ENVIRONMENT IMPACT ASSESSMENT

OF

JIANGXI SHIHUTANG SHIPPING AND HYDROPOWER PIVOTAL PROJECT
AT THE KAN RIVER

CLIENT: NAVIGATIONAL AFFAIRS ADMINISTRATION, JIANGXI PROVINCIAL
COMMUNICATIONS BUREAU
EVALUATOR: CCCC SECOND HARBOR CONSULTANTS CO., LTD.
JIANGXI PROVINCIAL WATER RESOURCE PLANNING AND
DESIGN INSTITUTE

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3. Ji’an City Environment Monitoring Station
4. Forestry Institute of Jiangxi Agriculture University (Garden and Park Design and Research Institute Co. Ltd. of Jiangxi Agriculture University)
5. Yangtze Aquatic Products Research Institute of China Aquatic Products Scientific Research Institute
6. Zhongshui Pearl River Planning, Exploration and Design Co. Ltd.
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APPENDIX 4: Experts’ review comments on Special Report of Impacts on Old and Famous Trees and Specially Protected Wild Plants of the Shihutang Shipping and Hydropower Pivotal Project at the Kan River;

APPENDIX 5: Experts’ Approval Report on Old and Famous Trees and Specially Protected Wild Plants within the Shihutang Shipping and Hydropower Pivotal Project at the Kan River;

APPENDIX 6: Taihe County People’s Government: “Response letter on adjusting the core area and buffer area of the county grade nature reserve – Zhujia Village Camphor Woods, Tangzhou Township, Taihe County” (2007.3.25);

APPENDIX 7: Ji’an City People’s Government’s Document No.: [2006] 83: “Notice on Printing and distributing Ji’an City Emergency Plan to Handle Water Emergencies”;


APPENDIX 10: Taihe County Environmental Hygiene Administration’s Letter of Commitment about Compensated Transport and Disposal of the Domestic Rubbish of environment protection of the Jiangxi Shihutang Shipping and Hydropower Pivotal Project at
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1.0 General

1.1 Background of the EIA Task

The Kan River flows through the whole Jiangxi province from south to north and is the largest river in Jiangxi except the Yangtze River, its basin is situated at the south bank of middle and lower reaches of the Yangtze River. The Kan River upstream Ganzhou City is called Gongshui River, after Zhang River affluxes in Ganzhou City, it is called the Kan River. It originates from the Wuyishan Mountain area, a common boundary of Jiangxi and Fujian, its headstream (main tributary) is near Shiliaodong, Shicheng County, flowing through Ganzhou, Ji’an, Zhangshu, Nanchang and Jiujiang from south to north, flowing into the Poyang Lake at Wucheng Township, Yongxiu County of Jiujiang City, then joining into the Yangtze River via the Xingziyu Lake intake. The drainage area of the Kan River upstream the Waizhou Hydrologic Station is 80948km$^2$, the catchment area controlled by the dam site of the Shihutang Shipping and Hydropower Pivotal Project (hereinafter referred to as the Project) is 43770km$^2$. The Kan River from Heyuan to Wucheng is 780km long in total.


The approved Jiangxi Kan River Drainage Area Planning Report recommends two trunk stream cascade development plans I and V through analysis on antiflood, hydropower generation, shipping, water resource application, construction condition, investment, cost and benefit etc. Plan I is an eight-step development plan (Xiashan High Elevation Plan), from upstream to downstream is Xiashan, Maodian, Wanan, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan. Plan V is a ten-step development plan (Xiashan Low Elevation Plan), from upstream to downstream is Bai’e, Baikoutang, Xiashan, Maodian, Wanan, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan. The two plans are the same just at the river section downstream Ganzhou, i.e. six steps of Wanan, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan are arranged. The planned preliminarily selected projects that will be implemented in the near future are the three steps of Taihe, Shihutang and Xiajiang.

The Kan River is the main tributary at the middle reaches of the Yangtze River, flowing through the whole Jiangxi province from south to north, and it is one of the key passages for shipping of Jiangxi province and has been listed into the state high-rank waterway network and is an important part of the state comprehensive transport system with a very important position.

As per the “Approval of Technical Grade of Inland River Waterway” (Document No. [1998]659) issued by the Ministry of Communications, the Ministry of Water Conservancy and the State Trade and Economic Relation Commission in 1998, the 525km long section of the Kan River (Ganzhou to Wucheng) is graded as Grade III inland river waterway.

As per the Jiangxi Inland River Shipping Development Plan, which passed the review of the Jiangxi Provincial People’s Government in February 2006, and through comprehensive cascade development of the Kan River trunk stream water resources and necessary waterway regulating measures, the 450km long waterway of the Kan River trunk stream from Ganzhou to Nanchang will reach Grade III waterway standard and the 156km from Nanchang to Hukou Grade II waterway standard before 2020.
The Project is a comprehensive application project mainly featured as shipping one and compromised to generate hydropower and to control flood and it is an important part of the Kan River water transport main passage construction and is also an important part of the comprehensive water resource control and cascade development of the middle and lower reaches of the Kan River. The project geographical location is shown in DRAWING NO.01.

