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Attachment 2: Power of Attorney about the Environmental Influence of Yuquanhe Hydroelectric Power Station Project edited by Yiye Hydropower Development Company Limited in Wufeng

Attachment 3: Official reply from the Bureau of Construction and Environmental Protection on the standards of assessing the environmental influences from the project of hydroelectric power station in Yuquanhe Basin by Yiye Hydropower Development Company Limited of Wufeng

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1 General Principles

1.1 Origin of the Task and Background of the Project

Yuquanhe (Heitan River) runs through the north side of Siyang River in Wufeng, ranking the largest tributary of Siyang Reach and the sub-tributary of Qingjiang River. Sharing the watershed with Wantan River and Tianchi River, Yuquan River originates from Beifengya Forestry Centre at an elevation of 2231m, runs through Songjiahe, Tangjiahe, Hongyuping, Kuzhuping, and flows into Erchakou Reservoir (the water lever is 420m) of Siyang River at Erchakou. The total length is 18.26km and the difference in elevation is 1793m. The catchment's area of the planned reach is 99.85km², with a mean annual precipitation of 1474.4mm; while the average annual runoff depth is 938.4mm, the average annual flow is 3.25m³/s, and the mean annual runoff is 102 million m³. The total hydropower potential is 13,800 kW, and annual hydropower available is 121million kWh accordingly.

According to the topographical and geographical characteristics and river configuration, Qingjiang River Hydroelectric Power Survey and Design Institution of Yichang worked out a *Report of Hydroelectric Power Development Plan for Yuquan River of Wufeng, Hubei Province* in January, 2004, which was officially replied by Hydroelectric Power Bureau of Wufeng Tujia Ethnic Group Autonomous County in the *The Development Planning Bureau of Wufeng Tujia Autonomous County No.34 Document / 2004* on February 10th, 2004. In accordance to the report, the cascade development plan for the river reach is to establish six power stations and one reservoir on the main stream of Yuquan River. To be specific, at the upstream of Yuquan River with an elevation of 1400m, a power plant, named Xiejiazhai Hydropower Station will be set at the mouth of Hongpiaowan (at an altitude of 1036m), whose installed capacity is 2×320kW and the average annual energy output is 2,678,300 kWh. At Liziping, a spring at an altitude of 1445m will be used to

generate hydropower. It is planned to take water at the spring opening and establish a station named Liziping Hydropower Station at an elevation of 1040m, whose installed capacity is $2 \times 400 \text{kW}$ and average annual energy output amounts to 3,217,300 kWh. Taking water at Hongpiaowan at an elevation of 1036m, and setting the station at Songjiahe at an altitude of 865m, Songjiahe I-Hydroelectric Power Station will be built with an installed capacity of $2 \times 630 \text{kW}$ and an average annual energy output of 5,387,600 kWh. With a water intake at the mouth of Dixiwan (at an altitude of 865m), located at the upstream of Yuquan River and a power station established at the end of Tangjiahe Reservoir, Songjiahe II-Hydroelectric Power Station will be set whose installed capacity is $2 \times 400 \text{kW}$ and average annual energy output reaches 3,316,600 kWh. At the right side of Tangjiahe River, a tributary ditch runs through the plain and vast terrain, where the stratum is made of shale of Silurian System. A small reservoir is planned to be established here with a dam 55 meters high and total water storage of $2,070,000 \text{ m}^3$, so as to store some water and adjust the hydroelectric power stations at lower reach. With headrace directing water from the reservoir to Hongyuping (at an altitude of 560m), Tangjiahe Reservoir Hydropower Station is to be constructed with an installed capacity of $5000 + 2000 \text{kW}$ and an average annual energy output of 23,306,700 kWh. Having water intake at the lower reach of Hongyuping (at an altitude of 560m), and power plant set at Kuzhuping, the end of Erchakou Reservoir, Kuzhuping Hydroelectric Power Station is to be established with a installed capacity of $2 \times 2500 \text{kW}$ and an average annual energy output of 22,024,200 kWh.

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 planned to develop Songjiahe I-Hydroelectric Power Station and Songjiahe II-Hydroelectric Power Station, Tangjiahe Reservoir and Hydroelectric Power Stations. Developmental Planning Bureau of Wufeng Tujia Ethnic Group Autonomous County

officially replied the hydroelectric power development program of this river reach on April 26th, 2004 in *The Development Planning Bureau of Wufeng Tujia Autonomous County No.34 Document / 2004*.

From February to October 2004, Water Conservancy, Electricity Survey and Design Institution of Qingjiang, Yichang have completed the project feasibility study reports on the above-mentioned power stations and reservoir construction. October 23, 2004, Wufeng Hydropower Development Co., Ltd. billion industry in accordance with the relevant national and local environmental protection laws and regulations on environmental protection requirements, especially commissioned the Environmental Protection Institute of Yichang City of the project's environmental impact evaluation. To this end, the Environmental Protection Institute of Yichang City, conducted a spot survey at the scene to investigate, gather information and so on. According to *The Law of the People's Republic of China on Environmental Impact Assessment* and the provisions of the People's Republic of China State Council Decree No. 253 *Administration regulations of Construction Project Environmental Protection*, , as well as the People's Republic of China Environmental Protection Industry Standard, *Technical Guidelines for Environmental Impact Assessment*, the institute has completed the preparations of the *Environment Impact Report of Tangjia River Second Cascade Hydroelectric Station of Wufeng, Hubei* . January 11, 2005, Yichang City Environmental Protection Bureau organized the review of the report and, in accordance with the formation of an expert group meeting on the report assessed the modified views. It is submitted to the construction unit and reported the Environmental Protection approval of the competent authorities.

1.2 Objectives of Evaluation

Based on the field work, investigation and supervision on present environmental condition and public participation about the district and its surrounding areas of Yuquanhe Reservoir Power Station plant project , surveying the area's natural

environment and social environment of Wufeng Tujia Autonomous County of Hubei Province reservoir power plant project, analyzing the major environmental issues, we evaluate favorable and unfavorable impacts come from engineering construction, reservoir submerges, engineering operation and other engineering activities comprehensively and systematically on natural environment, social environment and the ecological environment; aimed at the project's adverse environmental problem , we propose practicable environmental protection measures and relief measures, so that the beneficial effects of the project can be brought into full play while the adverse effects can be relieved through adoption the practical environmental measures, to ensure that projects will not only promote the regional socio-economic development, as well as protecting and improving the regional eco-environment .

Through the assessment on the environmental impact of the project, environment feasibility basis was provided to the feasibility study of the project, enabling a more complete engineering design file, so as to facilitate the progress of construction works; as well as providing a scientific basis for environmental management, supervision and monitoring of the project.

1.3 Compilation Basis

1.3.1 Laws and Regulations

- (1) *Environmental Protection Law of the People's Republic of China (1989)*
- (2) *The Law of the People's Republic of China on Environmental Impact Assessment (2002)*;
- (3) *Water Law of the Peoples Republic of China (amended in Aug.2002)*
- (4) *Land Administration Law of the People's Republic of China (amended in 1998)*
- (5) *Communicable Disease Prevention Act of the People's Republic of China*

(Feb.1989);

(6) Law of the People's Republic of China on Water and Soil Conservation (June.1991);

(7) Forestry Law of the People's Republic of China(amended in 1998)

(8) Law of the People's Republic of China on the Protection of Wildlife(Nov.1988)

(9) Fisheries Law of the People's Republic of China(Oct. 2000)

(10) Law of the People's Republic of China on Prevention and Control of Water Pollution (Nov.2002)

(11) Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution (amended in April.2000)

(12) Law of the People's Republic of China on Prevention and Control of Pollution from Environmental Noise (March.1997)

(13) Regulations on the Administration of Construction Project Environmental Protection (Nov.1998)

(14) Administration Methods of Soil and Water Conservation Schemes for Development and Construction Projects (1994.11)

(15) Public places, Health Management Ordinance'' (1987.4);

(16) Law of the Peoples Republic of China on the Prevention and Treatment of Infectional Diseases (Dec.1991)

(17) Name List of Construction Projects for Category Management of Environmental Protection (1998 State Council Decree No. 253);

(18) Notice of public participation about strengthening environmental impact

assessment of construction project, national and local laws and regulations.

1.3.2 Technical Specification

(1) *Guidelines for Environmental Impact Assessment - Non-Pollution EIA (HJ/T19-1997)*

(2) *Guidelines for Environmental Impact Assessment (HJ/T2.1~2.3-93)*

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

(4) *Water Conservancy and Hydropower Project Environmental Impact Assessment Technical Specifications" (SDJ88-2003);*

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

(6) *Technical Regulation on Medical Evaluation of Environmental Impact of Water Resources and Hydropower Engineering (GB/T16124-1995)*

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

(8) *General Rule of Planning for Comprehensive Control of Water and Soil Erosion (GB/T15772-1995)*

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

(10) *National Key Protected Wild Plants List (first batch) (Aug.1999);*

- (11) *National Key Protected Wild Animals List (Jan.1989)*;
- (12) *Hubei Province Key Protected Wild Animals List (June.1994)*;
- (13) *Hubei Province Key Protected Aquatic Animals List (Dec.1994)*;
- (14) *Disinfection Technical Specifications (Ministry of Health, awarded in 1992)*;
- (15) *Surface Water and Wastewater Monitoring Ttechnical Specifications (HJ/T91-2002)*;
- (16) *Drinking Water Quality health norms (2001.6)* and other technical specifications.
- (17) *Rural Hydropower Environmental Assessment Principles*
- (18) *Soil erosion classification and grading standards (SL190-96)*.

1.3.3 Project-related Documents

- (1) Planning Development of Wufeng Autonomous Country, *Entrustment Letter for Implementing EIA for Tangjia River Second Cascade Hydroelectric Station of Wufeng, Hubei* (see attachment 1)
- (2) Wufeng Yiye Hydroelectric Development Co. Ltd *Entrustment Letter for Implementing EIA for Tangjia River Second Cascade Hydroelectric Station of Wufeng, Hubei* (see attachment 2)
- (3) *Reply to the EIA Implementing Standard for Tangjia River Second Cascade Hydroelectric Station by Wufeng Yiye Hydroelectric Development Co. Ltd* No.8/2005 (see attachment 3)

1.3.4 Engineering Design Files

(1) *Planning Report of Hydroelectric Development in Yuquan River Basin of Wufeng* (Water Conservancy and Electricity Survey and Design Institution of Qingjiang, Yichang / Jan. 2004)

(2) *Feasible Study Report of Tangjiahe-Hydroelectric Station of Wufeng, Hubei* (Water Conservancy and Electricity Survey and Design Institution of Qingjiang, Yichang / Feb.2004)

(3) *Feasible Study Report of Tangjiahe-Hydroelectric Station of Wufeng, Hubei* (Water Conservancy and Electricity Survey and Design Institution of Qingjiang, Yichang / July .2004)

(4) *Preliminary Design Report of Tangjiahe Reservoir Power Station of Wufeng, Hubei* (Water Conservancy and Electricity Survey and Design Institution of Qingjiang, Yichang / Dec.2004)

(5) *Report of the Water and Soil Conservancy Plan of Songjiahe-Hydroelectric Station Project of Wufeng, Hubei*

(Water Conservancy and Electricity Survey and Design Institution of Qingjiang, Yichang / Mar..2004)

(6) *Report of the Water and Soil Conservancy Plan of Songjiahe-Hydroelectric Station Project of Wufeng, Hubei* (Water Conservancy and Electricity Survey and Design Institution of Qingjiang, Yichang / Sept.2004)

(7) *Report of the Water and Soil Conservancy Plan of Tangjiahe Resovior Hydroelectric Station Project of Wufeng, Hubei* (Water Conservancy and Electricity Survey and Design Institution of Qingjiang, Yichang / Dec.2004).

(8) *Wufeng Tujia Autonomous County of Hubei Province, flowers Song Heung River Power Development Zone, the planning stage of a geological survey report of the project* (Central-South Research Institute of Metallurgical Geology, February 28, 2004)

(9) *Report on Geological Investigation of Songjia River 2nd Stage Power Station during Preliminary Design Stage in Caihua Town Wufeng Autonomous Country Hubei Province* (Central-South Research Institute of Metallurgical Geology, June 28, 2004)

(10) *Engineering Geological Investigation Report Hubei Wufeng Tangjiahe reservoir power station* (Central-South Research Institute of Metallurgical Geology,, October 28, 2004)

(11) *Wufeng County River Basin fishery seven points a database of geological disasters in power plant construction site risk assessment report* (Geological Investigation of Foundation Engineering Co. Hubei Province, in May 2004)

1.4 Destruction Control and Ecological Environment Protection Goals

(1)Water quality: Control the emission of pollutant not to exceed standard, and protect water quality. The effluent quality meets the first grade criteria of *Integrated Wastewater Discharge Standard (GB 8978-1996)* during the construction period, *meets the Surface Water Environment Quality Standard (GB 3838-2002)* II standard.

(2) Ambient Air Quality and Sound Environment

No significant decreasing of ambient air quality and sound environment caused by construction work. The air quality complies with the secondary standard of the

National Ambient Air Quality Standard (GB3095 - 1996) , and sound environment complies with the first standard of the *Standard of Environmental Noise of Urban Area* (GB3096-93) .

(3) Soil Erosion: Engineering measures and vegetation measures should be taken in order to restore or improve the anti-erosion function of the land affected by excavation, filling, 占压 activities in construction, so as to make the treatment degree rate of water and soil loss higher than 95%; water and soil loss caused by the project construction should be prevented and managed, so as to make the control rate of water and soil loss higher than 95%; to make the disturbance of land management rate higher than 70%; basic residue of the construction should be handled properly, so as to make the spoil protective rate more than 95%.

(4) Vegetation: Reduce the destruction of vegetation due to the construction, renew the vegetation on the bare soil surface after the completion of the project, and make sure that the vegetation coverage rate reaches 90%, trees and grass coverage within the prevention and control responsibilities scope higher than 20%; slow down adverse effect of aquatic organisms due to the changes in hydrological conditions.

(5) Land Resources: Minimize spoil works processing, conditioned reclamation; mitigate the pressure on reducing local land resources due to the projects construction.

(6) Socio-economic: Do a good job of population health planning during the construction period; avoid all kinds of epidemic outbreak during the construction period, so that construction personnel and residents of neighborhoods can be less affected by air and noise pollution.

The focus of environmental protection objectives , see Table 1-1.

**Table 1-1 Environment Protection Targets Summary List for Hydropower
Projects in Yuquanhe River Basin**

Protection Target	Distance	Position	Scale	Protection Level
Yuquanhe River	-	-	From the 1km reach upstream of Yuqianhe I Hydropower Station to the entire downstream reach	Class II of Surface Water Quality Standard
Songjiahe I and II Hydropower Station, Tangjiahe Reservoir Hydropower Station and Diversion Tunnel Construction Area	Construction activities and impact range	Proximity	1km extending from the border of construction area	Class II ambient air; Category I noise; Water and soil erosion alleviated and controlled, vegetation restored;

1.5 Rating Grades and Scope

1.5.1 Water Environment

Yuquanhe Basin Hydroelectric Power Station basically non-discharge of sewage during operation, only have a certain impact on the environment during the construction and the early stage of water reservoirs.

Hierarchy based on the work of the water environment: ① sewage wastewater emissions: According to the project feasibility study report, the construction period mainly comes from the sand-gravel aggregate system flushing wastewater, concrete production system and recurrent pit drainage, mainly from domestic sewage construction of staff of domestic sewage. In construction, waste water peak

emissions close to 475 m³/d; ② the complexity of the wastewater quality: the construction period for the production of major pollutants in wastewater SS, and major pollutants in domestic sewage are BOD₅, COD and NH₃-N, degree of this project sewage shows moderate complex ③the scale of ground surface water area ,to construct three stations and one library project, Tangjiahe power station is located in the downstream of the reservoir, where the dam site Department for many years the average flow 1.71 m³/s, and the size of the river surface is small river ④ surface water quality requirements: according to the area under the protection of the water quality requirements for *Surface Water Environmental Quality Standards* (GB3838-2002) II-type water standards. Thus, according to the evaluation principles of classification in the *Environmental Impact Assessment Technical Guidelines for Surface Water* (HJ/T2.3-1993), the environmental assessment on the water has been determined as level three.

1.5.2 Ecological Environment

Hydroelectric power is a kind of clean energy, and hydropower stations have very few polluted emissions during the run-time; the impact of the projects on the environmental belongs to non-polluted ecological impact. According to preliminary investigations, the reduction of region biological populations biomass, species diversity caused by the construction of the project is far less than 50 percent, and will not lead to the disappearance of endangered species; although the extent of land-based connectivity will be deteriorated, the reduction will be controlled below 1/2,and basically would not lead to the deterioration of physical and chemical properties of water, soil and land; there is no sensitive areas in the region. The project construction will affect less than 20km²; the ecological impact of the project environmental impact assessment has been determined as three grades in accordance with the *Environmental Impact Assessment - Non-polluted Ecological Impact (HJ/T19-1997)*.

1.5.3 Atmospheric Environment and Sound Environment

The atmospheric environment and sound environment along the roads in and close to the construction area will be affected at a certain degree during the construction period, due to the main works of the project, simple construction of roads. It is found at the field survey, there are no residents within 50m of Songjiahel-Hydroelectric Power Station, neither residents nor activities within 2km of other Hydroelectric Power Stations except for 4-6 scattered households of the scope of 100m. There are no centralized settlements, schools and other sensitive receptors along the construction road either. Therefore, the atmospheric environment and sound environmental impact only need a brief evaluation. The scope of the evaluation will focus on construction areas and around the works area and the scope of about 1km extends to the border.

1.6 Evaluation Criteria

1.6.1 Environmental Quality Standard

- (1) *Standard of Surface Water Environment Quality* second criteria (GB3838-2002);
- (2) *Ambient Air Quality Standard* secondary standard (GB3095-1996);
- (3) *Standard of Environmental Noise of Urban Area* first criteria (GB3096-93)

1.6.2 Pollutant Discharge Standards

- (1) *Integrated Wastewater Discharge Standard* first grade criteria (GB8978-1996);
- (2) *Construction Noise Limits* (GB12523-90);
- (3) *Integrated Emission Standard of Air Pollutants* secondary grade criteria

(GB16297-96).

1.7 Rating Period

Environmental impact assessment period of the project is divided into the construction period and operation period. Evaluation of the current condition is set at 2004 while the forecast condition is set at 2010.

1.8 Rating Focus

Identified and screened according to the nature, scale, and impact scope of the project, with reference to similar environmental impact assessment of other water conservancy and hydropower projects, this evaluation has been set to focus on three aspects, including water environment, ecological environment and construction area environment; general evaluation will be made on other issues such as local climate, hydrology, sediment, geology, population health ect.



2 Project Overview

2.1 Basin Overview

Yuquan River (Heitan River) is on the right bank of Siyang River, Wufeng. It is the largest tributary of Siyang River Basin and sub-tributary of Qingjiang River (a tributary of Yangtze River). The rivers share the watershed with Wantan River, Tianchi 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), Hongyu Ping (name of one of the 16 Villagers Committees 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 level: 420m) of Siyang 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 channel grade 11.7%, the middle reach of the river is from Dixi Bay mouth to Hongyu Ping, with a length of 6.96km. Elevation from 870m to 565m, and channel grade 6.3%; and the lower reach of the river is from Hongyu Ping to the end of Erchakou Reservoir, with a length of 4.6km, elevation from 565m to 420m, and channel grade 4.9%. The river reaches flowing through Songjiahe area outcrops Ordovician limestone, occupying 1.3km of the channel. The river reaches flowing through Yuquan River area outcrops Dyas limestone. Within the reach in plan, the catchment's area measures 99.85km², the average annual precipitation is 1474.4mm, the average annual depth of the runoff is 938.4mm, the average annual discharge is 3.25m³/s, the average annual runoff is 102 million m³. The theoretical hydroelectric reserve is 13.8 thousand kW, and the corresponding annual hydroelectric is 121 million kWh.

Wufeng is rich in rainfall, intense storm, and is one of the country's heavy rain centers.

The largest annual precipitation is 2578mm, the smallest 965mm; the largest 24-hour precipitation is 422.9mm. A onetime precipitation from July 3rd to July 7th, 1935 is 1318mm. The average precipitation of the county in nearly four decades is 1588mm. There are six large rivers in Wufeng, namely Yuyang River, Siyang River, South River, Tianchi River, Wantan River and Baixi River. According to the statistics in *Water Resources Assessment of Yichang*, the annual runoff volume of all rivers in the county amounts to 2.44 billion m³. A theoretical water reserve of the county is 324,000 kW, and can be developed to 255,300 kW, of which 79,000 kW developed. Rich hydropower resources provided favorable conditions for the development of small hydropower in our county.

Good vegetation within the basin, forest coverage rate is higher than 73%, from the Valley to the Peak, shrubs and trees, deciduous and non-deciduous plants, lush all year round. Good vegetation can prevent soil erosion effectively. River Plate Basin width generally ranging from 20 ~ 60m, most of "U"-type valley, a small portion of the "V"-type river valley, the general integrity of the riverbed on both sides of the exposed rocks, providing excellent natural conditions for building a hydropower station.

2.2 Project Location, the Development of the Mandate, Size and Layout

2.2.1 Project Site Selection

2.2.1.1 Songjiahe I -Hydroelectric Power Station

(1) Water Dam Site Selection

Songjiahe-Hydroelectric Power Station is the first level of the hydroelectric power cascade development, it is supposed to be a runoff-type hydroelectric power station,

the plant is located in Song River. Dixiwan, a tributary on the left bank, joins the main stream in Songjiahe, the upper reaches of Yuquanhe was dendrite distribution, which has three large tributary, from east to west, respectively, for the Matishan, Liziping and Mapengling.

Songjiahel-Hydroelectric Power Station Water intake dam is determined at the confluence of two tributaries, namely Liziping and Mapengling, the natural surface elevation is 1035.00m. The riverbed bedrock at the dam site are cropping out (other tributaries and concourse area, the river bed are deeper cover), rock was thick layer structure, which belongs to the II-type of rock, a relatively small amount of dam projects, and under the dam site 6m high natural Diego Hom, of water, sand and flood control scheduling very favorable. Village road passing through the right bank of dam site, 25m from the abutment, facilitate the construction and operation management. The elevation of the riverbed is 960.00m, at which the downstream tributary of the right bank of Matishan confluence with the main stream. In order to divert the water from Matishan branch and not lower the intake elevation, the design is made as intercepting water from upstream and then using culvert pipe to lead water to the intake dam. The basin area controlled by the intake dam is 20.8km² including Matishan branch 4.6km².

(2) Water Diversion Options

The headrace at Songjiahel-Hydroelectric Power Station will use the left bank layout scheme. A 630m long D500 culvert, a 2000m long non-pressure tunnel, and a 356.952m long main pressure pipe mainly compose the construction project. After settling pond water into the tunnel and 1 # 2 #tunnels to reach the fore bay, the pressure of pipe before the next pool, then under the power house, arranged along the ridge.

The powerhouse was arranged on the left bank of the river tributary to Bay Hill and

the main stream of the convergence of mouth, plant height and river flood coordinated. Site for plant are forest without buildings. Bedrock of the site is not deep, and for the reverse slope, ground conditions are better. A ditch, apart from each other, only separates village-level road and the plant 25m, external transportation are convenient.

2.2.1.2 Songjiahell-Hydroelectric Power Station

(1) Dam Site Selection

Songjiahell-Hydroelectric Power Station is the second stage in a small watershed and fisheries hydropower cascade development, according to watershed planning report, the project is a run-off ceremony for the station, the check dam is located in Songjiahe River, which is connected with the Song River power station tail water level. Powerhouse is located in Tangjiahe, and it is connected with Tangjiahe convergence.

Song River dam site is located in the upper reaches of a 90m power station plant, the dam on the river bed is 10m width, due to the role of river flow, the river bed and the two sides' fresh rock expose. Lithology of bedrock, riverbed and the left bank are better impermeability shale. Although the right bank is limestone, generally, the anti-seepage is in a better condition.

(2) Diversion Channel Line Selection

Songjiahell-Hydroelectric Power Station is a run-off-style power plant, including water intake project, water canal project, Hydroelectric Power Station powerhouse, booster stations and other components. Water intake engineering includes dam bottom fence, sand-basin, scouring sluice; water diversion project is made up of tunnel, aqueduct, pressure fore bay, pressure pipe and so on.

(3) Site Selection

Songjiahell-Hydroelectric Power Station is a run-off-style power plant, the dam is located in the upper reaches of Songjiahel-Hydroelectric Power Station around 80m. The power plant is located at Bridge Bay, about 1.5km away from the dam.

2.2.1.3 Tangjiahe Reservoir and Power Station

(1) Dam Site Selection

Tangjiahe water conservancy and hydropower pivotal project is the key project in the cascade development of Yuquanhe basin; the project is mainly aimed at generating electricity, providing drinking water, aquaculture and other benefits at the same time.

Dam site is located at Yuquanhe Bridge (until Baiyizhai Highway Bridge) upstream 0.3km. The riverbed is narrow at the dam site, the elevation of riverbed is around 751 ~ 756m; the river flows about 320 °; the width of the riverbed is around 7 ~ 10m; the valley was asymmetric "V"-shaped. The slope is steep on the left bank, gentler on the right bank. Wu (peak) Niu (Village) is located on the left bank, and its elevation is around 775-790m. The left bank of the dam on the Silurian bedrock basic nudity, partial formation hung upside down, the overall slope of about 700; dam site, while the left bank of the objects covered by colluvium, topographic gradient of about 40-450. The main dam site rock mechanics indicators: fine-grained sandstone saturated compressive strength value of approximately 41.0MPa, is in hard rock, rock a more complete. Politic siltstone saturated compressive strength value is 23.6Mpa, a soft rock. According to geological conditions of the terrain, the layout of reinforced concrete dam appropriate CFRD, in order to meet the comparability and Remembrance rock fill dam, roller compacted concrete gravity dam and other programs in the comparison.

(2) Site Selection

Tangjiahe Hydroelectric Power Station is located at the gentle slope on the left bank

of Yuquanhe, which is 250m downstream from BaiyipingII-Hydroelectric Power Station. It is composed of several buildings, such as main workshop, deputy plant, booster station and flood control buildings. the main plant used $32\text{ m} \times 13.6\text{m} \times 1.2\text{m}$ (L \times W \times thick) reinforced concrete foundation for the entire board, basal elevation 569.20m; the main workshop is close to river bank, long 30.4m, width 12.0m, in order to reduce investment of flood control projects, floor elevation 575.00m; deputy plant is behind the main plant, long 30.4m, width 5.1m, floor elevation 575.40m; booster station is located in the right plant, long 27.0m, width 25.0m.

A new 500m highway need to be built for the power plant, Wuniu highway will not be affected by the highway construction except for the impact of blasting time, and road surface doesn't need very high standards. Engineering quantity along the highway lines is very small. Changes in pressure pipe happens after the surge shaft, the surge shaft position to consider the elaboration of the main location of surge shaft ground elevation must be appropriate, so the program does not compare well to consider the changes in voltage regulator.

Location, see Attached picture 1.

2.2.2 Construction Task and scale

2.2.2.1 Construction Task

The project mainly uses the reservoir regulation of power plant water for power generation, to bear the peak load and waist load in power system. The main task is to generate electricity, to provide much-needed electricity for the local life and production.

Hydroelectric power is a pillar industry in Wufeng County. Accelerating the development of hydropower resources is a necessary condition for economic development of Wufeng County.

Based on national economic and social development planning, the construction of Songjiahel-Hydroelectric Power Station, Songjiahell-Hydroelectric Power Station and Tangjiahe Hydroelectric Power Station are necessary and urgent. The construction of this series of Hydroelectric power stations, will improve the quality of power supply in Huaxiang to a large extent, improve electricity supply to ensure that the level of rural society to promote the development of local forestry, medicine, special, deep processing of mineral products industry, increase the residents income in Huaxiang, and gradually realize " electricity replace firewood." It has a positive and realistic significance for the consolidation of local "closing hillsides to facilitate a forestation", "returning farmland to forests".

2.2.2.2 Projects Scale

(1) Songjiahel-Hydroelectric Power Station

Songjiahel-Hydroelectric Power Station is a run-off-type Hydroelectric Power Station, acting as base load in the system. The water head of power plant design is 159.205m, the design flow is $0.62\text{m}^3/\text{s}$, power station installed capacity of $2 \times 630\text{kW}$, to ensure that efforts 740kW (P=80%), multi-year average generating capacity 5,248,000 kWh, annual operating hours 4165h. The rank of the project is V, the corresponding level of hydraulic structures is five (including water hub, diversion of construction, power plant and booster stations, etc.).

(2) Songjiahell-Hydroelectric Power Station

Songjiahell-Hydroelectric Power Station is a run-off-style power plant, power station scale of installed capacity is 800kW, the corresponding level of hydraulic structures is five (including water hub, diversion of construction, power plant and booster stations, etc.). Check dam, a 10-year flood design, peak flow $181\text{ m}^3/\text{s}$, 30-year return period Verification, peak flow $240\text{ m}^3/\text{s}$, plant and booster station in the back of Tangjiahe

Reservoir, according to a 30-year flood design, peak flow 285 m³/s, 50-year return period verification, peak flow 307 m³/s.

Power design head 59.594m, design flow 1.80 m³/s, power station installed capacity of 2 × 400kw, to ensure that efforts 153kW (P = 80%), multi-year average generating capacity 3,033,800 kWh, annual operating hours 3792h.

(3) Tangjiahe Reservoir Hydroelectric Power Station

Tangjiahe reservoir dam is a concrete-faced rock fill dam; the height of the largest dam is 54.44m, total storage capacity 2,396,400 m³, installed capacity of 5000+2000kW. According to the *"Flood Control Standard"* (GB50201-94) of the People's Republic of China, the project for small (1) reservoir engineering, IV, the main building grade four, secondary buildings and temporary structures grade five. Water-retaining structure is concrete-faced rock fill dam; the reservoir is design by 50-year flood, according to a 500-year flood check; the power plant by 50-year flood design, according to a 100-year flood check.

The storage capacity is 2,069,600 m³ of Tangjiahe hydropower project when it's at the time of normal water level--800m, dead water level of 774.00m capacity 113,600 m³, adjusting capacity 1,956,000 m³, storage coefficient $\beta = 3.63\%$. It is a never-ending reservoir regulation for the whole year.

2.2.3 Project layout

2.2.3.1 Dam Type and Construction Layout

(1) Songjiahe-Hydroelectric Power Station Selection

Songjiahe-Hydroelectric Power Station check dam is located in the upper reaches of Yuquanhe, dam site area of rain over the plot area was a fan, steeper than the riverbed,

22% of longitudinal slope, there are skyrocketing up and down in the river, and the riverbed bed load to drift stone, gravel-based. As the river than longitudinal steep, difficult to form the upstream water storage capacity, even if we manage for a little storage capacity, as well as gravel blockage of water power station cannot adjust. Therefore Song River Hydropower Station use Low Dam water level.

To resolve the contradictions of water sand, facilitate the operation and management, Songjiahel-Hydroelectric Power Station dam water used at the end of fencing in the construction of the grit chamber to boulders, pebbles from the top of the dam directly discharged to the downstream, smaller harmful sediment in Grit Chamber ruled out on a regular basis after precipitation. There is a scarp downstream the dam, with the favorable conditions of the grit chamber construction, to make the end barriers closer to the grit chamber, and buildings more concentrated.

(2) Songjiahell-Hydroelectric Power Station Selection

As not to increase the flood damage, at the same time to prevent the water level from getting too high, leading to the right bank of the occurrence of a large number of leakage, determine the height of 1.3m, the basic maintenance of the natural hydraulic condition of the river. As the dam height of only 1.3m, intake inevitably have silt deposition, in order to understand the contradiction between water row sand, fencing at the end of dam design, coupled with grit chamber to deal with silt.

(3) Tangjiahe Hydroelectric Power Station Selection

Tangjiahe dam-type power plant is a concrete-faced rock fill dam. Anti-wave elevation wall stands 803.44m high, crest elevation 802.24m high, crest length 94.70m. According to the geological survey of the dam conducted by Hubei Province Geographical Surveying Co...Ltd, the plinth of the base surface elevation stands 749.00m high, while the maximum height for this project is 54.44m, and crest width 5m. In accordance with regulatory requirements and engineering experience,

this stage determines the upstream dam surface gradient as 1:1.4, in the downstream slope at a height of 771m and 791m Office 2m wide Ma Road 2, in order to conduct dam after-water works observation, Ma Road slope above to 1:1.3, MA Road, the following two slope is 1:1.4. The largest rock-fill dam is 149.4m wide. According to the design specifications of panels at the top of the thickness of not less than 0.3m, and at the bottom of a gradual increase in the use of C25 concrete panels, with two aggregate, impermeability grades shall not be less than W8, antifreeze labeling F200. Water-cement ratio should be controlled at between 0.4-0.5, not more than 0.5.

The use of bank spillway spillways from drains into the control weir, chute, and pick energy dissipation has four major components, a total length of 219.91m. Drains into the full-length paragraph 108.00m, drainage at the bottom of elevation under the weir top elevation 791.70m, drains into the weir and control for arc connected drains into the floor above longitudinal $i = 0$. Guide wall 1.00m thick paste of C15 concrete slope lining. Backplane using the aluminum seal 1mm thick. Control weir gates to control the use of WES practical weir by flood calculus and techno-economic comparison, to determine the top weir elevation for 791.70m, net width of the gate hole is 10.00m. Weir located on the single open-top curved door work together, using low-flow season overhaul, not a separate gate overhaul. Radial Gate Size: $W \times H = 10 \times 10.04\text{m}$. Reservoir normal water level 800.00m, arc ultra-high security doors 0.50m, to meet the requirements of retaining anti-waves.

Chute length of 71.27m, the use of rectangular cross-section width 10.00m. China's combination of bottom slope terrain geological conditions choice, the use of 1:1 and two different longitudinal 1:2.8. Chute first floor side elevation 778.32m, sidewall top elevation 783.25m; the end of floor elevation 750.38m, side wall at the top of the high-755.43m. Consumers can choose to adopt bucket energy dissipation approach bucket at the top elevation 751.30m, sidewall top elevation 755.43m, anti-arc radius $R = 13.0\text{m}$, angle 25° .

2.2.3.2 Major Buildings and the Overall Layout of the Project

(1) Songjiahel-Hydroelectric Power Station

Water intake dam is determined at the confluence of two tributaries, namely Liziping and Mapengling, the natural surface elevation is 1035.00m. Control drainage area of the check dam is 20.8 km². Songjiahe Hydroelectric Power Station dam water used at the end of the fence. Because the left bank of the water line is shorter than the right bank of the water line, and there is no pressure catch waters, left bank contains mainly tunnels, right bank mainly channels, determine the use of the left bank of the water diversion program.

Water hub consists of three buildings: the end of fencing dam (dam height of 2m, dam length 26.4m), Headwork grit chamber (width 1.6m, total length of 18.2m), cited from the culvert stream Horseshoe Hill (for a total length of 630m diameter D500). Diversion canal system including the tunnel, the two full-length 2000, before the pressure in the tunnel beside the pool arrangement, the pressure pipeline 357m, the diameter of D600, the installation of hydro-generating unit 2, a single 630kW. The length of the plant is 18m, width 9m, high-9.6m, and booster station 10m, width 9m.

(2) Songjiahell-Hydroelectric Power Station

Check dam is located in Songjiahe, the use of physical barriers at the end of dam water. Although the water line on the left bank is of poor geological conditions, larger engineering capacity, but the water diversion program of left bank can make full use of hydropower resources, increase development effectiveness, and be in line with the planning principles, with a comprehensive analysis, the use of the water diversion program of left bank has been confirmed.

Water hub includes the dam at the end of the fence; lose sand channels, headwork grit chamber and other sources of water intake buildings.

Diversion canal system includes the tunnel, aqueduct, the pressure before the pool, pressure pipe and so on. Full-length of the two tunnels is 1427m, the two tunnel were connected by the aqueducts with a total length of 36m. Pressure fore bay is arranged in 2 # tunnel, the pressure pipe is used to connect the fore bay and plant. Joint water supply is adopted; the length of the pressure pipe between the fore bay inlet water chamber and bifurcated pipe center is 107.03m, the distance from bifurcated pipe center to 1 # machine tube is 9.80m, bifurcated pipe center to 2 # machine tube is 3.30m. Two hydro-generating units were installed, a single 400kW. The length of the plant is 18m, width 9m, the total floor height 8m, the length of the booster station is 9m, width 8m.

(3) Tangjiahe Hydroelectric Power Station

Vertical intakes, pressure tunnel, surge shaft, and pressure pipelines compose Tangjiahe Hydroelectric Power Station diversion structures.

The layout of the in pressure intake will adopt the shaft scheme. The inlet is arranged at the left bank of the hillside, divided into the import segment, lock chamber and transition section. The entrance of the tunnel is a pressure circular tunnel, with a excavation diameter of 2.40m; the thickness of reinforced concrete lining is 0.30m. Lock chamber and shaft are connected; the diameter of the shaft is 3.0m, thickness of lining is 40cm. A steel gate is set inside the gateway, to be the gate for maintenance and accidents. There is no working gate; the main valve at the end of pressure pipe replaces the working gate. The hoist room will be built above the 803m high shaft building, with a length of 3.0m, width 3.0m. There will be a hoist in the hoist room. The maximum width of the hoist is 1.36m; it will be arranged in the shaft center, to make the width of pedestrian passageway meet the requirements.

