation now in our country about the analysis of economic benefits and losses of the environment of the water conservancy project. Still, some environmental influence is hard to be measured exactly or measured in money. The analysis of the environmental benefits and losses of TangjiahellHydroelectric Power Station is based on the experience of analyzing the current water conservancy projects in our nation, combining the features of the environmental influence of this project. The principles to follow in the analysis of environmental benefits and losses are as follows:

The principle of ultimate influence: The water conservancy project has a wide related extension and a long construction period. The eco-system influenced by the project is a complicated one, among which the inner environmental elements have complicated relations. The project may have a chain reaction on the ecology and environment. Thus, while analyzing the economic benefits and losses of the environment, we only consider the ultimate results of the direct influences on the ecological environment or people's economic activities.

The principle of recovering the functions: When analyzing the environmental influence from the project, we should give priority to prevention, protection and saving in order to protect and recover the original function of the ecological environment. Thus, when analyzing the economic benefits and losses of the environment, we should be sure of the fees of protective measures and remedial measures and the fees can reflect the influence of the project. And we should regulate the investment scale of the protective and remedial measures with the limits of maintaining and recovering the ecological environment before the construction.

The principle of one-off estimation: Because of the differences in time between the environmental losses and the environmental effects, there is no comparison among the losses. As a result, in the analyzing, convert the environmental losses and environmental effects to current value according to the regulations and proper time limit. The once-time evaluation may be convenient for analysis and calculation.

As for those environmental effects that cannot be evaluated, no quantitative economic analysis need to be conducted, qualitative instructions only.

(3) Methods of Analyzing

According to the basic principles and the features of the major ecological and environmental elements influenced by the project, measures like market value method, prevention cost method, replacement cost method and shadow project method can be used to estimate the environmental effects and losses. Later, we can evaluate by comparing the losses and profits. The choice of the method depends on the specific substance and the features of the elements, which includes:

The market value method is used to assess the quality changes' influence on the production of the production market.

The prevention cost method evaluates the economic effects of the environmental quality through taking environmental protection measures.

The replacement cost method uses the fees needed for recovering the damaged natural resources and various assets to the original conditions thus to evaluate the economic effects of the environmental quality.

The shadow project method actually is a special form of replacement cost method, which evaluates the losses of the environmental destruction of the profits of environmental protection through the fees on shadow project. The shadow project means the supplementary project used as the substitute for the original environmental quality.

13.2.2 Analysis of the Economic Profits and Losses of Environment

(1) Positive Benefits

The ultimate influences of the completion of TangjiahellHydroelectric Power Station is preventing the soil erosion and water loss and protect the local vegetation and forests in the remote poor areas. By the adjustment on the flow of the reservoir, the distribution of the water in the river within a year will be average and the flow in the flood period will decrease which will alleviate the eroding of the flood on the riverbanks and ease the destruction of the loss of water and soil on the ecological

environment. The increase of the flow in the dry season is beneficial for the agriculture at the banks and the water used by the residents.

The average capacity of generating electricity of TangjiahellHydroelectric Power Station is 18.2709 million kWh. Developing electricity and using it instead of burning brushwood is a measure, which is easier for the local to accept. The completion of the station will provide credible guarantee for replacing brushwood with electricity and it provides material basis for protecting the current forest resources, which will have extensive influence on the local environment.

After completion, the hydropower station will have an installed capacity of 2× 2500kW with an annual average electricity generation capacity of 1303.85×104kW·h. The income of generating electricity should be adjusted following the shadow prices. The electricity shadow price for the central China power grids is 0.2225yuan/kWh. The adjustment quotiety $K_{1\ is}$ 1.15 relating to the large grids, the quotiety $K_{2\ is}$ 1.15 when there is a lack of electricity and K_3 will be 1.15 for transportation. The quotiety of the available electricity quantity is 1.0. According to the operation experience of the power stations of the same kind, the rate of electricity consumption in the factories is 1% and the net damaging rate is 9%.