According to the regulations of Environment Impact Assessment Law of PRC and Rules of Environment Protection Management of Construction Projects, to lessen and prevent and treat adverse impacts on environment during construction and operation of construction project, and to practically coordinate the relations among economic growth, social progress and environment protection, the Navigational Affairs Administration of Jiangxi Provincial Communication Bureau (hereinafter referred to as NAA) authorized CCCC Second Harbor Consultants Co., Ltd.(hereinafter referred to as SHCC) to undertake the environment impact assessment (EIA) work of the Project. (For Letter of Entrustment, see APPENDIX 1).

After the EIA of the Project is reviewed and approved, it can be used as the basis of engineering design, construction, environment management and monitoring during construction and operation.

1.2 EIA Purposes

The Project will cause impacts on the environment of the dam site and inundated area to a certain extent. The environment impact assessment of the project is to be carried out in order to understand and master the environment situation before construction and to forecast the environment impacts by the construction of the project through project pollution analysis and to put forward feasible measures for pollution prevention and treatment and impact lessening and to give out basis for project decision and to supervise environment protection design and environment management of the project and to achieve economic, social and environment benefits at the same time.

More specifically, the purposes of the EIA are:

(1). To improve the decision-making process by introducing environmental criteria and assessment to design engineers and decision makers and to ensure the Project is environmentally sound and sustainable;

(2). To ensure adverse environmental impacts be identified and evaluated in the earlier stage of the Project development so as to develop appropriate measures to avoid, mitigate, reduce or otherwise minimize the adverse impacts to acceptable levels;

(3). To develop measures of compensation for the impacts which could not be avoided or mitigated; and;

(4). To provide a basis for Project executing agency and relevant government agencies to develop and implement plans for environmental management and monitoring.

1.3 EIA Preparation Basis

1.3.1 Laws, regulations and rules concerning EIA of construction project

- Environmental Protection Law of PRC 1989.12
- Environment Impact Assessment Law of PRC 2002.10
1.0 General

- Water Pollution Prevention Law of PRC 1996.5
- Air Pollution Prevention Law of PRC 2000.4
- Noise Pollution Prevention Law of PRC 1996.10
- Solid Waste Pollution Prevention Law of PRC 2005.3
- Land Management Law of PRC Rev. 1998
- Wild Animals Protection Law of PRC 1988.11
- Water and Soil Conservation Law of PRC 1991.6
- Forestry Law of PRC Rev. 1998
- Water Law of PRC Rev. 2002.10
- Flood Control Law of PRC
- Cultural Relic Protection Law of PRC 2002.11
- Law on Safety in Production of PRC 2002.6
- Fishery Law of PRC 2000.10
- Infectious Disease Prevention and Curing Law of PRC 1989.2
- Rules of Environmental Protection Management for Construction Projects (the State Council Order No. 253 of PRC);
- Basic Farmland Protection Rules (the State Council Order No. 257 of PRC in 1998);
- Nature Reserve Ordinance of PRC (the State Council Order No. 167, 1994.10.09);
- Decision on Several Issues Concerning Environment Protection (Doc. No.[1996] 31)


(22) Implementation Regulations of Law on the Prevention and Control of Water Pollution of PRC (the State Council Order No.[2000] 284)

(23) Pollution Prevention and Treatment Management Rules of Drinking Water Source Protection Zone issued by the SEPA, the Ministry of Health, the Ministry of Construction, the Ministry of Water Conservancy and the Ministry of Geology and Minerals on July 10, 1989;

(24) Directory of Systematic Management of Environment Protection for Construction Projects (Order No. 14 of State Environment Protection Administration SEPA);

(25) Notice on Enhancing Ecological Protection of Everglade issued by the SEPA, March
31, 1994;

(26) Notice about strengthening Ecological Environment Management of Natural Resource Development Projects (SEPA, 1994.12);

(27) Management Regulations on Sanitation at Public Places (1987.4);

(28) Implementation Regulation of Infectious Disease Prevention and Curing Law of PRC (1991.12);

(29) Implementation Regulations of Cultural Relic Protection Law of PRC (1992.5);

(30) Water and Soil Conservation Scheme Management Methods of Construction Projects (1994.11);

(31) Wild Plants Protection Ordinance of PRC (1997.1);

(32) Implementation Regulations of Aquatic Wild Animals Protection of PRC (1993.10);

(33) Terrestrial Wild Animals Protection Implementation Ordinance of PRC (1992.2);

(34) Directory of State Specially Protected Wild Animals;

(35) Directory of State Specially Protected Wild Plants (1999);

(36) Safety Management Ordinance of Hazardous Chemicals (2002.3.15);

(37) Notice on Orderly Developing Small Hydropower Projects and Practically Protecting Ecological Environment (SEPA, State Development and Reform Commission, SDRC Doc. No. [2006] 93);


(40) Notice on Strengthening EIA Management to Prevent Environment Risks (SEPA Doc. No. [2005] 152);