Power diversion tunnel arrange in the left bank. It used a circular pressure tunnel, tunnel length of 3906m, in which Class III rock 1532. II-type rock 2374m.

Longitudinal tunnel consider to design by 3 / 1000. It tunnel excavation diameter 2.40m. According to rock classification for lining or sprayed concrete, rock used for Class II Concrete thickness 0.1m; for Class III rock, using C20 lining, lining thickness of 0.30m, double-reinforced fabric, the length of the expansion joints 12m.

The pressure pipe is located at the confluence ridge of Yuquanhe and Hongyuping Xiaoxigou, the inner diameter of pressure pipe is 1200mm. The distance from the surge tank to bifurcation center penstock is 299.46m, which is bifurcated pipe center to 1 # captain 22m, and bifurcated pipe center to 2 # machine tube 16m. The support of penstock buttress is saddle, bifurcation pipe used to strengthen the crescent rib bifurcated pipe, according to head of the proliferation of 6 ° angle to set up their equipment, bifurcation cone tube wall thickness 20mm.

The plant mainly includes the main plant, the deputy plant and booster station. Factory layout 3.7km away from the dam downstream Hongyuping. The slope on the left bank of the Yuquanhe. It is from the current Baiyiping Station 2 250m; plant for ground water diversion plant. Power station installed capacity of 5000+2000kW, the main plant room and installation from the host site of the long-30.4m, width 12.0m, roof beams at the bottom of the high-8.3m, the main plant for more than the total high Nimodipine 10.037m. Deputy plant layout in 569.20m elevation, high-4.5m, left high voltage switch room layout, with an area of 14.5m × 5.1m, in the control room in the middle, with an area of 9.5×5.1m².

Booster station is set at the left of the plant; the elevation of floor is 566.00m.

The total project layout, see Figure 2; Tangjiahe Reviver dam layout see Figure 3; Songjiahe Power Plant I hub level layout see Figure 4; Songjiahe Power Plant II hub layout see Figure 5.

2.3 Reservoir Inundation, Resettlement and

Permanent Project Occupation

2.3.1 Reservoir Inundation Treatment Scope and Physical Indicators

Tangjiahe Hydroelectric Power Station Project is uncompleted year water-shortage-style water and hydropower project, located in the middle reaches of Yuquanhe. The dam site is located in Tangjiahe, and the Hydroelectric Power Station is built in Hongyuping. The water-retaining structure is Face Rock fill Dam, and the height of the biggest dam is 54.44m. The normal water level of Tangjiahe reservoir is 800.00m, and the check flood level is 801.74m.

The compensation of land requisition will be in accordance with the *Contract on Cascade Hydroelectric Power Stations Development Project Yuquanhe Basin, Wufeng*, as well as compensation standards and program implementation offered by the owners, as follows:

(1) Village Collective Land Compensation

Arable land to compensate for 6 times in accordance with the annual output value of 1000.00 Yuan / acre; woodland to compensate for 5 times in accordance with the annual output value of 500.00 Yuan / acre; flood area without compensation.

(2) Resettlement Subsidies of Farmers

a, arable land is counted as 1000/mu per capita; resettlement grant will be six times of annual output value of 1000/mu; compensation for young crops which is 500 RMB per mu will be paid all at once

b, forest land resettlement grant will be five times of annual output value of 500.00 Yuan / acre;

c, No compensation for flood area.

(3) Attachments Compensation

a, Regular tea garden 10.00 / m², irregular tea garden 4.00 Yuan / root;

b, Citrus: fruit-bearing: 80.00 Yuan/strain, non-fruit-bearing: 2.00 Yuan/strain
transplanting fee;

c, Encomia: above 10cm: 20.00 / strain, below 10cm: 10.00 / strain;

d, Palm: 3.00 / strain;

e, Honokaa: above 10cm: 20.00 / strain, below 10cm: 10.00 / strain;

f, Philodendron: above 10cm: 20.00 / strain, below 10cm: 10.00 / strain;

g, Cedar (not including the met sequoia, willow): dbh above 10cm: 10.00 / strain,
dbh below 10cm: 5.00 Yuan / strain, and forest won't be compensated as woodland;

h, Weed tree: matured: 4.00 Yuan / root for compensation, other compensation by
woodland;

i, Medicinal materials treated as by transplanting, 2.00 Yuan / strain compensation
fee;

j, The flower of Xingyi: dbh above 10cm: 30.00 Yuan / strain, dbh below 10cm: 15.00
/ strain;

k, Other fruit trees: fruit-bearing : 30.00 Yuan / strain, non-fruit-bearing 2.00 Yuan /
strain compensation fee;

l, the construction of submerged within the scope of a single grave 300.00 Yuan each
compensation to farmers, carried out by the farmers themselves.

(4) The relocation will be in accordance with the 31st document of the County Government (1998)—*House Removal during the transformation of Yalai Highway*.

(5) In the course of the compensation to farmers, everything must be in accordance with the law; the interests of farmers cannot be harmed. Strict procedures should be enforced, the owner of the compensation will be a one-time designated and paid by the rural land resources.

(6) The taxes and fees

a, Land Management Fees

According to *Notice on Releasing Provincial Land Management System of Administrative Fees and Standards* issued by the Hubei Provincial Department of Finance, the Hubei Provincial Price Bureau, the fee of land required of the project is 1.1% of the total land compensation investment.

b, Forest Vegetation Restoration Fee

In accordance with state regulations, Wufeng are long anti-forest project area, all forest land belongs to shelterbelt, shelterbelt forest vegetation restoration fee charges 5.00 Yuan /m².

2.3.2 Resettlement

According to the physical indicators of the survey statistics, the removal population of the submerged reservoir is four. According to local actual conditions, the housing department locates on the right bank of Tangjiahe; the relocation of the indigenous inhabitants of the nearest take back is backing the reconstruction. In the settlement of a traffic bridge submerged in the River Song has two plants everywhere there is a stone arch bridge built in order to access. Song River from the plant to two power

stations in Tangjiahe 1km settlements built roads, funded by the owners, local residents built together.

Submerged physical indicators of the project, see Table 2-1.

Chart 2-1 The Index of the Material Submerged by the Reservoir

Name of the Submerged Material	Unit	Per Unit Compensation(Yuan)	Number	Cost(Ten Thousand Yuan)
Land Unused	MU	2100	82.00	17.22
Woodland	MU	5000	39.01	19.51
Tea Garden	MU	12000	31.2	37.44
Remove of 10kV Transmission Line	m	Public Facility	1351	30.00
Electric Pole			11	
Remove of Post and Telecommunications Line	m	Public Facility	1343	
Electric Pole			15	
Low-voltage Line				
High Way	MU	Public Facility	7.63	
House Site	MU	12000	0.81	0.97
Remove of House Site	Family		4	40.00
Payment of Farm Population	People	2100	15	3.15
Management Expense of Land Expropriation		1.1% of the Total Investment of Land Compensation	74.17	0.82
Recovery of Forest Vegetation	MU	3333.33	39.01	13.00
River Plain	MU	0	82.15	
Bridge		Public Land Occupation	2	
Total Cost				162.11

According to chart 2-1, the compensation of the material submerge amounts to 162.1 thousand Yuan.

2.3.3 Project Land Occupation

(1) Songjiahel-Hydroelectric Power Station

The water intake dam of Songjiahel-Hydroelectric Power Station is low in height, located in the river; there is no reservoir inundation treatment and resettlement task.

Project covering area mainly refers to temporary and permanent covering area of buildings. Permanent covering area is 3.8 acres, of which 0.6 acres of flood land, 3.0 acres of timber, 0.2 acres of tea plantations; temporary covering area is 8.0 acres, of which 0.2 acres of flood land, 7.2 acres of timber, and 0.1 acres of arable land.

(2) Songjiahe II-Hydroelectric Power Station

Songjiahe II-Hydroelectric Power Station take the lower dam, located in the river, there is no reservoir inundation treatment and resettlement tasks.

Project covering area mainly refers to temporary and permanent covering area of buildings. Permanent covering area is 7.63 acres, of which 5.95 acres of barren hills, 0.26 acres of timber, 1.42 acres of arable land; temporary covering area is 507 acres, of which 2.5 acres of barren hills, 0.9 acres of timber, and 1.67 acres of arable land.

(3) Tangjiahe Reservoir Power Station

Project covering area mainly refers to temporary and permanent covering area of buildings. Permanent covering area is 29.22 acres, of which 7.5 acres of flood land, 2.98 acres of woodland, 0.24 acres of tea gardens, 18.5 acres of wasteland; temporary covering area is 20.5 acres, of which 5.0 acres of flood land, 2.0 acres of woodland, 0.5 acres of tea gardens, and 13.0 acres of wasteland.

2.4 Construction

2.4.1 Construction conditions

(1) Outbound Traffic

Wuniu Highway passes through Songjiahe where the Songjiahe Village Committee locates. There is a coal road at the estuary from Songjiahe to water dam. Songjiahe is 24km away from the county town, and about 3km from the check dam, the road construction material and equipment meet the transportation requirements, the entire project will not need other highways, traffic conditions are relatively good.

(2) Characteristics of the Project Layout

Songjiahe I-Hydroelectric Power Station is a run-off-type Hydroelectric Power Station, the barrage used bottom stockade dam, the big dam is made of lime and cement mortar. Maximum height of the dam is 2m, the top of the dam elevation is 1036.75m, the length of the dam is 26.4m; power plant water intake and diversion tunnel, pressure pipes, factories and other buildings are arranged on the left bank. The total length of diversion tunnel is 1999.9m; part of the fore bay lies in tunnel, the elevation of the fore bay floor is 1031.5m, the length of pressure pipe 356.952m. The elevation of ground workshop is 856.9m.

Songjiahe II-Hydroelectric Power Station projects for the main construction site one the two points which street on a line, on the two-construction area, power station plant, and pressure pipe works area. That is, two first-line power plant diversion tunnel works area. In the two works area there are large number of houses, check dams because of the volume of smaller projects. Construction of factories without layout, just a small number of warehouses, housing and the preliminary design considerations for the construction of houses are rent space; plant near flat land can be warehouse layout, campsites, etc., it can also be part of the rental houses nearby. Diversion tunnel near the import and export of a more moderate slope can be arranged nearby temporary camp, pressure points, and some else.

Tangjiahe 1km upstream of the reservoir dam on the left bank there mesa and

settlements can be arranged camp, machine repair and other ancillary facilities construction, dam downstream on the left bank of 300m there are settlements for corporate hire, layout. Relatively speaking, more decentralized, but from the work area is less than 1km. Concrete-faced rock fill dam excavation waste less, the majority of its spillway excavation to be done fill-dug pit filling material can be used for cofferdam. Dam surface to clear the two sides do not waste ballast building materials, the preliminary design of disposable ballast 2000 m³, can be stacked on the downstream dam and the dam spillway bucket idle between the riverbeds.

(3) Main Building Materials

- **Cement**

Total cement for Songjiahel-Hydroelectric Power Station Project is around 470t, Songjiahe II-Hydroelectric Power Station Project 700t, Tangjiahe reservoir Hydroelectric Power Station Project 6000t. There is a cement plant named Yuyang in Wufeng County, producing 42.5Mpa and 52.5Mpa cement, with an Annual Output of 280,000 t, about 90km away from Songjiahe. Its cement production capacity and quality can meet the need.

- **Steel**

The need of steel works is relatively small, and can be bought by county materials sector organizations can supply or directly from Yichang and other places.

- **Timber**

The construction area is rich in forest resources, while the project needs very few, purchasing and processing can be organized on the spot.

- **Materials, Fuel and Electricity supply**

Explosives, detonators, fuses will be supplied by Wufeng County Construction Company or the local police station. Consumption of diesel oil, gasoline will be relatively small during the construction, and the construction unit can organize the procurement. The electric power used for the construction is existing systems 10kv line branch to the working points, with three 100kVA transformer (one for 1 # dam and tunnel import, one for 1 # tunnel export and 2#tunnel import, one for plant and foray) can meet the requirements of the construction of electricity.

(4) Aggregate Mining

Natural building materials of this project include stone, gravel and sand. However, due to the lack of natural construction materials in the project area, the vast majority of natural building materials rely on artificial stone mining processing. Based on the principle of make full use of the digging materials, reclamation and other refilling works fully used those excavation materials, except the concrete aggregate rock of the dam.

The upstream right bank of Tangjiahe dam steep hillside with exposed bedrock. According to geological reports, the major regional rock categories are Silurian shale and sandstone, the compressive strength of its saturation are between 20-30Mpa, which is soft rock category. Two kinds of rock dams do not meet the requirements of the material. Dam more than 2km there is a large area Nanjin Feixianguan limestone dam 2km Department following a large area Qixia Formation limestone, siltstone exposed. Reserves of more than 500,000 m³, according to the engineering characteristics and the results of Geological Survey together Chichi wan Huang is located upstream and downstream yard Ping Yi-white, 2 are road accessible yard can be used to share. Vice-yard located at the existing quarry River Song, the main production of concrete aggregate, the yard were no new highways. Stone transport costs are lower, so this stage of the primaries in the upstream dam 24m yellow Chichi wan yard and downstream white overflow Ping yard field-based material. Mountain basic no cover and its huge storage capacity to meet the needs required for the

projects.

By design, CFRD Rock fill total 174,000 m³, the total concrete 16511 m³, need gravel 13200 m³, sand 14000 m³. Rock fill material can be used spillway excavation volume of 55,100 m³, sand tunnel excavation materials available grinding machine-made sand bar. In addition to the use of materials, the yard exploitation is 120,000 m³. Yard mining using pore DTH drilling, deep-hole bench controlled blasting, and blasting the use of technology, in order to obtain better gradation filling material unsuitable chamber blasting. On the exploitation of strength by 4-8 million m³, can ensure that the dam in the flood season to meet the spillway flood elevation, the average strength of the dam by 2000 m³/d dam excavation material strength by filling the reserve strength increased by 1.2 coefficient, mining strength 2400 m³/d. Blasting yard field test should be identified in order to protect the exploitation of aggregate gradation good.

(5) Gravel Processing

Aggregate processing plant by the wool by the hopper, rough broken workshop, screening workshop, in broken workshop, rehabilitation screening workshop, the system sand workshop, finished reactor, such as materials and belt conveyor components.

The stones from the extraction will be transported by automatic unload trucks to the wool collecting house. The castor-oil plant on the roof of the house can strain the stones whose diameters are more than 350mm. Other stones will be transported to the stone plant through the strap, and these stones are from the material machine and the broken jaw crusher crush these stones and then they are transported to the straining house through the strap. The straining house has two two-tier machines, with one being 80mm and another 40mm. If the size of the material is more than 80mm, they will be sent back to the material house for restraining by the straps. They are divided into two groups. One group is sent to the finished goods group and

another group is sent to the straining house, which strain the stones of 40mm. a standard cone crusher is set up in the workshop, the size of the choose is <40mm, and the broken materials and the straining materials are sent together to the restraining house. The restraining house has a two-tier straining machine. The sizes of the straining nets are relatively 20mm and 5mm. The materials on the straining net which is >20mm will be transported into the finished products. The rest materials are divided into two groups. One group is sent to the finished goods group and another group is sent to the sand maker house. The materials of 5mm will be sent to the sand washer house in phases. Workshop equipped with the system sand short head cone crusher broken, broken out of the sand and rehabilitation under the sieve workshop <5mm of material to the spiral classifier with sand washing machine washable sand, sand finished machine by the belt to the finished product stockpile.

Aggregate finished with 10t from 1-m³ loader truck transports to the concrete mixing system. The project is not the amount of block-stone to the main plant may be close to the use of excavation material.

2.4.2 Construction Diversion

According to the *Organization Standards of Water Conservancy & Hydropower Engineering Construction*, the level of corresponding diversion buildings is class V. Diversion by the October-June for a return period of 20 years maximum flood design is 96m³/s. According to the hydrological characteristics, geological conditions and layout features, the use of Construction diversion cofferdam revascularization, diversion tunnel. Responsible for building the main dam diversion Qing-based and part of the dam rose Backfilling diversion mandate period. Will be arranged on the right bank of the diversion tunnel, diversion of imports of low-floor elevation 760m, long holes 202.00m, the beginning of the diversion tunnel to be high profile 2.47m, width 2.2m, the use of reinforced concrete tunnel lining and increase capacity over Hung. Cofferdam for the soil type of stone cofferdam, cofferdam closure using

pre-built sub-gap legislation blocking the way, stop in early to be carried out at the end of October, according to closure discharge $P = 20\%$ of traffic, is $11.7 \text{ m}^3/\text{s}$.

(1) Way of Diversion and Closure

● Reservoir-Hydroelectric Power Station

According to hydrology, topography, geological conditions and layout features, Tangjiahe hub Reservoir diversion works will adopt the closure cofferdam, diversion tunnel approach.

Closure in mid-November to complete by the end of April the following year completed before the abutment, and part of the dam foundation excavation and pouring. Winter concrete dam construction, taking into account the normal concrete arch dam body can make use of over-current, temporary flood gap and no dam diversion bottom outlet. According to the scale of project and condition of construction, the water storage period of the reservoir has been set at January-March in the third year after the closure.

● Second cascade hydroelectric power Station

The diversion work of the project mainly lies in the check dam construction. Check dam is a masonry dam as the terrain conditions of the dam site and situation of construction. Taking into account the masonry dam body can be used to against the flood, and not lead to any significant impact, so take a temporary shortfall in flood program guide flow standard has been reduced accordingly, the average flow near the dam site is only $5.60 \text{ m}^3/\text{s}$ for many years, flow mediated by flushing sluice flow capacity considerations. It uses the diversion channel mode. This is left bank of sand flushing sluice gate and then up and down the diversion.

(2) Dimensioning Buildings

● Reservoir-Hydroelectric Power Station

By the dam riverbed terrain conditions and layout requirements, arranged in the left bank of the diversion tunnel. Diversion tunnel section compares the circular openings and the City type of two types, the former works in a small amount of investment in the province, recommended a circular cross section. Imports dam axis is located in the upper reaches is 40m, and the diameter is 4.1m, imports Center Height 394.233m, export center elevation 392.05m. Diversion tunnel in the plane arc 呈圆 layout, import straight long 44.797m; middle arc radius axis paragraph 24.05m, central angle 60 °, long 25.185m, the export straight long 38.658m. Total length is 108.64m. Diversion Tunnel reserved imports a hole 4.2m × 4.2m gate, to be under the gate after the completion of dam water plugging and sealing off the use of C20 concrete, reinforced by the consolidation, contact grouting.

According to the characteristics of small and medium-sized project, the upstream and downstream cofferdams are earth-retaining structures, the use of disposable materials filling abutment excavation. Top upstream cofferdam elevation 396.4m, the bottom elevation 390.0m, weir high 6.4m. The width of cofferdam peak is 2.0m; the upstream and downstream slope is 1:2. The elevation of downstream cofferdam peak is 393.0m, the bottom elevation 390.0m, weir high 3.0m. The upstream and downstream slope is 1:2. Cofferdam used Shanggong impermeable membrane, alveolar concrete infrastructure.

● II-Hydroelectric power Station

According to the terrain conditions of the dam, foundation excavation and dam construction needs, two cofferdams will be set up. The upper reaches of the dam axis is located at the upstream cofferdam 15m department main river, the downstream cofferdam is located in the lower reaches of the dam axis department 20m main river diversion channel through the flushing sluice duct laid on the left bank of the slope.

Cofferdam using a dry season completed by the end of March the following year dam construction.

Only plant-based Foundation cofferdam, the use of the main river has been hung. Topographical conditions in accordance with the factory, just outside the longitudinal cofferdam foundation set. Cofferdam should have a dry season, and use masonry cofferdam. The width of weir peak is 0.6m, upstream face slope 1:0, negative side water slope 1:0.4, the elevation of weir top is 226.30m, the elevation of weir end is around 219.50 ~ 221.0m.

2.4.3 Main Construction

2.4.3.1 Songjiahel-Hydroelectric Power Station

(1) Dam

The dam projects need little work. In accordance with the overall implementation arrangements for power plants, dams should be non-controlled engineering, so it is advised that the right bank should be constructed after the left bank of the dam and the grit chamber. After the closure of the right bank, the water flow directly into the corridor by the red sand gate row to the lower reaches of the riverbed.

(2) Water Diversion Canal System

The water intake system got a long tunnel line, as the length of first tunnel is 1134m, and the second tunnel is 852m. It becomes the control works because of the construction progress is subjected, as the tunnel cross-section is small, and it is not suitable for mechanized construction. Thus makes us taking the use of pneumatic drill holes, smooth blasting, and artificial tire rack car out ballast. The four face cutting into the shale into the side lining edge at the same time, taken for safety reasons.

The power supply of the 1 # holes import face is transferred by transformer arranged in the dam area and the air by the gas compressor. The 1 # holes export and import-hole is supplied by the same equipment arranged at the foot of the mountain, and 2 #-hole export is supplied in the factory. Ventilation inside the cave uses JBT-52 explosion-proof hybrid axial fan. The fan is set up outside. It can extend the pipeline forward step by step.

(3) Pressure Pipe

The pressure pipeline construction, owing to the long lines, the construction interference and the difficulty of the construction control, it works as first digging the pipeline ducts buttress and then the excavation of the buttress, in order not to affect the plant construction. The buttress concrete pressure pipe used to install cableway transport concrete, poured with steel pipes installed simultaneously in order to save human transportation.

(4) Plant

The excavation of the factory building is carried out after the excavation in the ducts, and then the housing construction. Single power shovel used to dig out and waste is transported by automobile.

2.4.3.2 Songjiahe II-Hydroelectric Power Station Construction

(1) Dam

The dam projects need little work. In accordance with the overall implementation arrangements for power plants, dams should be non-controlled engineering, so it advised that the right bank should construct after the left bank of the dam and the grit chamber. After the closure of the right bank, the water flow directly into the corridor by the red sand gate row to the lower reaches of the riverbed. Dam excavation using hand-made pneumatic drill hole blasting, artificial out ballast, masonry because of

using a small amount of manual operation, the use of people mixing concrete construction, plug-in vibrated rods vibrated.

(2) Water Diversion Canal System

The water intake system got a long tunnel line, as the length of first tunnel is 844m, and the second tunnel is 583m. It becomes the control works because of the construction progress is subjected, as the tunnel cross-section is small, and it is not suitable for mechanized construction. Thus makes us taking the use of pneumatic drill holes, smooth blasting, and artificial tire rack car out ballast. The four face cutting into the shale into the side lining edge at the same time, taken for safety reasons.

The power supply of the 1 # holes import face is transferred by transformer arranged in the dam area and the air by the gas compressor. The 1 # holes export and import-hole is supplied by the same equipment arranged at the foot of the mountain, and 2 #-hole export is supplied in the factory. Ventilation inside the cave uses JBT-52 explosion-proof hybrid axial fan. The fan is set up outside. I can extend the pipeline forward step by step.

Masonry tunnel system used to market to the system, the plastic car transport, artificial masonry. Chi Aqueduct is before artificial aggregate concrete. Aggregate processing arrangement in the Yellow Chichi wan aqueduct near the excavation can make use of stone ballast on the 1st hole. They also may choose to use the riverbed boulders broken, 0.8 m³ concrete mixing machine focused on the Huangjiawan Aqueduct Department, the former used tire dump concrete pool inside the cave, transport, on-site mixing of artificial secondary warehousing, real ramming rod vibrated. To be newly built temporary road summary 300m, in order to approach mixing machine.

(3) Pressure Pipe

Pressure pipeline construction, due to shorter lines, but the construction of interference, mainly excavated at the upper half of the ducts. Thus affects the transit of Wuniu highway, so the construction control is more difficult. As a result, pipeline excavation work takes the plan of first excavated the ducts and then the buttress. This will not affect or reduce the impact on traffic, and need only appropriate restrictions on the traffic during the construction for safety reasons. The buttress concrete pressure pipe used to install cableway transport concrete, poured with steel pipes installed in tandem with the support of steel pipe required on a temporary basis in order to save human transportation.

(4) Plant

The excavation of the factory building and the ducts is carried out at the same time, and then the housing construction. Single power shovels are used to dig out and waste is transported by automobile. Concrete Construction uses 0.8m³ mixer, and plug-in vibrated rods to vibrate. Another 200m highway needed to connect the Plant, and a 10m river-crossing highway bridge needed to meet the plant construction and the transportation of the equipment into the plant.

2.4.3.3 Tangjiahe Reservoir Power Station Construction

(1) Dam Construction

The excavation of dam is top-down approach based. Plinth excavation clearance with greater than 4m is done by deep hole respite blasting, and the banks with plinth foundation excavation less than the thickness of 4m and riverbed excavation is cleared by using hand-held pneumatic drilling, shallow hole blasting and excavation slope thin split ways. Dam foundation is excavated to 0.3m above the target depth designed, combining both mechanical and manual clearance. The reserved protective layer of the plinth should be poured before the excavation. Foundation excavation of disposable ballast material can be used on constructing the cofferdam;

the banks have excavated soil waste dumped ballast to the downstream market. Disposable ballast and gravel riverbed cover, the use of 1-3m³ excavators and loader with 10-20t Dump Truck out ballast. Backfilling dam used yard truck loader, 18t truck transportation dam, bulldozers positions, vibration roller is, each 20m high RCC should be done upstream slope and cement mortar spray protection, slope protection on the lower reaches of the use of machinery and artificial combining manner.

After the end of Qing-based, timely pouring concrete plinth above the riverbed, and the two sides' first bank toe board, with the dam after the rise, systematically pouring the plinth bank, in the concrete reached certain intensity, the conduct at the bottom of the plinth of the grouting works. Plinth C25 grade concrete design with two, small-site production of concrete mixing machine, rickshaw transport, and vibrated Tap browser. C25 grade concrete panels with two used trolley slip form construction, in the layout of dam surface mixing systems, the use of pumping and conveying the combination of chute.

(2) Tunnel Construction

The tunnel is divided into diversion tunnel and power generation tunnel. The cross section of the diversion tunnel is door-shaped, with an area of 9.46m², total length 202.0m. The power-generating tunnel has a total length of 3852.00m. Diversion tunnel is excavated from ends, air-feed leg drilling, and smooth blasting, with a 0.5m³ sides installed a ballast mounted wheel motor vehicles to clear the wastes, which are then stacked 50-100m away outside the tunnel and used as a cushion material in concrete aggregate processing.

(3) Spillway Construction

The maximum height of the spillway is 20m. Most of the dumped ballast can be used in most of the main dam rock fill. Spillway excavation can be carried out in phases. The total volume of the spillway is designed to 5717m³, of which C15 concrete 3087m³ and C25 concrete 2625m³. Diversion canal and lock chamber can

be poured after the excavation, and work chute bridge can be found in the post-pouring, two concrete pumps are used at the scene send construction.

(4) Plant and Tail-water Construction

Excavation is mainly to backhoe excavation, supplemented by hand-made pneumatic drill hole blasting. Ballast waste is transported to transport abandoned dumps ballast market by motor vehicles or tractors. Stones are stacked in the vicinity in order to get the materials ready to do masonry.

2.4.4 Construction Layout

The construction is only as stacking space. Living space use nearby and temporary camp erection. Concrete aggregate mining and processing yard layout approximately vice. Plant used in aggregate, the nearest small-scale machinery and equipment layout broken system, the raw materials used water hole excavated material. Concrete mixing systems, the use of mobile concrete mixers and pump scatter arrangement, the use of in situ mixing concrete spillway. Building materials warehouse rented houses nearby kept mainly on the construction to meet the needs of the temporary Treasury explosive material in a secure location for the construction of explosive material. A small amount of residue soil will be carried to the disposable ballast market of the dam to the left of downstream river bed, and the rest for the dam is used for filling, excavation plant waste to power plant upstream dumped ballast market.

Tangjiahe reservoir power station construction general layout, see Figure 6; a general layout of Songjiahel-Hydroelectric Power Station Construction, see Figure 7; a general layout of Songjiahe II- Hydroelectric Power Station Construction, see Figure 8.

2.5 Spoil planning

Spoil owners in accordance with the transfer of planning the overall layout of the project and *Feasibility Study* of the project was carried out.

According to the works of the report of soil and water conservation program, all residues produced are about 129,200 t.

Among them, Songjiahel- Hydroelectric Power Station Construction Spoil that arises during the main part of the project comes mainly from the foundation excavation, money-based, cutting back the formation of the spoil, disposable stonework.

Excavation of the main works, money-based, such as roads and construction of slope cutting a total of 01,700 square spoil m³, about 03,000 t; disposable stonework 11,400 m³, about 22,800 t; a total of 25,800 t.

The residue that Songjiahe II- Hydroelectric Power Station Construction project generated during the construction is mainly from the formation of the spoil, disposable stonework during the excavation works, base cleaning, and cutting back of the main foundation. Excavation of the main works, base cleaning, such as roads and construction of slope cutting 4,600 square spoil m³, about 8,000 t. Disposable stonework 7,300 m³, about 14,800 t; totally 22,800 t.

Tangjiahe reservoir Hydroelectric Power Station Construction process of the residue comes mainly from the foundation excavation works, money-based, cutting back, spillway excavation, stone (aggregate) market Spoil, diversion tunnel carbide. Spoil planning mining quarry rock about 120,000 m³, cover and production volume of residue generated 05,000 m³, about 08,800 t; the main works of residue generated 29,100 m³, about 52,000 t; Construction of the road resulting residue of 11,200 m³, about 19,800 t.

2.6 Construction Progress

Under the premise of available funds and construction quality, we will strive to ensure that the power station generate and produce benefit as soon as possible. The total duration of the project has been determined as 24 months after a comprehensive analysis. Overall progress of construction is from July this year to August next year, totally 24 months.

2.7 Project Management

2.7.1 Regulatory Agencies

The four Hydroelectric Power Station developed by the same owner are located in Yuquanhe basin, namely Songjiahe- Hydroelectric Power Station, Songjiahe II- Hydroelectric Power Station Construction, Tangjiahe Hydroelectric Power Station Construction and Kuzhuping Hydroelectric Power Station. These mainly compose a proposed project: check dams, water diversion tunnel, pressure pipes, powerhouse, booster stations and other components.

According to the scale and efficiency, combined with the laws of the market and owners envisaged, and the ease of a hydropower station River Song, Songjiahe II- Hydroelectric Power Station, Tangjiahe Nigatake Ping Hydropower Station and the construction and operation management, has been set up to Wufengyiye Hydropower Development Co., Ltd. by the company responsible for centralizing the management. The number of standard works in accordance with the Hubei Provincial Water Resources Department of Rural Power Agency [1985] will be 080 word documents on the management of small hydropower stations in Hubei Province's request, the establishment of project management institutions, to develop project management staff.

According to the owners, combined with the laws of the market operators, has set up Wufengyiye Hydropower Development Co., Ltd. has organized the Songjiahe

Hydroelectric Construction Project manager for the Department. The manager should take the responsibility of Project Manager Department, be in charge of Songjiahe Hydroelectric Construction Project preliminary design review, construction, financing, bidding and operation management. There are institutions such as offices, Ministry of Planning and Finance, Engineering and Technology and other, authorized personnel 21.

2.7.2 Management and Scope of Protection

The management scope of Songjiahe II-Hydroelectric Power Station, which means the permanent scope of construction land occupation, includes the dam, pressure pipelines, power station plant, booster station and office and living areas.

2.8 Investment and Efficiency

2.8.1 Investment

Static investment of Yuquanhe Hydroelectric Power Station Project is 61,587,700, and the total investment is 63,975,800 Yuan. Of which:

Static investment of Songjiahe I-Hydroelectric Power Station is 5,575,800 Yuan, reserve price 106,200 Yuan, construction period interest 112,300 Yuan, a total investment of 5,794,300 Yuan. Unit static investment 4424 Yuan/kW; Static investment of Songjiahe II-Hydroelectric Power Station is 553.33 million Yuan, basic reserve fund 254,900 Yuan, construction period interest 86,400 Yuan, a total investment of 5,619,700 Yuan, unit static investment 6916/kW. Static investment of Tangjiahe Hydropower Engineering is 50,478,600 Yuan, construction period interest 2,083,200 Yuan, a total investment of 52,561,800 Yuan, unit static investment 7888 Yuan kW.

2.8.2 Benefit Analysis

After the projects is completed and put into production, the major economic indicators Songjiahe Hydroelectric Power Station are as follows: EIRR = 19.44% > 12%, ENPV = 253 million Yuan, EBCR = 1.4 > 1, FIRR before income tax = 13.54% > 10%, FIRR after income tax = 10.34% > 10%. FNPV before income tax = 208.29 million > 0, FNPV after income tax = 73.74 million > 0, fixed-asset investment loan repayment period of Pd = 8 years. Two major economic indicators of Songjiahe Power Plant are EIRR = 12.04% > 12%, ENPV = 1 million Yuan > 0, EBCR = 1 > 1. FIRR before income tax = 6.33% < 10%, FIRR after income tax = 5.04% < 10%; FNPV before income tax = -1,020,900 Yuan < 0, FNPV after income tax = -155.22 million < 0, fixed-asset investment loan repayment period of Pd = 10.7 years. Major economic indicators of Tangjiahe reservoir power station are EIRR = 12.02 % > 12%, ENPV = 7 million Yuan > 0, EBCR = 1, FIRR before income tax = 8.91% < 10%, FIRR after income tax = 7.188 %, FNPV before income tax = -347.87 million < 0, FNPV after income tax = -834.76 million < 0. The statistics shows that, once the investment and income increases, all indicators cannot meet the evaluation regulatory requirements, so the project's financial ability to resist risks is not very strong, and the fixed asset investment loan repayment period of Pd = 11.9 years.

In short, the project has good social benefits, it can meet the regulatory requirements in the national economy evaluation, while does not meet regulatory requirements in financial evaluation.

2.9 Table of Engineering Properties

Table of Engineering Properties, see table 2-2.

Table 2-2 Engineering Feature Table for Tangjiahe Reservoir in Yuquanhe River Basin

Number and Name	Unit	Quantity
1. Hydrology		
1.1 River Basin Area		
The whole river basin	km ²	99.85
Upstream of project site (dam and water sites)	km ²	60.8
1.2. Useful Life of Utilized Hydrological Series	Year	42
1.3. Multi-year average annual runoff Multi-year average water flow	100 million m ³	0.50
1.4. Representative flow volume Multi-year average flow Normal operation (design) flood standard(P) Corresponding flow volume Abnormal (check) flood standard (P) Corresponding flow volume	m ³ /s % m ³ /s % m ³ /s	1.71 2 265 0.2 370
1.5. Flood volume Design flood volume Check flood volume	100 million m ³	0.29 0.40
1.6. Sediment Annual sediment discharge of multi-year average suspended load Multi-year average sediment concentration Annual sediment discharge of multi-year average bed load	10k t kg/m ³ 10k t	1.05 0.2 0.16
2. Reservoir		
2.1. Reservoir Water Level		
Check flood level(P= %)	M	801.74
Design flood level(P= %)	M	800
2.2. The reservoir area at normal impounded level	km ²	0.18
2.3. Length of back water	Km	2.5
2.4. Reservoir capacity		
Total reservoir capacity (below check flood level)	10k m ³	225.77 206.99
Reservoir capacity below normal impounded level	10k m ³	34.34 195.60
Flood control capacity (From high water level for flood control to flood season limit)	10k m ³	11.39

capacity)		
Regulative capacity (normal impounded water level to dead water level)	10k m ³	
Dead storage capacity	10k m ³	
2.5.Capacity Factor	%	3.8
2.6.Regulating Property		Incomplete Annual Regulation
2.7.Water Utilization Coefficient	%	90
3. Discharge Flow and Corresponding Downstream Water level		
3.1.Maximum Discharge at Design Flood Level	m ³ /s	265
Corresponding Downstream Water Level	M	755
3.2.Maximum Discharge at Check Flood Level	m ³ /s	370
Corresponding Downstream Water Level	M	756
3.3.Regulated Flow (P = %)	m ³ /s	
Corresponding Downstream Water Level	M	
3.4.Minimum Flow	m ³ /s	
Corresponding Downstream Water Level	M	
3.5.Station Maximum Water Head	M	240
Station Minimum Water Head	M	214
Station Weighted Average Water Head	M	227
4. Project Benefits Indicators		
4.1.Power Production Benefit		
Installed Capacity	kW	7000
Firm Capacity (P= %)	kW	1348
Multi-year Average Power Production	10k kWh	2330.67
Annual Utilization Hours	H	4485
Annual Average Benefit	10k yuan	861.13
5. Submersion Loss and Project Permanent Land Occupation		
5.1. Submerged Cultivated Land (P= %)	Mu	270
5.2. Migrated Population (P= %)	person	
5.3.Houses in Submersion Area	m ²	
5.4.The Length of Railway or Highway and Relocation of Line in Submersion Area	Km	
5.5.Other Submerged Important Area		
5.6.Project Permanent Land Occupation	Mu	40
6. Main Buildings and Equipments		
6.1.Type of Water Retaining Building (Dam Water Gate)	M	Rock-fill Dam 801.3

Crest Elevation	M	56.2
Maximum Dam Height	M	105
Crest Length		
6.2. Type of Sluicing Structure (down flow weir, spillway, tunnel, sluice opening, etc.)	M	Spillway
Length of Overflow Section (or size, quantity of sluice tunnel and opening)		10×10 1
Means of Energy Dissipation		Deflecting Flow
6.3.Diversion Structure		
Design Diversion Flow	m ³ /s	4
Maximum Diversion Flow	m ³ /s	4.2
Type of Diversion Channel		Tunnel
Length of Diversion Channel	M	3700
Section Size of Diversion Tunnel	m×m	2×2
Main Dimension of Fore Bay	m×m	
Type of Pressure Pipeline		Opened
Quantity of Pressure Pipeline	Line	1
6.4.Powerhouse		
Type		Ground
Dimension of Main Powerhouse (Length×Width×Height)	m×m×m	28×12×10
Installed Elevation of Hydro-turbine	M	563
6.5.Hoisting Station		
Type		12×18
Area(Length×Width)/Layer	m ² /layer	
6.6.Main Electromechanical Devices		
Numbers of Hydro-turbine	Unit	2
Model of Hydro-turbine		CJA237-W-185/2×18 for 5000kW set CJA237-W-130/2×11.5 for 2000kW set
Rated Output	kW	5000
Rated Rotate Speed	r/min	500
Rated Water Head	M	215
Rated Flow	m ³ /s	4
Numbers of Generator	Unit	2
Model of Generator		SFW5000 -18/2600 for 5000kw set SFW2000 -14/1730 for 2000kW set
Single Capacity	kW	5000
Power Factor of Generator		0.8
Rated Voltage	kV	6.3

7. Construction		
7.1.Quantity of Main Works		
Earthwork	10k m ³	
Stonework	10k m ³	31.10
Concrete and Reinforced Concrete	10k m ³	1.92
Installment of Metal Structure	T	250
7.2.Main Construction Material		
Wood	m ³	500
Cement	T	6720
Reinforcing Steel Bar	T	340
Steel	T	
7.3.Required Labor	10k	
Total Working Days	Man-day	23.84
Average Workers	person	451
Peak Time Workers	person	550
7.4.Construction Land Occupation	Mu	
7.5.Entire Construction Period	Year	2
8. Economic Indicators		
8.1.Total Fixed Investment	10k yuan	
8.2.Total Investment	10k yuan	8505.80
8.3.Economic Indicators of Comprehensive Utilization	yuan/m ³	8982.57
Reservoir Unit Capacity Investment	yuan/kW	
Power Station Per kW Investment	yuan/(kW	5709
Unit Electrical Energy Investment	·h)	1.30
Electricity Production Cost	yuan/(kW	
Unit Irrigation Area Investment in Irrigation Range	·h)	
	yuan/field	12.71
Internal Economic Return Rate	%	349.00
ENPV	10k yuan	4.0
ENPV Rate	%	13.35
Internal Financial Return Rate	%	2280.66
FNPV	10k yuan	25.38
FNPV Rate	%	10.3
Payback Period	A	

2.10 Construction pollution analysis

2.10.1 Main Environmental Factors and Countermeasures during Construction Period

2.10.1.1 Analysis on Earthwork, Construction Residue and Domestic Waste

(1) Use of Earthwork and Construction Residue

According to Residue Planning 2.5, the projects have a residue of about 129,200 t totally.