S=(K1×K2×K3)×0.2225=0.3384 元/kWh。

S=(K1×K2×K3)×0.2225=0.3384yuan/kWh。

The quantity of sold electricity = average electricity generation quantity of many years×useful charge coe ×(1- the rate of electricity consumption in the factories) × (1- the net damaging rate) = 11.7464 million kWh

The income of generating electricity= quantity of sold electricity×S=3.9698millon yuan

(2) Negative Benefit

The fields submerged by TangjiahellHydroelectric Power Station is about 44.53 mu,, among which the woodland is 2 mu, the farmland is 4.68 mu, the river shoal is 21.25 mu and the barren hills is16.6 mu.

The compensation for the land according to the standards from the owners and the schemes are as follows:

① The compensation fee for collective fields in the village

Compensate the farmland, according to the annual production, six times as 1000.00 yuan/mu; the forestland, five times as 500.00 yuan/mu and no compensation for the occupied river shoal.

②Resettlement subsidy for farmers

a. The farmland is calculated by 1 mu per capita and the subsidy for the farmers is six times as 1000.00yuan/ mu and the subsidy for young crops is 500.00yuan/mu one time.

b. The subsidy for forestland is five times as 500.00yuan/mu according to the annual production.

c. No subsidy for river shoal

③ compensation for attachments

a. The compensation for the tea garden with lines of tea trees is 10.00yuan/m^2. The tea garden with irregular shape should be calculated by 4.00 yuan/ Dou

b. oranges: 80.00yuan/plantbfor those with fruits; 2.00yuan/ plant as fees for transplant for those without fruits

c. Encomia Bark: 20.00yuan/plant for those higher than 10cm; 10.00yuan/plant for those below 10cm.

d. Palm: 3.00 yuan/plant

e. Magnolia: 20.00 yuan/plant for those above 10cm, 10.00 for those below 10cm

f. Phellodendron: 20.00yuan/plant for those above 10cm and 10.00 yuan/plant for those below 10cm

g. Fir tree (metasequoia and willow are excluded): For those with a dbh of more than 10cm, 10.00 yuan/plant. For those with a dbh of less than 10cm, 5.00yuan/plant.

h. miscellaneous trees: 4.00yuan per lumber. Others compensated as forestland.

i. Medicinal materials should be transplanted and 2.00yuan/plant as compensation.

j. Magnolia liliflora: 30.00yuan/plant for those with a dbh of more than 10cm and 15.00 yuan/plant for those with a dbh of less than 10cm.

k. other fruit trees: 30.00yuan/plant for those with fruits and 2.00yuan/plant for those without fruits as transplant fee

l. As for the tomb in the submerged areas, give the farmers 300.00yuan per tomb as compensation and ask the farmers to move the tomb by themselves.

④ The resettlement of the buildings should follow the standards in the ***Resettlement of Buildings in the Reconstruction of Yalai Road*** issued by the people's government of the county.(1998, No.31)

⑤ In the process of compensation, we should act in accordance with the law and never harm the interests of the farmers. The owners should submit the compensation

fees to the Station of Land and Resource in the county altogether, which in return will give the compensation to the village and every household.

⑥ About the tax

a. Tax for occupied farmland

According to the ***Implement of the Tax for Occupied Farmland in Hubei Province*** (No.73 [1987], issued in 11th, July, 1987 by the provincial government), the standard of the tax is 4000yuan/ mu.

b. the management fees for land expropriation

According to the regulations in the ***Items and Standards of the Administrative Undertaking Charge in the Management System of Land*** issued by the Department of Finance of Hubei Province and the Bureau of Price in Hubei Province, the management fee of the land expropriation in this project accounts for 1.1% of the total investment for land compensation.

c, the fees for recovering the forests

According the regulations, Wufeng belongs to the zones of the protection forest of the Yangtze River and thus all the forestland belongs to the protection forest. The charging standard of the fees for recovering the forests is 5.00yuan/$m^{2.}$

⑦Other fees for compensation

The river shoal belongs to the public expropriation and thus no compensation.

The temporary occupied barren hills is 2.3 mu and the compensation fee is about 700 yuan as 300yuan/mu; the temporary occupied farmland is 0.45 mu and the compensation fee is 200 yuan as 500 yuan/mu; the temporary occupied tea garden is 1.10 mu and the compensation fee is 500 yuan as 500 yuan/ mu.