(41) Notice on Printing and Distributing “Interim Procedures of EIA Public Poll” by SEPA 2006.2.14;

(42) Notice of the SEPA and State Development and Reform Commission on Enhancing Environment Protection Work of Hydropower Construction (Doc. No. [2005] 13);

(43) Notice of the Ministry of Realm and Resources on Seriously Implementing “Basic Farmland Protection Rules and Further Well Doing Basic Farmland Protection Work (Doc. No. [1999] 122);
1.0 General

(44) Notice to Strengthen the Environmental Impact Assessment Management of Construction Projects Financed by International Financial Organizations, jointly issued by SEPA, the Ministry of Health, the Ministry of Construction, the Ministry of Water Conservancy and the People’s Bank of China;


(46) Implementation Regulation of Management Regulations on Sanitation at Public Places—the Ministry of Health, 1991.3

(47) Environment Management Regulation of Preventing and Treating Inland River Pollution by Ships;

(48) Measures Concerning Environmental Protection and Management for Transportation Construction Projects, issued by MOC in 2003;

(49) Notice on Carrying out Environment Supervision Work of Communications Projects (Document No. of the Ministry of Communication MOC [2004]314);

(50) Yangtze Fishery Resources Management Regulations 2004.7

(51) Jiangxi Environment Pollution Prevention and Treatment Ordinance (2001.3.1)

(52) Jiangxi Drinking Water Source Pollution Prevention and Treatment Method 2006.8.1

(53) Jiangxi Old and Famous Trees Protection Ordinance 2004.11.26

(54) Implementation Regulation of Jiangxi Basic Farmland Protection

(55) Directory of Jiangxi Specially Protected Wild Plants (the first lot)[1995]30;

(56) Proposed Methods of Jiangxi Woodland Protection and Management (Revision) 1998.2.10

(57) Directory of Jiangxi Specially Protected Wild Plants (the first lot) 1994.10

1.3.2 World Bank Requirements

The World Bank requirements include primarily the Bank’s ten safeguard policies, including Operational Policies (OP), Best Procedure (BP), Good Practice (GP) and Operational Directives (OD). These safeguard policies are:
1.0 General

Environmental Assessment (OP/BP/GP4.01);
Forestry (OP/GP4.36);
Natural Habitats (OP/BP4.04);
Safety of Dams (OP/BP4.37);
Pest Management (OP4.09);
Involuntary Resettlement (OP4.12);
Indigenous People (OD4.20);
Cultural Property (OP4.11);
Projects in Disputed Areas (OP/BP/GP7.60); and
Projects on International Waterways (OP/BP/GP7.50).

Among these safeguards policies, Environmental Assessment (OP4.01) is the primary requirements and thus will be fully applied in this report and other EA documentation. In addition, other safeguard policies will first be screened during the EA and fully applied if triggered by the screening. Safety of Dams (OP/BP4.37), Natural Habitats (OP/BP4.04), Pest Management (OP4.09) and Forestry (OP/GP4.36) will be applied in this Report too. Involuntary Resettlement (OP4.12) and Cultural Property (OP4.11) will be applied in by two separate teams, but the major findings and subsequent assessment will be included in the EIA process and the EIA reports.

Since there are no project components that involve international waterways (OP/BP/GP7.50), indigenous people (OD4.20) or disputed areas (OP/BP/GP7.60), policies related to these subjects will not be applied in the EIA.

1.3.3 EIA technical documents

- Environment Impact Assessment Technical Guide Rules (HJ/T2.1-2.3-93)
- Environment Impact Assessment Technical Guide Rules for Acoustic Environment (HJ/T2.4-1995)
- Environment Impact Assessment Code for Inland River Shipping Construction Project (JTJ227-2001)
- Integrated Treatment Code for Water and Soil Conservation (GB/T16543.1-16543.6-1996)
- Technical Specification for Water and Soil Conservation Plan of Construction Project (SL204-98);
1.3.4 Related plans, documents and design documents

- Jiangxi Kan River Drainage Area Planning Report (Jiangxi Kan River Drainage Area Planning Commission)
- Jiangxi Inland River Shipping Development Plan (Jiangxi Provincial Communications Bureau);
- EIA of Jiangxi Inland River Shipping Development Plan (Jiangxi Provincial Communications Bureau);
- Taihe County Seat Master Plan of Jiangxi Province (1999—2020) (Taihe County People’s Government of Jiangxi Province);
- Statistical Yearbook of Taihe County 2005;
- Feasibility Study Report of the Project (Communications Survey and Design Institute of Sichuan Provincial Communications Bureau);
- Letter of Entrustment for EIA work for the Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River to CCCC Second Harbor Consultants Co., Ltd. issued by the Navigational Affairs Administration of Jiangxi Provincial Communications Bureau (See APPENDIX 1);
- Special Report on Impacts of the Project on Old and Famous Trees and Specially Protected Wild Plants (Forestry Institute of Jiangxi Agriculture University (Garden and Park Design and Research Institute Co. Ltd. of Jiangxi Agriculture University);
- Cultural Relics Investigation Report of the Project (Jiangxi Cultural Relics Archaeological Exploitation Institute);
- Navigation Demonstration Report of the Project (Jiangxi Harbor Engineering Investigation and Design Institute;
- Assessment Report of Mineral Resources Buried by the Construction Land of the Project (Jiangxi Geological and Mineral Exploitation Development Bureau);
- Geological Hazard Risk Assessment Report of the Project (Jiangxi Tianjiu Geological and Mineral Construction Institute);
- Flood Control Assessment Report of the Project (Jiangxi Provincial Water Resources Planning and Design Institute);
1.0 General