Among them, Songjiahe I- Hydroelectric Power Station Construction Spoil that arise during the main part of the project comes mainly from the foundation excavation, money-based, cutting back the formation of the spoil, disposable stonework.

Excavation of the main works, money-based, such as roads and construction of slope cutting a total of 25,800t square spoil. Four slag yards are going to be located in the dam, tunnel area, the pipeline area and powerhouse areas.

The residue generated mainly from the main foundation excavation works, money-based, cutting back the formation of the spoil, disposable stonework during the construction of Songjiahe II- Hydroelectric Power Station. A total of 22,800t abandoned earth. In the dam, diversion canal, tunnel mouth, the pressure along the pipeline and plant set up on both sides of four slag yards.

Tangjiahe reservoir power plant construction process of the residue comes mainly from the foundation excavation works, money-based, cutting back, spillway excavation, stone (aggregate) market Spoil, diversion tunnel carbide. Cover and production volume of residue generated by 08,800 t, the main project to the residue of 52,000 t, road construction volume of residue generated 19,800 t. Planning 2 Java games, with a total floor space, 1 # slag dam, situated at the lower reaches of the river bed, 2 # Jar dine plant, situated at the vicinity of the left bank of the flood land.

(2) Treatment of Garbage

Construction sunrise peak of about 367 workers, according to 1.0kg per person per day basis, their maximum daily garbage generated about 0.367t. Total construction period of 24 months, the average sunrise about 245 workers, the construction period the total amount of refuse generated about 180t, could not be properly disposed of, will result in mosquitoes, flies breeding ground for breeding and secondary pollution.

Therefore, garbage dumps should be set up in specialized sites, classified storage, composted after recycling the useful ingredients.

2.10.1.2 Analysis on Drainage and Discharge of Major Pollutants during Construction Period

The total amount of Yuquanhe River Basin hydropower project construction period is 99670m³, the total amount of wastewater discharged is 79736 m³, including the construction of wastewater and sewage construction period of two major parts.

(1) Water for Construction, Main Water Pollution Sources and Pollutants

Construction of the project consumes a total volume of water as 63900m³; the total amount of construction-wasted water is 51120m³. Construction wasted water mainly includes pouring concrete conservation wastewater, aggregate processing system flushing water, construction machinery and vehicle washing wastewater. In addition, construction will also generate a large number of pit wastewater, mainly by precipitation, cofferdam seepage pooled together; the peak period of wastewater generated is about 200m³/d. The construction of the project will enable the Foundation as a result of construction of water increased the concentration of suspended solids. The foundation works are to be taken to set up set in puddles, wastewater-holding precipitation more than two hours, the suspended solids concentration of less than 70mg/L, the Drainage pump in order to reduce the environmental impact of surface water.

- **Concrete Pouring Water Conservation**

Resulted from concrete pouring, conservation, cement grouting and so on, a higher concentration of suspended solids in the waste water, pH value can be as high as 11 ~ 12.

- **aggregate wash water processing system**

Aggregate processing system process is in general as follows: mining → wool yard semi-finished products → screening →, finished aggregate screening station yard sand system → finished mixed sand. Under normal circumstances, the production of 1t Concrete Aggregate 2.7 m^3 of water around the sand content of aggregate average of 8 percent, in accordance with the principle of material balance, aggregate washing wastewater contained suspended solids concentration of about $2.5 \times 10^4 \text{ mg / L}$. In aggregate processing, due to the surface of water-bearing materials, such as evaporation and seepage of water loss caused by water consumption accounting for about 20 percent, and the remaining 80% is the production of wastewater, the project concrete totals 17693 m^3 . The total amount of wastewater generated about 38220 m^3 . The progress of the project construction control arrangements, the main dam of reactor building for about five months, therefore, a displacement of about $16 \text{ m}^3/\text{h}$.

- **Washing Wastewater of Construction Machinery and Vehicle**

According to the plan of construction organization, compare with the similar scale projects, the quantities of major construction machinery and vehicles estimated at about 30, focusing parked. The wastewater used to wash each vehicle is about 0.6 m^3 , count by 50 percent per day, so the completely produced oil wastewater is about 9.0 m^3 per day, and the entire construction period will have a wastewater of 5400 m^3 .

The project report did not propose specific measures for the wastewater treatment during the construction period. In the light of similar conventional wastewater treatment measures, the evaluation of the proposed construction of wastewater

treatment using the following measures: the major pollutants in the aggregate processing wastewater are the SS, which can use stratospheric sedimentation tank processing. The concrete pouring conservation wastewater with its pH value as high as 11 ~ 12, can use the sedimentation tanks and processing. Oily wastewater generated by construction machinery and vehicle washing, can use grease traps for processing. After the above treatment, wastewater can discharged. Yuquanhe Basin Hydroelectric Power Station projects and its major pollutants, see table 2-3.

Table 2-3 Construction Wastewater and the Main Pollutants Production

No.	Wastewater Type	Wastewater Production in Peak Period (m ³ /d)	Total Wastewater Production in Construction Period(m ³)	Pre-Treatment	Pro-Treatment
1	Sand-Gravel Processing Wastewater	380	38220(255)	SS : 2.5×10 ⁴ mg/L , 6375kg/d	SS : 70mg/L , 17.85kg/d
2	Concrete Pouring and Curing Wastewater	75	7500(50)	SS : 5000mg/L 250kg/d	SS : 70mg/L 3.5kg/d
				pH : 11-12	pH : 6-9
3	Construction Machinery, vehicle rinsing wastewater	20	5400(9)	Petroleum : 15mg/L 0.135kg/d	Petroleum : 5mg/L 0.045kg/d
				SS : 300mg/L 2.7kg/d	SS : 70mg/L 0.63kg/d
Total		475	51120(314)	/	/

Note: The main wastewater sources of the foundation pit are rainfall, cofferdam leakage, which are not included in the statistics of total wastewater discharge in construction period. And datas in parentheses are daily average wastewater

discharge, and are counted by standard-meeted concentration.

(2) Water and Sewage Situation

It is mainly owing to the domestic sewage of the construction staff. The peak construction labor is about 367 people, and the average number is 245. According to the convention in water use of hydropower construction stuff, the limitation is about 200L per day, and the total amount in construction period is about 35770 m³, of which 80 percent to become the discharge. The drainage limit is 160L per day, while the maximum daily sewage discharge is up to 58.7 m³, and the average daily sewage disposal capacity is 39.2 m³. The sewage emission in the construction period is 28616 m³. The main pollutants include COD, BOD₅, SS and NH₃-N.

The construction area is located between barren hills, away from residential areas and urban areas. Considering of the overall level of the construction site at the present and the and regional environmental status, building temporary toilet and simple septic tanks uses to deal with such problem is in accordance with the local conditions and technical standards requirements.

Domestic sewage and discharge of major pollutants in table 2-4.

Chart 2-4 State of Discharge of Domestic Sewage and Main Pollutant

Amount of Waste Water		Pollutant	Pre-processing			Post-processing		
m ³ /d	Total×10 ⁴ m ³		Concentration mg/L	Discharge Quantity		Concentration mg/L	Discharge Amount	
				kg/d	Total		kg/d	Total
39.2	2.8616	COD	400	15.68	11.45	160	6.272	4.58
		BOD ₅	200	7.84	5.72	80	3.136	2.29
		SS	220	8.624	6.29	66	2.587	1.89
		Ammonia	15	0.588	0.429	15	0.588	0.429

2.10.1.4 Waste Gases, Pollution Sources and Pollutants during the Construction Period

Emission sources during the construction period include dust generated by mixing concrete batching system, dust generated by artificial feeding system gravel crusher. Emissions generated by mining vehicle and demolishing; emissions generated by living coal-fire; fugitive dust and automobile emissions generated by transportation, dust generated by the transportation of cement and fly ash; dust generated by excavation of earth and stone, etc. The main pollutants are total suspended particles (TSP), SO₂, CO and so on.

According to the design and construction organization analogy estimates, the construction area mainly for fuel oil, the total consumption of fuel is about 449.2t in 20 months. In accordance with the pollutant law, major pollutants generated by the construction fuel, see Table 2-5.

Chart 2-5 Category and Amount of Main Pollutants Produced by Construction Fuel of Yuquanhe River Basin Hydropower Station

Feature	Oil Consumption (t)	Category and Amount of Main Pollutants Produce by Fuel (t)		
		SO ₂	NO ₂	CO
Daily Produce Volume	0.615	0.694	10.57	17.37
Totals During the Construction Period	449.2	417	6339	10423

Due to the scale of the projects is small, and construction sites are scattered, its source strength is also scattered, so its' impact on ambient air quality is not sufficient, but it will have a certain impact on the local area and on-site staff, prevention and control

measures should be taken to reduce the harm.

The project on the effects of the atmosphere is limited to the construction schedule; the project impact would be eliminated after its completion.

Tangjiahe gravel process of reservoir system, see Figure 9 hands.

2.10.1.5 Equipment and Noise

The main equipment for the project construction, see Table 2-6.

Table 2-6 Main Construction Machinery

Type	Name and Specification	Unit	Quantity	Type	Name and Specification	Unit	Quantity
Loading	Electrical Shovel Excavator 3m ³	Set	2	Sand Processing	Feeding Engine – Slot Type K3500 t/h	Set	1
	Electrical Shovel Excavator 0.5m ³	Set	1		Feeding Engine – Electromagnetic Type 45DA	Set	3
	Hydraulic Shovel Excavator 1.0m ³	Set	4		Unloading Trolley 15kW	Set	1
	Loader 1.6-1.7m ³	Set	2		Main Body of Rod Mill φ2100×L3600	Set	1
	Loader 3.0-3.3m ³	Set	4	Concrete Construction Machinery	Concrete Mixer – Discharge 0.8m ³	Set	3
	Bulldozer 59kw	Set	1		Concrete Mixer - Volume 30m ³	Vehicle	2
	Bulldozer 74kw	Set	2		Concrete Delivery Pump 40m ³ /h	Set	1
	Bulldozer 88kw	Set	2		Spraying Machine 75L	Set	2
	Bulldozer 103kw	Set	1		Vibrator – Plug Type 2.2kW	Set	10

	Centrifugal Pump	Set	2		Wind (sand)	Set	3
					Hydraulic Giant 2-6m ³ /min	Set	
Roller Compaction	Tractor 59 kw	Set	2		Slip Form Equipment	Set	2
	Slope Grinder 5t	Set	1		Trolley Power Equipment	Set	1
	Self-propelled Vibrating Roller CA30	Set	2		Drawplate Power Equipment	Set	1
	Hand-held Vibrating Roller 1.5t	Set	1		A.C. Welding Machine 25kVA	Set	2
Rock Drilling	Hand-held Pneumatic Drill	Set	7				
	Air-leg Pneumatic Drill	Set	10	Drilling and Pouring	Type-150 Hand-held Oil Pressure Geological Drilling Rig	Set	4
	Type-80 Down-the-hole Drill	Set	3		Grouting Pump - Mid and Low Pressured Slurry	Set	4
	Type-100 Down-the-hole Drill	Set	1		Mortar Mixer	Set	4
				Transport	Auto truck – Oil Type t	Unit	2
					Diesel Dumper 3-5t	Unit	2
					Diesel Dumper 8t	Unit	4
					Diesel Dumper 10t	Unit	4
					Diesel Dumper 12t	Unit	4
	Air Compressor 4L-8/20	Set	2				
	Air Compressor DVY-9/7	Set	1				
	Air Compressor DVY-6/7	Set	2				
	Jack Equipment	Set	3				
	Axial Flow Ventilator 28kW	Set	2				

	Axial Flow Ventilator 37kW	Set	2		Diesel Dumper 18t	Unit	15
					V-shape Narrow-gauge Tram – Volume 0.6m ³	Unit	1
	Jaw Crusher 600×900mm	Set	2		V-shape Narrow-gauge Tram - Volume1.0m ³	Unit	1
	Spiral Classifier φ450mm	Set	2		Rubber Belt Conveyor 500mm×10M	Set	11
	Self-fixed Centre Shale Shaker	Set	2		Rubber Belt Conveyor 500mm×15M	Set	1
Sand-gravel Processing	Inertia Vibrating Screen 1250×2500mm	Set	2		Rubber Belt Conveyor 500mm×30M	Set	8
	Heavy Vibrating Screen 1500×3000mm	Set	2		Spiral Air Delivery Pump 65t/h	Set	1
	Disc-type Feeding Engine DB-1600	Set	2		Rubber Tire Wheel Burrow	Unit	50

Table 2-6 and other major construction device revealed that the main construction works from the earth and mechanical noise (such as Down-hole drilling, excavators, loaders, etc.). Concrete pouring equipment (such as crawler cranes, concrete pumps, concrete hanging cans, etc.), drilling irrigation equipment, concrete production equipment (crusher, sieving machines, sand washing machines, concrete mixing stations), as well as auxiliary processing equipment (carpentry, machine repair, air compressors, pumps, transformers), such as about 180 sets of equipment. According to the operational characteristics of mechanical equipment, noise sources can be divided into fixed and mobile sources two categories.

According to the same construction, period of mechanical equipment operation noise and experience of the actual value estimated that the project the main noise source strength shown in Table 2-7.

Chart 2-7 Chart for the Main Noise Source and Noise Level

Type of Noise Source	Mechanical Title	Equivalent Noise Level dB (A)
Fixed Point Source	Grab, shovel loader, stirring mill, grouter etc.	95-100
Moving Linear Source	Camion, bulldozer	85-95
Blasting Noise	Blasting	130

Because the construction area is located in the valley, noise-proliferation is barefaced by the mountain. So its impact is mainly limited to the scope of working area near the local area, the noise will mainly bring a certain impact on workers during the construction period; tunnel excavation, mountain blasting will disturb the local residents in the mountain and wild animals, but it is only in the construction period.

2.10.2 Reservoir Inundation Period

Tangjiahe hydropower project could not finish the whole year is a regulation-style water and hydropower project, located in the middle reaches of River fisheries, retaining the buildings for CFRD, the greatest height to 54.44m. Tangjiahe normal water level in the reservoir is 800.00m, check flood level 801.74m. River Basin hydropower and fisheries reservoir submerged the scope of only a township (town), as the canyon is located in the mountains, the main submerged in kind, including within the scope of 39.01 acres of forest land, 31.2 acres of tea plantations, highways (about 3km) 7.63 acres, 0.81 acres of homestead, homestead relocation 4 15 bridges 2. Reservoir boundary that is not flooded and cultural relics, such as mineral deposits, therefore, River Basin hydropower station construction and fisheries involves relocating production and placement of life less, there is no mineral resources and

cultural relics in the reservoir area, such as a special deal with the problem.

According to *Water Conservancy and Hydropower Project Design Specifications Reservoir Inundation Treatment* (SD130-84) provides that submerged in the reservoir area of the project dealt with design standards: flooded forestland requisition standards reservoir normal water level. Based on the above water level, the scope of flooding submerged physical indicators provided by the owners responsible for the investigation.

Reservoir submerged part of the vegetation, causing changes in plant biomass; aquatic habitat area caused by the expansion of aquatic organisms and fish resources, changes in the types and distribution; reservoir submerged land caused by loss of wildlife habitat. Early reservoirs, soil and vegetation were flooded in the decomposition of organic matter into the water body to release nutrients, water likely to cause environmental problems. In addition, the process of reservoir water could trigger landslides and leakage problems, such as environmental geology.

Overall, the reservoir submerged mainly has a certain influence on some terrestrial plants, terrestrial animals, land use, water environment, environmental geology and other environmental factors.

2.10.3 Project Run-time

Operation of the project is a water storage, power generation, discharge process; the project has no wastewater and other pollutants. Once the project is completed; the reservoir operation and dam barrier will cause some irreversible environmental impact.

Reservoirs, the water level, flow rate slowed down, sediment deposition in the hangar, water temperature and other environmental factors with the natural state of the difference so that fish and fisheries River in the middle of Tangjiahe River Power Station dam above the waters of the river changes from natural for the artificial lakes.

Therefore, the water level, flow rate, temperature and sediment, such as hydrological situation changed. Reservoir flow as slowing down reduced self-purification capacity of the water bodies; water would quickly deteriorate for the point. At the same time, the reservoir water storage will change the dam upstream and downstream sections of the Board of connectivity, on aquatic life have a greater impact on the environment. At the same time, as a result of reservoir operation run in the reservoir area to form a certain degree of level-fluctuating zone of level-fluctuating zone have a certain impact on the ecological environment.



3 Environmental Status

3.1 Overview of natural environment

3.1.1 Natural survey

Wufeng Tujia autonomous county which is located in the mountainous area of southwest Hubei, an offshoot of Wuling range, is an important part of Western Hunan and Western Hubei Revolutionary Base Area. Its longitude is 110°25'-111°25' and north latitude is 29°56'—30°25'. Wufeng borders on Yidu and Songzi city, and borders upon Shimen county in Hunan province to the South and Changyang Tujia autonomous county to the north. It has a common boundary with Hefeng and Badong county to the west. The whole county covers an area of 2372 km².

Ranking the largest tributary of Siyang Valley, Yuquan River (Charcoal River) is the sub-tributary of Qingjiang River. Sharing the watershed with Wantan River and Tianchi River, Yuquan River originates from Beifengya Forestry Centre at an elevation of 2231 meters, running through Songjiahe, Tangjiahe, Hongyuping, Kuzhuping. It flows into Siyang River Erchakou Reservoir (the planning water level is 420m) at Erchakou. The total length is 18.26km and the difference in elevation is 1793m. The upstream from Cong Yuan to the bay mouth of Songjia River is 6.7kilometers long, elevation 2213m to 870m. The difference in elevation is 1343m and the river slope is 117‰; the midstream from the creek bay mouth to Hongyuping is 6.96km long, elevation 870m to 565m, and river slope of 63‰; the downstream from Hongyuping to Erchakou Reservoir head is 4.6km in length, elevation 565m to 420m, and river slope of 49‰. The river has a watershed square of 99.85 km², average precipitation 1474.4mm. Its annual average runoff reaches 938.4mm, average flow 3.25m³/s and average total runoff 101million m³ for years. Theory potentiality of water power is 13,800kw and the corresponding annual capacity reaches 121million kWh. It is a mountain river with suddenly and sharply water

rising and falling , featuring in a great disparity in richness and dryness.

Songjiahe II-Hydroelectric Power Station intake dam is located in the creek bay mouth of the Yuquan River midstream with watershed square 31 km^2 , river weighted average slope of 117‰; the power house is at Tanjiahe Reservoir end with watershed square 41.5 km^2 and river weighted average slope of 90‰.

The dam site of Tangjia River hydroelectric hinge project is located in Tangjia River of the Yuquan River midstream, with watershed square 49.0 km^2 , and the river is 10.8km long and of 68‰ weighted river slope; the power house is in Hongyuping with watershed square 91.1 km^2 , and the river is 14.3km long, average slope of 61‰.

3.1.2 Meteorological features

The proposed Songjia River I, II and Tangjia River Hydroelectric Power Station are in the Northern Hemisphere subtropical warm and humid monsoon climate area which features in distinctive alternation of winter and summer monsoon, clear four seasons, sufficient sunshine, profusion of rainfall, warm spring with changes, early summer with rainfall, hot autumn with droughts, and cold winter. Meanwhile, it has features of mountainous region climate because the basin is located in mountainous canyon region. Due to the characters of geographical changes, the hydrologic meteorological elements demonstrate a clear vertical distribution.

There is no weather station in the basin. Its weather information is based on the measured information of Wufeng weather station, which is located in the midstream of Tianchi River and is about 10km to the power station. The weather station was founded by the weather bureau of Hubei province in 1956 and since February in 1957 it has started measure of ground meteorological elements like: air temperature, humidity, air pressure, wind direction, wind velocity, precipitation, sunlight, cloud,

weather phenomenon, visibility, exhalation and ground temperature of different depth. Wufeng weather station has complete information, fine precision and can meet the need of project design. It is one of the national basic weather stations in Hubei province and the measured data is reorganized and printed out by the weather bureau of Hubei province. Details are as follows: table3-1

Table3-1 relevant weather value of Wufeng weather station

No.	Project	Unit	Figures	Remarks
1	Annual average air temperature	°C	13.1	
2	highest temperature	°C	37.1	
3	lowest temperature	°C	-15	
4	Annual average absolute humidity	Pa	127	
5	Annual average relative humidity	%	76	
6	Annual average wind velocity	m/s	1.3	
7	Utmost wind velocity	m/s	15	
8	Dominant wind direction		SE	
9	Annual average sunlight hours	h	1533	
10	Annual average non frost period	d	247	
11	Evaporation capacity of water surface	mm	630	Evaporation map of evaporation capacity in Yichang
12	Evaporation capacity of ground	mm	540	Evaporation map of evaporation capacity in Yichang

3.1.3 Regional geology

3.1.3.1 Regional topography and stratum litho logy

Wufeng Tujia autonomous country is located in the Southwest of Hubei province. This region has a precipitous physiognomy with cliffs and peculiar mountains around. The relative difference in height is 800m ~ 1000m, and the elevation of the highest mountain peak in project region reaches 1255m, the lowest 860m. It is a middle and high mountainous region in tectonic denudation.

The regional strata belong to Huangling districts of Huangling octal mountainous region and they are all sediments, of which clastic rocks are widely distributed. The strata from Nanjinguang Fm of lower Ordovician system to Yuntaiguan Fm of middle Devonian System and Quaternary are cropped out.

3.1.3.2 Regional geological structure

The proposed III Hydroelectric Power Station project site is located in composite parts of East-west structural zone of Yangzi River midstream and downstream and northeast structural zone of Xinhua Cathay Ian. Former one is represented by Lions Nao synclinatorium and controlled by the east-west structure. It was shaped in the Indo-Chinese epoch and late Yanshan movement (lithosphere movement). In the same period with fold, the regional fractures mostly developed on the precipitous side of the fold and changed its directions toward east west, north east and north east as the fold axial direction moves. In the east west structural zone, it is major in folds and rare in fractures.

The overall layer's strike of Songjia River I Hydroelectric Power Station project region goes the same with regional Mapeng Mountain syncline、 Songjia River anticline axis, inclining to southeast along the axis with a dip angle of 20~39°, no big changes; the II layer's strike parallels to anticline axis, inclining to northwest and southeast along the axis with a dip angle of 57°on northeast side and 37°on southeast side; Tangjia River Hydroelectric Power Station project site is located in the composite parts(uptift in east Hubei) of western structural zone of Yangzi River

midstream and downstream and northeast structural zone of Xinhua Cathay Ian. Former is represented by Lions Nao synclinorium and controlled by the east-west structure. It was shaped in the Indo-Chinese epoch and late Yanshan movement (lithosphere movement). In the same period with fold, the regional fractures mostly developed on the precipitous side of the fold and changed its directions toward east west、 north-north east and north east as the fold axial direction moves. In the east west structural zone, it is major in folds and rare in fractures. The overall layer's strike of the project area parallels to Baiyiping syncline axis, southern terrain inclining to northwest, from northern terrain to southeast. On the whole, it shows that the dip angle of southern terrain, generally 30~58° , is more precipitous and with great changes than the northern one, generally 28°.

Since tertiary, the lithosphere in the region presents an overall intermittent slow rise. The physiognomy features in various levels of plantation surfaces, river terrace and partial developing to caverns. The plantation surfaces, terraces and Tangjia River water system near the site haven't appeared deformation, displacement or distortion. The faults haven't presented a clearly movement in new formation period which shows that the site is in a relative stable formation environment.

Attached drawing10: Regional geology and Tangjia River reservoir Hydroelectric Power Station project's geology

3.1.3.3 Earthquake

According to the national earthquake bureau、 relative earthquake recordings of Hubei province and investigation data from Changjiang water conservancy committee Qingjiang geological group Madu River Hydroelectric Power Station, at the range of 220km from the site, since the time having recordings till now, there have been 57 times of $MS \geq 4.7$ earthquake. The influence intensities of these earthquakes on the site are all lower than VI grade. Around the site, there never happen any earthquakes

above 3.0degree in history. The frequency and intensity of earthquake are very low.

The earthquakes happened at the range of 365km near the site in history had very weak influences on the site and the intensities are below 6degree. Changmaosi in western NNE direction near the site has broken, which haven't showed any obvious movements since tertiary though with a history of movements in various periods. No faults have been found in the area, and only tectonic joint and relaxed joint have developed a little. The outcropping faults with small scale and shallow incising depth do no good for the strain energy storage.

In view of the above, to draw an analogy with the earthquake intensity of Madu River Hydroelectric Power Station site (when the earthquake damage probability in 50 years is over 10%, the intensity of that site is 5.83degree) and earthquake ground motion parameters of China (2002), the basic earthquake intensity of the site is defined as VI degree according to earthquake intensity zoning map of China (1990). Therefore, the tectonic security design of Songjia River I, II Hydroelectric Power Station and Tangjia River Reservoir project should be in accordance with VI degree's requirements.

3.1.4 Geological conditions of the reservoir project zone

3.1.4.1 Geology characteristics

At the dam site axes under the Tangjia River reservoir, the elevation of dam foundation valley is about 752.0m, and elevation of tail valley is 801.2m. The river bed slope is 25%, and the valley is 20~80m wide. On the whole, the valleys of reservoir head and end are generally very narrow, and the middle valley of the reservoir area is wider, 80m to the utmost. The ridges near the banks have elevations of 1119.5~1279.5m to the left bank and 1055.1~1258.9m to the right, which means left bank is generally higher than the right. There are three channel systems developed toward east west and north east on right bank and only one stream in north west

direction at the reservoir end on left bank. The three channel systems that near Tangjia River bed are of very small slopes and always form the reservoir area with Tangjia River; the one that at the reservoir head on left bank is of very steep slope which can't form reservoir area but a state of hanging off the bank.

3.1.4.2 Geological formation

There are two faults with small scale in the reservoir area, fault F_1 and original F_2 fault. Due to the fact that F_1 fault is already at the reservoir end, its property has little influence on the project while original F_2 fault is near the drafted dam axis and its property has a big effect on the project. Therefore, in this survey, only spot survey is adopted on fault F_1 to strengthen verification while on original F_2 fault, spot survey and geophysical means are adopted to focus on assessment. The report has demonstrated that fault F_1 are shallow fractures left by the hypo primary fold because of the geological agency hitting the hard, soft rock during the Baiyi Ping syncline formation. It extends to north west—south east with a length of 870m, and the attitudes of two sides have slight torsions distributing in the Maxi Fm litho logy at reservoir end. According to the spot survey on original F_2 fault, attitudes of two sides' strata are nearly the same. The gully internal terrain of down stream's right bank has cropped out and has a manifestation of connected parts' fracture. On the other hand, the geophysical result has showed that there is a probable original F_2 fault crushing zone on left bank. The two sides' rock mass has a good continuity and only the surface appears some bedding peeling off. It can be confirmed from the above that the original F_2 fault is not existed.

The dam site strata in reservoir area are composed by muddy siltstone of Sanding Fm Silurian system or muddy siltstone and fine stone inter-bedding and partial limestone with mud (like stratified or lenticular distributing). The stratum of reservoir head is made up of Silurian system Sanding Fm muddy siltstone. In reservoir storage area, the strata are made up of Silurian system Longmaxi Fm shale, carbonaceous shale,

siliceous shale and Silurian system Luore Ping Fm salty, muddy siltstone with shallow fine siltstone, and in reservoir end area they are composed by Ordovician system Linxiang Fm argillaceous nodule limestone with bio-clasts, muddy siltstone and shale.

3.1.5 Engineering geological conditions of power station area

3.1.5.1 Songjia River I power station

(1) Engineering geological conditions of dam site

Located at an elevation of 1036m from Hongpiao bay mouth, Songjia River power station intake dam is on Mapeng Ling syncline north limb and Songjia River anticline south limb. The bedrock of dam site river bed has cropped out and floodplain hasn't developed. Only the upper and down streams of the dam have 3m thick overlay. Left rock is a steep bedrock cliff while right bank has a gentle upside and a steep downside. The top overlay is 1~4m thick diluvium. There is a little micro-weathered bedrock on the ground with a slope of $30^{\circ} \sim 40^{\circ}$. The dam site structure which is on Mapeng Ling syncline north wing is very simple, and the attitude of strata inclines to the upstream with an dip angle of $7^{\circ} \sim 28^{\circ}$; it mainly exists steep dip cranny in southwest direction with fine closure. However, dam foundation has a translational fault paralleled to the river bed, and its bedrocks on two sides are complete and hard with heavy layers. Therefore, these structural planes have good engineering properties on the whole and there will not be big influence for the designed dam height of 2m. According to the analogy with similar geological conditions and this survey result, the permeation rate of dam's left bank is below 2Lu and right rock a little high 2.8Lu.

The dam top has an elevation of 1036.75m and a length of 26.4m while the river bed of dam foundation is 20m wide and 0-1.5m water deep, and most bedrock of dam foundation and left dam abutment are cropped out; a large part of right dam abutment

is covered by 1.5m thick diluvium, a slope of 30°-40°. The bedrock of dam foundation is off white- yellow thick quartzite sandstone of Yuntaiguan Fm Devonian system with 0.1cm ~ 10cm schist incompetent bed. The micro-weathered terrain is in thick structure type and its initial quality is in II grade.

The engineering geological problems of Songjia River power station intake dam are about limestone of right dam abutment and leakage of diluvium, which need leaking preventing.

(2) Geological conditions of Power Station diversion tunnel engineering

The origin of diversion tunnel which is on left bank of Songjia River dam site extends to north-north east of 2000m with a sectional dimension of 1.5×1.9m(width × height), intake elevation 1036m and an average longitudinal slope of 1/2000.

The tunnel axial direction from NWW355°turns to NWW353°, basically changing as the stratum's trend and is approximate off trend. Tunnel trunk strata are Maxi, Luore ping, Sanding Fm of Silurian system and Yuntaiguan Fm of Devonian system. Tunnel line basically goes through Songjia River anticline south wing and its south limb terrain tends to SSW with a gentle dip angle (7° ~ 30°) of southern tunnel trunk and a steeper dip angle(43° ~ 55°)of the north. Ground elevation of tunnel top, except entrance and exit, generally is 1086 ~ 1246m and the large embedded depth of tunnel trunk is good for its stability. As a whole, thanks to the Songjia River I Power Station intake tunnel axial direction vertical to strata strike and large embedded depth, conditions of tunnel forming are very good. However, middle section and north exit of the tunnel trunk have weak stabilities because of the shallow embedded depth and well developed Silurian system weak weathered unloading cranny、 shear joint. According to the system statistics, shear joints with wrench feature are mainly at SE direction (145°) and the fissure plane is very smooth. During the construction,

supporting work should be done in case of top collapse of small dip angle and unloading developing section.

3.1.5.2 Songjia River II power station

(1) Engineering geological conditions of intake dam site

Intake dam is located at about 100m to west north side of Chen family field. Upstream trend of dam axis is in south-south east direction, and downstream to Huangjia wan east side road in northwest direction turns to northeast direction to Tangjia River and then to northwest direction. Rivers in dam area present a southwest gibbose as a whole and partly have frequent turnings. Dam site is 863.43m~864.45m to right bank, slope of 5~10° while to left bank 863.49m~865.15m, slope of 0~30°.

The river bed of dam site is 2.6m wide and of 862.9m elevation. Its groove is 0.6m deep near left bank. The overlay of sand cobble on the riverbed is 0~0.5m thick and boulders can be seen in some parts with grain diameter of 50×50mm. Right bank is a gentle bedrock slope of easy flow direction which is composed by caesious medium thickness seam nodular microcrystalline limestone on the top of Guniu Tan Fm Ordovician system; on the upper part of left bank there are 0.5m~1m thick residual diluvium bulk, and lower part is a gentle reverse slope of bedrock which is made up of Ordovician system Miaopo Fm grey calcareous shale and shallow with carbonaceous shale inter-bedding; rock of two sides is in conformable contact. The micro-weathered rock mass surface of right bank is 0.4~1.5m thick. Left bank rock mass have two zones: weak weathered zone of 1~2m thickness on the surface and 0.5~1m thick micro-weathered zone below. In the Intake dam axial section, right bank is simple hard rock, and left bank is made up of medium hard rock and soft rock inter-bedding.

There is no big fault in dam site area and only have developed three structural joints, first group with an dip angle of 80° inclining to $NWW275^\circ$, second group with an dip angle of 62° inclining to $NE30^\circ$, and third 75° oblique inclining to $NEE75^\circ$. The attitude of strata inclines to $SSE175^\circ$ with a dip angle of 38° . The joint planes developed in dam area are very tight with a poor connectivity. The cross-line of jointed rock plane and rock layer inclines to the slope and introversion, and layer consequent slope without free face presenting a medium thick layer structure. Because of the rare structural planes of rock mass, the jointed rock plane and rock layer are in stable structure. However, the natural slope angle is greater than layer dip angle; in addition the natural slope and layer are all in outward orientation which is easy to form layer slipping.

(2) Engineering geological conditions of diversion canal

Diversion canal extends to northwest and southeast. The outcropping bedrock of open channel in southeast part is Miaopo Fm calcareous shale with fine water-proving character, 0.5m~1.5m thick weak weathered zone on the surface and 0.1~1.0m thick micro-weathered zone below; fresh bedrock mass is in shallow structure with good integrity and developed structural planes. There are only 1m~4m thick floodplain composed by sand, gravel and boulder along the northwest part where is full of boulder soil at its end point. This soil with strong permeability is hard to start digging and easy to collapse. Under the soil it should be Guniu Tan Fm nodular microcrystalline limestone, a kind of hard rock.

(3) Engineering geological conditions of Diversion tunnel

The areas that Diversion tunnel passed through are carbonate distributing zone, presenting karst topography and characters of many monoclonal mountains and bedding developed caves.

Number one Diversion tunnel axial direction of southeast section is a combination of

Ordovician system Guniu Tan Fm thick nodular microcrystalline limestone, Dawan Fm muddy nodular microcrystalline limestone and shale inter-bedding, Red garden Fm thick nodular microcrystalline biogenic calcilithite. The rock mass inclines to south-south east with an dip angle of $30^{\circ}\sim 36^{\circ}$. Northwest and middle parts are combinations of Ordovician system Fenxiang Fm thick layer with starry limestone with sand, limestone of oolitic sand cutting and shale inter-bedding. As for the rock tendency, is from SSE direction to SWW with $12^{\circ}\sim 20^{\circ}$ oblique because the tunnel axis is on Songjia River anticline inclining side.

The southwest part of Number two Diversion tunnel axial direction is a combination of Ordovician system Fenxiang Fm thick layer with sandy bio-clastic sparite calcarenite, limestone of oolitic sand cutting and plane rock inter-bedding. The rock mass tends to northwest with a dip angle of $20^{\circ}\sim 39^{\circ}$; the middle and NNE parts are combinations of Ordovician system Red Garden Fm thick layer bio-spararenite, Dawan Fm shale nodular microcrystalline limestone, muddy nodular microcrystalline limestone with boiclastics with shale inter-bedding, thick layer nodular microcrystalline limestone of Guniu Tan, Miaopo Fm carbonaceous shale with limestone inter-bedding, Baota Fm thick layer crack bio-clastic microcrystalline limestone, and the rock mass of it tends to NNW with a dip angle of $50^{\circ}\sim 54^{\circ}$.