The permanent occupied barren hills is 16.60 mu and the compensation fee is 34900 yuan as 2100yuan/mu; the permanent occupied farmland is 4.68 mu and the compensation fee is 58500 yuan as 12500 yuan/mu; the permanent occupied tea garden is 2.0 mu and the compensation fee is 13300yuan as 6667yuan/mu.

The tax for expropriating the farmland is 4000yuan/mu and the compensation fee for 4.68mu farmland is 18700yuan. The management fee for expropriating the land accounts fro 1.1% of the total investment of the compensation fee of the land, altogether 1200yuan.

Altogether, the total compensation fee is 128000 yuan.\

13.2.3 The Comprehensive Analysis of the Environmental and Economic Benefits of the Project

For those evaluation elements in the environmental influence that can be quantitative, evaluation method ecological economy should be adopted for estimation. For those losses and elements that cannot be quantitative for the moment, make them qualitative as unsure. The quantitative and qualitative analysis of the losses and benefits of the project-related environmental influences is shown in table 13-2.

Table 14-2 Analysis of Economic Profits and Losses of the Environment in the Project Unit: 10000yuan

Environmental elements	Features of the environmental influence	Current value		rate
		benefits	losses	
1. Local climate	Improved slightly	positive		57.1
2. Water quality	Little change			
3.Water temperature in the reservoir	No obvious negative influence			
4. Geological environment	Landslide, collapse, leakage and reservoir-induced earthquakes are possible.		positive	

5. Mud and sand in the reservoir	The reservoir holds up the mud and sand in the upstream and improves the water quality in the downstream.	positive		
6. Terrestrial propagation	No obvious influence on the terrestrial propagation around the reservoir. No block in migration channel of the animals. Possible to attract birds to inhabit. A better condition for the species replacement for the surrounding vegetation.	positive		
7. Aquatic organisms	Negative influence on the aquatic ecological environment		positive	
8. environmental protection in the construction site	Deal with the waste gas, wastewater and residue. Conduct health care on the workers and recover the slash		19	
9. Soil and water conservation	The loss of water and soil in the construction site		80	
10. Environmental inspection	Environmental inspection in the construction and operation periods		20	
11. Environmental management	Manage the construction and environment and supervise the quality of the project		20	
11. Electricity generation	The total profit of generating electricity is calculated in 50 years.	7939.6		
12. Flood prevention	Improve its function of flood detention and flood regulation.	positive		
Total:		7939.6	139	

As shown in table 13-3, the ecological environmental losses on the designed areas mainly are the deterioration of the environmental quality, the submerging of the land, the loss of water and soil, the geological environment in the reservoir, the regional climate, aquatic organisms, the water quality, terrestrial living organisms and the environmental supervision and management in the constructed areas in the construction period. In addition, the profits are shown in electricity generation, the mud and sand and flood prevention. According to the estimation of the economic profits and losses of the environment, the rate between the ecological economic profits and the losses in this project is 57.1, that is, the ecological economic profits are

more than the losses. As the calculation in Table 13-3, some beneficial influences which are hard to be quantitative haven't' been taken into consideration. Thus, taking all the quantitative and qualitative analysis of the environmental economic profits and losses into consideration, it is feasible to construct the project in terms of its environmental economic profits and losses.

14. Conclusion and Suggestion

14.1 Conclusion of the Current Environmental Quality

14.1.1 Ecological Environment

The TangjiaheⅡHydroelectric Power Station is located in Caihua Village of the autonomy county of Tujia Autonomous County in Wufeng, Yichang, Hubei. The drainage basin of the project has luxurious forests and vegetation with forest coverage of 73%. The basin is not greatly influenced by human activities and the productivity of the regional ecological system is 979.37g/m^2.a. Being a transitive ecological system between the coniferous forests in the north and the broadleaf forests in the temperate zone, this basin has relatively strong resistance stability.

14.1.2 Current Situation of the Soil Erosion and Water Loss

The construction site is located in the Yuquan River of Caihua Village in Wufeng County, which has inconvenient transportation, scarce population, intact preservation of the vegetation, smaller sedimentation concentration in the rivers and the loss of water and soil is caused by the eroding of water. Due to the intact preservation of the vegetation in the region, the loss of water and soil is often the surface erosion with an area of 23.2km^2 with occasional occurrence of gully erosion and gravity erosion .The modulus of the eroded soil in the project is around 3031t/km²•a.