- Water Resources Demonstration Report of the Project (Jiangxi Provincial Water Resources Planning and Design Institute);
- Resettlement Action Plan (RAP) of the Project (Jiangxi Provincial Water Resources Planning and Design Institute);
- Water and Soil Conservation Plan of the Project (Jiangxi Provincial Water Resources Planning and Design Institute);
- Cultural Relics Survey Report of the Project (Jiangxi Provincial Cultural Relics Archaeological Research Institute);
- Approval of State Development and Reform Commission on the Project Proposal (SDRC Doc.No. (2007) 717);
- Comments about Proposal of the Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River (Doc. No. (2006) 421);
- (20) Land Application General Plan Modification Scheme of Taihe County Affected by the Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River;

1.4 EIA Standards

As per Jiangxi Provincial Environment Protection Bureau’s Document No. [2007]213: “Approval for the implementation standards for the environment impact assessment of the Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River”, the following standards will be applied in the EIA.

1.4.1 Water environment

- Category II of Surface Water Quality Standard (GB3838-2002) will be based for water environment baseline and impact assessment for the water area of Gouzinao Water Intake and its water source reserve and Nanmenzhou Water Intake and its water source reserve. Category III of Surface Water Quality Standard (GB3838-2002) will be based for water environment baseline and impact assessment for the other water areas. (See Table 1.4-1).
Table 1.4-1  Surface Water Quality Standard (GB3838-2002)  Unit: mg/L (except pH)

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Category</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PH</td>
<td>6~9</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>NH₃-N</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>DO</td>
<td>1.6</td>
<td>1.5</td>
</tr>
<tr>
<td>4</td>
<td>Potassium permanganate index</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>BOD₅</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Oils</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>7</td>
<td>Total P</td>
<td>0.1 (lake, reservoir 0.025)</td>
<td>0.2 (lake, reservoir 0.05)</td>
</tr>
<tr>
<td>8</td>
<td>Total N</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>9</td>
<td>Volatile phenol</td>
<td>0.002</td>
<td>0.005</td>
</tr>
<tr>
<td>10</td>
<td>Coliform (pcs/L)</td>
<td>2000</td>
<td>10000</td>
</tr>
<tr>
<td>11</td>
<td>Hg</td>
<td>0.00005</td>
<td>0.0001</td>
</tr>
<tr>
<td>12</td>
<td>Cr⁶⁺</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

□ Wastewater discharge will be evaluated by Class I in Integrated Wastewater discharge Standard (GB8978-1996) (Table 1.4-2). Productive and domestic waste water is strictly prohibited to drain into drinking water source protected river sections.

Reservoir area water environment function zoning is shown in DRAWING NO.02.

Table 1.4-2  Integrated Wastewater Discharge Standard (GB8978-96)  Unit: mg/L

<table>
<thead>
<tr>
<th>No</th>
<th>Pollutant</th>
<th>Scope of application</th>
<th>Grade 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SS</td>
<td>Other drainage firms</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>COD</td>
<td>Other drainage firms</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>BOD₅</td>
<td>Other drainage firms</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>Oils</td>
<td>All drainage firms</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>NH₃-N</td>
<td>Other drainage firms</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>Phosphate (as P)</td>
<td>All drainage firms</td>
<td>0.5</td>
</tr>
</tbody>
</table>

1.4.2 Ambient air

□ Class II of the Ambient Air Quality Standard (GB3095-1996) will be applied for ambient air baseline and impact assessment (See Table 1.4-3).

□ Emissions of air pollutants are evaluated using Class II standard in Integrated Emission Standard of Air Pollutants (GB6297-1996) (see Table 1.4-4).
Table 1.4-3  *Ambient Air Quality Standard (GB3095-1996)*  Unit: (mg/m³)

<table>
<thead>
<tr>
<th>Item</th>
<th>SO₂</th>
<th>NO₂</th>
<th>TSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily average</td>
<td>0.15</td>
<td>0.12</td>
<td>0.30</td>
</tr>
<tr>
<td>Hourly average</td>
<td>0.50</td>
<td>0.24</td>
<td>/</td>
</tr>
</tbody>
</table>

Table 1.4-4  Class II of the *Integrated Emission Standard of Air Pollutants (GB16297-1996)*