No big crack section was found in No.1、2 non-pressure diversion tunnel axial zone, and there is only one small scale fault F1 with unclear character extending 800m to north west and south east direction in No.2 non-pressure diversion tunnel of NNE part. On two sides of the fault, Rock mass attitude is in disorder and vegetations are developed with partial cropping out under the weathered and water erosion process. The distributing features of structural rock can't be identified, but according to the relationship between fault orientation and Songjia River anticline axial direction and the analysis of regional stress field, it can be initially confirmed that F1 fault is a wrenched fault with a northeast tending section.

(4) Engineering geological conditions of Power Station site

There exists a northwest extending unidentified fault in the north 50m to site area. The rock attitude of its two sides is in disorder so there is a zone of 15m length that normal layer position can't be identified; there have developed spring in the southwest side of front-line hollow on pressure piping top and geological phenomenon of small scale layer slipping as well.

II Power Station pressure piping extends to a direction of NE81°, which has a slight oblique crossing with stratum trend. Stratum is of NW335°slope and of 57°dip angle while the layer's strike is at SW255°. The rock mass's strike and direction show that it's a diagonal slope. The strata that pressure pipe line passed through are Ordovician system Baota, Miaopo, Guniu Fm layer. Along the pressure pipe line there are two zones: weak weathered zone and micro-weathered zone.

Bedrock mass of Power Station workshop are Guniu Tan Fm layer nodular microcrystalline limestone, Miaopo Fm calcareous shale, and Baota Fm nodular microcrystalline limestone with biogenic calcilithite. Rock mass attitude at the direction of NE32°has a dip angle of 41°. Rock mass is a slope of easy flow direction and has developed one group of joint. Structural plane of rock mass without developing has a good integrality, but the rock mass strike is the same with natural slope direction and rock mass dip angle is greater than natural slope, so the rock mass is in unstable structure. Therefore, during the proposed power workshop construction, back slope is not easy to form high and steep slope, or it will form large scale layer slipping.

About Power Station site area hydrological and geological conditions and permeability of rock and soil mass, according to the survey, permeable layer of site area should be Guniu Tan Fm nodular microcrystalline limestone and Baota Fm microcrystalline limestone. They have poor permeability for the reason that two

rock masses have low sponginess and permeable ratio, besides the Miaopo Fm calcareous shale between Guniu Tan Fm and Baota Fm limestone is a relatively aquiclude, distributing in the area of II Power Station tail water which has a water resistance function.

3.1.5.3 Tangjia River

Tangjia River is a very important part of Yuquan River basin and its reservoir site is located in Tangjia River reach 300m to upstream of Tangjia River Bridge with a structural erosion physiognomy. The upstream valley of dam site tending to 300° is very straight; downstream valley bends a little at a tendency of 320° . The riverbed is 7~10m wide with a character of wide at the top and narrow at the bottom. Reservoir head to the dam site section has a slope of 13‰, and dam site riverbed has an elevation of 720m so the initial checked flood elevation is 801.0m. Left abutment slope, a dip angle of $40\sim 45^\circ$ is a skew slope (diagonal slope) and the surface of sloping field above 780m elevation is almost outcropping bedrock except some collapsing slope soil; below it, excavation of earth or stone in road construction has formed 1~2m thick debris and under it is bedrock slope. Right abutment, from riverbed to 825m is steep cliff and partial forming an overhang, with a slope angle of 70° and a slope surface of outcropping bedrock.

Now the riverbed sediments of dam site are ratchet with boulder layers filling by a large amount of sands and the drilling controlled utmost thickness is 5.20m. Bedrock mass is composed by Silurian system Sanding Fm with a rock property of muddy siltstone, finestone inter-bedding, and partial with lenticular marlite, which have strong, medium, micro weathered layers. 1.00~2.30m thick strong weathered layer distributing in partial left bank has developed joint, weathered cranny and is impregnated with much soil and iron, as a result, most rock mass has alteration. Medium weathered layer is 3.10~17.0m thick with well developed joint, weathered cranny. Known from the drilling, this layer in riverbed is very thin and on two banks

is thicker. Crack is impregnated with iron and is in a slightly opening-opening mode. Micro weathered layer with less developed joint, weathered cranny has a thick layer structural rock mass with good integrality and it is in closed type.

Dam site is located on Baiyi Ping syncline south limb with monoclinic structural rock mass. The rock layers are distributed very stable with a dip angle of $38\sim 47^\circ$ and strike of $340\sim 345^\circ$. However, the characters of well developed joints and suspected faults distributing in dam site area are as follows:

a、 joint

According to the statistics of joints in dam site area and authorized joint rose diagram, there mainly has developed two structural joints: first group, strike of 340° inclining to southwest and a dip angle of 43° , the cranny developing density is $3\sim 4/m$ with an extending length of $3\sim 5m$; second group, strike of 30° to east south, 60° dip angle, and density is $1\sim 2/m$ with an extending length of $2\sim 3m$. The two groups of crack in SHPB property are both closed with straight and smooth crack surface and poor connectivity,

b、 suspected fault

The survey report of feasibility study stage demonstrates that there have distributed faults near the toe board in this dam site area. Aiming at the problems above, we restart a field exploration in this region and geophysical explanations during this stage survey. Based on field work analysis, this region of left bank has a physiognomy of accumulated collapsing diluvium after shallow erosion and stripping along the incompetent rock layer. As for the relatively attitude raised in the report, the right side attitude is a jointed plane. Meanwhile, the attitude of two sides is the same which is in shallow wide cranny and partial connected physiognomy, according to the survey of right bank gulch.

Songjia River I Power Station engineering geological conditions, as figure 11:

Songjia River II Power Station engineering geological conditions, as figure 12

3.1.6 Sediments

The forest vegetation above Yuquanhe River Reservoir and three hydropower station is relatively good. The soil is mainly made up of carbonate yellow soil, mixed with a small amount of limestone soil. Since there is no real survey data in the watershed of the Siyangxi, we can transfer the sediment data surveyed in the Yuyangguan Station. According to the real survey data, the average model rate of sand lose of suspension is $145\text{t}/\text{km}^2$. The sand amount of the suspension in the dam address is $0.13\text{kg}/\text{m}^3$. The dry intensity of suspension and pushing sand are considered as $1.3\text{t}/\text{m}^3$ and $1.5\text{t}/\text{m}^3$. The rate of blocking sand is estimated in accordance with the reservoir storage coefficient, 80%. Thus the multi-average sand accumulation in the reservoir is $6,400\text{ m}^3$.

The year limitation of the sediment accumulation is set as 20 years in the first step according to the 4.7.4 item of <Design Standard for the small-scale hydropower stations> (GB50071-2002), so the sand accumulation in the reservoir is $128,000\text{ m}^3$, the accumulated height upstream of the dam is 767.1m.

3.1.7 Soil

According to the soil survey of Hubei Province and the second soil survey of Wufeng County, soil in the project site can be divided into six categories: red earth, yellow earth, yellow brown earth, mountain meadow soil, limestone soil and paddy soil. Among them, red earth is distributed on gentle slopes or platforms which has a good drainage at a relatively altitude in the tour area. Yellow earth is distributed on top of read earth. Yellow earth, the soil type which is of relatively extensive distribution in the tour area, is distributed above yellow brown earth. Mountain meadow soil is

distributed on the local gentle slopes at the mountain top in the tour area. Limestone is distributed from the top to the foot of the mountain. The distribution area of paddy soil is small; it is only distributed sporadically on the banks of river valley. Limestone is endodynamorphic soil developing on the parent material limestone. Its soil layer is relatively shallow, often mixed with gravel. It is suitable for the growth of north subtropical broad-leaved deciduous forest and mixed broadleaf/needle leaf forest, such as the pine, cypress, taxodium, and oak.

3.1.8 Land Plants

Wufeng Tujia Autonomous County is located in the western part of Hubei Province at mid-latitude with subtropical humid monsoon climate. There is plenty of plant resource. They comprise 126 families, 132 genera and 1,025 species of seed plants; five families, seven genera, ten species of gymnosperm; 121 families, 425 genera and 1,015 species of angiosperm, making up 63.00%, 31.88% and 17.85% of contribution to the flora of Hubei Province, respectively. As for detailed information about regional plant seeds, please refer to figure 3-2.

Table 3-2 Regional Seed Plant Statistics

Project	Gymnosperm			Angiosperm			Total		
	Family	Genus	Species	Family	Genus	Species	Family	Genus	Species
Construction Area	5	7	10	121	425	1015	126	432	1025
Hubei	9	31	100	191	1324	5550	200	1355	5741
China	10	34	238	291	2940	25000	301	2974	25291
Tourist Area in Hubei %	55.56	22.58	10.00	63.35	32.10	18.29	63.00	31.88	17.85
Tourist Area in China %	50.00	20.59	4.20	41.58	14.46	4.06	41.86	14.53	4.05

Among the 126 families of seed plants, 103 families, 81.75% of the total, like Family Taxaceae and Family Eucommiaceae, etc., contain Genus 1-4. Their existence is of great significance to the Assessment of characteristics of seed plants in this area. Fifteen families, 11.90% of the total, like Family Araceae and Family Araliaceae, and Family Berberidaceae, etc., contain Genus 5-10. Eight families, 6.35% of the total, contain genera above Genus 10. Among them, Family Asteraceae and Family Gramineae, etc. are large cosmopolitan families. Family Lamiaceae, Family Papilionaceae and Family Orchidaceae, etc. are families of medium size. These families are small in number, but they contain lots of genera. Therefore, they are an important source of flora diversity in this area.

3.1.9 Current Situation of Terrestrial Animal Resource

We have conducted a research on diversity of terrestrial vertebrates in Wufeng County, Hubei Province through field investigation, interview survey and document searching. There are 109 regional terrestrial vertebrates (vertebrates which have no trace in years are not included here), belonging to four classes, 23 orders and 56 genera. There are 29 kinds of mammals which belong to seven orders and 17 genera, 54 kinds of birds which belong to 11 orders and 27 genera, 16 kinds of reptiles which belong to three orders and seven genera, ten kinds of amphibians which belong to two orders and five genera. As for specifics, please refer to figure 3-3.

Table 3-3 Regional Terrestrial Animal Resource Statistics

Type Class	Order	Family	Species	Protection Level					
				National Key				Provincial Key	
				Rank I	%	Rank II	%	Provincial	%
Amphibia	2	5	10	0	0	0	0	7	70.00
Reptilia	3	7	16	0	0	0	0	5	31.25
Aves	11	27	54	0	0	7	12.96	19	35.19

Mammalia	7	17	29	0	0	3	10.34	11	37.93
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3.1.9.1 Population

The method of quantitative degree has been adopted to show the abundance of various animal groups' quantities. This survey has shown that there are 109 species groups of regional terrestrial vertebrates, which indicates that the survey is no counting of a single species group's quantity. Therefore we can not use the formula above to calculate the quantity of the 109 animal groups one by one. The only way to show the abundance of quantities of various animal groups is to adopt the method of quantitative degree on the basis of our research.

Quantitative degree: an animal population, which makes up more than 10% of the animals studied in unit area, is the local dominant species and represented by “+ + +”; an animal population, which makes up 1~10% of the total in unit area, is the local common species and represented by “+ +”; and an animal population, which makes up 1% or has only one in number in unit area, is local rare species and represented by “+”. As for Assessment standards of quantitative degree, please refer to figure 3-4.

Table 3-4 Evaluation Standard of Quantity and Rank

Population Condition	Symbol	Standard
Local Prevailing Species	+ + +	Accounts for more than 10% of all surveyed animals in unit area
Local Common Species	+ +	Accounts for 1-10% of all surveyed animals in unit area
Local Rare Species	+	Accounts for less than 10% or only one of all surveyed animals in unit area

The statistical result has shown that there are nine local dominant species: *Pelophylax plancyi* (also known as the Eastern golden frog), *Pelophylax nigromaculatus* (also known as the Dark-spotted frog or black-spotted frog), *Zoacys dhumades*, *Entechimu major*, *Phasianus colchicus*, *Cettia fortipes* (also known as the Brownish-flanked bush warbler), *Lepus sinensis* (also known as the Chinese hare), *Mutela sibirica* (also known as the Siberian mountain weasel, Siberian weasel, Kolinsky or Himalayan weasel), and *Sus scrofa* (also known as the Wild boar). There are 19 local common species: *Euphlyctis limnocharis*, *Paa spinosa* (also known as the Giant spiny-frog), Green japalure, *Eumeces chinensis*, *Elaphe mandarinus* (also known as the Mandarin Rat snake), *Elaphe rufodorsata* (also known as Red-backed Rat snake), *Bambusicola thoracicus* (also known as the Chinese bamboo partridge), *Streptopelia chinensis* (the Spotted-necked dove or spotted dove), *Cecropis daurica* (also known as *Hirundo daurica* or the Red-rumped swallow), *Motacilla alba* (also known as the White wagtail), *Spizikes semitorques Swinhoe*, *Phylloscopus inornatus* (also known as the Yellow-browed Warbler or Inornate Warbler), *Parus major* (Great Tit), *Melophus lathamii* Crested Bunting, *Rattus flavipectus*, *Rattus norvegicus* (also known as the Sewer rat), *Trogopterus xanthipes* (the Complex-toothed flying squirrel), *Arctonyx collaris* (the Hog badger), and *Muntiacus reevesi* (also known as Chinese muntjac.) The eighty-one left are local rare species.

3.1.9.2 Distribution Characteristics

(1) Horizontal Distribution

□ Animal Groups in the Water Space and Its Periphery

a. Animal group reproducing and living in water: The amphibia Caudata animals distributed in the area almost spend their whole life in the water. Though they won't die if they are out of water for a short period, they still live in the water all the time and rarely go on land.

b. Animal group which reproduces in water and lives both in water and on land: The amphibia anura animals distributed in this area, i.e. all frogs, must reproduce in the water. They also go on land to find food. But because their physical structure does not adapt to terrestrial life perfectly, they cannot stay far away from aquatic environment and must go back to water uninterruptedly so as to absorb moisture through skin to add water previously lost on land by evaporation.

c. Animal group which moves and looks for food in the water: Wading birds include birds of Ciconiiformes, Gruiformes and Charadriiformes. They wade across shallow water and irrigated fields to look for aquatic, such as petite fish and little shrimps. We have discovered that the amount of wading birds is relatively small, which may have something to do with the relatively small water area.

d. Animal group which looks for food in the water: Most kinds of Coraciiformes animals forage in the water. They stand on objects like branches on the shore side and fly to capture petite fish and little shrimps in the water. Besides, a few songbirds of Passeriformes also stand on objects like branches on the shore side and fly to capture petite fish and little shrimps in the water.

□ Animal Groups Distributed in the Forest Belt

Animals distributed in the regional forest include: birds, mammals and part of reptiles whose home ranges are in the forest. These groups, which have many species and a large quantity, are the main body of animal groups in the forest. They mainly forage in the forest, shrubs in and along the forest, and the underbrush. Thus, it comprises the complex food web together with other animals and plants.

The species diversity of forest animals is an important factor in the balance of nature. Besides, forest animals are closely related to human life. They can provide human with multiple economic utilization channels. Forest birds, saurian reptiles and serpentry reptiles are important natural enemies of agricultural and forest pests and bandicoot. Therefore forest animals are a precious animal resource in this area.

□ **Animal Group Closely Related to Human Economic Activity Area**

Rodents are the mammal with most species and largest number (twelve in total, making up 46.15% of all the mammals). The living environment where Gonorhynchidae and Cricetidae animals inhabit and human economic activity area overlap largely. Some species of Gonorhynchidae and Cricetidae live alternately in domestic environment and wild environment as seasons change. For example, *Rattus norvegicus* and *Rattus flavipectus* would live in domestic environment in winter when there's a food shortage in the wild environment; and they would go back to the wild environment in spring when the temperature rises and food is plentiful outdoors. Some species, such as *Apodemus agrarius*, *Rattus flavipectus* and *Rattus norvegicus*, and *Hystrix hodgsoni*, do great harm to agriculture and forest. Besides consuming a great deal of crops such as rice, wheat, corn and sweet potatoes, they also store numerous potatoes and precious herbs in the caves for winter. Some rodents are the main source for the spread of natural-focus diseases. In addition, some species of Passeriformes are important coexistent animals of human. They move and look for food in the residential area, capturing harmful insects and thus purifying environment.

(2) Vertical Distribution

□ **Vertical Distribution of Poikilothermal Animals**

Amphibians and reptiles are poikilothermal animals, regulating body temperature through external temperature. Therefore most species like to move in low-altitude and warm area.

Among all amphibians distributed in the area, *Pelophylax nigromaculatus* (also known as the Dark-spotted frog, or Back-spotted frog), *Pelophylax plancyi* (also known as the Eastern golden frog), *Euphyctis limnocharis* and *Bufo gargarizans* (the Asiatic toad) are dispersed species. Species of Microhylidae are mainly distributed in mid-altitude highland and water area. Paa frogs and stinky frogs are distributed in

relatively high-altitude area.

Most reptiles are distributed in mid-altitude highland. However, among them, *Elaphe carinata* (also known as the King Rat snake or Keeled Rat snake), *Elaphe bimaculata* (also known as the twin-spotted rat snake or Chinese corn snake), *Elaphe taeniura* (also known as Beauty rat snake) and *Zoacys dhumnades* are dispersed species, distributed at all altitudes.

□ **Vertical Distribution of Homoeothermic Animals**

Birds and mammals are homoeothermic animals, with perfect body temperature regulation mechanism. Therefore they have extensive geographic distribution and vertical distribution. Most species are forest animals, mainly inhabiting areas with relatively good forest vegetation. That's because the forest community has good food web structure with relatively easy food source, providing good cover and inhabiting condition. As the food varies vertically with seasons changing, the animals form the characteristic of seasonal vertical migration. For example, they migrate to low-altitude areas in winter when there's a food shortage at high altitude; they migrate to high-altitude areas in spring and summer when the food is plentiful at high altitude.

3.1.9.3 Species, Amount and Distribution of Endangered Wildlife

There are all together 52 species of protected vertebrate in the region. Among which there are 10 species of wildlife under second class state protection: *Accipiter virgatus* (also known as the Besra), *Buteo buteo* (also known as the Common buzzard), *Falco tinnunculus* (also known as the Common Kestrel), *Purcraasia macrolopla*, *Chrysolophus pictus* (also known as the Golden pheasant or Chinese pheasant), *Glaucidium cuculoides* (also known as the Asian Barred Owlet), *Asio otus* (also known as Long-eared Owl), *Macaca mulatta* (also known as the Rhesus Macaque or the Rhesus monkey), *Ursus thibetanus* (also known as *Selenarctos thibetanus* or the

Asian black bear), *Viverricula indica* (also known as the Rasse or the Small Indian Civet). These species amount to 9.17% of the total animal species in the area. There is no wildlife under first class state protection.

There are 42 species of wildlife under special province protection, making up 39.62% of the total species. Among them, there are 7 species of amphibians: *Bufo gargarizans* (also known as the Asiatic toad), *Paa boulengeri*, *Paa spinosa* (also known as Giant spiny-frog), *Euphlyctis limnocharis*, *Pelophylax nigromaculatus* (also known as the Dark-spotted frog or black-spotted frog), *Pelophylax plancyi* (also known as the Eastern golden frog), *Microhyla ornate* (also known as Ornate Narrow-mouthed Frog). Five species of reptiles also belong to the wildlife under special province protection: Green Japalure, *Elaphe mandarinus* (also known as Mandarin Rat snake), *Elaphe carinata* (also known as the King rat snake or Keeled rat snake), *Elaphe taeniura* (also known as Beauty rat snake), and *Zoacys dhumnades*. Nineteen species of birds are include in the conservation list: *Bambusicola thoracicus* (also known as the Chinese Bamboo Partridge), *Phasianus colchicus*, *Streptopelia chinensis* (also known as the Spotted-necked dove or the spotted dove), *Cuculus micropterus* (also known as the Indian Cuckoo), *Cuculus canorus* (also known as the Common Cuckoo), *Upupa epops* (also known as the Hoopoe), *Picus canus* (also known as the Gray-faced woodpecker), *Hirundo rustica* (also known as the Barn swallow), *Hirundo daurica* (also known as *Crecropis duarica* or the Red-rumped swallow), *Lanius schach* (also known as the Long-tailed Shrike), *Oriolus chinensis* (also known as the Black-naped Oriole), *Dicrurus hottentottus* (also known as the Hair-crested drongo), *Garrulus glandarius brandtii* (also known as the jay), *Urocissa erythrorhyncha* (also known as the Red-billed blue magpie), *Cyanopica cyana* (also known as the Azure-winged magpie), *Pica pica* (also known as the European magpie or Common magpie), Melodious Laughingthrush (also known as *Leucodiopton canorum* or the Chinese Hwamei), *Parus major* (also known as the Great tit), and *Melophus lathami* Crested Bunting. Eleven species of mammals are also in the list: *Lepus sinensis* (also known as the Chinese hare), *Trogopterus xanthipes* (also known as the Complex-toothed flying

squirrel), *Petaurista alborufus* (also known as the Red and white giant flying squirrel), *Callosciurus erythraeus* (also known as the Pallas's squirrel), *Hystrix brachyura* (also known as the Malayan porcupine or Himalayan porcupine), *Nyctereutes procyonoides* (also known as the Raccoon dog), *Meles meles* (also known as the European badger or Eurasian badger), *Arctonyx collaris* (also known as the Hog badger), *Paguma larvata* (also known as the Masked palm civet or Himalayan palm civet), *Prionailurus bengalensis* (also known as the Leopard cat), and *Elaphodus cephalophus* (also known as the Tufted deer).

Affected by the exploitation and development of wildlife resource in years, the quantity of nationally protected animal groups is relatively small, under the due carrying capacity of habitat. The birds of Galliformes are hunted in large number. Though their reproductive ability is relatively strong, their number is largely affected.

3.2 Current Situation of Soil Erosion and Water loss and Conservation of Soil and Water

3.2.1 Current Situation of Soil Erosion and Water Loss

According to the results by the Bureau of Water Conservancy of Hubei Province using remote sensing technology, the current areas of soil erosion and water loss in the whole county are 1058km², accounting for 44.75% of the total area. The light loss area is 380 square kilometers, and the medium loss area is 527 square kilometers, respectively accounting for 35.9% and 10.6% of the total area of soil erosion and water loss. The areas are mainly distributed in Yuguan, Wufeng County, Renheping Town, Caihua County. Areas with heavy loss are 39km², 3.7% of the areas with soil erosion and water loss, mainly distributed in Wufeng County and Yuguan Town. The annual average soil erosion modulus is 2659 t/km² and average amount of soil erosion totals 6,372,000t.

The soil erosion and water loss in the basin of Yuquan River in Caihua County in this

project is mainly caused by water erosion and the main form is surface erosion. The total area of soil erosion and water loss is 2320 hm² that is 23.2 km², which accounts for 23.17% of the total area. The area with light loss is 1271hm², 54.8% of the areas with soil erosion and water loss. The area with medium loss is 793.44hm² and the area with heavy loss is 81.20km² which accounts for 3.5% of the area with soil erosion and water loss. The annual average soil erosion modulus is 3031t/km² and the annual average amount of soil erosion is 70,300t.

3.2.2 Current Situation of Soil and Water Conservation in Project Site

The soil and water conservation, whose main project is transforming sloping fields into terrace, started in Wufeng County at the end of 1950s. The comprehensive treatment has been carried out in the unit of province administrating Changpuxi, Baiguowan, and small water space of Qianping since 1980s. In recent years, Wufeng County has been listed as a key administration county of ecological environment and national debt on soil and water conservation in central budget. Through this well-organized administration in this basins such as the comprehensive treatment project in the small basin of Yangjiahe in Yuguan Town, the accumulated treated area of soil erosion and water loss is 125km² and the areas transformed from sloping fields to terrace is 62,000mu, that is 4133hm². Areas treated by other measures is 8366.67hm²

In this project, the accumulated treated areas of soil erosion and water loss is 1500m², among which the basic farmland is 80hm², water conserved forest is 200hm², the economic forest is 420hm² and closed forest is 800hm². All the measures above are for the investment projects like cropland construction project, Yangtze River protection forest project and the comprehensive development project of agriculture.

3.3 Social Environment

3.3.1 Socio-economic Condition of Wufeng County

Located in the southwest of Hubei Province, Wufeng Tujia Autonomous County was originally called Changle County and then changed into the current name. Having obtained consent from State Council in July, 1984, Wufeng Tujia Autonomous County was founded. It has an area of 2,372 square kilometers, administrating five towns and three villages. The Tujia accounts for 67% of the whole population which is 208,000.

Wufeng County enjoys a distinct natural environment, for which it is renowned as "wonderland". Green streams meander through between ridges and peaks of the county. Abundant in natural resources like water energy, minerals, forest specialties, and tourism, Wufeng County promises a bright future for development.

Before the founding of our country, Wufeng County was very backward in its economy and its people suffered greatly. After our country was founded, the productive relationship and people's living standard have gradually improved. Benefited from the policy on ethnic affairs and the reform and opening up, the national economy has grown rapidly, especially in the twenty years after the Third Plenary Session of the Eleventh Central Committee of CPC. Since then, we have taken on the development path of "promoting the development of industry with agriculture, bringing along the development of agriculture with industry, systematic development in virtuous circle". By the end of 1998, the GDP, fiscal revenue and rural per capita net income of Wufeng County had reached 510,000,000 RMB, 50,180,000 RMB and 1404 RMB respectively. These figures increased by 4.7 times, 15 times and 13.5 times respectively over 1978.

3.3.2 Socio-economic Condition of Project Area

According to statistics, the total population in Wufeng County is 209,400 and the rural population is 183,600. The area in the county is 2364km² and the farmland is

19120hm². The grain production is 101,000t, the total principle value of industry and agriculture is 808,000,000BMB and the net income per capita in agriculture is 1526yuan. Han Group and Tujia minority group live together in this region and the population of the Tujia minority group is larger. This region is one of the key poverty relief counties in Hubei.

The project of Tangjiahe Hydropower juncture is located in Caihua Village in Wufeng, which is a main area of tea production in Wufeng. Caihua County governs 16 villages and 107 villager groups. There are 3014 farmers in the total population of 10248 and the work force in agriculture is 5687. In 2001, the total grain production is 5,445,000kg and the grain production per mu is 311kg with a production of 531kg per capita. At the same year, the total income of agriculture is 20,829,700 RMB and among it 14,075,500 comes from planting, 705,700 RMB from forestry and 5,800,000 from husbandry and 248,500 from other fields. The net income in agriculture per capita is 1720 RMB. The project areas are mainly in the three villages in Tangjiahe, Hongyuping, Songjiahe, in which the number of work force in agriculture is 1937, and the net income in agriculture per capita is 1821 yuan. The total area of land is 4340hm², that is 43.4km² and the farmland accounts for 4293mu.

3.3.3 People's Health and the Conditions of Major Diseases

The counties and villages in the hydropower station in Yuquanhe basin has formed a medical treatment network consisting of hospitals in the county and city, hospital stations in the village and village clinics. According to the materials provided by the medical departments in the Tujia Autonomy County of in Wufeng, the main epidemics and verminosis in recent years are viral hepatitis, malaria, TB, flue, leptosporosis, hemorrhage fever occurs sporadically.

According to the investigation in the construction area of Yuquanhe Hydropower Station, there is no natural focus disease around the reservoir.

3.4 Current Situation and Assessment of Environmental Quality

3.4.1 Current Situation and Assessment of Air Quality

(1) Arrangement of Monitoring Sites

To know the current ambient air quality in the construction site of project, the Environmental Monitoring Station of Wufeng Tujia Autonomous County monitored the ambient air quality in the area in five consecutive days from November 1st –November 5th, 2004.

According to the meteorological characters in the region, the distribution of environmental sensitive spots, four monitoring spots are set up in the factories in Tangjiahe Hydropower Station, the dam of Tangjiahe, the factories of the Songjiahe □Hydropower Station and the Songjiahe□ Hydropower Station. Refer to figure 13 for the specific positions and refer to table 3-6 for the names and their functions.

Table3-6 Information about Monitoring Sites

No.	Monitoring positions	Relative distance(m)	Direction and function
1 #	Factories of Tangjiahe power station	800	South of Tangjiahe PowerStation. Background monitoring position for PowerStation.
2 #	Tangjiahe dam	300	North of the dam site. Target of key protection in near the dam site.
3 #	Songjiahe □power station	300	South of the primary power station. Background monitoring position for primary PowerStation.
4 #	Songjiahe□ Power station	100	North of the secondary PowerStation. Background monitoring position for the secondary PowerStation.

(2) Monitoring Project and Methods

The monitoring factors of ambient air quality are sulfur dioxide, nitrogen dioxide and total suspended particles (TSP). Sampling and analysis are carried out according to the methods stipulated by the State Environmental Protection Administration. The setting of monitoring points and sampling height is in accordance with the *Technical Specifications for Environmental Monitoring, Atmosphere Part*. Please refer to figure 3-7 for sampling and analysis.

Table 3-7 Sample and Analysis of the Air Pollution

Pollutant	daily monitoring time	Methods of sampling	Equipment for sampling	Method of analysis	Equipment for analysis	Criteria
TSP	≥12h	Preconcentration of membrane filter	Intelligent Sampler of Total Suspended Particles with a large capacity Type TH-1000C	Gravimetric method	TG328Analytical balance	GB3095-1996 GB/T15432-95
SO ₂	≥18h	liquid absorption-stripping	Microcomputer sampler of the daily average concentration of air pollution Type TH-3000A	Tetrachloromercurate (TCM)-parosaniline spectrophotometric method	721(B)Spectrophotometer	GB3095-1996 GB8970-88
NO ₂	≥18h	liquid absorption-stripping	Microcomputer sampler of the daily average concentration of air pollution Type TH-3000A	Griess-Salzman method	721(B)Spectrophotometer	GB/T15435-95

(3)The Result and Assessment of Monitoring

The monitoring of ambient air quality obtained 60 valid average daily data, with SO₂, NO₂, and TSP accounting for fifteen respectively. The statistical analysis of monitoring data at three points is listed in figure 3-8.

Table3-8 Monitoring Results of Air

Items		1# factories of Tangjiahe Reservoir	2# Tangjiahe Reservoir dam	3# Songjiahe □PowerStation	4# Songjiahe □PowerStation
SO ₂	Scope of daily average number (mg/m ³)	0.016	0.014-0.016	0.016	0.018-0.020
	Rate of meeting water standard	100	100	100	100
	Maximum multiple of exceeding standard(times)	0	0	0	0
NO ₂	Scope of daily average number (mg/m ³)	0.026-0.028	0.028	0.030-0.032	0.026-0.028
	Rate of meeting water standard	100	100	100	100
	Maximum multiple of exceeding standard(times)	0	0	0	0
TSP	Scope of daily average number (mg/m ³)	0.030-0.036	0.034-0.038	0.052-0.058	0.030-0.036

Rate of meeting water standard	100	100	100	100
Maximum multiple of exceeding standard(times)	0	0	0	0

According to the Assessment of monitoring results, the monitoring values of daily average concentration range of SO₂ in three monitoring points are: 0.016mg/m³ in the plant location of Tangjiahe PowerStation, 0.014-0.016mg/m³ in the dam of Tangjiahe Reservoir, 0.016mg/m³ in the plant location of Songjiahe PowerStation, 0.018-0.020mg/m³ in the site of Songjiahe Hydropower Station, which all are consistent with the daily average concentration limit for the second standard of 0.15mg/m³ in *Ambient Air Quality Standard*. The scope of the monitoring value of the daily concentration of NO₂ in the plant site of Tangjiahe PowerStation is 0.026-0.028mg/m³, 0.028mg/m³ in the dam of Tangjiahe reservoir, 0.030-0.032mg/m³ in the plant site of Songjiahe Hydropower Station and 0.026-0.028mg/m³ in the plant site of Songjiahe Hydropower Station, which are all consistent with the daily average concentration limit of the second standard of 0.12mg/m³ in *Ambient Air Quality Standard*. The scope of daily average monitoring value of TSP is respectively 0.030-0.036mg/m³ in the plant site of Tangjiahe reservoir, 0.034-0.038mg/m³ in the dam of Tangjiahe reservoir, 0.052-0.058mg/m³ in the plant site of Songjiahe Hydropower Station, 0.030-0.036mg/m³ in the plant site of Songjiahe Hydropower Station, which are all below the highest limit of daily average concentration of the second standard of 0.3mg/m³ in the standard of air quality. In conclusion, the environment quality under control in the dam site areas and the factories in the project are relatively good.

3.4.2 Monitoring and Assessment on Current Environmental Quality for Surface Water

(1) Setting of Monitoring Section

In order to know the quality of water body containing sewage, the Environmental Monitoring Station of Wufeng Tujia Autonomous County monitored the water quality of rivers in the reservoir basin. Considering the fact that there was no concentrated sewage outlet in the upper and lower reaches of the dam site, we set four monitoring section, distributed respectively in the upper and lower reaches of the proposed dam site and the upper and lower reaches of the diversion dam respectively. There is one sampling point in every monitoring section.

In the fourteenth attached drawing are the specific locations of these sections. Please refer to figure 3-9 for the names of these monitoring points and their functions.

Figure 3-9 Setting of Water Quality Monitoring Section

The serial number of monitoring sections	Name of monitoring sections	Relative distance	Function of monitoring sections
1#	the upstream to the plant site of Tangjiahe Reservoir Power Station	about 100m upstream to the plant site	check cross - section
2#	the downstream to the plant site of Tangjiahe Reservoir Power Station	about 200m downstream to the plant site	control cross - section
3#	the upstream to the dam of Tangjiahe Reservoir	about 100m upstream to the plant site	check cross - section
4#	the downstream to the dam of Tangjiahe	about 200m downstream to the	control cross -

	Reservoir	plant site	section
5#	the upstream to the plant site of Songjiahe I Power Station	about 100m upstream to the plant site	check cross - section
6#	the downstream to the plant site of Songjiahe I Power Station	about 200m downstream to the plant site	control cross - section
7#	the upstream to the plant site of Songjiahe II Power Station	about 100m upstream to the plant site	check cross - section
8#	the downstream to the plant site of Songjiahe II Power Station	about 200m downstream to the plant site	control cross - section

(2) The Monitoring Items and Analytical Method

In light of main pollutants in the project sewage, the monitoring items of current water quality are determined as PH value, water temperature, SS, DO, permanganate index, BOD₅, amino nitrogen and total phosphorus.

The item analysis is carried out in accordance with standard method specified in *Environmental Quality Standard for Surface Water* (GB3838-2002) .

(3) Time and Frequency of Monitoring

One sampling was conducted in each of the four monitoring sections in November 1st and 2nd, 2004.

(4) Result and Assessment of Monitoring

We obtained 112 valid monitoring data of seven items. The monitoring result is in figure 3-10 below.

Figure 3-10 Statistical Result of Monitoring on Environmental Quality for Surface Water

cross-section	index	pollutant concentration (Except for pH, the unit for other items are mg/L)						
		pH	Oil type	DO	NH ₃ -N	permanganate index	BOD ₅	TP
1 # the upstream to the Tangjiahe plant site	range value	8.14	<0.005	9.56-9.62	0.190-0.192	1.44-1.46	0.70-0.72	<0.005
	reach the standard	II	II	II	II	II	II	II
2 # the downstream to the Tangjiahe plant site	range value	8.16	<0.005	9.60-9.62	0.190-0.194	1.74-1.80	0.68-0.70	<0.005
	reach the standard	II	II	II	II	II	II	II
3 # the upstream to the Tangjiahe dam site	range value	8.08	<0.005	9.78-9.80	0.175	1.86-1.88	0.88-0.90	<0.005
	reach the standard	II	II	II	II	II	II	II
4 # the downstream to the Tangjiahe dam site	range value	8.15	<0.005	9.80-9.84	0.173	1.60-1.68	0.92-0.94	<0.005
	reach the standard	II	II	II	II	II	II	II
5 # the upstream to the I Power Station	range value	7.96	<0.005	9.04-9.08	0.128-0.134	2.07-2.10	1.10-1.12	<0.005
	reach the standard	II	II	II	II	II	II	II
6 # the downstream to the I Power Station	range value	8.05	<0.005	9.08	0.126-0.128	2.12	1.14-1.16	<0.005
	reach the standard	II	II	II	II	II	II	II
7 # the	range value	8.07	<0.005	9.48	0.116	1.74-1.78	0.92-0.98	<0.005

upstream to the II Power Station	reach the standard	II	II	II	II	II	II	II
8 # the downstream to the II Power Station	range value	8.10	<0.005	9.44-9.48	0.114-0.118	1.72	0.94-0.98	<0.005
	reach the standard	II	II	II	II	II	II	II
the secondary standard of water quality in GB3838-2002		6-9	≤0.05	≥6	≤0.5	≤4	≤3	0.1 (lakes and reservoir 0.025)

Judging from the monitoring result, seven items in eight monitoring sections all reached the secondary standard of surface water quality, which indicated that the section of Yuquanhe in construction area was of good water quality.