14.1.3 Air Quality

The concentration of SO_2、NO_2 in the region is low and the one hour number and the average daily number are both consistent with the standards of the second grade in ***Standard of Air Quality*** GB3095-1996. The average daily number of TSP is between 0.032~0.036mg/m^3 ,which also accords with the standards in the evaluation. Thus, the air quality in the construction area is good.

14.1.4 Environment of Surface Water

Judging from the inspection statistics of the current situation with the evaluation method stated above, evaluation is carried out in the water quality of all the sample section in the region. In addition, the indexes of water quality inspection in the section are consistent with the standards of second class in ***Standard of the Quality of Surface Water //***GB3838-2002, which shows that the water quality in the region is good.

14.1.5 Sound Environment

All the inspection points in the designed construction site accord with the first grade in ***the Standard of Noise in Urban Areas*** both in the daytime and at night. The noise in the daytime and at night in the environment-sensitive points meets the evaluation standard, which shows that the noise in the evaluated region is good.

14.2 Conclusion of the Environmental Influence in Construction Period and Operation Period

14.2.1 Ecological Environment

After the completion of the power station, part of the forestland and fields of grass and shrub, which had high productivity, originally may change their functions after being expropriated and the natural productivity of the landscape system may reduce. However, there is no such a problems as submerging the reservoir because the main buildings of the project have a small permanent occupied area, only 0.0067% of the regional area. The productivity of the natural system after operation is 979.30g/m^2·a, only down 0.07g/m^2·a before the construction. Thus, the influence from the operation and construction of the hydropower station on the productivity of the region is within the limit of the ecological capacity, which the nature in the region can bear.

The construction occupied fields do not include those large-scale natural forests and

the precious plant. Thus, there is no influence on the precious plants and the natural forests protection zones, which will not exert obvious influence on the reproduction and survival of the species. As the completion of the construction, the flattening of the slashing, backfilling, greening and planting trees will recover the vegetation in the construction sites, which will drive the regional ecological environment on a beneficial trend.

After the completion of the construction, as the fulfillment of all the recovery and protective measures and the recovery of the vegetation in the temporary occupied regions, the home range of the animals can be improved and they can return to their original regions. Thus, there will not be an obvious influence from the construction on the animal species in the region. As the discharge of wastewater from construction and domestic sewage is small and the wastewater will be discharged after being treated according to the relevant chapters in the report, the influence on the aquatic organisms is not serious enough that it will disappear as the completion of the construction. After the completion, if the abundance of the water and the cleanliness of the water quality in the river can be guaranteed combined with protective measures, the original aquatic organism resources and the living environment will not be influenced greatly.

14.2.2 Soil Erosion and Water Loss

The possible accelerated eroded area of the construction may reach 4.08hm^2 and the estimated loss may be 1800t. The newly added loss of water and soil is 1200t; the loss of the dregs is 21600t; the possible total loss of water and soil can be 23400t and the newly total loss of water and soil is 22800t. As the ground surface in the expropriated range will be damaged in different degrees, part of the landscape will undergo big changes. If measures of conserving water and soil are not taken, influences of different degrees will be conducted on the regional land productivity, the regional ecological environment and the change of scouring and silting in the watercourse of the Longtan River.

14.2.3 Solid Waste in the Construction Period

The solid waste in the project mainly is construction dregs and domestic garbage.

(1) Construction dregs: The dregs from the construction are 41600 $m^{3.}$. If not treated properly and rushed to the watercourse, it will not only increase the difficulty of the construction and interfere with the schedule, but also damage the natural ecological environment and cause the loss of water and soil, influencing the ecological balance in the region. In the primary design of the construction, six dumping sites are planned, occupying an area of 2.46$hm^{2.}$ After the abandon of dregs, we should return the land to farmlands and to forests, controlling the influence of the loss of water and oil on the environment to the largest degree.