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Max. Concentration allowable (mg/m³)</th>
<th>Max. Discharge Speed (kg/h)</th>
<th>Limit for diffused discharge (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Height of chimney(m)</td>
<td>Class II</td>
</tr>
<tr>
<td>TSP</td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>23</td>
</tr>
</tbody>
</table>

1.4.3 Acoustic environment

With reference to the *Standard of Environmental Noise of Urban Area (GB3096-93)*, Category IV will be applied for the scope 50m at both sides of the waterway section where towns are situated, Category II for the scope beyond 50m; Category IV will be applied for the scope 35m at both sides of the waterway section where villages are situated, Category I for the scope beyond 35m; Category II will be applied for outside of sensitive buildings as schools, hospitals (sanatorium and homes for the aged) within the evaluated area; Category IV of Noise Standard of Boundary of Industrial Enterprise (GB12348—90) will be applied for boundary of firms within the EIA scope of the project: 70dB(A) at day and 55dB(A) at night. *Standard of Environmental Noise of Urban Area* are detailed in Table 1.4-5.

Table 1.4-5  *Standard of Environmental Noise of Urban Area (GB3096-93)*  Unit: dB(A)

<table>
<thead>
<tr>
<th>Category</th>
<th>Standard values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daytime</td>
</tr>
<tr>
<td>Category I</td>
<td>55</td>
</tr>
<tr>
<td>Category II</td>
<td>60</td>
</tr>
<tr>
<td>Category III</td>
<td>65</td>
</tr>
<tr>
<td>Category IV</td>
<td>70</td>
</tr>
</tbody>
</table>

*Noise Limits for Construction Site (GB12523-90)* will be applied in the assessment for construction phase noise impacts (Table 1.4-6).
Table 1.4-6  
*Noise Limits for Construction Site* (GB12523-90)  
<table>
<thead>
<tr>
<th>Construction stage</th>
<th>Major source of noise</th>
<th>Noise limit</th>
<th>Unit: dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daytime</td>
<td></td>
</tr>
<tr>
<td>Earth &amp; stone work</td>
<td>Bulldozer, excavator, loader, etc.</td>
<td>75</td>
<td>Earth &amp; stone work</td>
</tr>
<tr>
<td>Piling</td>
<td>Pile driver, etc.</td>
<td>85</td>
<td>Piling</td>
</tr>
<tr>
<td>Structuring</td>
<td>Concrete mixer, etc.</td>
<td>70</td>
<td>Structuring</td>
</tr>
<tr>
<td>Fitment</td>
<td>Hoist, elevator etc.</td>
<td>65</td>
<td>Fitment</td>
</tr>
</tbody>
</table>

1.5 EIA Class  
Based on the project characteristics and the environment features of the project area, and based on the requirements in the Technical Guidelines for Environmental Impacts Assessment, the classification of EIA for the project is described as follows:

Table 1.5-1  
**EIA Classification**

<table>
<thead>
<tr>
<th>Description</th>
<th>Class</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acoustic environment</td>
<td>Class III</td>
<td>Based on HJ/2.4-1995, the noise level is expected to increase by 3-5 dB(A) when the project is completed. This project falls into a large &amp; medium size project. As per the sensitivity grade of the project, the EIA is based on Class I.</td>
</tr>
<tr>
<td>Ambient air</td>
<td>Class III</td>
<td>Based on HJ/12.2-93, emission volume Pi&lt;2.5X10^7</td>
</tr>
<tr>
<td>Ecological environment</td>
<td>Class II</td>
<td>Based on HJ/T19-1997, the affected area&gt;50 km², biomass reduced by&lt;50%, bio-diversity reduced by &lt;50%.</td>
</tr>
<tr>
<td>Water environment</td>
<td>Class II</td>
<td>Based on HJ/T2.3-93, for wastewater discharge &lt;1000 m³/d, the large, medium and small rivers will follow the Class I_IV surface water standard respectively.</td>
</tr>
</tbody>
</table>

1.6 Scope and Period of Assessment

1.6.1 Scope of assessment  
Based on the requirements of the Technical Specifications for EIA of Inland River Shipping Construction Project and the actual situation of the site surveys of the project, the scope of assessment is determined to be:

- Social Environment: the area directly affected by the project;
- Ecological Environment: about 38km channel of the inundated area and within 33km downward the dam (Shengkong section of Shengang Mountain, Ji’an City), 3.0km beyond fending groyne line of the protection area, the assessment scope will be properly extended as per the distribution of the borrow sites, spoil sites, nature reserve and species to be protected;
- Water environment: about 38km long inundated area and within 33km downward the dam (Shengkong section of Shengang Mountain, Ji’an City), altogether 71km Kan River section;
- Acoustic environment and ambient air: within 200m beyond fending groyne line of the protection area and 200m at both sides of construction road, 500m beyond the dam site plant.
area, 500m beyond borrow sites, spoil sites and construction points, the assessment scope will be properly extended as per the distribution of the environment protection objectives;

1.6.2 Assessment level year
The environment situation assessment level year of this project is 2006, the prediction level year during construction period is construction peak year, and the prediction level year during operation period is 3~5 years and 2020 after operation.