3.4.3 Monitoring and Assessment on the Current Situation of Noise

(1) General Situation on Monitoring

To understand the current situation of regional noise environment in construction area, our department entrusted Environmental Monitoring Station of Wufeng Tujia Autonomous County with the monitoring of the noise in November , 2004 , in proposed power plant site of Tangjiahe Reservoir area, dam site of Tangjiahe Reservoir area , Songjiahe I power plant area and Songjiahe II power plant area. Because the dam site and power plant area were of original ecological environment, we only set one representative monitoring point in each of the two areas.

(2) Monitoring Time

We monitored the environmental noise both day and night. Specifically, the monitoring time is from 8 : 00-20 : 00 and 23 : 00 to 6 : 00 next day.

(3) Result and Assessment of Monitoring

We obtained eight monitoring figures of equivalent noise. Please refer to figure 3-11 for the monitoring result.

Figure 3-11 Monitoring Result of Ambient Noise

The serial number and names of monitoring points	Monitoring Time	Sound level of equivalent noise	category of assessment standards	standard value of assessment	whether exceed the standard or reach the stand	Main impact factors
1 # plant site of Tangjiahe Power Station	day	53.6	1	55	reach the standard	background value
	night	44.5		45	reach the standard	background value
2 # dam site of Tangjiahe Power Station	day	52.4	1	55	reach the standard	background value
	night	42.8		45	reach the standard	background value
3 # Songjiahe I power plant area	day	50.6	1	55	reach the standard	background value
	night	43.4		45	reach the standard	background value
4 # Songjiahe II power plant area	day	52.8	1	55	reach the standard	background value
	night	44.6		45	reach the standard	background value

According to the monitoring result in figure 3-11, the noise in the day and at night of

four representative points in the project area meets the requirement of Grade □ standard limit which is 55dB(A) and 45dB(A) by the standards in *Standard of environmental noise of urban area (GB3096-93)*, indicating a good acoustic environment in the proposed project site.

3.4.4 Assessment of Current Ecological Environment

3.4.4.1 Background Assessments on the Integrity of Natural Ecosystem

(1) Background Productivity of Natural System

The net primary production of natural vegetation shows a plant community's productivity under the condition of natural environment, i.e. the productivity of a natural system with no man-made interference. Many ecological models have developed a model of comprehensive natural vegetation's net primary production. This model is based on measured data, the physiological characteristics of plants, and the correlation equation of water-heat balance. Compare to others, this model can better reflect the net primary production of natural vegetation. Its calculation formula is as follows:

$$NPP = RDI^2 \cdot \frac{r \cdot (1 + RDI + RDI^2)}{(1 + RDI) \cdot (1 + RDI)} \times \text{Exp}(-\sqrt{9.87 + 6.25RDI})$$

$$RDI = (0.629 + 0.237PER - 0.00313PER^2)^2$$

$$PER = PET/r = BT \times 58.93/r$$

$$BT = \sum t / 365 \text{ 或 } \sum T / 12$$

In this formula:

RDI- radiation dryness index

r- (Annual) rainfall, mm.

NPP- net primary production (of natural vegetation), $t/(hm^2 \cdot a)$

PER- potential evaporation rate

PET- potential evapotranspiration, mm

BT- (annual) bio-temperature , $^{\circ}C$

t- daily mean ($0^{\circ}C < t < 30^{\circ}C$)

T- monthly mean ($0^{\circ}C < T < 30^{\circ}C$)

According to river basin and the hydrological and meteorological observation data of Wufeng County, the mean annual temperature is $13.5^{\circ}C$ and the annual mean rainfall is 1474.4mm. If we use the model above to do computational analysis, the net primary production of natural vegetation in Assessment area would be $3.16g/m^2 \cdot d$ which is at a relatively high level.

(2) The Steady State of Natural System Background

According to the result, the productivity of Assessment area is $3.16g/m^2 \cdot d$ ($1153.4g/m^2 \cdot a$) . By comparing and analyzing the net productivity of ecological system on earth and the research on phytomass, we can conclude that the average net production of this area is close to that of temperate broadleaf forest, which is $1200g/m^2 \cdot a$. The vegetation's net productivity is high, i.e. the system has a relatively strong resilient stability. It shows that the Assessment area has a relatively strong stability.

3.4.4.2 Current Maintenance of Ecological Integrity of Natural System Integrity

(1) Current Maintenance of Natural System's Productivity

According to filed investigation and the current situation of vegetation coverage in Assessment area, the vegetation of this area are divided into woodland, shrubbery, farmland and river beach, etc. Based on the result, the average net productivity of this area is estimated to be around $1150\text{g/m}^2\cdot\text{a}$, slightly lower than the background value of this area-- $1153.4\text{g/m}^2\cdot\text{a}$. This indicates that there is little man-made interference and destruction in this area.

The comprehensive analysis has shown that although human activities interfere with nature system's productivity in a certain degree, there is no radical change in its number and the natural system still owns a relatively strong capability of recovery and regulation.

(2) Stability State of Landscape

□ Resistance Stability of Landscape

Without much man-made interference, the biology sections in this area almost do not change in the degree of differentiation and heterogeneity. We learn from the present land-use map that among all the sections that make up the landscape, woodland section is the one with relatively good connectivity and high frequency of appearance. This shows that the main vegetation type in this area is woodland. Therefore, the natural ecosystem has relatively strong resistance stability.

□ Landscape Recovery Ability

Though the vegetation's primary production in the area has declined compared to the background, the vegetation still remains a transitional ecosystem between boreal coniferous forest and temperate broadleaf forest. This indicates that this area's natural system has strong recovery ability.

3.5 Main Environmental Problems

There are no industrial enterprises in the project site and river basin. The population intensity there is small. Besides, this area has a small distribution of arable land and good vegetation with low-level application of pesticides and fertilizers. Therefore, environmental pollution there is low. The main environmental problem in the project site is low-grade roads which restrict traffic. The traffic of dam site and power plant completely depends on the low-grade country roads or mountain roads. The backward traffic has severely hampered the economic development in this area, affecting the construction of project. Besides, we can ignore the serious soil erosion and water loss caused by local development and construction.



4. The Prediction and Assessment of Environmental Impact

4.1 Hydrology、 Sediment

The activities during engineering construction period, the transformation of natural characters by interception also diversion and etc. during operation period, and the caused transformation of assessment reservoir area、 downstream the dam、 estuary mouth, flow rate, velocity and siltation situation of sediment, will directly or indirectly bring certain influence to the environment.

4.1.1 Hydrology

The project of Tangjia He (the river of Tang's) hydroelectric power station has the characteristic of cross valley water transfer, it is bound to affect the downstream runoff、 water line and etc. to a certain extent.

Tangjia He reservoir hinge belongs to Yuquan (the stream of Yu's) which is a typical mountainous river, its flood characteristic under the impact of rainstorm intensity and topography is inhomogeneous period distribution, plentiful rainstorm and numerous strength. The inhomogeneous period distribution manifest mainly in the distribution of rainfall which is: the average rainfall from April to October is 1247.3mm which is the high water season, occupies 15.4% of the whole year. The maximum actual measurement rainfall in 24h is 422.9mm (7/3/1953); three days rainfall is 1076.1mm, seven days rainfall is 1318.0mm. Analyzing from the rainfall statistics that the times of daily rainfall above 100mm is 0.8, the most months are June to August. Due to the strong rainfall, steep riverbed slope, short flood conflux period, the flood is always rising and break.

Great changes of the river flow rate will be taken place in the reservoir area. The formed reservoir caused by the dam interception is much larger than the original one, so the flow rate will be slowed down in the reservoir reach, the rate and quantity will have business with that of the flood. The average flow rate of the hydroelectric power station in Yuquan He (the river of Yuquan's) basin for years is $1.71 \text{ m}^3/\text{s}$, while the runoff is $53.900.000 \text{ m}^3$, the original design neglected the discharge flow, there is a ten-odd kilometer channel from the dam down to the mouth of Yuquan He, in order to guarantee no mutation upon the downstream channel ecological environment, we should ensure certain amount of water discharge, in this case, no great variations of the downstream hydrological regime will take place.

4.1.2 Sediment and Aggradations

The reservoir is an artificial still water region, the river rate slows down after entering the reservoir, the water flow moving capability is descending, and the brought sediment is aggravated and piled on the reservoir bottom, forming reservoir aggradations. The rough sand piled in the upstream, and the granule in the downstream, the shoal substances are putting forward to the upper reservoir along with the march of time.

The aggradations of reservoir in some degree act as natural covey to prevent the reservoir leakage, but a great amount of aggravated substances will affect the reservoir volume, the water becomes shallow, which would have impact on the operation of the hydro power station to shorten the reservoir ages.

The solid runoff resource of the reservoir aggravation has business with the regional rocks, landforms and motivation effects. The reservoir solid runoff resource is mainly the sediment brought by the reservoir river, the mud-rock flow in the region, the transformation destroy of the reservoir banks and the slices of rush materials on the slopes around the reservoir. The sediment problem of Tangjia He reservoir is not

outstanding, the main reasons are the three as follows: first is the soil conservation is well done in Yuquan basin, the sediment by the river is less, and there are various levels of development in the upstream, which descent the amount of sediment in river; second, the reservoir is mostly carbonated formed, no mud-rock flow development region; third, the reservoir bank is stable, there would be no large-scale transformation destroy.

The backwater length is short in the reservoir area, sediment brought by the short-time flood formed in the upstream gully of the reservoir don't have enough time to aggravate in the reservoir, most of the sediment is brought to the downstream by the flood, the rest little sediment could be solved through delisting measure.

4.2 Local Climate

After the water storage construction of Tangjia He, the total area of the reservoir is 0.18km². Owing to the variation from dry land to water surface, the evaporation capacity of the reservoir area is much larger than before, the income water steam is increasing, and the nave humidity level and temperature will take place and cause local climate variations.

(1) Precipitation

According to the related research fruit, reservoir area will not change the precipitation obviously, but only change the rainfall distribution. The rainfall in summer and the whole year of the central reservoir is less than before, and more in the surrounding regions. For the rivers around the reservoir are stormy, and it rains heavily in summer, the tiny rainfall change will hardly affect the whole reservoir area.

(2) Temperature

The underlying surface turning into water from land after the reservoir filling, great changes has taken place on the underlying surface physical characteristics, natural

channel has become relative still water surface, the water level is higher, the water surface is larger, the water depth is increasing. Changes also taken place in the exchange of reservoir water and air heat, which caused the temperature increase a little after the reservoir. Moreover, the temperature change is mitigated, daily and yearly variation is shorter, the highest temperature during a year has slight decrease while the lowest has slight increase, though slight.

(3) Humidity

After the reservoir, due to the water surface evaporation increase, the reservoir area humidity will be different than before, annual average relative humidity will increase, in the aspect of season distribution; it will increase in summer and decrease in winter, no obvious variations in spring and autumn.

(4) Wind

Planned project is a typical channel reservoir, the prevailing wind direction after the construction will hardly change due to the big climate and terrain condition. The reservoir area is weak-wind area, because of the caloric difference, common wind rate is increasing, while the stir wind frequency is relatively decreasing; after the reservoir, the former undulate land is replaced by flatness, roughness is reduced, which makes the surface wind speed increasing.

(5) Fog

After the construction, the temperature rising in summer and daytime, and the reducing in winter and nighttime is slower than those of air and surface; this kind of cold and heat source effect is in favor of forming steam fog in winter and radiation fog in summer. But meanwhile, due to the temperature humidity and wind effects, temperature will rise in winter and lower in summer; humidity is will lower in winter and rise in summer; wind speed in increasing all over a year, those factor variations goes against the form of fog. Though the factors above may have certain impact on

the form of fog, the main form factor should be the atmospheric circulation. The prediction is that the planned construction will hardly cause variations to the fog.

4.3 Environmental Geology

4.3.1 Analysis on Leakage

The watershed of the reservoir surface is high steep and wide, which is shared by both the ground and surface water, there seldom seen single watershed and the nave low valley paralleled with Tangjia He reservoir area, meanwhile the lithology of reserve area is consisted of shale、salty shale mixed with muddy power sand rock、lamed power tiny sand rock、rocky shale、siliceous shale、salty mudstone、and muddy salt stone mixed with lamella power sandstone. When this kind of mixture facing no structural damage, it's a good barrier from water. According to the research on the reservoir lithology and permeable medium, the type of ground water is sole, and it belongs to the fissure water of the elastic rock classification, it's mainly stored in the strong and medium level of regolith in the reservoir, has some capacity of water-storage, however under the control of fissure developing level also the equivalent opening.

The storage area is a water-insulation rock mass consists of muddy power sandstone、salty mudstone、shale and etc.. The end of the reservoir is composed of Ordovician limestone, this leakage reach is located above the height of 820m, the backwater of reservoir hardly come up to the leakage reach, only the F1 faultage located around the nabe of the left bank of the backwater level, but the occlusion of the F1 faultage is good, therefore the rock mass can always being completed with little leakage possibility, and no huge leakage project geological problems. The leakage around the dam should be emphasized in the whole reservoir leakage problem.

4.3.2 Analysis on the Stability of Reservoir Bank

After the storage construction finished, the reservoir bank condition has changed a lot, and now under a new environmental and motivated geology impact, it can always lead to the deformation destroy on the reservoir bank. The destroy circumstances are: bank collapse、 landslide and landfall.

There are two types of slopes on the banks of the reservoir area, namely rocky slope and earthiness slope (located on the left bank covered with artificial abandoned sediment and stones). The rocky slopes are almost diagonal slopes, occupying nearly 90% of the whole slope area; while the earthiness slope occupying the other 10%. The rocky slopes consisted of Silurian Longma Steam has loose constructions because of the strong weathering; while those consisted of Luore Ping is almost completed also because of the strong weathering; and those consisted of the Shamao is basically completed for the weak weathering. Earthiness slopes has small soil thickness of 0.5~8m, covered with the economic crops of farmlands and tea leaves etc.. On the part of the left bank of reservoir, there are some loose soil slopes consists of □—terraces and spoiled slope wash with a thickness of nearly 5~12m.

According to the project geological research, the reservoir area rocky and earthiness slopes are in a steady condition, no big landslide and collapse are discovered, only regional layer slide happens on the right bank channel of ne-trending. Meanwhile, the Silurian Longma Stream is consisted of some regional bank slopes where exists some small scale of collapse, which has no big danger to the reservoir. However, after the reservoir storage, during the process of adjusting and electricity generating of the downstream multi-grade electricity power station, there are some hidden trouble including landslide on the left bank reach. For example, there are some hidden trouble existing in Tangjia He and its downstream 550m.

4.3.3 Reservoir Immersion

According to the analysis of hydrological geological conditions, both sides of the watershed are high, steep and wide, there hardly can be any differences between ground water and surface water, and almost no sole watershed paralleled with the Tangjia He reservoir in the nabe low valley. Due to the closure part of the watershed is the topography of steep slopes without any uncommon lowland area, so the immersion shouldn't be the problem.

4.4 Water Environment Impact Prediction (Analysis) and Assessment

4.4.1 Pollution Source Analysis

(1) Agricultural Non-Point Source

According to the research, this project item area are mainly gathered in the three villages of Tangjia He、 Hongyu Ping、 Songjia He, which enjoy 4292 hectares of farmland in total. Among them, Tangjia He reservoir occupies 550 hectares of land; the use of fertilizer in elemental area has little differences, with an average of almost 24kg/h. Due to the limited traffic conditions and farming level in planned region, the actual fertilizing level is lower than the average one, calculate with the average level, the fertilizer use in this area is 13.2t/a, according to the local use of nitrogen and phosphate fertilizer to estimate, the use of nitrogen is 7.9t/a, while the phosphate use is 3.7t/a.

According to the analysis of statistical report, the use of fertilizer by the surrounding villages has little variation in five years; therefore, after the construction finished, the fertilizer use in the predicted year of 2010 could be determined as the level of 2003. In addition, according to the feasible research report, the gross soil loss is small, the N, P loss caused by it should be considered as the number of 10%.

Prediction Method: Adopt the prediction equation of soil nutritious substance in

Hydroelectric Engineering Project Environmental Impact Assessment Standard

(*Try-out*) (SDJ88 - 2003) to calculate. Namely:

in the arithmetic expression of $E = aS_{NP} + bcdF_{NP}$

E – The gross of N and P in the predicted soil losses into the reservoir, t/a;

S_{NP} – The gross of N and P in the aquatic soil, obtained from the gross soil into the reservoir multiplied by total N and P;

a – The consumption of N and P along the way, 70% for N, 95% for P, namely, the amount into the water are 30% and 5%;

b – The average content of N and P in fertilizer, the standard content of fertilizer are 23% of N and 15% of P;

c – The utilization ratio of N is 30%, P is 15%, those into the water are 70% and 85%;

d – The loss ratio after entering the soil and water, 30% of N, and 5% of P.

After the calculation, the gross N and P brought from the agricultural non-point source in the year of 2010 are 0.88t/a and 0.10t/a.

The agricultural runoff pollution load is affected not only by rainfall、terrain、soil and etc, but also decided by the ground pollution quantity and its migration process. After the analogy analysis with the farmland runoff pollution research fruit in three gorges area, the preliminary estimation of ground runoff pollution COD's discharge in Yuquan He reservoir in 2010 is almost 16t/a、 and the discharge of BOD₅ is nearly 8t/a.

(2) Domestic Pollution Source

According to the research, there are few people live in the reservoir area, no industrial polluted enterprises, involving 800 resident populations. The discharged domestic sewage is the main domestic pollution source. The domestic sewage discharge quantity prediction can be calculated by the following formula:

$$X_t = L_t Y_0 (1 + \mu)^{t-t_0}$$

In this formula:

- X_t The sewage discharge quantity in the prediction year ;
- L_t The per capita sewage discharge quantity;
- Y_0 Population in base year;
- μ Population increase rate

Refer to the outdoor drainage design standard, count the per capita domestic sewage discharge quantity as 150L/(d·P), the main pollutants COD、BOD₅、T-P、T-N counted as the domestic sewage common discharge viscosity 400mg/L、 200mg/L、 2.0mg/L、 25mg/L, the predicted domestic sewage quantity in 2010 is almost 44.000t/a, and discharge quantity of the main pollutant COD is almost 17.6t/a、 while those of BOD₅ is 8.8 t/a、 T-P's is 0.088 t/a、 and T-N's is 1.1 t/a.

4.4.2 Reservoir Water Quantity Prediction and Assessment

4.4.2.1 The General Water Quality in the Reservoir

(1) Initial Impoundment Period

At the initial impoundment Period, along with the release of organic matter in drown soil and vegetation, great amount of organic matter's outflow and decomposition will

put unfavorable impact on reservoir water quality. According to the supervise statistics of the build-up reservoir, the do in water、salinity、nutrition and plant hyperplasia has business with the reservoir storage. The hydroelectric power station area of Yuquan He basin is 0.18km², the drown area is less. Meanwhile, due to the reservoir bottom hygienic cleaning before the storage, organic matter quantity has decreased, the outflow and decomposition quantity of organic matter in drown soil are relatively decreasing, but has little impact on the general water quality.

(2) The Regular Runtime of the Reservoir

During the Yuquan He basin hydroelectric power station regular runtime, the main pollutants are consist of upstream background value、upstream domestic sewage and the surrounding field runoff. Make a prediction over the general water quality during the reservoir runtime with the zero-dimensional model.

Prediction Model:

$$C_{(t)} = \frac{W_0}{K_h V} + \left(C_h - \frac{W_0}{K_h V} \right) \exp(-K_h t)$$

$$K_h = \frac{Q}{V} + K$$

选取 BOD₅ 作为预测因子，其它项目只作定性分析。蓄水后 2010 年 BOD₅ 平均浓度预测结果见表 4-1。

In this Formula: C(t)—The pollutant concentration, mg/L ; W₀ -- The pollutant inflow speed, g/s ;K_h -- Midst variable, s⁻¹ ;V—Reservoir volume, m³ ;Q - Reservoir outflow, m³/s ;K - The synthetic attenuation coefficient, s⁻¹ ;C₀ - The concentration of present reservoir pollutant, mg/L.

BOD5 will be selected as the prediction criteria, while others serve for qualitative analysis. After submergence, the average BOD5 density can be seen in the Chart 4-1 below.

Chart 4-1 The average concentration prediction value of the main pollutant BOD₅ of Yuquan Basin hydroelectric power station in 2010

Calculation Time	Calculation Time t (s)		
	1	1000	3600
Prediction Result	0.010	0.010	0.006

The result shows , the average concentration value of BoD₅ in reservoir has met the □water standard in the level year of 2010 according to *Quality Standard of Surface Water Environment* (GB3838-2002) .

Thus it is clear that the hydrology circumstances after the storage running of Yuquan He basin hydroelectric power station will not cause bad effect on the general water quality in this reservoir, the water there will remain the original water quality condition.

(3) The Reservoir Eutrophication Prediction and Assessment

Adopt the dilon model:

$$[P] = \frac{L(1 - R)}{H\rho_{\omega}}$$

In this formula : P— The concentration of N and P in the reservoir, mg/l ; L— Load quantity of the inflow N and P, g/m²·a ; H— The average depth of the reservoir, m.

In this formula:

$$\rho_{\omega} = \frac{Q}{V}$$

Q – The annual inflow water quantity, m³/a ; V— Volume, m³ ;

$$R = 0.246\exp(-0.271Q_i) + 0.574\exp(-0.00949Q_i)$$

In this formula :

Q_i—hydraulic loading, Q_i = Q/A , m/a ;

A— water surface area of reservoir, m².

After the construction, according to the unfavorable condition, namely, no consideration for the land loss caused by land submergence or artificial governance, the amount of N and P inflow are calculated as the current quantity. And attained the N and P load are 4.88g/m²·a and 0.55g/m²·a. After the calculation, several of prediction parameters are listed in Chart 4-2.

Chart 4-2 The Forecasting Parameters of Tangjia He Reservoir Nutrient Laden

Item	Q (m ³ /a)	V (m ³)	A (m ²)	H (m)	ρ _w	Q _i (m/a)	R
Parameter	0.539×10 ⁸	0.2396×10 ⁸	0.18×10 ⁶	26.0	2.25	299.44	0.034

The prediction year is 2010. From this model and parameters, we can calculate the general N concentration of the reservoir water quality is 0.004mg/l, while the general P concentration is 0.0005mg/l.

In the eutrophication of lakes and reservoirs, the main controlling factor is nutritious factor. Based on the determination about AGP in *Lake Eutrophication Research Standard* (□edition), most of the lakes are P limited, but there are also N limited lakes. There is no standard about eutrophication of lakes in our state at present, the

assessment this time will analogy the classification standard of some big national lakes to ensure the eutrophication degree after the Yuquan He basin hydroelectric power station construction, the specific standard see to Chart 4-3.

Chart 4-3 Domestic Reservoir Eutrophication Condition Standard Unit: mg/L

Trophic Type	Water Quality Centre Index		Tai Lake Index		<i>Lake Eutrophication Research Standard</i> Index	
	Total Nitrogen	Total Phosphorus	Total Nitrogen	Total Phosphorus	Total Nitrogen	Total Phosphorus
Nutrition-Poor					< 0.25	< 0.02
Poor-Middle	0.2~0.4	0.005~0.01	0.16	0.01	0.16	0.01
Middle	0.3~0.65	0.01~0.03	0.31	0.023	0.310	0.023
Middle-Rich	0.5~1.5	0.03~0.10	0.65	0.050	0.650	0.05
Rich	> 1.5	>0.10	1.20	0.110	1.20	0.11

According to this report of current assessment result, various water quality of the water body above the dam is accord with GB3838-2002 *Surface Water Environmental Quality Standard* □ Category standard requirements.

From chart 4-3 we can tell that, after the construction of Yuquan He basin hydroelectric power station, the water quality is poor-nutrition. There are few people live along the road from dam to the reservoir, and the upstream condition of pollution source loading is limited, though the depth has increased and flow rate has decreased after the completion, the renewing of the water body is more frequent, there hardly can be any eutrophication phenomenon. Therefore we can draw a conclusion that, under the current nutrition load level, the general water quality of the Yuquan He basin hydroelectric power station reservoir will not transfer to the condition of eutrophication.

(4) Downstream Dam Water Quality Analysis and Assessment

The topography and geomorphology from the Yuquan He basin hydroelectric power station to the river mouth reach are familiar, there are few people live along the bank, and no domestic drinking water intake and discharge mouth. The adjusting degree of downstream reach runoff by reservoir running and its discharged water quality condition will be the main factors which affect the downstream reach water quality of the dam.

□ **Analysis of Flood Season Water Quality Variation**

The flood prevention duty of the Yuquan He basin hydroelectric power station is to ensure the safety of the dam and the ordinary running of the station factory. The flood starting regulation level is the usual storage level of the reservoir, when the flood detention is above the line, gates will unlock to set flood free. This has little variation to the downstream reach hydrology situation of the dam and comparing with the natural river way situation, in addition, the sink-clear actions will better the quality of the discharge water than the natural condition, which has improving effects on the water quality of downstream. According to the dispatch running analysis of the in-built reservoirs, the reservoir dispatch running in the flood season will has little impact on the water quality of the downstream dam.

□ **Analysis of Non-Flood Season Water Quality Variation**

Analogy the average runoff of the other in-built hydroelectric power station projects after the dispatch running for years with those under the natural condition, the reservoir begins to storage water after the flood season, the outflow quantity is less than the natural one, while the number has no obvious increase than that under natural condition during dry period.

The reservoir begins to storage after the flood; the outflow quantity of the dam is less than the natural one, however basically above the number in dry period under natural conditions. From the view of water environmental capacity, the water environmental capacity is large when the flow rate is large. Therefore, there are

decreases in different degrees after the flood, which has a certain impact on the downstream reach water environment of the dam, but will be higher than those in dry period under natural conditions, which has no obvious impact on water quality condition of that reach.

4.4.3 Reservoir Water Temperature Prediction

Reservoir water temperature is an important index of the water environment. The fish in China are mainly temperate-water fishes, the suitable water temperature for living is 15 - 30℃, the downstream temperature change will affect the aquatic organisms down to the dam; water temperature has close relation with the water quality, especially to DO、BOD₅、COD、fecal coli form and etc.; Water temperature is also necessary material for concrete dam seepage and leakage research and monitoring. Therefore, researching and analyzing is significant for reservoir water temperature to the comprehensive use of water resources、water quality protection and make full use of the comprehensive benefit of the reservoir.

(1) Reservoir Water Temperature Construction

After the running of the reservoir storage, water temperature, as a hydrology factor showing heat condition, will change. The reservoir water temperature distribution type is affected by the solar radiation、reservoir volume、in and out flow quantity and temperature、reservoir shape、sediment condition、reservoir dispatch running method and etc..

Whether the reservoir water temperature is divided by the retention, we have two various methods: the reservoir water exchange time index α and the ratio β of the once-flood and the actual reservoir volume; or the density ford index method F_d to judge. During the pre-construction period of three gorges project, the Changjiang Water Resource Protection and Research Institute has studied on it, and the rise-up

“Seven- Five” national key tackling subject Three Gorges Hydro-Junction Water Temperature Prediction to do a overall research to the reservoir water temperature effects. The water temperature in different depth are various, we can generally divide them into three species : mixed、 stratified and transition, see to Chart 4-4.

- Mixed : The reservoir water temperature distribution at any time is equal, the grades are small.
- Stratified : The surface water temperature during temperature rising period is obviously above that at the middle and down level, the grads can be as high as 1.5℃/m. The annual differed of temperature at bottom level are below 15℃.
- Transition : The reservoir water temperature has the both traits of mixed and stratified.

Chart 4-4 Reservoir Water Temperature Value Judge List of α

The Value of α	Reservoir Water Temperature Type
< 10	Stratified
> 20	Mixed
10~20	Transition

(2) Reservoir Water Temperature Type Judging and the Impact Analysis

This assessment adopts the method of coefficient to judge the reservoir water temperature structure of Yuquan He basin hydroelectric power station. A coefficient method is simple, according to the reservoir check in our national measured water temperature materials; the check result of this method is basically accord with the reality. Its formula is: $\alpha = \text{annual average runoff for years} / \text{reservoir total storage capacity}$

After the calculation, the α value of Yuquan He basin hydroelectric power station reservoir is 2.25 (<10), which expresses the water temperature structure is typical stratified structure. Due to the obvious seasonal flow and flood flow, the flood in this basin are mainly formed by rainstorms, the rainfall is concentrated, and the floods are up and down rapidly, which is short and large. The water body are almost still after the construction of the reservoir, and its heat-storage function is stronger than rivers, the surface temperature will be higher than the natural river's, according to the measured material of the branch reservoirs, the water in temperature rising period may easily affected by temperature rising and surface water temperature along the reservoir :reservoir head inflow segment、mid-reservoir and anterior segment of dam、outflow reach of the dam、 surface temperature value of the reservoir head inflow reach is close to the natural temperature at the same time. The winter surface water temperature of the middle reservoir and its forepart has little difference with the natural situations: there are differences in spring、 summer and autumn, in general, the surface water will be 2℃ higher than the temperature in natural river way, but the temperature at the bottom will have little differences with those at surface.

(3) Reservoir Outflow Water Temperature Analysis

The reservoir outflow water temperature has business with the location of reservoir water intake、 inflow water temperature、 the temperature then and there, according to the measured materials of Xin'an River and Dan River, the downstream dam reach has good relation with the temperature in certain depth of the reservoir, this depth is about 15~20m. The reservoir water temperature of Yuquan River basin hydroelectric power station has no big differences; therefore its outflow water temperature has no little differences with those in the natural river at the same time before.

According to the research, the water is rapid here in this reach, and there is no

spawning ground for large economic fishes and treasured fishes, no process and domestic water demand, neither the irrigation requirement, therefore, it will bring unfavorable impact to the growth and reproduction, downstream dam water quality and aquatic organisms, agricultural irrigation in this river reach.

4.5 Ecological Environmental Impact Analysis and Assessment

Hydraulic engineering has distinct characteristics upon the ecological environment, during the project construction period, mainly unfavorable impact, but running period, there are several impacts. The unfavorable ones are mainly the reservoir inundation may lead to the decrease of the organism quantity and the whole organism system. While the favorable impacts including: development of small hydropower may change the bad habit of the villager's interests for firewood, and shrink the probability of habit lessen of mild creatures by villager's arbitrary chop; along with the local climate's improvement, it will provide beneficial conditions to the plant species' subrogation around the reservoir; the project construction will effective control the artificial and primary water and soil loss, and improve the ecological environment by decreasing the disaster of floods, landslide, debris flow and etc..

4.5.1 Ecological Environment Integrity Assessment

Yuquan He basin hydroelectric power station project has impact on the integrity of the regional natural system, which is come from the reservoir submergence and project land occupation. After the construction and operation of this project, sections of fields and farming land were submerged. Reservoir submergence and project land occupation will lead to the direct decrease of regional greenland area, which will cause the transformation of regional natural system producing power and

the stability situation, and this will affect the integrity of the regional landscape ecological system in some degree.

(1) Regional Natural System Productivity Change Analysis

The landscape ecological system productivity is affected by the reservoir submergence and project land occupation, which will change each packed-block types also the area, and the influenced area of the used high productivity level woods, submerged shrubs and the project land occupied area will decrease. Along with the reservoir storage, another part of the used low productivity level rivers and sands will be changed from unsteady mountain-river to stable reservoir, the aquatic organism quantity will obviously become less, and the productivity power will be improved. However, the regional total productivity power level will be lower in a short time.

(2) The Stability Variation Analysis of Landscape Ecological System

The stability of landscape ecological system includes two types of characteristics, recovery and resistance. Recovery is the capacity of system recovering to its used condition after variations; while resistance is the capacity of system resisting and preventing changes after the environmental variations. After the regional terrestrial ecological system drowned in the project area, it will move into a new aquatic ecological system. A new balance will be made of the productivity power of each system after a short time undulation, for the drowned and internal occupied land covers the area less than 5%, it will not cause a lower to level natural system due to the submergence of a few woods by the reservoir storage. This hydroelectric power station construction has little stability influence on the landscape ecological system. Therefore, the construction running impact to its regional landscape is below its ecological bearing capacity, which is enduring high pressure of the regional natural system.

(3) Comprehensive Assessment of the Landscape Ecological System Quality

After the implement and running of the Yuquan He basin hydroelectric power station project, regional soil use pattern has changed, and changes also happened on the aspects of the carried out land type dominance, among which the aquatic sections has increased its significance due to the reservoir submergence, and the dominance value of the shrubs is decreased by the reservoir submergence, so that the dominance value of the woods will has no obvious change. For the total area of the reservoir is 0.18km², the regional landscape ecological system is more above the variable quantity, so the woods are in the mode of region. It shows that the implement and running has little impact to the assessment area of natural system landscape quality.

4.5.2 Terrestrial Plants Impact Analysis

Due to the construction activities during the construction period such as the excavation of quarry and borrow materials, the rebuild of traffic routes, diversion and power system construction and etc., these will have a certain impact on the vegetation.

According to the scene research, there is a hasty road leads to the construction scene, which belongs to village and mountain road, and now it's under upgrade reconstruction, the passing regions are mason pine forest, shrubby-grass forest and etc.. The vegetation will be destroyed within the road-excavation lines, meanwhile, curb excavation exposed surface will be formed, soil and water loss could easily happen with rainstorms. The main types of the construction temporary occupied land are shrubs and wild grass ground.

According to research, drowned plants are most the widely distributed sorts in the reservoir and Hubei province, non-protected national and local key prior plants under the drowned line, therefore, the reservoir drowning will not cause the regional creature extinction. Due to the small area of the project construction occupation, and limited in the scope of project construction area, it will not affect the forest-cover rate

in this project area obviously.

After the storage of the reservoir, it will bring beneficial conditions to the vegetation sorts subrogation around the reservoir along with the input of the project funds and improvement of the local climate, and also to the growth and normal succession; meanwhile, after the completion of the project, due to the water area growth of the reservoir, improvement of the local climate, which are beneficial to the plants growth.

4.5.3 Terrestrial Creatures Impact Analysis

The construction activity will affect the amphibians and reptiles in this area, section of the animals will migrate to non-construction and non-submerged areas, which will not threaten their surviving. The construction will force the birds and mammals of this temporary expropriation region move leave their original habitat, the birds and large-middle mammals around this construction area are frightened from the blasting and drilling noises and will leave their primary habitat, but this unfavorable impact could only be happened during construction period, along with the recovery of plants on temporary occupied land, their habitat will be regained. The snakes' quantity in construction area will be increased; the trimeresurus snake is highly toxic, which should be accordingly kept away during the construction activity.

After the reservoir construction, the submergence will decrease the distribution of the terrestrial creatures, the primary river way and the both-shores plants、shrubby-grass ecological system will become reservoir ecological system, but the original animals living in the reservoir are almost non-specific animals, they can migrate to the surrounding places of the reservoir. Therefore, during the construction running period, this will not lead serious threat to their living composition. Meanwhile, for the water surface ascent and expansion of water area, it provides a suitable living environment for the dead water amphibian animals, which is favor for the species group quantity growth and has some attraction to waterfowls and sub-waterfowls,

their species and quantities, will increase.

4.5.4 Aquatic Creatures Impact Analysis

(1) Aquatic habitat impact analysis

Under the natural circumstances, Yuquan He belongs to canyon jet river habitat with rapid flow speed, great quantity, large water level amplitude, large amplitude of runoff in flood and dry seasons, the bottom quality are main consists of rocks, gravels, and sandstones, which is unfavorable for the form of junior production capacity in aquatic ecological environment. After the reservoir construction, Yuquan He basin hydroelectric power station reservoir reach hydrology situation hasn't changed allot, the reservoir water level variation is becoming plain, the primary jet open water habitat to the slow water habitat in the reservoir range, the water ecological environment has transferred from river phase ecological environment to lake phase ecological environment. When the reservoir running reach the height of 800m, it forms into a reservoir with an area of 0.18km², compared to the natural situations, when the water area increase 0.1km², the water level up about 20-60m. The water area, depth and body is increasing, flow speed is slowing, sediments are aggravating, transparency is adding; because of the nutritious salt of the reservoir river reach is increasing, the primary production power is adding, the fish food condition is improving, which is adapt to the creature species increasing in slow flow water environment, and those adapt to rapid water environment is decreasing.

(2) Impacts on Planktons:

The water flow speed is slowed down after the storage, which made the turbidity decreasing, transparency increasing, and it's favored for planktons to photosynthesis; meanwhile, the exudates of the soluble substance in submerged area, and the inflow nutritious matters stays long at the reservoir, which provides abundant matter

foundation to the reservoir planktons multiply. Compared to the primary ecological rivers, the planktons are obviously increasing at the group structure and quantity. Plankton's distribution density and location has changed, and the quantity has increased, at the same time, the cladoceran and the some will emerge which are suitable for slow-flow and still rivers, the chironomy larvae and big water earthworm adapt to deep water in increasing, which become the dominant group.

(3) Impact on Zoo benthos

After the reservoir storage, the water lines of fore dam will rise, which will change the exchange capability of the natural river way water body, the sediment deposition will change the bottom quality and destroy the habitat of zoo benthos, in prediction, the group structures of zoo benthos will greatly change, the flowing water prefer species will decrease in primary river way, the group structures in shoaling water will mainly be mollusk、oligochaetes and chironomus larvae.

(4) Impact on Fishes

After the reservoir running, there is great changes of primary river way, and it will directly affect the perch、propagate、food intake conditions, which makes it suit the fishes migration of canyon、rapid water and shallow sands prefer species; and those have strong adaption、high propagation、omnivore fish just like carp and crucial will become dominant species. Those can adapt both flow water and still water, will continuously distributed in reservoir. All in all, the area composition of fishes will transfer from flow water prefer habitat group to slow and still water habitat.