(2)Domestic garbage: The total amount of domestic garbage produced in the construction is 58.4t. If not treated properly, it will lead to the breeding of mosquitoes, the reproduction of bacteria and the damage of rodents, which will be a major cause of epidemic. At the same time, the improper piling of the domestic garbage will damage the soil structure in the places for piling the waste or it will be polluted by the pathogenic bacteria and thus secondary pollution may emerge, which will have negative influence on the surroundings.

14.2.4 Environment of Surface Water

(1) Construction Period

The discharge of the wastewater in the construction and the domestic sewage will have partial pollution in the Yuquan River. The discharging of wastewater from the construction is 246000 m^3, including the wastewater from the construction and the domestic sewage in the construction period. The total discharging of construction wastewater is 19100 m^3 with the major pollutants of pH 、SS. The discharging of the domestic sewage is 5600 m^3 with major pollutants of SS、BOD_5、COD. The wastewater will be discharged in to Longtan River after proper treatment.

(2)Operation Period: The water-taking dam in the power station only has the function of retaining water into the trench. Generally, the upstream water level is 1.higher than the natural water level and thus there is, basically, no storage in the reservoir. And there are few people in the dam and the upstream basins, the emission of pollutants is small. Although the depth of the water increase after the construction of the dam and

the flow speed reduce, the eutrophication is not easy to happen.

The Tangjiahe Ⅱ Hydroelectric Power Station is a one of diversion, which basically has no reservoir storage. Although there is a dam to take water, the general water level is only 1m higher than the natural water level before the construction of the dam. The highest water level before the dam is 5.1m (the water-taking dam is an overflow dam with a highest dam of 5.1m). The flow in front of the dam is rapid and the leaking and permeability is strong. There is no change of temperature in the water within a year in both the horizontal and perpendicular directions and the distribution of the water temperature upstream is average with no big difference from the water temperature in the natural watercourse at the same period. Because of the diversion tunnel of 3.87km, the electricity generation tail water in the station is 2~5℃ lower than the natural watercourse in temperature.

14.2.5 Sound Environment

The areas polluted by the construction noises seriously are the construction sites. The environment-sensitive points within a short distance from the construction sites will have obvious influences. Thus, construction management should be reinforced and construction at night is forbidden to avoid the noise from troubling the residents.

14.2.6 Air Environment

The influence of the project on the air in the surroundings is mainly the flying dust of construction and the coal burning exhaust of living. The areas influenced are mainly the construction site and the living zone. However, the ability of spreading in the valley is weak. Thus, the height of the exhaust stack should be properly increased to improve the ability of spreading and diluting and improve the regional air quality.

There is a period and limitation of the influence from the construction on the air quality in the surroundings. Once the construction ends, such influence will no exist.

14.2.7 Regulating the Flow

The influence of the completion of Tangjiahe Ⅱ Hydroelectric Power Station on the river flow is not large. During the dry seasons, the water-taking dam can hold up the tail water in the primary and secondary power stations in Baiyiping and the Tangjiahe I Hydroelectric Power Station(designed). As the demand for generating electricity in the station, the Tangjiahe Hydropower Station (designed) can regulate the flow. Thus, the flow in the low water level period, the high water level period and the normal water level period tend to be average. This is beneficial for regulating floods and the ecological development in the basin for the rivers with steep dropping and rising.

14.2.8 Scouring and Silting of Mud and Sand

The sand concentration of the suspended load in the dam is 0.18kg/m^3 with an multi-year average suspended load of 10100 m^3 and the multi-year average suspended load is 1700 m^3.(the dry density of the dry density of the suspended sand and pushing sand is respectively calculated by1.3t/m^3、1.5t/m^3). Tangjiahe Ⅱ Hydroelectric Power Station doesn't have a reservoir and thus there is no silting up of mud and sands. The highest part of the diversion dam is only 5.1m and it is easy to clean the mud and sands in front of the dam. In addition, the river is clean with a relatively small number of silting, which will not interfere with the operation of the power station.

14.2.9 Ecological Environment

The project is a river-run power station with basically no storage capacity. The ecological structure in the region is stable and the possible of inducing earthquakes is rather slim.