1.7 Environment Protection Objectives

1.7.1 Protection objectives of acoustic environment and ambient air
Protection objectives of acoustic environment and ambient air include the residents’ places of Shihutang Village, Sangyuan Primary School, Jiangjiazhou Village, Lingbei Village, Xiayinxia Village at the left and right banks of the recommended dam site. In addition, odd residents’ places distributed within 200m at both sides of construction road, and within 200m at both sides of fending groyne line and drainage pumping station are listed as environment protection objectives. Details are shown in Table 1.7-1, Table 1.7-2 and DRAWING NO.03.

Table 1.7-1 Main protection objectives of acoustic environment & ambient air

<table>
<thead>
<tr>
<th>No</th>
<th>Objective</th>
<th>Location and distance</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shihutang Village</td>
<td>~400m downstream of right bank of recommended dam site</td>
<td>~100 households, 350 people</td>
</tr>
<tr>
<td>2</td>
<td>Sangyuan Primary School</td>
<td>~500m downstream of right bank of recommended dam site</td>
<td>~200 students, 10 teachers</td>
</tr>
<tr>
<td>3</td>
<td>Jiangjiazhou Village</td>
<td>~450m upstream of right bank of recommended dam site and ~150m away from ship lock</td>
<td>~110 households, 385 people</td>
</tr>
<tr>
<td>4</td>
<td>Lingbei Village</td>
<td>~500m at left bank of recommended dam site</td>
<td>~50 households, 175 people</td>
</tr>
<tr>
<td>5</td>
<td>Xiayinxia Village</td>
<td>~500m downstream at left bank of recommended dam site</td>
<td>~40 households, 155 people</td>
</tr>
</tbody>
</table>
1.0 General

1.7.2 Water environment protection objectives

Water environment protection objectives are Gouzinao Water Intake & its water source reserve and Nanmenzhou Water Intake & its water source reserve. In addition, Shangtian Water Intake & its water source reserve planned for long-run construction listed as environment protection objectives. There are existing water intakes and water intakes to be built within 33km downstream of the recommended dam site (river section upstream of Ji’an City area) as Jinggangshan Power Plant Phase I, Jinggangshan Power Plant Phase II, Wuyueguan Water Plant, Ji’an City No.2 Water Plant, Ji’an City No.1 Water Plant, Pharmaceutical Plant water source, Ji’an City Hedong Water Plant etc. Water environment protection objectives are given in Table 1.7-3 and Drawing No.1.7-1 and DRAWING NO.03.
### Table 1.7.2 Protection objectives of acoustic environment and ambient air