After the construction of Yuquan He basin hydroelectric power station lasher, the primary rapid water ecological system will be continuously destroyed. After the construction of dam, it will form a block to the fish upstream going, so that it will lead to the decrease of the fish resources. Due to the hydrology condition improved from

natural river way, in addition of the reservoir construction, the primary rapid water open water creatures are transferring to slow water habitat in reservoir range, the water body primary production capability is increasing, which is favored to the perch and propagation of slow flow and still water fishes.

4.5.5 The Impact of Tunnel Construction to the Ecological Environment

The diversion power tunnel is located at the left bank, and it adopt a kind of circular stressed tunnel with a whole length of 3906m, among them, type □ wall rock 1532m, type □ rock 2374m. The tunnel design of longitudinal slope is considered as 3/1000. The diameter of the excavated tunnel is 2.40m. Based on the wall rock distribution to lining or concreting, for the type □ wall rock, we adopt the way of concreting, with the thickness of 0.1m; for the type □ wall rock, we adopt C20 (2) to lining, with the thickness of 0.30m, laying out double steel with a stretching joint length of 12m.

The whole stability of the rock in the dam reach and the diversion power route reach are good, but since the regional weathering of the rock is strong, cranny' growth and the existing of the interlayer soft dissection, however the buried depth of the diversion power is huge, most are in the depth of 50 to 100m, which will never block the animal migration passage. Therefore, tunnel construction has impact on ecological environment mainly in vegetation destroy by the tunnel excavation waste and soil water loss.

The tunnel to be constructed mainly includes diversion tunnel, power station diversion tunnel and cross-strait abutment grouting audit. The stratigraphic characteristics the tunnel goes through is: the diversion tunnel is arranged on the right bank, mainly goes through wall rocks which includes Silurian sandstone、marline、loose overburden; the diversion tunnel is arranged on the left bank, mainly goes through wall rocks which includes Silurian sandstone、marlines、Devonian mudstone、quartz sandstone、

carboniferous limestone、 Permian limestone and etc., the grouting flat audit on both sides is mainly through the wall rocks of Silurian sandstone. Judging comprehensively, the tunnel stability is good, and the tunnel instability phenomenon will be mainly represented as large wedge collapse.

This project has two waste marshalling yards according to construction area division; they are located around the branch tunnel. The yard planned to three sided open gutter, pulp stoning lining, the drain is connected with the surrounding rivers, and a sediment region will be built at the mouth. Before piling up the waste, peeling off the mellow soil on the surface and put it at the corner, waiting for the accomplishment and then return the fields and forests. After the carrying out of the draft, the unfavorable impact by the tunnel will decrease.

4.6 Soil Erosion Analysis and Assessment

This chapter is based on the *Hubei Wufeng Songjia He Hydroelectric Power Station Project Soil Conservation Proposal Report*, *Hubei Wufeng Songjia He Hydroelectric Power Station Project Soil Conservation Proposal Report*, *Hubei Wufeng Songjia He Reservoir Power Station Project Soil Conservation Proposal Report* compiled by Yichang Qing River Water Power Investigation Design Institute.

4.6.1 Damage Mizuho Facility Area

Project construction land occupation area include project permanent land expropriation、 construction material site、 abandoned dreg site、 construction roads and roads recovery and construction temporary occupation and etc..

4.6.1.1 Project Construction Land Occupation

(1) Tangjia He Reservoir Power Station

The construction land area of Tangjia He reservoir power station project includes project permanent land acquisition, construction material site, waste dreg site, construction roads and roads recovery and construction temporary land occupation and etc.. According to the primary report combining with reconnaissance investigation material, the occupied area is about 219.45mu. See to Chart 4-5.

Chart 4-5 Project Construction Occupied Area Statistical Table unit: mu

Content \ Item	Submerged Reservoir	Project Management Occupied Area	Others	Total
1.Project permanent Occupied Area	160.65	1.8		163.95
2.Construction Traffic			12.0	12.0
3.Construction Material Site			6.0	6.0
4.Abandoned Dreg Site			30.0	30.0
5.Construction Temporary Land			3.0	3.0
6.Concrete Mixing Station			4.5	4.5
合 计	160.65	1.8	55.5	219.45

(2) Songjia He □ Power Station

According to the soil erosion control responsibility range, combining with the project construction and the soil erosion characteristics in effected region and the control objective of this plan, this project soil erosion control is planned to be divided into four regions, which are dam area, tunnel area, pipeline area, station powerhouse area. And respectively carry out control method to the abandoned dreg site, material site, project permanent occupied area, construction temporary land, among which the abandoned dreg site is the key control object. The project construction occupied area is 9.0mu, see to Chart 4-6.

Chart 4-6 Project Construction Land Statistics Table

Item	Land Type and Quantity (mu)				
	Field	Forest	Open Forest	Waste Land	Subtotal
Project Permanent Land	2.7	1.2		0.15	4.05
Abandoned dreg Site				3.75	3.75
Construction temporary Land	0.3			0.9	1.2
Total	3.0	1.2		4.8	9.0

(3) The Songjia He □ Hydroelectric Power Station

According to the soil erosion control responsibility range, combining with the project construction and the soil erosion characteristics in effected region and the control objective of this plan, this project soil erosion control is planned to be divided into four regions, which are dam area, tunnel area, pipeline area, station powerhouse area. And respectively carry out control method to the abandoned dreg site、 material site、 project permanent occupied area、 construction temporary land, among which the abandoned dreg site is the key control object. The project construction occupied area is 19.4mu, see to Chart 4-7.

Chart 4-7 Project Construction Land Statistics Table

Item	Land Type and Quantity (mu)					
	Field	Economic Forest	Forest	Open Forest	Waste Forest	Subtotal
Project Permanent Land		0.5	2.0	1.0	0.8	3.8
Construction Road Recovery			0.2			0.2
Abandoned dreg Site			3.1	3.8	1.4	8.2
Construction temporary Land	0.1		0.5	6.2	0.4	7.2
Total	0.1	0.5	5.8	10.4	2.6	19.4

4.6.1.2 Project Construction Damage Area

Within limits of project construction land occupation, due to the excavation or buried abandoned dreg, it has various degrees destruction to the surface rock structure and surface vegetation, lower or loses the primary function of soil conservation; accelerate the development of soil erosion. The destruction caused by project construction is counted into the mizuho facility area; the total damage area of the project construction is 218.91mu. Tangjia He hydroelectric power station project damaged area, see to chart 4-8 ; those of Songjia He see to chart 4-9; those of Songjia He □project, see to chart 4-10;

Chart 4-8 Tangjia He Reservoir Power Project Damage Mizuho Facility Area

Statistics Table Unit: mu

Content & Item	Field	Forest	Water Surface	Shrub	Homestead	Total
1.Project Permanent Expropriation Occupied Land		70.2	59.85	0	0.81	130.86
2.Construction Traffic		12.0				12.0
3.Material Site		6.0				6.0
4.Waste Site		30.0				30.0
5.Construction Temporary Land		3.0				3.0
6.Concrete Mixing Station		4.5				4.5
Total		125.7				186.36

Chart 4-9 Songjia He □ Power Station Project Damage Mizuho Facility

Area Statistics Table Unit: mu

Item	Added Loss Area	Super posited Loss Area	Subtotal
Project Permanent Land	1.05	0.45	1.5
Abandoned Site	3.75	1.5	5.25

Construction Temporary Land	1.2	1.2	2.4
Total	6.0	3.15	9.15

Chart 4-10 Songjia He □ Power Station Project Damage Mizuho Facility Area

Statistics Table Unit: mu

Item	Added Loss Area	Super posited Loss Area	Subtotal
Project Permanent Land	3.8	1	4.8
Construction Road Recovery	0.2	0.5	0.7
Abandoned Dreg Site	8.2		8.2
Construction Temporary Land	7.2	2.5	9.7
Total	19.4	4.0	23.4

4.6.2 Volume of Waste Soil and Residue

The abandoned dreg made by Yuquan He basin hydroelectric power station project is not only produced by the main project, but also include the borrow area, construction road and etc. of foundation excavation, foundation clearing, slope shaving tapping. According to the accounting, the project waste volume also the total waste generation is about 129.200t.

4.6.3 Added Soil Erosion Volume Prediction

4.6.3.1 The Possible Soil Erosion Volume Prediction

The erosion is mainly point at the various damage、movement and accumulation process by the exogenesis power (including natural power and human actions) of parent materials. To this project, mainly directing the abandoned dreg volume and geomorphologic shape、soil structure and the accelerated erosion volume after

vegetation damage.

(1) Abandoned Dreg Loss Volume Prediction

The abandoned soil, stone and waste are the foundation of soil erosion, but not all wastes can be lost, only those through effective transport can compose soil erosion. This is the formula:

$$W_{S2} = \sum D_{ei} W_i$$

In this formula: W_{S2} - The loss volume(t) of the dreg;

D_{ei} - The dreg volume(t) in each dreg site;

W_i - The loss coefficient in each dreg sit.

The affect factors to the waste loss coefficient is great, mainly has business with the four factors as the terrain of the waste piles、rainstorm runoff and other dynamic conditions、composition of abandoned dreg matter and control measures. According to the scene research, the project wastes are mostly the mixed body of mainly soil, piling among the mountains, and combining the rainfall intensity to consider, the loss coefficient of dreg loss is 0.20. The abandoned dreg of this project is 129.200t. After the accounting, the loss by the dreg is 25800t. From this a conclusion can be made that, the huge amount of abandoned soil、stone waste will cause great loss if not being treated or piled loose in this project construction process.

(2) Erosion Volume Prediction

The added erosion volume caused by discharged waste in the process of project construction and added erosion of surface destruction combined together, the total

added erosion volume is 8260t; the annual average added erosion volume is 7922t.

4.6.3.2 The Possible Soil Erosion Harm Prediction

During the project construction process, within the range of land expropriation in the project area will suffered various degrees of damage, the regional geomorphology will have great change, if soil conservation measures are not carried, the added soil erosion in this project area will have various degrees of impact on the regional land productivity、 regional ecological environment and Yuquan He river way erosion-deposition change.

(1) Impact on Land Productivity

Soil erosion rushes the rich land surface sources, the regional soil is becoming poor, and the productivity is decreasing.

(2) Impact on the Project Itself

Soil erosion will affect the project construction and running. If the abandoned soil in the construction area can't be effectively treated, the lost soil will enter the construction site and affect the construction progress, and the safety running within the produce date, could also threaten people's life security.

(3) Impact on the River way

Along with the entering of sediment, the downstream reach is kind of deposited, and the harmful substance in the loss matter will cause water quality pollution, and affect people's producing and living environment.

(4) Impact on Ecological Environment

Soil erosion will not only cause direct loss to the land, but also affect the whole environment by precipitate pollution and etc.

According to the project soil conservation proposal, the main project construction of it is the treatment towards project dreg and the discharge measure design for the temporary piled area to sandstone material in the construction site; otherwise, it provides some constructive suggestions to the road construction. According to the project wastes situation, it has taken plants measure design for the ten abandoned dreg site respectively, and adopt the methods of cryptomeria plant、 creep magnolia plant、 bark pine plant and combining forest with grass to green the places above, and furthest control the soil erosion's impact to the environment.

4.7 Human Health Impact Analysis

(1) Construction Period Analysis

The medical level is low in the construction area at present; it only has simple medical instruments. During the construction peak, there should be 367 people in this area, and the production of domestic sewage is $58.7\text{m}^3/\text{d}$, the production of domestic waste is $0.25\text{t}/\text{d}$.

The high strength physical labor in the wild place affect the human immunity, if the domestic sewage and waste can't be treated effectively, it's easy to provide medium for mosquitoes and flies, so that some arbor infectious diseases、 water borne diseases are becoming popular. Therefore, we should enforce the health quarantine and health examinations to the construction workers, and strengthen the management of water source and the control and check of nonnative, strengthen the construction area medical condition. Furthermore, we should pay more attention on the management of food health, and prevent the group food poisoning events.

(2) Operation Period Analysis

During the process of reservoir submergence, the drowned barren hills、 waste and

feces and pathogenic bacteria are along into the water, which makes the organic pollutants increasing, the health condition is getting worse. After the construction, the reservoir area is getting larger, the water flow is getting slow, the regional climate change is favor for the surviving and propagation of bacteria, virus and worm eggs, therefore, if the clearing work can't be well-done before the reservoir storage, the water quality may easily be infected in the primary period, and cause the intestinal diseases outbreak and epidemic.

According to the research, there is no natural focus disease around the reservoir, during the process of the reservoir submergence, rodent will migrate to the high places along with the rise of water level, therefore, the rat-medium disease infected possibility in and around the reservoir will increase; the regional climate condition and the water environment will both changed by the reservoir, its regional climate is more interested by mosquitoes' propagation; the water surface's enlarging and water flow's slowing will be benefit for the mosquitoes' living, as a result, the mosquito density is rising, so that to increase the possibility of mosquito-medium infectious disease. In order to prevent the increasing trend, we should totally clear the surviving condition of mosquitoes in weed and shrubs of the reservoir draw-off zones.

4.8 Reservoir Submergence and Resettlement Arrangement Environmental Impact Analysis

4.8.1 Reservoir Submergence Physical Index

According to the project primary design report, this project submergence impact range is related with Hetang village Caihua Town of Wufeng Tujia autonomous county, the migration population are four households of fifteen people, all gathered in Tangjia He village. The physical index of the submerged range, see to Chart 2-1.

4.8.2 Immigration Environmental Volume and Impact Analysis

Population environmental capacity is refer to the bearing population quantity under certain production、 living lever and environmental quality requirement by the land, once above this allowable amount, the ecological environment will be deteriorated, the living standard will descent, the regional economic development will have difficulties. The land bearing capability has close relationship with the population environmental volume, namely the impact to the supported population by quantity、 quality and the output of the agricultural products, generally, owning a certain amount of land resource, especially the field resource is the key guarantee of the immigration aftercare.

(1) Land Bearing Capability Analysis

The measurement of land bearing capability is decided by the land resource quantity and agricultural products quantity, Chart 4-11 has listed the land bearing capability of the influenced village in the reservoir before submerged.

Chart 4-11 Situation Table of Land Bearing Capability Before Submergence

Item	Field Area	Per Capita Land Occupation	Reduce Grain Productivity	Per Capita Grain Occupation	Per Capita Income
Before Submergence	Almost 37mu	0.37mu per capita	0.4t	400kg per capita	1500 RMB

Combining with Chart 4-11 to analyze, according to the living standard divided by the World Bank to measure: simply adequate type(300kg/person), poverty-shake off type (400kg/person), standard custom type (500kg/person), well-off type (600kg/person), the present condition living standard is still poverty-shake off type. After the reservoir construction, the drowned 31.2mu land will be partly used to compensate for abandoned dreg site reclamation and returning of the coastal roads relocation project, the immigrants per capita grain occupation amount may be

discounted, but through other compensation and regional water area increase, which has provided favorable conditions for the development of reservoir breeding industry, and it's favorable for the land-used structure adjustment and improvement of the productivity.

(2) Impact on Natural Resources

Caihua Xiang (the village of Caihua) is located on the land of hill land with few arable lands, the forest covey rate of the upstream is good, the natural vegetation is mainly the shrubs, the riverbed is deep, the human activity is limited, and the vegetation recovery rate is relatively high in this reservoir influenced range.

The wild animal in this area are mainly small-sized animals, no national and provincial endangered species, immigrants range only involves the villagers in a village or a small concentrated area, the influenced area is quite limited; the aquatic organisms in the Ganhe Gou are mainly small carps and herring, the amount is small, also is the economic value.

In addition, immigrants will probably be arranged to the back of the original address, the population density of the arranged-area is not big, new production、 living should utilize a part of the wasteland grassland and forests, this also compresses the living space of those small animals living in the shrubs and grass, which makes their living environment and surviving condition changed. However, the influenced shrubs are limited, and it will obviously affect the regional vegetation distribution, the reservoir submergence will not cause great damage to the reservoir natural resources in prediction.

(3) Impact on Soil Erosion

Generally speaking, the immigrants' development of hydro junction project will cause a favorable and an unfavorable effect on the local soil erosion. The unfavorable impact is produced by the neglect of adopting contour cultivation during the process

of field excavation, they use favoring grade reclamation instead of it, the new replicated agricultural-favored slope fields is easy-soil erosion, evaluated according to the present condition of the new reclamation land area, it will be 1400t new per year; the favored impact is that the immigrants will do slope-to-terrace and dry-to-wet transformation during the producing and developing process to the original and added waste slope, this isn't only improve the fields quality but also the quantity, and reduced the soil erosion. Therefore, during the immigrants' settlement and open producing process, we should pay attention to the present soil erosion and avoid new erosions, strengthen the soil conservation and ecological environmental construction, which makes the soil erosion well-controlled in the reservoir.

During the project construction and immigrants settlement, the road repairing, house building and other fundamental facility construction will cause short-term, expandable soil erosion, though the impact is limited, we should rise the sense of soil erosion, returning grass and forests in time during the whole process of project construction and immigrants settlement, and prevent the growing of exposed soil, which may cause soil erosion phenomenon.

(4) Impact on Regional Economy、 Life Quality

The submergence of reservoir and movement of immigrants brings a new opportunity to the regional economic development, the immigrants can take this chance to contact new concept, obtain new thought, renew partial ancient and laggard life customs, change living environment, adjust production structure. Therefore, the construction of reservoir has huge promoting effect on the improvement of regional economy、 development of society.

In addition, along with the construction of this hydro junction project, the basin hydropower terrace excavation will be finished, the basin power-provided system will be perfected, which provided plenteous energy foundations to the economic

development of Wufeng county; and of course, along with the construction of this hydropower station, regional traffic、communication、medical、environmental protection will be improved day by day, which will be fordable for the local people's enjoy of happiness.

4.9 Social Economic Impact Analysis

Yuquan He basin hydroelectric power station is located in the economy backward areas of Hubei, industrial and agricultural foundation is weak. After the reform and opening-up, along with the improvement of the traffic condition, the domestic economic strength is generally growing, but due to the natural condition's limits, its economic development is relatively slow compared with the other places of Hubei, the domestic economic index places long in the backward area.

The construction of Yuquan He basin hydroelectric power station is aiming at developing and utilizing its abundant water power resources, and improving the regional economic development. After the commissioning, the annual net surfing quantity can reach the number of 73381.800 kw•h , the direct economic benefit is considerable. Meanwhile, huge project investment will be the motivation to promote the economic development of Wufeng Tujia autonomous county; this project will arrange some of the local labor force, and solve some of their employment; great amount of construction worker's enter will greatly improve the local consuming; after the construction finished, the reservoir residents could make full use of the rich tourist resource to develop tourism of the Yuquan He basin hydroelectric power station, and increasing the employment chances. In brief, the construction of Yuquan He basin hydro power station will improve the local social and economic development in many aspects.

4.10 Project Construction Impact Analysis and Assessment

4.10.1 Construction Period Sewage Impact Analysis

Construction activities may affect the water quality, mainly because of the industrial sewage discharge and domestic area living sewage discharge. Construction sewage is mainly come from sandstone processing system backwashing waste water, foundation pit excavation discharge water, construction maintaining backwashing waste water and concrete mixing sewage, the main pollutants are suspended substance, alkaline water and petroleum. The domestic sewage are mainly the construction unit and producers' daily discharge domestic water, the main pollutants are BOD₅, COD and NH₃-N.

(1) Prediction Model and Parameters

Planned to adopt the impact of one-dimensional prediction, one-dimensional water quality model:

$$C_x = C_0 \exp\left(-k \frac{x}{u}\right)$$

$$C_0 = (C_p Q_p + C_h Q) / (Q_p + Q)$$

In this formula: C_x — the pollutants density after the distance of x , mg/L ;

C_0 — the pollutants density at the starting section , mg/L ;

k - the coefficient of pollutant degradation (settlement) , 1/d ;

u - average velocity , m/s ;

C_p - the discharge density of pollutant discharge , mg/L ;

Q_p - the discharge volume of sewage , m³/s ;

C_h - background density of river pollutant , mg/L ;

Q - reach flow , m³/s.

Yuquan He basin hydroelectric power station river dam address downstream dry season main parameters see to Chart 4-12.

Chart 4-12 Yuqan He Basin Hydroelectric Power Station Construction Area Water Quality Prediction Accounting Parameter Value Table

Item	Flow Speed u (m/s)	Water Depth H (m)	Min Flow Volume Q (m ³ /s)	Reduced Coefficient K (1/d)	
				Oxygen Consumption Coefficient	Sediment Coefficient
Value	2.0	0.5	0.5	0.25	50

(2) Sandstone Material Processing System Sewage

Sandstone material processing construction process includes screening、 classification and etc., among which the screening needs watering and dust falling; the added water amount will mostly be discharged as sewage except to some small consumption besides producing process. When the sandstone material processing system is doing its aggregate wash, the mud in rough lumber and tiny sands smaller than 0.15mm will

be brought away by water flow, the SS density is high in washing sewage, generally, the content of sediment in sandstone used in material site is between 2.26 ~ 13.6%, the sediment content will be calculated as 8% in this project, we usually needs 2.7t water to produce 1t aggregate, according to the SS density of $2.6 \times 10^4 \text{mg/L}$ in sandstone material washing sewage in material balance theory, much higher than the suspended substance allowable discharge standard in *Sewage Comprehensive Discharge Standard* (GB8978-1996). According to the project analysis, the estimated sewage discharge volume of sandstone is about $190 \text{m}^3/\text{h}$. The water quality impact prediction of Yuquan He basin hydroelectric power station after sewage discharged, see to Chart 4-13.

Chart 4-13 Construction Area Sandstone Material Processing Sewage Discharge Suspended Substance Prediction Result Unit: mg/L

Distance (m)	50	100	200	300	400	500	800	1000	1200
Density (mg/L)	1002.1	833.3	612.6	522.0	432.4	256.7	83.4	43.2	16.9

From the chart we can see that, after the discharging of sandstone processing system sewage to the Yuquan He basin hydroelectric power station, the suspended substance in river has went through settlement, the density is rapidly descent, and through fully mixed, is has basically recovered to the density value under natural conditions at the 900m location of downstream.

(3) Foundation Pit Drainage

Foundation pit drainage is divided into primary drainage and frequent drainage. The discharged sewage is composited of rainfall、 seepage and construction water, for the foundation pit excavation and concrete casting maintenance, the suspended substance

content is as high as pH value in foundation pit water. According to the other hydraulic engineering supervision statistics, the suspended substance density of foundation pit discharge is about 2000mg/L, and the density becomes 100mg/L after precipitation, the pH value of concrete maintenance water is 11 ~ 12, which will has certain effect to the water quality of downstream regional reach.

(4) Concrete Mixing and System Washing Water

Mixing system sewage is come from the wash to tumbler and hoisting bucket, the density of suspended substances in the sewage is about 5000mg/L , the pH value is about 12. The concrete washing sewage has the characteristics of intermittent centralized discharge; the volume is small, which has little impact on the water body.

(5) Oil Wastewater

An equipment repair station is set on the north bank of the construction area, one of the contents is bearing the construction mechanical and the transport vehicle's routine maintenance and distribution change of simple parts. The oil wastewater comes from the sewage from machine run shop and car washing sewage; the main pollutants are petrol classification and suspended substances. If the oil wastewater hasn't being treated, it will form an oil film on the surface to block the water body reaeration process after the discharge, so that to cause unfavorable influence on the water body quality.

(6) Domestic sewage of Office and Living Quarter

It's mainly come from the construction workers' domestic sewage. The project construction peak period daily max worker population is about 367, and the average daily worker population is 245. According to the domestic water use regulation of the project construction workers, the daily use of water is about 200L, the total use of water during construction period is about 35770 m³ , among which 80% is discharged

as sewage, with an index of 160L/d, so the max daily domestic sewage discharge volume has reached 58.7m^3 , the average daily domestic sewage discharge volume has reached 39.2m^3 , the sewage discharge volume during the construction period is totally 28616m^3 , with the pollutants of COD、BOD₅、SS、NH₃-N.

The construction area is far away from the residential area and the wasted hills in the town, considering of the present whole level of the project construction area and the regional environment condition, the construction of temporary toilet and simplified septic tank around the construction site is accordance with the local objective conditions and technology standard demand. The general purification rate of the septic tank is between 50% - 90%, the purification rate of COD、BOD₅ has reached 60%, the SS purification rate is accounted as 70%, the COD、BOD₅ discharge density after treatment are hard to reach the first level demand. This project has small scale, disrupt buildings, the discharged sewage by each construction area is small, it has little impact after this kind of measure-adopting, but the peak period of the construction are mainly appear in winter, when the river flow is small, if it's directly discharged without any treatment, it will cause phased regional impact on the sewage quality.

4.10.2 Environmental Atmosphere Quality

It will produce dust and fugitive dust during the project process such as the main projects of fundamental excavation、earthwork backfill、aggregate processing screening、material damage handling and etc.; the mechanical operation of construction、dusts and automobile exhaust produced inside and outside traffic transportation process; excavation mechanical production and waste gas by the explosion of gunpowder and the waste gas by the domestic fuel in the living area; inside the construction area and due to the recovery of the submerged construction,

will have impact on the surrounding air environment with the main pollutants of TSP, SO₂, NO₂, CO, hydrocarbon and lead compounds.

According to engineering analysis, analog other hydropower projects during the construction period, the main pollutants CO, and NO₂ emissions respectively on 10423t, 6339t.

(1) Prediction Model

The existing street canyon models can be divided into empirical mode, box model, Gaussian model of three kinds of types theoretical model of street canyon due to the smaller, Boundary conditions and the complexity of the flow field is rarely used to simulate the spread of automobile exhaust Valley. the Pollutant concentration of Monitored from street canyon Can be seen as composed of two parts: $C = C_b + \Delta C$, C_b is the environmental background concentration, ΔC was in this street automobile exhaust emissions generated by concentration, Available street canyon models to estimate.

Construction area of this project has obvious canyon features, dominant wind direction is paralleled with canyon, it has adopted Gaussian model to simulate the proliferation of automobile exhaust in larger-scale valley. As the dominant wind direction at the bottom of the canyon generally paralleled with the carriageway, the canyon width is much greater than the width of the carriageway, Therefore, parallel to the wind with an unlimited line of Gaussian source model to simulate the proliferation of automobile exhaust in the valley

Forecasting model is:

$$\Delta C = \frac{Q_L}{(2\pi)^{1/2} u \sigma_z(r)}$$

In this formula :

σ_z is a vertical atmospheric diffusion parameters; $r = (x^2 + z^2)^{1/2}$, $\sigma_z(r)$ values $0.48r$.

(2) The Forecast Results and Impact Analysis

Under normal working conditions , when the wind and small wind ,The highest concentration of NO₂ value / h appears in the distance from the centerline of both sides of the canyon where about 80m,when The wind , the concentration of value is 0.535mg/m³, More than two standard 0.24mg/m³ about 1.23 times the limit; when the small wind, The concentration of value is 0.374mg/m³, More than two standard 0.198mg/m³ about 0.65 times the limit, Also appeared from where in the road-side about 80m away, More than the standard range is about 220m away from the centerline of the road within, From the layout and construction of the district the situation atmospheric environmental background, the scope of Exceeded have in the works area within the scope of local area, The environmental impact of the outside world in the "ambient air quality standard" (GB3838-2002) of 2 standard requirement.

4.10.3 Sound Environment

4.10.3.1 Forecasting Model

(1) Fixed Sound Source

The stronger fixed source of the noise in the construction site is mainly come from the sandstone material processing system, foundation pit excavation, concrete mixing and comprehensive processing and etc.. According to " environmental impact assessment technical guide the environment of sound " (HJ/T2.4-1995) relevant requirements of the following prediction equation.:

Fixed point source of noise source calculation formula: $LA(r) = LwA - 20\lg r - 8$

In this formula: $LA(r)$ — Sound source distance r (m) Department of A sound level, dB;

LwA — A sound power level , dB

R - The measuring point with the distance from the sound source, m.

Sound can be used to derive forecasts point Superposition noise level :

$$L_{\text{总}} = 10\lg\left(\sum_{i=1}^n 10^{0.1L_i}\right)$$

In this formula:

Equation: $L_{\text{总}}$ —Sound level forecast , dB ;

L_i - the superposition sound level, dB;

n - n a sound pressure level.

(2) Mobile Sound Source

All kinds of heavy-duty transport vehicles and bulldozers and other noise can be regarded as a mobile sound source , Its size and traffic noise, vehicle speed and road conditions and other factors, Ready to use the following model to calculate the attenuation.

Mobile sound source forecasting model :

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

Equation:

L_m — Sound source distance r (m) Department of sound pressure level, dB;

N -traffic flow, vehicles / h;

V — Speed, km / h

R — Measuring point with the distance from the sound source, m.

4.10. 3.2 Impact Analysis:

(1) Fixed, Continuous Point Source of Noise

Considering as the most disadvantageous situation, namely value the max number, and the sandstone material processing system source intensity is 110dB, concrete mixing system 88dB, wheel-wood processing factory 105dB, foundation pit excavation 112dB, its impact range see to Chart 4-14.

Chart 4-14 Yuquan He Basin Hydroelectric Power Station Construction Area Fixed Continuous Noises Source Prediction Value

Sound Source	Strength (dB)	Prediction Value of Various Distance from Sound Source (dB)							
		10m	20m	30m	40m	50m	80m	100m	120m
Sandstone Material Processing Factory	110	82.0	76.0	72.5	70.0	68.0	63.9	62.0	60.4
Wheel-Woods Processing Factory	77.0	71.0	67.5	65.0	63.0	58.9	57.0	55.4	77.0

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

The foundation pit excavation, artificial sandstone material processing system and etc. in the dam address in relatively high, which has unfavorable impact on the short-distance workers.

There is no resident living near the construction area; the noise is mainly affect the construction workers in this section. Based on various background situations from various noise source and sound environment, we can predict the various degree of impact on the workers in the construction area. The calculation results see to Chart 4-15.

**Chart 4-15 Impact Value of Yuquan He Basin Hydroelectric Power Station
Construction Activity to the Sensitive Point**

Sensitive Point		Nearest Distance to Sound Source (m)		Noise Impact Value (dB)
Location	Name	Sandstone Processing System	Concrete Mixing System	
North Bank of the Dam	Living Area during Construction	400	1600	<45

The workers in the construction area are affected, the noise value is above the □standard of *Urban Regional Environment Noise Standard* (GB3096-93) , but due to the interruption of mountains, the real acoustic environment is a little lower than the prediction value.

(2) Mobile Noises

The day and night vehicle flow of the project construction traffic routine is considered as 80moving/h, the speed is 35km/h; the vehicle flow at night is 40 moving/h, the

speed is 15km/h. The traffic noises impact range, see to Chart 4-16.

Chart 4-16 Impact Range Prediction of Construction Traffic Routine Flanks

Time	Noise Prediction Value from Various Distance (dB)								Standard Distance (m)
	5m	10m	20m	30m	40m	50m	60m	70m	
Day	71.4	68.4	65.4	63.6	62.4	61.4	60.6	59.9	10
Night	57.3	54.3	51.3	49.6	48.3	47.3	46.6	45.9	10

Within the length of 10m day and night in the construction area is below the standard, for the construction domestic area located at the banks of the factory road, the noise impact is great here.

(3) Blasting Noise

The blasting noise has the characteristics of short time、 timing、 definite-located, within the strength of 130 ~ 140dB(A) ,the blasting point of the project are mainly left and right bank, factories of the dam, and block stone factory. The blasting has certain impact to the construction workers.

4.10.4 Solid Abandoned Property

The solid abandoned property is mainly construction abandoned soil, wastes and the domestic rubbish of the construction workers.

(1) Construction Abandoned Soil and Dreg

The abandoned dreg during the process of project construction are mainly come from the spoiled soil and stone square by the main body project foundation excavation、 foundation clearing、 slope shaving and the surface clearing of the soil material site.

According to the earthwork excavation filling balance volume, the main body project and the construction area plates and so as the piled waste dreg are planned to the big abandoned dreg site. If the construction abandoned dreg wouldn't be carried to the pointed place and adopt prevention measure, arbitrary pile will not only affect the surrounding environment, but also well for soil erosion. The great pit abandoned wastes site utilizes cast depression with enough wasted piling space, it almost cause no destruction to the vicinal natural landscape.

(2) Domestic Rubbish of Construction Workers

Many workers are gathered in the construction area during the construction period, the number has reached 367 at the peak time, accounted as the per capita daily domestic rubbish is 1kg, daily domestic rubbish output at peak time is about 0.367t. If the domestic trash isn't treated in time according to the environmental health requirement, it will not only affect the landscape, pollute the air, in some certain climate condition, it's easy for the living and propagation of mosquitoes, flies and rats, which may cause the occurrence and propagating of various insect transmitted disease, even in the high population density construction area, which would affect the health of workers. At the same time, after the various kinds of pollutants and germ in the domestic trash inflowing towards the Lou River along with the rainfalls and runoff, it will also pollute the river water body.



5. Analyses of the Environment Risk

5.1 Risk identification

The environmental risk analysis of the Yuquan River Basin Hydroelectric Power Station Project is mainly analyzing the probability and the possibility of the accident in the future, which is caused by the engineering constructing and applying. Environmental risk in engineering construction is potential, and only when the risk arises and explodes as an accident, it harms.

According to the development mission, scale, project arrangement and main building design, the way of reservoir utilizations, as well as environmental conditions, such as the project in the regional geological environment, the climatic conditions, the landscape vegetation, the hydrology silt condition, water environmental aspects, aquatic organism and so on, the environment risk of the Yuquan River Basin Hydroelectric Power Station Project is dam break and environment geology risk. The conclusion based on the engineering constructing environmental effect forecast and appraisal, and the preliminary risk recognition.

5.2 Dam break risk

5.2.1 Recognition of the risk

Once the dam of Yuquan River Basin Hydroelectric Power Station breaks,, the local electricity contradictory becomes prominent, the project investment wastes, and also possibly causes the unpredictable personnel casualty, bringing inestimable loss to the place. Possibly causes for the reservoir dam break are mainly: earthquake, catastrophic flood and improper reservoir operational guidance.

5.2.2 Risk analysis

(1) Earthquake

The new tectonic movement in southwest Hubei inherits the characteristic of the old structure in its intensity or the increase rate. Since ???, the home court's main characteristic is the reoccur of intermittence uplift in large scale and difference in partial rupture . Since the Quaternary Period, the earth's lifting movement has intensified, with its sticking out speed of 2.9~9.5mm ("The Study of Hubei West Mountainous Area's Mountain Stability And Crag Collapses Landslide Investigation" according to the Hubei Province hydrological team). This kind of uplifting and the different activities have shaped the region's river valley deep cut and formed multistage surface and river terrace. The region's major active break are the Xiannv Mountain, Tianyangping Break, with its both sides are often turning points of the blister and subsidence. These breaks all belong to the new China structural system, and they are the main active earthquake gestation faults in the area.

With the analogy of earthquake geology and engineering geology, the geologic report shows that the Tang jiahe Reservoir will not induce an earthquake that is beyond the greatest magnitude within its structural system. We may consider magnitude 4 in the near zone as the upper limit. The reservoir district adjusts the size of stress fields, and is the determining factor of the reservoir induced earthquake intensity; the storehouse district's area and the upper limit of induced earthquake's intensity have obvious relations. Considered the example of the nowadays massive reservoir induced earthquakes, the middle and small area reservoir have not induced microseism. Therefore, induced macroseism is also impossible for this area. At the same time, the preliminary quantitative analysis and forecast are done, with the two magnitudes of fuzzy synthesis judgment methods, finally indicating that the storehouse district's most greatly possible magnitude is 2.03, possibly with the epicenter the most dangerous area.

The aquiferous rock coupling model was adopted on the time of induced earthquake, and the report predicts that the main or the primary earthquake occurs mostly several

hundred to more than 1000 days after water being stored. The analysis indicated that this area will not produce induced earthquake of big reservoir, even if it happens, its magnitude will be very small, bringing the storehouse dam no serious harm. Moreover, because of the many limestone caves in the storehouse districts, when water rises to a certain height, the karst airing induced earthquake would possibly occur. But as the cavern scope is limited, and so is the storage, the induced earthquake magnitude will be very low (lower than 2 degrees), and shakes will not be centralized.

According to the People's Republic of China national standards "the Chinese Seismic Parameter Regionalization Map" (GB18306-2001), the seismic motion acceleration is smaller than 0.05g (equal to the earthquake basic intensity of VI degrees) in the west region of Wufeng County; in the east and north of the Wufeng County is equal to the 0.05g, while the area from Changde, Hunan to Jinshi and from Zhushan, Hubei to Zhuxi the acceleration is 0.1-0.15g. Tang Jiahe Reservoir hinge is located with 0.05g acceleration, the earthquake basic intensity of VI degree, and the corresponding seismic motion response spectrum circle is 0.35s.

Moreover, the Tang Jiahe Project belongs to the small-scale water conservancy project, and the dam height and the storage capacity are relatively small. The storehouse district is in the natural earthquake periphery, areas with relatively stable structuring activities. The new tectonic movement is not obvious, and no active fault passes the storehouse district. The storehouse district's stratum is the granulated substance or the shale, belonging to the middle hard and soft rock, and the rock mass is relatively complete or complete. Except for a not big NW~SE fault in the storehouse, the others have decency crevasse and structure crevasse. These crevasses are small with no deep cuts, and are not in favor of the accumulation of the strain energy. In terms of the exploration and investigation situation, the crevasse's penetration is bad, and the storehouse water's load function and the pore-water pressure effect are limited. Now, the designated storehouse district has no large-scale karst system or mine tunnel, and the large-scale landslide and the avalanche seem

impossible to happen. Therefore, Tang Jiahe Project is unlikely to have induced earthquake after the storage.