14.3 Conclusion of the Measures of Environmental Protection

14.3.1 Protection Measures of the Water: The wastewater from processing sandstones, the wastewater from depositing and preserving concrete and wastewater

used for washing the machines and vehicle in the construction should be respectively dealt with in neutralization precipitation, coagulation sedimentation and oil separation tank. The domestic sewage should be coped with in three-squared septic tank.

14.3.2 Measures for the Project of Maintaining Water and Soil: Through building temporary dumping sites, protection slopes and protection banks, the source of the loss of water and soil like the abandoned soil and stones can be dealt with. After the completion of the project, the vegetation should be recovered in time, construction slashing be removed and the forestation should be carried out in the construction site.

14.3.5 Protective Measures of Living Organisms and Ecological Environment: Properly plan the land for construction, the method of construction and the schedule. Protect the forests and wildlife as much as possible.

14.3.4 Other Measures for Environmental Protection: Adopt wet mix method and operation in hermetic closure to control air pollution. Adjust properly the plane layout of the construction and the timetable of construction. Avoid using machines with loud noses and explosions during the people's rest. Collect in fixed points, transport immediately and deal with the domestic garbage.

14.4 Conclusion of Comprehensive Evaluation

14.4.1 Positive Influence

The positive influence on ecology and environment of the Tangjiahe ⅡHydroelectric Power Station mainly shows in the following aspects:

The construction of the project not only improves the guarantee rate of supplying electricity of the grinds in Yichang, but also provides a powerful guarantee for energy and a precious development opportunity for the local economic development in Wufeng and for the further exploitation of the resources.

During the operation of the project, due to the regulations of generating electricity in the power station, the flow in the downstream during the dry season may be increased and the water quality may be improved. It will also prevent the occurrence and spread of epidemic, which is in favor of the local economic and social development as well as the wellbeing of the people.

During the construction of the project, the large investment on the construction fund, material and techniques will have positive influences on the local economic and social development, the exploitation of the resources, the administration and construction of the ecological environment.

14.4.2 Negative Influence

The negative influence on ecology and environment of the Tangjiahe ⅡHydroelectric Power Station mainly shows in the following aspects:

The permanent occupied land will lead to the loss of the land resources and the pressure of the local environmental capacity. Moreover, the negative influences are permanent and nonreversible.

After the completion of the power station, the water in the reach 0.43km away in the downstream will reduce, the flow speed will slow down and the ability of self-purification of water will weaken. Strict controls must be conducted for preventing the discharging of the pollutants in the upstream. Make sure that the water quality after the completion will not have the tendency of degradation.

In conclusion, there are positive and negative influences on the ecological environment of the Tangjiahe Ⅱ Hydropower Station. But in terms of its whole and long term use, the benefits are more than the harms. The positive influences have a long period of function with a wide range of influence and it also has the effect of accumulation. The negative influence is that the permanent occupied land of the construction is nonreversible and others can be prevented or reduced by taking measures. Thus, in terms of the analysis of the environmental influences and development of ecological environment in the region, the construction scale and its

address is feasible in terms of environment.

14.5 Suggestions

In order to reduce the negative influence of the project to the largest and make full use of its social, economic and environmental benefits, the following work is suggested:

14.5.1 Make a General Plan for the Comprehensive Development in the Region

Combine the development plans, the national territory renovation plans and the environmental plans and make a plan for the comprehensive development in the region. Establish a high efficient and high energetic ecological and economic system with virtuous circle. Fulfill the coordinated development of economy and society and the integration of the social, economic and environmental benefits.

14.5.2 Make Plans for the Regional Water Resources

According to the tasks, the current situation of the water quality and the function, plans for comprehensively using the water resources should be made and carried out. Make sure the lowest flow below the dam is no less than 0.34m^3/s to meet the least ecological demand for water in the water-reduced reaches and the demand for water for the aquatic organisms in the downstream. Strictly control the new sources of pollution. Inspect and predict the water quality in the reaches where the project locates regularly and make fullest use of the comprehensive benefits of the hydropower station.

14.5.3 Implement Various Investment of Environmental Protection

Implement investment for environmental protection and establish the relevant supervision mechanism to make sure the special use of the special investment on environmental protection. Make sure all the environmental protection measures coincide with the “three meantime” of the major project.