<table>
<thead>
<tr>
<th>No</th>
<th>Objective</th>
<th>Location and distance</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sangyuan Village</td>
<td>~100m to the road to be used for construction</td>
<td>~20 households; 80 people</td>
</tr>
<tr>
<td>2</td>
<td>Duxia Village</td>
<td>~50m to the road to be used for construction</td>
<td>~15 households; 60 people</td>
</tr>
<tr>
<td>3</td>
<td>Kou’an Village</td>
<td>60m to the road to be used for construction</td>
<td>~20 households; 80 people</td>
</tr>
<tr>
<td>4</td>
<td>Xiehouling</td>
<td>100m to the road to be used for construction</td>
<td>~20 households; 80 people</td>
</tr>
<tr>
<td>5</td>
<td>Xiabian Village</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households; 160 people</td>
</tr>
<tr>
<td>6</td>
<td>Yinxiajiang</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households; 160 people</td>
</tr>
<tr>
<td>7</td>
<td>Maqian Village</td>
<td>~80m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households; 60 people</td>
</tr>
<tr>
<td>8</td>
<td>Pingshang Village</td>
<td>~20m to the fending groyne line &amp; road to be used for construction</td>
<td>~50 households; 200 people</td>
</tr>
<tr>
<td>9</td>
<td>Gaozhang Village</td>
<td>~50m to the fending groyne line &amp; road to be used for construction</td>
<td>~10 households; 40 people</td>
</tr>
<tr>
<td>10</td>
<td>Dunshang Village</td>
<td>~70m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households; 60 people</td>
</tr>
<tr>
<td>11</td>
<td>Zhang Jia</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households; 160 people</td>
</tr>
<tr>
<td>12</td>
<td>Huwei</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households; 80 people</td>
</tr>
<tr>
<td>13</td>
<td>Zengjia</td>
<td>~70m to the fending groyne line &amp; road to be used for construction</td>
<td>~25 households; 100 people</td>
</tr>
<tr>
<td>14</td>
<td>Zhushan</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~50 households; 200 people</td>
</tr>
<tr>
<td>15</td>
<td>Mazhou city</td>
<td>~160m to the fending groyne line &amp; road to be used for construction</td>
<td>~60 households; 240 people</td>
</tr>
<tr>
<td>16</td>
<td>Maozhou</td>
<td>~80m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households; 60 people</td>
</tr>
<tr>
<td>17</td>
<td>Jingouwan</td>
<td>~60m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households; 80 people</td>
</tr>
<tr>
<td>18</td>
<td>Yaoxi</td>
<td>~40m to the fending groyne line &amp; road to be used for construction</td>
<td>~10 households; 40 people</td>
</tr>
<tr>
<td>19</td>
<td>Xiamu</td>
<td>~80m to the fending groyne line &amp; road to be used for construction</td>
<td>~25 households; 100 people</td>
</tr>
<tr>
<td>20</td>
<td>Fenglin Village</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households; 60 people</td>
</tr>
<tr>
<td>21</td>
<td>Dengjia</td>
<td>~120m to the fending groyne line &amp; road to be used for construction</td>
<td>~50 households; 200 people</td>
</tr>
<tr>
<td>22</td>
<td>Shangyinxia</td>
<td>~50m to the fending groyne line &amp; road to be used for construction</td>
<td>~30 households; 120 people</td>
</tr>
<tr>
<td>No</td>
<td>Objective</td>
<td>Location and distance</td>
<td>Features</td>
</tr>
<tr>
<td>----</td>
<td>-------------------</td>
<td>------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>23</td>
<td>Tongluobei</td>
<td>~40m to the fending groyne line &amp; road to be used for construction</td>
<td>~50 households/200 people</td>
</tr>
<tr>
<td>24</td>
<td>Heshupeng</td>
<td>~180m to the fending groyne line &amp; road to be used for construction</td>
<td>~60 households/240 people</td>
</tr>
<tr>
<td>25</td>
<td>Heshuxia</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households/160 people</td>
</tr>
<tr>
<td>26</td>
<td>Caoping</td>
<td>~30m to the fending groyne line &amp; road to be used for construction</td>
<td>~80 households/320 people</td>
</tr>
<tr>
<td>27</td>
<td>Guibang</td>
<td>~60m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households/80 people</td>
</tr>
<tr>
<td>28</td>
<td>Huangkengpengxia</td>
<td>~50m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households/60 people</td>
</tr>
<tr>
<td>29</td>
<td>Xiaojia</td>
<td>~50m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households/80 people</td>
</tr>
<tr>
<td>30</td>
<td>Xinju</td>
<td>~30m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households/160 people</td>
</tr>
<tr>
<td>31</td>
<td>Kangjia Lake</td>
<td>~40m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households/80 people</td>
</tr>
<tr>
<td>32</td>
<td>Jiangqian Village</td>
<td>~80m to the fending groyne line &amp; road to be used for construction</td>
<td>~30 households/120 people</td>
</tr>
<tr>
<td>33</td>
<td>Shanjia</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households/60 people</td>
</tr>
<tr>
<td>34</td>
<td>Zengjiapengxia</td>
<td>~60m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households/160 people</td>
</tr>
<tr>
<td>35</td>
<td>Nanmenzhou</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~30 households/120 people</td>
</tr>
<tr>
<td>36</td>
<td>Duwu Village</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households/80 people</td>
</tr>
<tr>
<td>37</td>
<td>Yutai Village</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households/60 people</td>
</tr>
<tr>
<td>38</td>
<td>Zhouwei</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households/160 people</td>
</tr>
<tr>
<td>39</td>
<td>Nanshanxia</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~50 households/200 people</td>
</tr>
</tbody>
</table>
### Table 1.7—3  Protection objectives of water environment

<table>
<thead>
<tr>
<th>No</th>
<th>Protection objectives</th>
<th>Water usage</th>
<th>Water intake flow $\times 10^4$t/d</th>
<th>Water flow converted m$^3$/s</th>
<th>Location and distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gouzinao Water Intake</td>
<td>Drinking water</td>
<td>6</td>
<td>0.694</td>
<td>19.04km upstream of the dam, left bank of the Kan River</td>
</tr>
<tr>
<td>2</td>
<td>Nanmenzhou Water Intake</td>
<td>Drinking water</td>
<td>5</td>
<td>0.579</td>
<td>24.05km upstream of the dam, left bank of the Kan River</td>
</tr>
<tr>
<td>3</td>
<td>Planned Shangtian Water Intake</td>
<td>Drinking water</td>
<td>4</td>
<td>0.463</td>
<td>29.0km upstream of the dam, left bank of the Kan River</td>
</tr>
<tr>
<td>4</td>
<td>Jinggangshan Power Plant Phase I</td>
<td>Industrial water</td>
<td>179/129</td>
<td>20.7/14.9</td>
<td>21.4km downstream of the dam, right bank of the Kan River</td>
</tr>
<tr>
<td>5</td>
<td>Jinggangshan Power Plant Phase II</td>
<td>Industrial water</td>
<td>6.07/5.49</td>
<td>0.702/0.636</td>
<td>21.5km downstream of the dam, right bank of the Kan River</td>
</tr>
<tr>
<td>6</td>
<td>Wuyueguan Water Plant to be built</td>
<td>Drinking water</td>
<td>5</td>
<td>0.579</td>
<td>27.0km downstream of the dam, left bank of the Kan River</td>
</tr>
<tr>
<td>7</td>
<td>Ji’an City No.2 Water Plant</td>
<td>Drinking water</td>
<td>10</td>
<td>1.157</td>
<td>28.5km downstream of the dam, left bank of the Kan River</td>
</tr>
<tr>
<td>8</td>
<td>Ji’an City No.1 Water Plant</td>
<td>Drinking water</td>
<td>4.0</td>
<td>0.463</td>
<td>30.0km downstream of the dam, left bank of the Kan River</td>
</tr>
<tr>
<td>9</td>
<td>Pharmaceutical Plant water source</td>
<td>Industrial water</td>
<td>2</td>
<td>0.231</td>
<td>32.5km downstream of the dam, left bank of the Kan River</td>
</tr>
<tr>
<td>10</td>
<td>Ji’an City Hedong Water Plant</td>
<td>Drinking water</td>
<td>2.0</td>
<td>0.231</td>
<td>33.0km downstream of the dam, right bank of the Kan River</td>
</tr>
</tbody>
</table>
1.0 General