(2) Catastrophic flood

The flood in this basin area is formed by the rainstorm; therefore the flood period is in accordance with the rainstorm periods. Rains mainly concentrate in months from April to October, and the peak of floods of the year mostly appears in June to August, with high frequency. In the basin area, high mountains accompanied by steep slopes, and deep valley filled with narrow rivers; rapid flood afflux, sudden rises and drops show the characteristic of the mountain stream flood. The shape of the flood peak is primarily unimodal, while the duplicate peak also appears. The actual biggest rainfall is 2578mm (in 1935), the actual biggest rainstorm in 24h 423mm, and the smallest rainfall 965mm (in 1936). The rainstorm changes not dramatically in years, and the year's biggest 24h and 72h rainstorm conversion coefficient is 0.37~0.38. The flood in this basin area is formed by the cyclone rain and peak surface rain system's rainstorm, also the typhoon rain system's rainstorm. Therefore the flood is bigger in the magnitude compared with its neighbor basin. Since the slope of both banks is big and the concentration time is short, the sudden rises and drops are formed. During the flood process it is mostly unimodal, belonging to the high summit type. Even if the duplicate peak appears, the peak and the quantity of its inferior peak are very small, and the duration is also quite short. The entire flood duration is generally 1~3 days, belonging to the typical mountain rivers.

According to the feasibility study, the Tang Jiahe hydroelectric junction is a small project. Its construction time is short, and mostly in the dry season, so the design of floods in the ample season is not necessary to be calculated, instead, the construction period from November to March in the next year. The computation result is in Table 5-1.

Chart 5-1 Designed Flood Volume in Different Seasons Unit : m³/s

Location	Area (km ²)	Time period	P (%)			
			5	10	20	50
Dam site	49.0	Nov. 1 st –March, 31 st	46	42	38	19
Plant	91.1	Nov. 1 st –March, 31 st	63	58	52	27

Based on GB50201-94 "Flood control standard", SL252-2000 "Water conservation Water and electricity Engineering order Division and Flood Standard" and project arrangement, this project for small (1) reservoir project, □ and other projects, the main building rank is 4 levels; secondary building and the temporary building rank is 5 levels. Tong kneading board rock-fill dam was used as keep-off water building, the reservoir meets the flood design according to 50 years frequency, the flood examination according to 500 years frequency; the power plant workshop meets the flood design according to 50 years, the flood examination according to 100 years. Regarding surpasses the 100 years frequency flood, through forecasts ahead of time, the soaring storage capacity, may also assure the dam security ahead of time. Therefore, reservoir dam because of catastrophic flood, the jitter possibility is very small; the flood influence in construction period is not big

(3) Reservoir operational management

- **Reservoir dispatch during the flood period**

During the reservoir dispatch process, especially the catastrophic flood period, the flood cannot excrete in time due to the dispatch fault, threatening the safety of the dam. It may also lead to the dam inundation, causing the dam instability, moreover, the disasters and the accidents. Precedent exists domestic and abroad. At present, along with the improvement of the weather and the hydrologic forecast, the forecast cycle will be lengthened, the accuracy further enhanced, winning a longer time for the reservoir dispatch, and guaranteeing more efficiently for the dam security.

- **Reservoir current management**

In the reservoir current management, the dam is possibly destroyed, bringing security risk to the dam, if services are improper. However, the present reservoir building's safety maintenance is technically guaranteed, so that the dam break probability caused by the management carelessness is negligible.

5.2.3 The slow down of the risk

(1) Strengthening the reservoir management is an effective method to slow down the dam break risk of fishing Quan River basin hydroelectric power station. The reservoir operational guidance personnel should carry on the operation strictly according to the science dispatch plan, watch out for the region weather forecasting and the basin hydrologic predict and carry on the rational analysis. Strengthening the dam building's daily security maintenance, we should find problems and hidden danger stitch in time, fulfilling exactly the formulated management system and working instruction, strengthening the management by supervision. At the same time, we should formulate plans for each kind of dam break emergency to reduce the environment loss

(2) Strengthen the monitor of natural disaster, such as the landslide, crag collapse, mud-rock flow and karst collapse during the construction period, especially the rainstorm period or the flood period. Lower the environment risk.

5.3 Risks of the environmental geology

According to the engineering geology reconnaissance, the main environmental geology risk of the engineering construction has the following aspects

5.3.1 Geology problems in the dam site area

5.3.1.1 Rock mass weathering and unload

In the dam area of rock bedding plane and joint fissures, rock mass structure classified as a medium thick layered structure, fine-grained sandstone, marl lenses of rock mass strength belong to hard rock, while argillaceous siltstone is the medium soft rock with softened coefficient of about 0.55, so engineering geology of rock mass of the dam foundation classified as fine-grained sandstone, marl lenses for BIII category, argillaceous siltstone for CIII category. The rock mass of strong weathering rock layer in partial sections is cataclastic structure, the engineering geology of Class IV.

The main types of weathered in the dam area have dissolving weathered and cataclastic weathered, which the former type mainly develop at the marl interlayer distribution area of 100m where the axis in the lower stream of the dam, while the latter type mainly refers to Silurian age within the scope of the reservoir area, which its extent of the rock mass weathering was gradually weakening trend from the surface down to the internal part of rock mass with a better vertical layered.

Due to the certain difference of lithology, the obvious difference of mechanical property, relatively steep of attitude of stratum, under the course of the bank erosion bank slope and rock unloading in the riverbed modified significantly, the region with the main characteristics of unloading as follows:

(1) The overall cross-strait offshore site is the reverse slope, the degree of unloading transformation abated; the whole unloading presented the characteristics of wide top and narrow bottom.

(2) The degree of unloading transformation control by the hard and soft rock of lithology. In the hard rock sites, it is characterized by the shape of strong tension crack and deformation. The large-scale unloading fissures, cutting deep, open obviously, take examples for the right bank of CK6 hole in the 10m ~ 13.8m, CK5 hole in 5m ~ 8m has obvious leakage phenomenon, therefore the degree of rock mass integrity with a significant reduction which mainly reasons of unloading effect of hard rock. The soft rock deformation weakened with small scale unloading fissures and

obvious open.

(3) Considering the contrast of the river bed and the bank slope's drilling hole, the out loading belt in the river bed has an influential depth of approximately 20m, its rock mass's completeness is worse compared with the high drilling hole in the bank slope, with increasing water percolation rate, e.g. CK6 hole compared with the ZK4 hole.

(4) The out loading crevasse in the area mainly traces the original structural crevasse's growth, and the transformation result makes the original crevasse expand, strengthening the crevasse connectivity, increasing the rock mass's water percolation rate.

The rock mass's efflorescence and the out loading transformation cause damages to the rock mass's completeness, having adverse effects on the dam base's stability and the anti-seepage. If the burying depth increases, the controllable quantity increases, the anti-seepage curtain deepens and the processing scope enlarges, the investment of the engineering construction will expand.

5.3.1.2 Rock and dam stability

According to the engineering geology survey and the drilling exposition, rocks in the dam site area are mainly the novaculite and the pelitic siltstone. The novaculite is hard crag, while the pelitic siltstone is soft rock, with high intensity. The structure grows in the medium regolith, and the rock layer's tendency flows along the river, tangentially contacting with bank slope. The both banks' rock is stable, and in the river bed and the dam base surface of both banks there's no weak structural surface, thus no weak structural surface of penetrability or structural body in favor of the instability in the dam. Therefore, the anti-slides stable problem does not exist, nor does the glide along the surface of dam base.

5.3.2 Suggestions of reinforcement and prevention measures

(1) The dam site treatment

Kneading board dam foundation treatment includes dam site treatment and kneading board foundation (toe board) foundation treatment. In terms of the dam site area geology structure, the right bank bedrock appears, the left bank sector is covered by thin layer of crushed stone (approximately 1~2m) or includes crushed stone clay (approximately 1~3m thick), others are appearing bedrock. For controlling the distorting, the scope from the dam spool thread to the toe board should be cleaned, the cleaning requests toe board excavating to the bedrock, and the rock-fill dam may only be excavated to the bedrock surface.

(2) Anti-seepage measures

The kneading board dam mainly depends on the kneading board for anti-seepage, and the dam base anti-seepage mainly on grouting the toe board. This project is of IV kind. According to the related standards, the water percolation rate of the dam's anti-seepage curtain is of $q < 5Lu$, the relative aquiclude burying depth of approximately 23.5m, given the aquiclude is of 5m. The curtain depth is approximately 28.5m, and the curtain bottom's controlling elevation is 727.6m.

The left bank (ZK4~CK5): according to the water test material of CK5 hole pressure and the water level observation material of final hole (CK5 hole's stable water level is about 18.6m, elevation is 778.0m), the relative aquiclude burying depth of CK5 hole dam site may be considered of 29.7m. The curtain depth nearby the CK5 hole is approximately 35m, while the curtain bottom's controlling elevation is 961.6m. The scope between ZK4~CK5 may change according to the permeating section graphic.

The right bank (ZK4~CK6): according to the water test material of CK6 hole pressure and the water level observation material of final hole (CK6 hole's stable water level is about 26.0m, elevation is 774.1m), the relative aquiclude burying depth of CK6 hole dam site may be considered of 18.5m. The curtain depth nearby the CK6 hole is approximately 23.5m, while the curtain bottom's controlling elevation is 776.6m. The

scope between ZK4~CK6 may change according to the permeating section graphic.

In order to avoid the dam abutment leakage, the both banks of the dam must undergo grouting processing, because the terrain slope is big, both banks may use the 平洞, which expands the diameter and makes the hole grouting, for reducing the invalid drilling work load. In the both abutment, the crosswise scope is showed in A and B area, while the longitudinal scope may refer to the water pressure test material of the nearby drilling hole.

(3) The conduction

The Tang jiahe Reservoir dam site has a narrow river valley with a small current capacity in the dry season. It uses the entire section tunnel conduction current, the conduction hole should be in the right bank, the height at the entrance below 760m. The right bank flushing ditch should build coffer dam and induct into the main coffer dam through canal. As showed here. The coffer dam should be chose in the narrow river course, with smooth current and near the board with big flood prevention capacity.

At the same time , we should strengthen monitor and observation of its stable condition. Formulate the emergency plan, once the unusual circumstance like slides collapse or the shore collapse appears, handle it in time according to emergency plan.



6. The Strategy and Advice on Environmental Protection

6.1 The strategy and advice on water environmental protection

6.1.1 Protection measures and suggestions in construction period

(1) The waste water used for washing the granulated substance stone material

□ Treatment scale

The treatment scale of the waste water for washing the granulated substance stone material is 16m³/h

② Technical process of the treatment

The methods for washing the sand-gravel aggregate are the Natural precipitation, flocculation precipitation and machinery acceleration clarification. From the point of the maintenance and movement fees, the natural precipitation is better; from the point of the deleting effect and the occupation square, the methods of flocculation precipitation and machinery acceleration clarification have more advantages. Although the machinery acceleration clarification takes the smallest room with the least amount of the flocculation liquid, the requirements of the design, construction and the level of management are higher. Due to the suspension are almost the inorganic pellets with speedy precipitation, the method of flocculation precipitation is considered as the treatment in the system of washing the granulated stone material.

Combining with the design of the water supply project, the technical process of the waste water treatment in the system of processing the granulated substance stone material is as the figure 6-1.

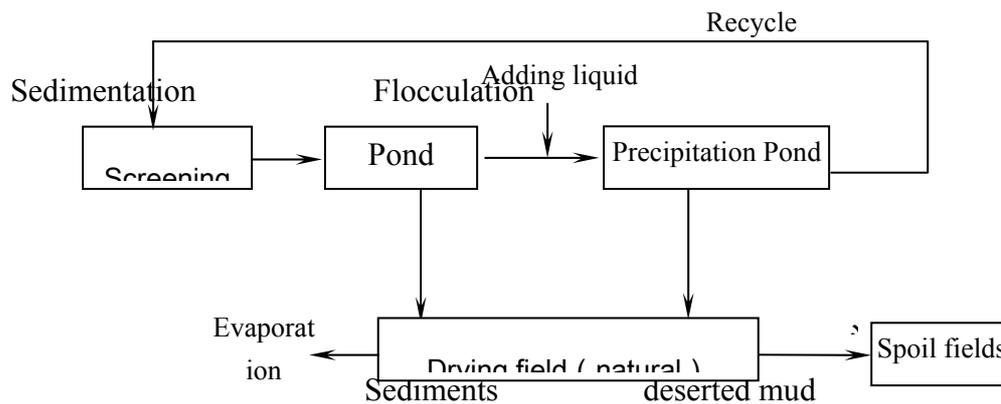


Figure 6-1 the technical process of the sewage treatment in the processing system of substance stone material

The washing waste water, outputted from the workshop of the screening and granulating substance enters into the sand collector, and would be reused after it is treated when entering into the flocculation precipitation pond. Under normal circumstances, it would enter into the workshop of the screening and granulating substance again to wash the stone material. The deserted mud from the sand collector and the flocculation precipitation pond is sent to the drying fielding and to the residue field after being dried. According to the features and the construction settlement of the Yuquanhe Hydropower Station, the natural drying method is used to deal with the deserted mud, which would be sent to the hang residue field after dried.

□The proposal design

The scale of sedimentation and precipitation ponds are: the square of the sedimentation pond is 20m², the size 6m×3m×2m ;the square of the precipitation pond is 40m²,the size 10m×4m×3m. If the precipitation liquid is PAM, no flocculation pond should be set.

The sedimentation pond and the precipitation pond are set close to the processing system of the substance stone material and in the direction of the downstream to the system. The drying field is chosen to be built near the polluted water treatment pond

and would be set with flexibility in accordance with the amount of the mud output and terrain.

(2) Foundation wasted water treatment

The suspension density of the frequent foundation water output is normally around 2000mg/L, and the pH of the maintenance water is 11-12. The rock and soil pellets and cement mortar in the frequent foundation output water are easily precipitated. According to the monitoring results from the constructed and constructing hydropower station, the frequent foundation water's density would meet the requirement after standing in the foundation for 2 hours. During the standing procedure, adding acid for neutralization would effectively decrease the Alkalinity of the maintenance water. Thus the plan for treatment of the foundation waste water is standing for 2 hours after adding acid for neutralization and outputted when meeting the requirements and using the Acid-base indicator to testify the wasted water.

(3) Concrete mixing and washing wastewater

The washing wastewater of the drum and the feed tank in the mixing system are collective periodically, and the suspension density of which is about 5000mg/l,pH 12. Due to the small amount of wastewater, a polluted water precipitation pond would be built beside the mixing system, with occupation square 2 m^2 , volume 2m^3 . The clear liquid should be reused as possible, and the waste mud be cleared in time and sent to the drying field.

(4) Treatment of water with oil

The mechanical workshop is close to the processing system of substance stone material, so the wastewater from the mechanical repair and washing contains much petroleum class and suspension.

● The proposal for wastewater treatment

The collective wastewater with oil could be treated in two ways with oil-water separator and dosing flocculation liquid timely. The oil-water separator is effective but expensive demanding highly for the maintenance. Dosing flocculation liquid timely is simple, cheap and easily managed. Due to the small amount of water use for mechanical repair, the wastewater output is not big, thus the method of dosing flocculation liquid timely is recommended.

- **Proposal design**

The mechanical maintenance field is placed with drains laid with mortar stone to collect the wastewater in the field, which is then sent into the rectangle treatment pond laid with mortar stone. The treatment pond is close to the living area, with occupation square of 6m^2 , the size is $3\text{m}\times 2\text{m}\times 1.5\text{m}$. After the waste water with oil is sent into the pond, medicine is dosed in the evening and outputted in the next morning after flocculation and precipitation during a whole night.

- **Management and maintenance**

Due to the small amount of polluted water and simple structure of the treatment pond, no machinery equipment and maintenance is in need. What is needed is clearing the flocculation in time.

(5) living sewage treatment

- **The amount of the sewage**

The living sewage is from the output of the living water consumption and the excrement by the staff. There is one public living area in the construction area. In the peak time, the living sewage output flow in the construction area is $58.7\text{m}^3/\text{d}$, of which the main pollutants are SS, BOD_5 , COD and $\text{NH}_3\text{-N}$.

- **The treatment proposal**

The methods of living sewage treatment could be equipment buried underground, Septic tanks, micro-motive sewage and biogas digester, etc. The treatment equipment of non-motive buried underground and septic tanks have their advantages, however, the water after treatment could not reach the output standard. The capacity of the digester is too large to settle.

The construction area is remote from the residence and city area. Considering the whole level and regional environmental situation, it is suitable to the local condition and technical requirement that establishing temporary toilets and simple septic tanks around the construction area. Normally the cleansing rate of the septic tanks is between 50% and 90%. The cleansing rate of COD and BOD₅ is considered as 60%, and the cleansing rate of SS as 70%. Although the output density of COD and BOD₅ in the treated sewage could still not meet the 1st degree standard for sewage output, the influence is limited periodically and regionally.

From the point of environmental protection requirement, it is suggested that the dry toilets be built and sent as fertilization to the villagers around timely in order to reduce the influence of the pollution caused by living sewage to the biggest extend.

6.1.2 Protective measures and suggestions during applying

(1) Pay special attention to the cleaning of the reservoir storehouse's bottom. The engineering constructing unit should clean up each kind of water pollution sources in the submerged scope thoroughly, preventing the water quality worsening phenomenon in the reservoir storage initial period, according to the reservoir storehouse's bottom cleaning request. At the same time, the cleaning of floating should be done regularly.

(2) Strengthen the governing of the storehouse district's pollution. In order to reduce the influence on the reservoir water quality from pollution sources, the local water conservation, agricultural, and forest department should strengthen and speed up governing of the soil erosion in the reservoir upstream areas and the storehouse

surroundings, turn the farmland into terraced fields, and return cultivated lands beyond 25° by the uphill to forest. Meanwhile the engineering constructing unit should take the afforested measures, making the storehouse region with the round-off work above 40% and should strengthen the management of using the chemical fertilizers and the agricultural chemicals. Apply fertilizer effectively according to the different soil type, crops and seasons, prevent and reduce the water pollution, which is caused by the agricultural chemicals and the chemical fertilizer out flowing.

(3) Sewage treatment. After the project works, the main produced sewage is the staff's sanitary sewage. Although the pollutant's amount is small, it still exceeds the allowed figure without processing. It is required that sewage processing facilities should be built during the engineering constructions, and the small motion sanitary sewage treating device may also be used, guaranteeing to meet the standards.

(4) Because the reservoir's storage capacity is small, it is not suitable for the fishery cultivation; otherwise, the water body would be easy to get the eutrophication.

(5) Forbid waste water discharge outlets being newly built in the storehouse district and the upstream.

(6) Make the regular monitoring forecast of the water quality in storehouse district, and provide the scientific basis for the reservoir water environmental management.

6.2 Air pollution prevention measures and suggestions

(1) Reduction and controls of fuel oil and waste gas

Strengthen the management for large-scale construction machineries and the vehicles. The project contractor's mechanical device should provide correspondingly the

equipment that eliminates smoke and dust, as well as the periodic inspection and repair, guaranteeing that the construction machinery and the vehicles meet the exhaust emission requirements with each environmental protection index.

(2) Dust reduction and controls in the constructing process

The granulated stone material processing prefers using the aqueous method----low dust technology of waterproof pulverization, reducing the dust quantity. Holes drilling and demolition advocate using aqueous method. When excavating, or blasting explosive in centralized dam area, the materials yard and other construction area, the water spray measure is adopted for falling dust and reducing the pollution scope. The understructure excavates use the spraying of water, ventilating of facilities, to improve pollutant proliferation conditions and reduce the dust density in the operation area.

(3) Dust reduction and controls in the transportation

In the field the permanent road surface uses Tong or cement hardening, reducing the earth, macadam pavement to produce dusts when transporting. We will conduct periodic road maintenance and cleaning and will maintain the path's normal operation. When loaded with the multi-dust material, wet making or canvas covering is needed. The storage tank for cement transporting should maintain good seal conditions. Sacked cement should be sealed, and the vehicle carrier be cleaned frequently. On a cloudless day or in the gale weather, the construction area needs water spray 2~3/days

(4) Health protection

The personnel protective measure ought to be taken by those constructors who receive the worst pollution effect, for instance wearing the respirator and so on. Afforested and falling dust on the both sides of the work quarters and road, considering water and soil conservation, the speed of vehicles which run in the work quarters should be limited, say, under 15km/h.

6.3 Noise prevention

Strengthen the construction noise source control, regular service and maintain construction machinery. Low noise production machinery and equipment are suggested. Big vibrating equipment is possible to use the absorption of shock seat-s . Both sides of the construction area and the main export-road carry on the afforestation to reduce the noise the pollution. High noise equipment's construction should be avoided in people's rest time. Strengthen the constructors labor protection: operating personnel who works under the high noisy environment's construction, should work no more than 6h every day per person and we should provide the noise suppression labor insurance to the constructors in high noisy environment

6.4 Solid Waste Treatment

(1) The treatment of dregs

The construction dregs should be placed to the planned location in time. At the same time, protective measures should be adopted to prevent water loss and soil erosion. The details are covered in the chapter of soil and water conservation.

(2) The Treatment of Domestic Waste

The peak amount of labor for the construction is 367. The domestic waste produced daily during the peak stands at 0.367 ton. Sanitary facilities are located in the construction area with several trash cans set at certain places to collect domestic waste in this area. The location of trash cans and toilets are basically the same. Frequent clean and disinfection is needed to avert flies and mosquitoes. The management department of the project construction should have the construction area cleaned and the waste disposed everyday by arranging forces or authorizing local environmental sanitation department, so as to improve the condition of environment and sanitation.

6.5 The Protection of Ecosystem

6.5.1 Territorial Organism

(1) The Protection of plants in construction area

Damage to the vegetation covering the construction area should be minimized during the mining in order to maintain topsoil for reclamation and revegetation renewing . Environmental planning should be carried out in construction site and within the area of power station and dam. Afforestation construction should be implemented to beautify the new landscape.

(2) Revegetation in and around the reservoir area

After the reservoir impoundment of the Yuquan River Basin Hydroelectric Power Station, about 70mu forestland and tea gardens will be submerged. Allopatry planting will be carried out in the submerged forestland for revegetation. Local forestry department should arrange the location and type of revegetation in light of actual site condition. Moreover, an altitude-based forest belt will be arranged by stages, with water-conserved forest, soil conservation forest and bank protection forest resting from top to bottom. The building of ecological protective forest will further expand forest coverage, which will protect and improve the scenic landscape and eco-environment within the reservoir area. Biological fence and plantation will also be developed for the establishment of a new reservoir area landscape ecosystem.

(3)Close off hillsides to facilitate afforestation and strictly prohibit indiscriminate cutting. Return cultivated land to forests in slopes above 25 degree for ecosystem restoration, so as to create a favorable habitant for the reproduction of territorial plants and animals. Also, a new round of water loss and soil erosion will be prevented as a result.

(4) Indiscriminate cutting is strictly prohibited in the reservoir area and habitats for wild animals should be conserved. Efforts are made to widely popularize and strictly act in accordance with the wildlife conservation law, which enhances the protection for rare and endangered wildlife, especially the nationally and provincially protected ones, thus maintaining a stable bio-diversity within the district.

6.5.2 Aquatic Organism

(1) Natural growth as the main part. No cage culture

Given that the composition of fish species in the reservoir will be balanced after a period of natural operation and the limited capacity of the reservoir. Therefore, cage culture is banned in case of water pollution.

(2) Strengthen the monitoring of aquatic organism

Changes will take place in fish food, water environment and the composition of fish species after the construction of the reservoir. The change trend of fish resources need to be clarified according to the outcome of monitoring and investigating, so as to make immediate adjustment in protection measures.

6.5.3 Other suggestions on ecosystem protection

(1) To ensure the safety of production and life downstream to the dam, the first reservoir impoundment is not allowed for productive use, nor living use. Related propaganda and monitor will be carried out accordingly.

(2) For the prevention of degradation on the present ecological environment of downstream river course after the construction of the dam, it is suggested to ensure certain amount of released water in light of actual condition and the season.

6.6 Measures for soil and water conservation

Project construction department authorized Yichang Investing and Designing Institute for Water-conservancy and Hydroelectricity to compile the report on water-conservation of the project. The report gives predictions of water loss and soil erosion that might be caused by the project and puts forward treatment scheme concerning the issues. The report cites the main content of it.

6.6.1 The responsibility range of water loss and soil erosion treatment

The responsibility range is confined by the defined range in reports of the following: *Hubei Wufeng County Songjia River First-class Hydroelectric Power Station Construction Soil and Water Conservation Scheme Report, Hubei Wufeng County Songjia River Second-class Hydroelectric Power Station Construction Soil and Water Conservation Scheme Report, Hubei Wufeng County Songjia River Second-class Reservoir Power Station Construction Soil and Water Conservation Scheme Report.*

6.6.2 Instructive suggestions

The newly added amount of soil loss comes mainly from dregs produced in the process of construction. Hence, the construction site, the transfer point of dreg filed and the dreg zone should be key sections for prevention and control.

According to the predicted intensity of water loss and soil erosion, engineering measures should be employed to block the dregs, supplemented by tree planting. The temporary stacking sites in dreg filed needs to be installed with drainage facilities to avoid the loss of dreg flushed by rainfall.

Viewing from the intensity and predicted amount of water loss and soil erosion, the monitoring should focus on construction period, and the key sections are temporary stacking sites for dreg and dreg filed.

6.6.3 Prevention of soil and water conservation goal

In accordance with “The technical Specifications of Water and Soil Conservation for the Development and Construction Projects”, the overall goal of this project is to protect the safety in construction and the ecological environment by the treatments of water loss and soil erosion. They are shown as followings;

(1) As for those plough lands, forestry and other soil and water conservation easily damaged by the construction, it's quite possible to restore or reconstruct. Protecting the ecological environment, reducing water loss and soil erosion, the treatment rate of the disturbed lands can be reached above 70%.

(2). For the lands that lost the soil and water conservation ability by the influence of excavation, filling and compression, immediate actions, like the treatments of engineering and plants restore or the improvement of water preserve, should be adopted so that the treatment of water loss and soil erosion could be over 95%, The treatment rate of water loss and soil erosion can come to over 95% when the control rate of newly-added water loss and soil erosion is brought up.

(3) Centralizing storage of engineering wastes, the loose deposit body formed by wastes needs to be double protected by engineering and plants treatments. Effectively prevent the loss of wastes and make its rate over 95%.

(4) For the land that is permanent or temporarily occupied by the construction, and can take greening measures under construction or completio, we should take second plowing, planting. and other greening measures. The purpose for that is to restore vegetation over 90%, maintain the coverage rate of forest and grass over 20% in the area, and improve ecological environment in the area so as to prevent the loss of soil

and water in the area or just newly-adding.

6.6.4 The layout of measures for water and soil conservation

According to the land topography , geology , soil condition and regional water loss and soil erosion, combining with the construction features, construction layout and the short or long –term development planning, also the influence of water loss and soil erosion and goals of conservation, there are different schemes respectively in terms of specific characteristics in different water loss and soil erosion conservation areas.

6.7 The Healthy Protection for People

6.7.1 Do well in cleaning the bottom of construction area

In the construction area, the sanitary clearance should be taken, various types of densities of pathogenic microorganism and entomophila animals need to be decreased. We should prevent different infections diseases from being prevailed.

(1) Site Disinfection

The sites should be cleaned and disinfected mainly are construction areas, centralplaces for workers and all the original toilets, manure pits, stock yards, rubbish stacking spots and graveyards. When the completion of the construction, those temporary living areas, toilets, and rubbish stacking spots are all required to be disinfected by power sprayer with carbolic acid based on “Disinfection Technical Guidelines”. At the same time, special attention should be paid on the waste clearance on disinfection.

(2) The elimination of the nocuous vector biology

Under construction, the living areas are usually eliminated at regular time every

spring and autumn. The major job is to kill rats, mosquitoes and flies, and then enable to control different infectious diseases and cut down the sources. There are usual two ways to kill rats: one is by rat clip; the other is by poison bait method; as for the mosquitoes and flies, they are usually killed by one kind of pesticides called “Mie hai ling”. Under the guide of epidemic prevention staffs, those drugs and tools will be used by those construction workers.

6.7.2 The program of sanitation epidemic prevention

(1) Sanitation quarantine inspection

Sanitation quarantine must be taken before the construction workers enter the construction site. Find and control the carrier and even the new disease carrier entering the building site, protecting the builders and the local people from being cross-infection. According to the survey, sample quarantine must be undertaken, which mainly include the viral hepatitis, hemorrhagic fever, and malaria etc. The frequency of the quarantine is as follows: the construction workers and the manager must take sanitation quarantine before they enter the building site; afterwards, during the construction period, sample quarantine twice among 20% of the total amount based on the number of workers. While the construction period, health inspection must be done periodically for the workers and establish the disease files.

(2) Physical check-up

After the construction started, as the surroundings and the physic status of the building site changed gradually, the working intensities are rather high and the constitutions are various, and some new infection cases may come out. Therefore, making observation and physical check-up are useful for knowing the health status of the working force. Preventing and controlling the occurrence and spread of various kind of disease, the check-up ensures the construction going on smoothly. According to the specific situation, the physical check-up should be fixed once a year for the

restaurant workers, the workers who inbreathe the powder and work in the noise area and other whose type of work is harm for their bodies. The records will be filed.

(3) vention and immunity

Because of the high density of population and large intensity of the working task, in order to improve the ability of disease resistance among the workers, and prevent from catching cold, hemorrhagic fever and some epidemic maladies from getting cross infection and spreading, there's a need for the building staff to take the arranged immunity. According to the characteristics of the epidemic and the rules of disease among the construction of the irrigation project, such as anticipated dosing, inoculation and other ways must be taken. Besides, store adequate lockjaw immunity preparation and medicine for curing the bite of viper, so that to rescue the people who had been infected with lockjaw and the builder who had been bite by the viper in time.

(4) Propagandac and epidemic supervision

Construction organizer and development organizer should point a liable person for the epidemic prevention . He should be responsible for the propaganda and epidemic supervision of the people within his administration. The building and perfection of an epidemic situation report network and notifying to higher authorities when cases occur are required. Construction organizer and development organizer should also conduct regular inspection and supervision of food sanitation in the construction site, check the health certificates of the catering staff, and strengthen the disinfection and monitoring of drinking water.

6.7.3 Public sanitary facilities

The arrangement of the public sanitary facilities of the construction site should be in accordance to the overall arrangement of the project and actual conditions of project management and workers. The building of temporary sanitation toilets is thus required.

The setting of temporary sanitation toilets requires the follows: the spot of toilets should be at least 30m from the mess hall, meanwhile the convenience of usage should be taken into consideration; the setting of the kneeling-squatting positions should meet the requirements of *Hygienic Standards for the Design of Industrial Enterprises (TJ35-79)* issued by the Ministry of Health and the National Labor Office; the number of toilets and the kneeling-squatting position in each toilet should be decided upon the population density in surrounding areas.

According to the distribution of workers and the arrangement of living space, the placing and setting of garbage cans and dustbins in working and living areas are necessary. Domestic waste should be cleaned in time and regularly. Dumping waste into the river or drain ditch is forbidden so that the pollution of water quality is avoided.



7. Environment Monitoring and Environment Management

7.1 Environment Monitoring Plan

7.1.1 The Purpose and Requirement of the Monitor

The environmental change and influence during the construction and movement of the Yuquanhe River basin hydropower station should be monitored. And the change of each environmental factor that the project influenced and the effect of the environmental protection measures should be mastered in order to identify certain environmental problems in time and state relevant strategy, release the adverse effect and provide scientific evidence for the environmental management and the completion approval of the project.

The ecological and environmental monitor should utilize the existed cross section (spot) of the local Environment Monitor Station, Health and Epidemic Prevention Station, the Bureau of Aquatic Product, and the Bureau of Forestry. The plan would request certain qualified institutions to proceed.

7.1.2 Environment Monitoring in the Construction Period

7.1.2.1 Water Quality

(1) River Quality Monitoring

Cross section settlement: set one cross section respectively at

the ending point of backwater of Tangjiahe Reservoir,

500 m point downstream to the dam of Tangjiahe Reservoir,

100 m point upstream to the dam of Songjiahe first-level hydropower station,
300 m point downstream to the dam of Songjiahe first-level hydropower station,
300 m point downstream to the dam of Songjiahe second-level hydropower station;

Set two cross sections in the construction area respectively at

Upstream to the dam of Songjiahe first-level hydropower station

Downstream to the dam of Tangjiahe Reservoir (also used as the water quality cross section in the construction area)

Monitoring Items: water temperature, pH, suspension, DO, BOD₅, Permanganate index, Petroleum class, TP, TN, NH₃-N and fecal colon bacillus flora

Monitoring Methods: monitoring according to the methods mentioned in the <Technical Standard of Surface Water and Waste Water Monitoring> (HJ/T91-2002)

Monitoring Time and Frequency: monitoring river quality for 1 year before water storage, and monitoring cross sections in the construction area is the 24 months of construction period. The frequency of monitoring is three times per year, respectively in the periods of ample, normal and dry seasons.

(2) Monitoring at pollution outlets

Monitoring point settlement: set one monitoring point respectively at production system of granulated substance stone material, machine repair parking lot, and waste water outlet at concretes mixing station, sanitary sewage outlet, etc.

Monitoring Items: For production waste water, monitoring items are pH, suspension. Other items should be added when necessary. For sanitary sewage, monitoring items are COD, BOD₅, suspension, TP, TN, petroleum class, fecal colon bacillus flora

Monitoring Methods: monitoring according to the methods mentioned in the <Technical Standard of Surface Water and Waste Water Monitoring> (HJ/T91-2002)

Monitoring Time and Frequency: in the construction period, the monitoring at pollution outlets will be together with the water quality monitoring.

7.1.2.2 Atmosphere Monitoring

Monitoring point settlement: set one point respectively at the area of dam construction and living region.

Monitoring Items: NO₂, SO₂, PM₁₀ (or TSP)

Monitoring Method: in accordance with relevant technical standard in the <Atmosphere Quality Standard>

Monitoring Time and Frequency: once per year for continuous 5 days. The monitoring period is the construction period of time.

7.1.2.3 Noise Monitoring

(1) Regional Noise Monitoring

Monitoring point settlement: set one point respectively at the construction area of dam, the construction area of the electricity production workshop, the concretes mixing station, a point near the road for enter into the workshop in the living places of the construction staff and the production system of granulated substance stone material, totally 8 points.

Monitoring Frequency: once per year for 24 hours only in the construction period.

(2) Noise Monitoring of Transportation

Monitoring Point Settlement: one point near the main road, the exact point should satisfy the requirement in the <Technical Standard of Environmental Monitor>; the frequency for monitoring is once per year, and the traffic flow through the area should be recorded.

7.1.2.4 Aquatic Organism Monitoring

Monitoring Cross Section:

Respectively at the ending point of the reservoir backwater, 200 m point upstream to the dam, 500 m point downstream to the dam.

Monitoring Content: float zoology and botany, benthonic organism advanced aquatic botany, fish.

Monitoring Time and Frequency:

One year before the water storage of reservoir, in April.

7.1.2.5 Human Health

Monitoring Content: the normal monitor for human health depends mainly on the three-stage medical network to monitor the epidemic change in the construction area, study the relations between the human health and the waste caused by the production and construction, monitor and control the infectious disease like natural epidemic source disease, water infectious disease, insect infectious disease and local infectious disease, etc. In the season and area that are highly popular, Spot-check and prophylactic inoculation should be implemented to the people that are easily infected. Meanwhile, the system of epidemic report should be established-when identifying the infectious disease, report and investigation process should be in time to protect the health of the construction staff.

Monitoring scale: the staff in the construction area

Monitoring Time: once respectively during the peak time of construction and before the end of construction by the local epidemic prevention institutions according to relevant requirement set by Health Ministry

7.1.2.6 Water and Soil Loss

Monitoring Factors: local precipitation, wind, land slope, slope length, the surface formation, the intensity, feature and damage of water and soil loss during the construction period, the living condition of plant, vegetation and its coverage degree, the soil loss amount, the soil nutrition and the number and change of the equipment for conservation of water and soil, etc

Monitoring content: the amount of water and soil loss, the damage of water and soil loss, the benefit of the project of conservation of water and soil

Monitoring method: spot investigation, point monitoring; Monitoring time and frequency: once during the construction period

Monitoring point settlement: set one point respectively at the abandoned dregs field, fetching materials field, for the construction road, set 2 typical sectors for monitoring cross section and 1 to 2 point at each cross section

7.1.3 Environment Monitoring in the Movement Period

(1) Water Quality

Cross section settlement: set one point respectively at the ending point of the reservoir backwater, 200 m point upstream to the dam of Tangjiahe, 500 m point downstream to the dam of Tangjiahe

Monitoring Items: water temperature, pH, suspension, DO, BOD₅, Permanganate

index, Petroleum class, TP, TN, NH₃-N and fecal colon bacillus flora

Monitoring Methods: monitoring according to the methods mentioned in the <Technical Standard of Surface Water and Waste Water Monitoring> (HJ/T91-2002)

Monitoring Time and Frequency: monitoring river quality for continuous 2 year after water storage, in accordance with three water seasons per year, respectively in the periods of ample, normal and dry seasons

(2) Water Temperature

Monitoring Cross Section Settlement: set one point respectively at the upstream of the Tangjiahe dam, 300 m downstream to the Tangjiahe dam and the river mouth of the downstream of Tangjiahe

Monitoring Cycle and Frequency: monitoring for continuous 3 years after water storage, 5 times per year, once in February, April, July, August, and December.

(3) Aquatic Organism

Monitoring Cross Section: set one point respectively at the ending point of the reservoir backwater, 200 m point upstream to the Tangjiahe dam, 500 m point downstream of the Tangjiahe dam; Monitoring Content: float zoology and botany, benthonic organism advanced aquatic botany, fish.

Monitoring Time and Frequency: after water storage

(4) Water and Soil Loss

Monitoring Factors: local precipitation, wind, land slope, slope length, the surface formation, the intensity, feature and damage of water and soil loss during the construction period, the living condition of plant, vegetation and its coverage degree, the soil loss amount, the soil nutrition and the number and change of the equipment for conservation of water and soil, etc

Monitoring content: the amount of water and soil loss, the damage of water and soil loss, the benefit of the project of conservation of water and soil

Monitoring method: spot investigation, point monitoring

Monitoring point settlement: set one point respectively at the abandoned dregs field, fetching materials field, for the construction road, set 2 typical sectors for monitoring cross section and 1 to 2 point at each cross section

Monitoring time and frequency: once before and after the flood period and once in the winter, within 3 years the movement period of the station

7.2 Environment Management

The environmental management is part of the project management for the Yuquanhe river basin hydropower station and will be all through the construction and movement periods.

7.2.1 The purpose and aim of environmental management

According to the Law of Environmental Protection, the purpose of the environmental management is “protecting and improving the living and ecological environment, preventing the pollution and other public harms, protecting human health and promoting social modernized construction and development”. The main part of this project is the management of the ecological environment. The purpose of the ecological environment management is: protecting the ecological environment, preventing the ecological damage by project during its construction and movement, promoting the continuous development of the society, economy and the ecology. The main aims of the ecological environment management for this project are:

(1) Preventing the ecological damage caused by project during the construction and movement periods, protecting the ecological environment of the whole area that the

project might influence;

(2) Strengthening pollution control like water quality, air and noise, preventing the eutrophication of the reservoir and degeneration of the water function of the hydropower stations in the Yuquanhe river basin area, and protecting human health.

(3) Keeping conservation of water and soil for this project;

(4) Protecting the diversity of species in the assessment area;

(5) Realizing each measure for the environmental protection and the policy of “Those who explored in charge of the protection, who damaged in charge of restoration, who utilized in charge of compensation”.

7.2.2 The Tasks of environmental protection

(1) Realizing and executing the laws, regulations and standards and relevant systems of local authorities for the environmental protection, then establishing and perfecting the regulation systems of environmental protection of this project, and ensuring the responsibility, reward and punishment systems;

(2) Coordinating each task stated in this proposal and evaluation opinions, realizing the compensation for ecological environment and finance for the pollution prevention;

(3) Processing pollution and ecological damage accidents of all kinds;

(4) Formulating and implementing the plan of ecological environment monitor;

(5) Realizing the monitoring;

(6) Establishing complete information files for project environment management;

(7) Organizing the vocational training for the staff of environmental protection and monitor;

(8) Enhancing the contact with local bureau of environmental protection and pursue direction and assistance.

7.2.3 Environmental management institutions

The environmental management should be in the charge of professional institutions. According to the national regulations for environmental management, environment management office will be established in the section of project management of the hydropower stations in the Yuquanhe river basin, whose main responsibilities are the daily project environment management, coordination of environmental disputes and accidents, implementation of environmental monitoring plan and measures for environmental protection, and acceptance of surveillance and inspection of relevant authorities for water resources, environment protection and health epidemic prevention.

The environment management office is formed by one personnel, who would be a staff with professional skills for environment protection.

7.3 Environmental Supervision

The environmental supervision is an essential part of the project supervision and should be penetrated all through the construction of this project. The environmental supervision office authorized by the environment management office takes charge of the supervision and inspection of all the professional institutions implementing the environment protection programs and project contractor's environmental protection.

7.3.1 The tasks for environmental supervision

(1) Supervising and spot-checking of the all the professional institutions implementing the environment protection programs and project contractor's environmental protection and requiring the time limit for completion of relevant

environmental protection tasks in accordance with relevant laws and regulations and program agreement for environmental protection;

(2) Assisting the environment management office for the process of the pollute accidents and disputes in the influential area of the project;

(3) Compositing the monthly and semi-annual environmental supervision report and sending to the environmental supervision office, summarizing the environmental supervision and stating the advice for existing environmental problems and resolutions and instructing the future arrangement and working essence.

7.3.2 Methods for supervision

The methods for supervision could inspect and check instruction files, etc.

7.3.3 The settlement of staff for environmental supervision

One staff of environmental supervision is in need according to the amount of work for environmental supervision of the hydropower stations projects in the Yuquanhe river basin.



8. Analysis of investment and economic profit and loss for environmental protection

8.1 Investment Estimation for Environmental Protection

It is essential to predict and estimate the ecological influence of this project and decrease the environmental risks to the lowest to prevent heavy damage to the environment and ecological degeneration and to promote the economic and ecological continuous development in accordance with the economic principles and environment laws and regulations and the basic principle that “Those who damaged in charge of cure and management”.

8.1.1 Principles for investment

According to relevant laws, regulations and policies and the project, the principles for investment are:

- (1) Principles that “Those who polluted in charge of cure and management; who explored in charge of protection: setting programs of environmental investment and instructing the investment shares when necessary;
- (2) “Function Protection” principle: pollution management is aimed for protecting the function of the project;
- (3) “Function Restoration” Principle: the investment is aimed for protecting or restoring the ecological function before the construction of the project;
- (4) “Disposable compensation” principle: for the ecological loss caused by the project, the standard for compensation is disposable.

8.1.2 Evidence for estimation

(1) Establishment Methods and Calculation Standard of the Design and Estimation for Hydroelectric Projects (NO.78, 2002, National Committee of Economy and Trade)

(2) Notice for regulating the consultation charge of the environmental influence by National Consultation Commission and General Bureau of Environmental Protection ([2002] NO.25)

(3) The design of measures for the environmental protection of the hydropower station projects in the Yuquanhe river basin

(4) Materials involved in accordance with the price of the first half year of 2004

(5) Hubei Province Temporary Charge Regulation for the Environmental Protection Industry and Management for the Charge of Environment Monitor, etc.

8.1.3 The Division of Investment Programs

In accordance with relevant regulations for the environmental protection of constructing programs, all devices in need for pollution process and environment protection, equipment, monitoring measure and project facilities belong to the environment protection facilities.

Estimation for investment for environmental protection facilities should be listed for all the constructions with environment protection facilities.

The main environmental programs that demand special investment for this project are: the environment protection in the construction area, environmental monitor and management, water quality protection of the reservoir, etc. For investments from other resources, like reservoir bottom cleaning, compensation for reservoir sinking, construction facilities for environment protection should be listed outside, and not be

calculated into the special investment for environment protection.

8.1.4 The main investment for environmental protection

According to the environmental influence by this project, the protection measures and basic single and compound price based on relevant resolutions, estimated with above mentioned principles, the total investment for environmental protection is 2,430,400 RMB, of which the investment in the hydro-junction area is 662,500 RMB, which takes 27.26% of the total investment; the independent finance is 288,000 RMB, 11.85% of the static total investment; the investment for conservation of water and soil is 1,479,900 RMB, which contains 60.89% of the total.

The investment for environmental protection is in Table 8-1 below.

Table 8-1 The Estimation Form of Sub-item Investment for Environment Protection of Yuquanhe Hydropower Station

Project/ Fee	Unit	Num	Unit Price (RMB)	Sum (×10 ⁴ RMB)	Notes
<input type="checkbox"/> Junction Project Environment Protection				66.25	
Polluted and Wasted Water Process				24.5	
Sanitary Sewage Process	m ³	39.2	1000	3.9	Septic tank + Micro-motion Sanitary Sewage Process Facilities
Wasted Water with oil Process		1	20000	2.0	
Granulated substance stone material and wastewater disposal process				18.0	this fee has been listed in the system of stone material process
<input type="checkbox"/> Construction Fee		3	40000	12.0	Pre-construction period
<input type="checkbox"/> Movement Fee	year	3	20000	6.0	Process Fee for Flushing Waste Water in the Production System of Granulated Substance Stone Material
Waste Water Process of Concretes Production System		1	6000	0.6	Including movement fees during construction period
Protection of Air Quality				10.37	
<input type="checkbox"/> Water Spray	year	2	25000	5.0	Including Salaries and Water Fees
<input type="checkbox"/> Bag-type Dust Catcher in the Concrete Mixing System	set	1	50000	5.0	
<input type="checkbox"/> Respirator	wrap	367	10	0.37	
Noise Prevention and Protection				0.37	
Personal Protection	wrap	367	10	0.37	
Home Trash Process				1.02	
Rubbish Bin		6	500	0.3	
Home Trash Process	t	180	40	0.72	
Human Health Protection				7.49	
Cleaning	m ²	20000	0.3	0.6	Once before and after the construction
Quarantine	Per personnel	2×367	60.0	4.4	
Immune	Per personnel	2×367	25	1.8	
Rat and Mosquito Extinguishing	Per year	2×367	5.0	0.37	Total Unit Price
Toilets		4	800.0	0.32	
Aquatic Organism Protection	year	6	20000	12.0	
Ecological Environment Monitor				10.5	
Water Environment				3.0	
Air Quality				1.5	
Noise				0.4	
Aquatic Organism				5.0	
Epidemic Situation Monitor				0.6	

Project/ Fee	Unit	Num	Unit Price (RMB)	Sum ($\times 10^4$ RMB)	Notes
<input type="checkbox"/> Independent Fee				28.8	
Construction Management Fee				18.64	
Fee for management staff of				1.98	3% of Section <input type="checkbox"/>
Fee for Scientific Research and Survey				15.0	
Fee for Environment Protection Propaganda and Skill Training				1.66	2.5% of Section <input type="checkbox"/>
Environment Monitoring Fee	Per year	1 \times 2	50000	10.0	
Project Quality Surveillance Fee				0.16	0.25% of Section <input type="checkbox"/>
Static Total Investment for Environment Protection				95.05	
<input type="checkbox"/> Static Total Investment for Conservation of Water and Soil				147.99	According to Water Protection Plan
Total Investment for Environment Protection				243.04	

8.2 Analysis of economic profit and loss by the ecological influence

8.2.1 Economic Benefit

The hydropower station in the Yuquanhe River Basin is mainly for electricity production, thus its main benefit embodies on the direct economic profit through producing electricity and social profit through protection and improvement of the surrounding environment.

The installed capacity of the hydropower station is 9060 kw, the average electrical power is 31,099,200 kw•h. Although the installing scale is not large, the station could join the peak load and be a group of power source that will be able to dispatch independently in the long term in the electrical system of Wufeng County, which would release the contradiction between power usage and peak load in the local system, and improve the power quality. The development of the electrical power will definitely promote the regional economy, agricultural and industrial development.

After completion of this project, the main economical indicators of the first-level hydropower station of Songjiahe are:

Economical internal returns ratio $EIRR=19.44\% > 12\%$, economical net present value $ENPV=2,500,000RMB > 0$, economic benefit cost ratio $EBCR=1.4 > 1$, Financial Internal Returns Ratio before tax, $FIRR=13.54\% > 10\%$; Financial Internal Returns Ratio after tax , $FIRR=10.34\% > 10\%$, Financial Net Present Value(before tax), $FNPV=2,082,900RMB > 0$, Financial Net Present Value(after tax), $FNPV=737,400RMB > 0$, and the repayment period of investment in the fixed assets loan, $Pd=8y$;

The main economical indicators of the second-level of Songjiahe Hydropower Station are:

Economical internal returns ratio $EIRR=12.04\% > 12\%$, economical net present value $ENPV=10,000RMB > 0$, economic benefit cost ratio $EBCR=1 > 1$, Financial Internal Returns Ratio(before tax), $FIRR=6.33\% < 10\%$; Financial Internal Returns Ratio(after tax) , $FIRR=5.04\% < 10\%$, Financial Net Present Value(before tax), $FNPV=-1,020,900RMB < 0$, Financial Net Present Value(after tax), $FNPV=-1,552,200RMB < 0$, and the repayment period of investment in the fixed assets loan, $Pd=10.7y$;

The main economical indicators of Tangjiahe Hydropower Station are:

Economical internal returns ratio $EIRR=12.02\% > 12\%$, economical net present value $ENPV=70,000RMB > 0$, economic benefit cost ratio $EBCR=1$, Financial Internal Returns Ratio(before tax), $FIRR=8.91\% < 10\%$; Financial Internal Returns Ratio(after tax) , $FIRR=7.188\%$, Financial Net Present Value(before tax), $FNPV=-3,478,700RMB < 0$, Financial Net Present Value(after tax), $FNPV=-8,347,600RMB < 0$. The result of calculation shows that, when increasing the investment and return, each indicator dissatisfies the requirement, indicating that the ability against financial risk is not strengthened enough. And the repayment period of investment in the fixed assets loan, $Pd=11.9y$.

Referred with the estimated agricultural and industrial output kWh power produced in central and eastern China, Wufeng Country would create over 150,000,000 RMB of agricultural and industrial output per year.

8.2.2 Social Benefit

This project takes the advantage of local natural geographic condition and producing electricity across river basins, and would bring good social benefit:

(1) After completion of this project, it would release the disasters like flooding,

landslide and mud-rock flow to some extent, and provide a stable living environment for local residents. Through the construction of forestry, the mountains and rivers would become more beautiful, offering a nice working environment for the staff of the station.

(2) The coming project brings benefit to protect and utilize the land resources: the ability to store floodwater would be strengthened, so as to increase the Flood prevention guarantee rate, due to the completion of water diversion dam and tunnel, the expelling flood ability would be increased to a certain extent, thus to decrease the squares and time of submergence.

(3) After the movement of the project, it would offer job opportunities, and increase the local income and bring nice social profit.

8.2.3 Ecological Effect

The ecological environment would be influenced during the construction period of this project, however after completion; the influence would turn to a nice aspect mainly. The threat to the down stream flood would be released and the land squares and flood prevention guarantee rate increased, being perfect to closing the hillsides and facilitate the forestation, water and soil loss control and ecological environment improvement. The total water quality in the reservoir area and downstream would be better. In conclusion, this project would bring ecological benefit after completion.

8.2.4 Environmental Effect

Compared with thermoelectricity generation project in the same scale, this project has better environmental effect. The hydropower is renewable and clean energy. In Comparison with the same scale thermoelectric station, the hydropower would substitute standard coal consumption to 480g/kW·h, decrease the original coal consumption to 1.49×10^4 t/a, decrease the emission of SO₂ about 78.6t/a, and the NO₂, CO₂, CO, mist and dust as well. Therefore, the harmful material to the air and water around would be lowing down. This project would also cut down 2×10^4 RMB/a for effluent fee. Due to non-coal transportation, a large scale of transport equipment and land that special lines occupied would be saved to release the damage to the

environment.

8.2.5 The compound analysis of environment economical loss and profit

Together with the investment for environmental protection and its environmental, economical and social benefit, the environmental loss is small compared with the benefit, the good influence is big compared to the bad effect; the social and economical benefit is mainly on power production and improvement to local economy; the environmental benefit is releasing the ecological damage, but loss is mainly on land submergence and water and soil loss, and these losses would be waived through compensation and environment protective measures. Therefore, this project would bring good environmental economical benefit.



9. Public Participation

Public participation is an essential part of the assessment of environmental influence. The assessment institute provided all kinds of activities for public participation in 2004 under assistance of local authorities in order to let people understand the project of Yuquanhe Hydropower Station, the construction, its features and environmental issues related, to listen to public opinion and advice; meanwhile to avoid the negative environmental effect and make the design more reasonable and improved, and to display enough benefit of the project.

9.1 The scale, method and content of public participation

9.1.1 The method, object and scale of participation

Different kinds of participation like visit and discussion in the areas of reservoir and dam, investigation in the reservoir and submergence areas and county are provided to residents with different occupation.

The object includes social organizations, management sections, and local residents of reservoir areas, with total 100 persons of technical workers, government officials, representatives of local people's congress, the commissar of CPPCC, normal people and emigrants, of whom, the people influenced in the construction and reservoir area contain the most parts, and the investigation would reflect the real public will from the construction area objectively.

9.1.2 Investigation Content

See Table 9-1, content and format of the investigation form

Table 9-1 Investigation Form for Public Participation

● Basic Information of Participants

Name	Gender	Age	Education	Occupation	Nationality/Nations
	<input type="checkbox"/> Male <input type="checkbox"/> Female		<input type="checkbox"/> College <input type="checkbox"/> Middle school <input type="checkbox"/> Primary School <input type="checkbox"/> Under Primary School	<input type="checkbox"/> Leader <input type="checkbox"/> Official <input type="checkbox"/> Peasant <input type="checkbox"/> Others	
Unit					
Address					
Tel					

● Investigation Content

1、 Do you know this project ?

Yes No

2、 What is your attitude toward this project ?

Approval Not Approval

3、 If constructing this project, when do you think is the best time?

Immediately Slow Construction

4、 What do you think this project will influence the regional economy?

Big improvement

Some improvement but not big

No improvement

5、 What do you think of the ecological environment in the construction area?

Good Fair Bad

6、 What do you think are the benefits that the construction of the hydropower station will bring?

Important benefit to the whole development

Improvement to local economy

Improvement to regional environment

Promote the flood prevention ability of downstream

Improvement to regional ecological environment

Improvement to living conditions

Increase of job opportunities

Improvement to transportation situations

Others: _____

7、 What do you think are the negative influence of the construction of the hydropower station? ?

Immigration

Land submergence

Submergence of rare animals and plants

Aggravation of water and soil loss

Others: _____

8、 What is your opinion of emigration and settlement?

Do not wish to emigrate

Difficulty but could overcome

Would like to emigrate

9、 What is your requirement for emigration ?

Near the original place to other places

10、 What are the environmental problems in your residing place ?

Inconvenience of transportation

Water and soil loss

Natural disasters

Other: _____

11、 What are the rare and precious animals and plants in your living place?

(1) Rare and precious animals : _____

(2) Rare and precious (including raw material for medicine) : _____

12、 Your supplement opinion ?

9.2 Statistical Analysis of the Investigation Result

9.2.1 Basic information of the investigated people

100 pieces of investigation form were distributed and 100 returned, the rate of returning was 100%, Table 9-2 shows the distributed situation of the investigated participants.

Table 9-2 Distributed Situation of the Investigation Participants

Participants		Peasants	Workers	Officials	Soldier	Other occupation	Total	
Category								
Gender	Male	34	12	8	8	10	72	100
	Female	8	6	10	0	4	28	
	Sum	42	18	18	8	14	100	
Education	College	0	0	10	0	4	14	100
	Middle School	20	14	8	8	6	56	
	Primary School	22	4	0	0	4	30	

The analysis of the participants' occupation shows that, peasants contained a large proportion, 42% of local villagers, of whom 10 in the submergence area, 10%; then were the officials and workers, both took 18%; from the analysis of the gender, mainly for men, 72%; from the analysis of degree of education, the participants with middle school education contained 56%, then were the primary school and the above, 80%, the proportion of the participants with college education was the lowest, 14%.

Among all the participants, there were 1 representative of the People’s Congress of the County, and 1 member of CPPCC of the County.

9.2.2 Statistical analysis of the Feedbacks

See Table 9-3, the summary of the investigation

Table 9-3 Summary of Public Opinion

NO.	Opinion	Num.	Num. (classified)	Percentage (%)
1	Do you know this project ?	100	50	100%
			0	0
2	When is the best time for construction?	100	98	98%
			2	2%
3	What will this project influence the regional economy?	96	90	93.75%
			6	6.25%
			0	0
4	What is the ecological environment in the construction area?	100	76	76%
			24	24%
			0	0
5	What are the environmental problems in your residing place ?	100	100	100%
			0	0
			0	0
6	What are the benefits that the construction of the hydropower station will bring?	100	100	100%
			100	100%
			52	52%
			24	24%
			64	64%

NO.	Opinion	Num.	Num. (classified)	Percentage (%)	
			Improvement to living conditions	96	98%
			Increase of job opportunities	52	52%
			Improvement to transportation situations	92	92%
7	What are the negative influences of the construction of the hydropower station?	100	Immigration	0	0
			Land submergence	84	84%
			Submergence of rare animals and plants	0	0
			Aggravation of water and soil loss	0	0
8	What is your opinion toward emigration and settlement?	0	Do not wish to emigrate	0	0
			Difficulty but could overcome	0	0
			Would like to emigrate	0	0
9	What is your requirement for emigration ?	0	Near the original place	0	0
			To other places	0	0
10	What are the rare and precious animals and plants in your living place?	50	Animals :Big Ni, Golden Pheasant	82	82%
			Plants: No	0	0

(1) Among all the participants, there were 100 participants who knew the Yuquanhe Hydro project that was under preparatory construction, 100% of the total participants. That meant most participants knew the construction of the project and the project had influence that people were concerned about.

(2) There were 98 who wanted the project to start constructing immediately, 98% of total; while the 2 who wanted slow construction worried about the investment. That meant people were active in the economical activities in the area of the project.

(3) There were 76% of the participants thought that the quality of the ecological environment in the construction area was good, with beautiful scenery and was ideal

place to live and travel; 24% thought the quality was fair, for the water and soil loss control was not enough, geological disasters like landslide happened sometimes, and matching facilities were imperfect.

(4) For the main problems of living, 100% of participants considered the transportation were so inconvenient that affect the development.

(5) Most people took positive attitude toward the good effect of the project and held highly expect, among whom, 100% thought it would improve the whole development of the area and would promote the local economy, 52% thought the regional environment would be improved, 98% thought it would improve the living conditions, while 92% thought it would cause improvement to the transportation.

(6) The distributed situation of the opinion toward the negative effect:

Immigration: 0, 0%

Land submergence: 84, 84%

Submergence of rare and precious animals and plants: no

Aggravation to water and soil loss: no

That meant the public were concerned about the immigration and the land source in the mountain area. The actual fact is that there are no immigration in the scale of construction and its influential areas.

(7) During the investigation of the rare and precious species, people were more familiar with the animals than the plants, 82% of local residents knew the main rare and precious animals and tried to protect positively; no one knew or replied whether there were rare and precious plants.

9.2.3 The problems that public most concerned

After visiting villagers, organizing people with different occupations for discussion, listening to public opinions and viewing the feedback from the investigation, the most concerning problems were listed below

(1) The land compensation issues. People hope the government and construction institution would make compensation plan and relevant implementation act. The Land expropriation compensation should be priced according to the national policy and standard combining local situation. The thoughts and requirements of the villagers should be understood deeply and solved perfectly without problems afterwards.

(2) The quality of the construction. The quality of the construction meant a lot in the long term; people did not hope the construction became a fake one.

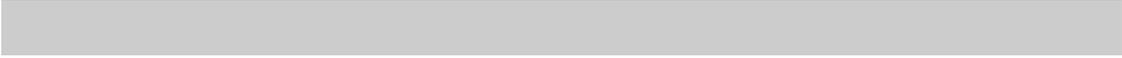
(3) The exploration and usage after completion that is the long-term plan for the local economy with the assistance of the project. There were some people who suggest the government to formulate matching facilities (roads and communication) and welfare proposal, accelerate the economy, improve the living condition and collect the construction fund.

(4) The issues about the timeliness of the flood discharge and expel during the movement period, the flood prevention ability and water and soil loss. People hope that the government pays more attention to these problems, examines carefully the technical measures and strategies to solve these problems in the design and environment assessment.

9.3 The Conclusion and Advice of Public Participation

Gathering the opinions from the investigation, most people knew this project and supported its construction, most participants believed that the construction would improve the living conditions and promote local economy and increase the job opportunities. The main problems concerned were the compensation to land expropriation, the environmental pollution and ecological damage, etc.

According to the public opinions from the investigation, the contractors are suggested to implement all measures to pollution cure and management, release the pollution in the air, surface water, noise and solid waste, and meanwhile decrease the water and soil loss and ecological environment damage.



10. Conclusions and Suggestions

10.1 Conclusions for the main environmental factors appraisal

(1) Local climate

After the reservoir being used to store water, the transpiration rate of the storehouse district will increase, compared to that before, because the original land turns into the water surface, and the water area increases. Vapor that intakes air increases, the solar radiating heat is under adjustment, the essential factors as humidity, temperature and so forth of the storehouse district change, causing the local microclimate changing. After that, the temperature changes more gently, the day and annual range turn small, the highest temperature in the year drops slightly, while the lowest temperature rises. Because the water surface increases, the roughness of the pad's downside surface reduces, and wind speed on the storehouse district's surface increases. Since the storehouse district is not wide, the influence only has limit around it, and the change scope is also very small

(2) The hydrology and silt

The Yuquan River basin belongs to the mountainous rivers, its flood is influenced by the rainstorm intensity and the terrain-----the high rainstorm intensity, the steep river bed slope, the short concentration time and the fast speed of flow contribute to the sudden and violent fall type. The project construction has changed the natural river course condition of this river section. The reservoir storage utilization silts up year by year, the water level, current capacity, speed of flow and so on hydrology conditions will have the corresponding change. The multi-annual amplitude of water levels increases, the velocity of stream slows down. As the storehouse district's backwater length is short, the silt in short lasted flood which is formed when the rainstorm flushes the upstream ditch has not enough time smuggles in the reservoir, as a result, the majority of silt is taken to the downstream, and the few silt left may be solved by discharging.

(3) Environmental Geology

The Yuquan River Basin Hydroelectric Power Station may seldom have limestone and fault leakage problems. The rock in the dam area is mainly for the novaculite and the pelitic silstone, the novaculite belongs to the hard rock, and the pelitic silstone the soft rock. The intensity is high, in the rock the medium regolith structure grows, the rock layer's tendency flows along the rivers, but with bank slope contacting, both banks rock masses are stable, on the river bed and the both bank bases are no weak structural surface, in the dam are no penetrable weak structural surface and syntagma that is not in favor of the stability, therefore, anti-slides problem doesn't exist, and neither the glide of the surface of dam base, causing no significant security problem. In the submerged area are no mineral resource of exploitation value or heritage attraction, no land immerse problem. The regional geology structure's steady condition is good, belonging to the weak shock area, so the high magnitude possibility of the project is really low, but in the engineering design, the earthquake resistance should also be considered.

(4) Water quality and temperature

After the water storage of the Yuquan River Basin Hydroelectric Power Station works, the change of water regime won't have obvious adverse effect on the overall water quality. The storehouse district's water quality can maintain the original condition. The few sewage emissions in the reservoir upstream does not affect the overall water quality. After the station being built, the reservoir belongs to the poor nutrition type.

Analyses shows the reservoir is the mixed type. Large-scale fields of economical or rare and precious fish spawns are not yet discovered, besides there are no producing, the domestic water offering and irrigating request, therefore the Yuquan River Basin Hydroelectric Power Station reservoir's low lukewarm water in summer has very small influence to the downstream water.

(5) Terrestrial ecological environment

After the station works, and part of highly productive forest lands being submerged, the land's function will have the corresponding change, causing the productivity of

the natural system in the region dropping, though is still in high level. The construction influence to the region's landscape and the ecological environment quality is not too strong.

However, the project and the submergence of the reservoir have adverse effects to the vegetation. The main cover type of the area is scrub forests, and the reservoir submergence does not involve the native vegetation, the economic forest and the unusual plant. The project is no big influence to wild animals, with no obvious influence to the population structure and the biodiversity of wild animals.

(6) Aquatic organism

After reservoir impoundment, the nutrition salts increase as the storehouse district being submerged, the primary productive forces increase, the fish food condition improve, and it provides favorable conditions for the perches and reproduces of the fish which lives in the slow running water or the still water.

After that, the dam forms impediment, thus the continuity of original ecosystems of jet stream is destroyed. Meantime, the dam forms impediment to the upstream fish, thus the fish resource reduces.

The tunnel construction has altogether 10 fields to abandon the dregs; they located nearby the main dam site and its holes. The fields plan to adopt drainages opened in three sides, lays with the mortar stone, penetrating the drain with the nearby rivers and creeks, and the sand sinking place plan to be built at the exit. Before piling up the dregs, the mellow soil on the surface layer should be peeled and stacked in the field corner; after the dregs being abandoned, the field returns the forest. The measures above taken, the ecological environmental influence may slow down and turn small.

(7) Construction's effect on the environment

The project is in the mountainous area, enjoying good air quality and the sound environment. The dust produced when constructing, the exhaust by machinery usage and the waste gas by traffic have no obvious influence on the ambient region's air quality, but the constructors, so protection should be strengthened to them. In the construction process, the source of water environment pollution is mainly from waste

water flushing the stone processing system and the construction machine, emission water of the structure excavation, and the constructors sanitary sewage. These water polluted waters in the construction section. The rubbish produced by massive constructors, waste water, gas and the noise by constructing and the home scrap have certain influence to the environment quality of this area, but it is not big, and will vanish along with the construction activity.

(8) Soil erosion

Because of the path construction, earth-rock excavation and aggregate source reclaiming and so on, the dregs are produced and the surface vegetation destroyed. With no measure preserving water and soil, the soil erosion quantity increases approximately 0.826 t in the project area, which influences the productive forces, the river course silt flushing and brings ecological environmental change.

(9) Health

The high strength physical labor reduces the immunity of the constructors in the open country, so if sanitary sewage, the production waste and the home scrap cannot be handled effectively, they may offer medium to the mosquito breeds, thus possibly causes some insect intermediary infectious disease, or water-borne infection sickness. In the initial period of impoundment, water-borne infection and spontaneous combustibility disease may raise its incidence rate, so measures should be taken. Besides, the construction affects endemic diseases not obviously.

10.2 Conclusion of Measures of Environmental Protection

(1) Measures of Environmental Protection in Construction Area

Wastewater produced during the dine processing and domestic sewage are the major pollutant sources in water environment in construction area. The measure of disposing the former one is to build sedimentation basins and the latter one is disposed by systems of water-free toilets and cesspools. Measures were proposed to reduce air pollution such as dust produced in construction and blowing dust in street and noise

pollution, including protecting constructors, watering roads and limiting car speed. The influence of constructions on air quality and the acoustical environment will be reduced to some degree after taking these measures mentioned above.

(2) the Ecological Environment

The construction of the Yuquan River Basin Hydroelectric Power Station would do probable harms to aquatic lives. Thus we came up with some ideas to protect them, including releasing fishes, monitoring aquatic lives and guaranteeing the ecological use of downstream water in the working time of the reservoir. Vegetation replantation, publicity and management are needed to reduce damages to land living creatures caused by submergence and construction. The discharge of downstream water should be limited so that the environment in the lower area would not be damaged after the construction of the reservoir.

(3) Conservation of Water and Soil

To deal with the increasing water loss and soil erosion in the construction area, plans about plants and the project are made, which can be executed respectfully to construction area, traffic area, waste slag ground, stock ground and factory buildings.

(4) Population Health

The protection of population health is merely about constructors because the arrangement of migrating population is not contained in this project. And protecting methods are cleaning, controlling vectors of viruses, testing epidemics, vaccinating and publicity.

(5) Environment Monitoring

Environment Monitoring is needed to make it known that how the environmental factors like water, air, noise, and aquatic lives change, and how these protecting methods work out.

10.3 Integrative Assessment and Conclusion

The power station can satisfy the need for electricity in Autonomous County of Tujia People, WuFeng , thus easing the current electric intensity and boosting local economy as well. First of all, electrical power derived from the dam's turbines will increase the government revenue. In addition, an investment on a large scale will definitely stimulate local economy due to the consumption accelerated by the construction and workers.

But the downsides are obvious: inundation caused by the reservoir, potential hazards posed to ecosystem in lower reaches, soil erosion plus the pollution by the waste water, gas, and residue during the construction. All these concerns can be downgraded and even eliminated by all means.

All in all, the Yuquan River Basin Hydroelectric Power Station can be both beneficial and harmful to the environment. Affected areas in construction can be environmentally compromised, but in the long haul, benefits gained in environment, economy and society will far outperform the drawbacks. Whole areas will only suffer mildly from the construction. Hence, as for the environment, it's feasible to construct Yuquan River Basin Hydroelectric Power Station by Wufengyiye Hydropower Development Co.,Ltd.

10.4 Suggestion

To minimize the disadvantages of the station and maximize the social, economical and environmental benefits, these things can be done:

- (1) Strengthen environment governing in construction period and environment protecting in construction area.
- (2) Strengthen water and soil conserving and plans implementing.

(3) Organize environment managing system, and make rules and implementing them.

(4) Building monitoring system to make sure investments aimed at environment protection are properly used.

Attached Map 1 Geographical Location of the Yuquanhe Hydroelectric Power Development Project

Attached Map 2 General Layout Plan of the Project

Attached Map 3: Layout Plan of the Dam of Tangjiahe Reservoir

Attached Map 4 Layout Plan of Factory Hubs in Songjiahe I Hydroelectric Power Station

Attached Map 5 Layout Plan of Factory Hubs in Songjiahe II Hydroelectric Power Station

Attached Map 6 General Layout Plan of the Construction of Tangjiahe Reservoir

Attached Map 7 General Layout Plan of the Factory Construction of Songjiahe I Hydroelectric Power Station

Attached Map 8 General Layout Plan of the Factory Construction of Songjiahe II Hydroelectric Power Station

Attached Map 9 Flow Chart of Processing Sand-gravel Materials in the Project of Developing Hydroelectric Power Station in Yuquanhe Basin

Attached Map 10 Regional Geologic Map and the Geologic Map of the Construction of Tangjiahe Reservoir and Power Station

Attached Map 11 Geological Map of the Construction of Songjiahe I Hydroelectric Power Station

Attached Map 12 Geological Map of the Construction of Songjiahe II Hydroelectric Power Station

Attached Map 13 Map of Monitoring Sites of Ambient Air Quality

Attached Map 14 Arrangement Plan of Monitoring Sections of Surface Water Quality

**Document from the Development and
Planning Bureau in Wufeng Tujia
Autonomous County**

No. 34, 2004

**The official reply from the Development and Planning Bureau in the
county on the project of cascade hydroelectric power station in
Yuquanhe River Basin**

Yiye Hydropower Development Company Limited of Wufeng:

Document No. 15 (2004) from your company has been received. As the Siyanghe basin enjoys abundant water resources and in order to promote the hydropower development in Siyanghe Basin to further boost the economical development in the county, after discussion, your project on constructing hydroelectric power stations in Yuquanhe Basin has been approved. Replies are as follows:

Content and scale of project: The development of the reservoirs of Songjiahel, □ and Tangjiahe Powerstation during the first period of the construction of developing hydroelectric power station in Yuquanhe has been approved. The planned capacity is 8660KW and construction covers an area of 5833 square meters.

Source of the total investment and fund: The total investment during the first period of construction is 3.8 million yuan and it is all self-supported.

Prediction of the benefits: After the project is completed, the annual power generation will be 36 million KW and the annual benefit from selling electricity will reach 7.2 million yuan, which will provide a yearly tax of 3.8 million yuan.

Construction period: May 2004. ~Jan. 2006.

After receiving the reply, you are expected to concentrate on the preparations according to basic construction procedures and try to start the construction as early as possible.

Hereby reply!

April 26th 2004

Keywords: Hydropower Development, Project Establishment, Official Reply.

CC: Bureau of Hydropower in the county,

Bureau of Land resource,

Bureau of Finance

Bureau of Development and Planning of Tujia Autonomous County, Wufeng

Printed on April 26th 2004

Entrusting Letter

Research Institute of Environmental Protection in Yichang:

In accordance with *Law of the People's Republic of China on Appraising of Environment Impacts* and the Order of the State Council of the People's Republic of China (No.253) *Regulations on the Administration of Construction Project Environmental Protection*, we are entrusted with drafting the environmental influence assessment of the project of developing hydroelectric power stations in the Yuquanhe basin. The report of environmental protection shall stick to the technique requirements and guidelines about assessing environmental influences and also meet the regulations and requirements from the executive apartments of Environmental Protection. The detailed issues will be explicitly listed in the contract signed by the two sides.

Consignor (seal)

Jan. 23rd, 2004

Attachment:

Legal representative of the consignor:

Contact person: Zhou Dajun

Tel: 0717-5821186 13886656789 13886656686

Document from the Bureau of Construction and Environmental Protection in Wufeng Tujia Autonomous County

[2004] No. 78,

Official reply from the Bureau of Construction and Environmental Protection on Environmental Impact Assessment Standard from the project of hydroelectric power station in Yuquanhe Basin by Yiye Hydropower Development Company Limited of Wufeng

Yiye Hydropower Development Company Limited of Wufeng:

The following standards should be followed in assessing the environmental influences of the hydroelectric power station project in Yuquanhe Basin:

I.Environmental Quality Standards

- (1)GB3838—2002 Standard in *Environmental Quality Standards of Surface Water*
- (2)GB3095—1996 Second Standard in *Ambient Air Quality Standards*
- (3)GB3096—93 Standard in *Standard of Environmental Noise of Urban Area*

II. Standard for Discharging Pollutants

- (1) GB8978—1996 First Standard in *Integrated Wastewater Discharge Standard*.
- (2) GB16297—96 Second Standard in *Comprehensive Emission Standard of Air Pollutants*.
- (3) GB12523—90 *Noise Limit in Construction Sites*

Hereby reply.

December 30th, 2004

Keywords: Environment Influence Assessment Standards Official Reply

Office of the bureau of Construction and environmental protection in the county

Printed on December 30th, 2004

Five copies in total

附表：

**Register Form for Approval of Environmental Protection in the
Construction**