Drawing No1.7-1  Water environment protection objectives at downstream of recommended dam site
1.7.3 Historical and cultural sites

Historical and cultural sites at the project area are shown in Table 1.7-4 and DRAWING NO.03.

Historical and cultural sites are Baikoucheng ancient town site (State grade cultural relics site under protection), Gouzi Pagoda (County grade cultural relics site under protection) and Ouyang ancestral hall (Provincial grade cultural relics site under protection under application for approval). The nearest distance of the construction site of the fending groyne of the Yongchang Protection Area of this project to the Baikoucheng ancient town site is over 5km.

Table 1.7-4  Environment protection objectives of historical and cultural sites

<table>
<thead>
<tr>
<th>No</th>
<th>Objective</th>
<th>Location</th>
<th>Protection grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Baikoucheng ancient town site</td>
<td>At Zhoutou Village of Tangzhou Township 3km southwest Taihe County seat with an area of 23×10^4 m², 25m to south bank of the Kan River</td>
<td>State grade cultural relics site under protection</td>
</tr>
<tr>
<td>2</td>
<td>Gouzi Pagoda</td>
<td>At the mountaintop at the Kan Riverside, ~20km upstream the recommended dam site.</td>
<td>County grade cultural relics site under protection</td>
</tr>
<tr>
<td>3</td>
<td>Ouyang ancestral hall</td>
<td>At Sujianggu Village of Mashi Township, ~35km upstream the recommended dam site, ~1.5km to the Kan Riverside.</td>
<td>Provincial grade cultural relics site under protection under application for approval</td>
</tr>
<tr>
<td>4</td>
<td>Huangkeng Ancient Ferry</td>
<td>Within the inundated range of reservoir area</td>
<td>Not belonging to historical site protection unit</td>
</tr>
<tr>
<td>5</td>
<td>Ancient city site</td>
<td>40 to the south bank of the Kan River, its side close to the Kan River is higher than design flood level, not to be affected due to level increase. But the north city wall foundation elevation is 56.7m, just about 0.2m higher than normal impounded level 56.5m, but lower than the design flood level 58.65m, which will be affected by level increase of Zhulin River.</td>
<td>Not belonging to historical site protection unit</td>
</tr>
</tbody>
</table>

Protective emblem of the Baikoucheng ancient town site  Panorama view of the Baikoucheng ancient town site
1.7.4 Protection objectives of ecological environment

Protection objectives of ecological environment are given in Table 1.7—5, Drawing No.1.7—2 and DRAWING NO.04.

Table 1.7—5 Protection objectives of ecological environment

<table>
<thead>
<tr>
<th>No</th>
<th>Objective</th>
<th>Briefing</th>
<th>Protection grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>County grade nature reserve – Zhujia Village Camphor Woods, Tangzhou Township</td>
<td>At the Kan Riverside at Zhujia Village of Tangzhou Township, with an area of 330Mu and an old camphor woods of about 200 camphor trees and over 30 species of wild plants.</td>
<td>County grade nature reserve</td>
</tr>
<tr>
<td>2</td>
<td>Old camphor trees etc.</td>
<td>Old trees at the dam site and surrounding of the reservoir area and 200m at both sides of fending groyne line, mainly distributed at the Jintan Old Woods and scattered at Huanghangpengxia, Xinzhou, Shihutang, Jiangjiazhou, Xiabian Village, Yinxi, Taipan, Zhangjia, Laohukeng, Yanxi Village etc.</td>
<td>County grade (all the old trees within the assessment area belong to Grade 3 authenticated on site by experts organized by Greening Commission of Jiangxi Provincial Forestry Bureau).</td>
</tr>
<tr>
<td>3</td>
<td>Baijiaxia Spawning Site</td>
<td>At the reservoir area of upper step pivotal project to be built, ~40km to the dam site of this project.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Taihe Spawning Site</td>
<td>At the reservoir area of this project, 2.1km long, 118hm², ~21.4km to the dam site, main spawning fishes are grass carp, snail carp, silver xenocypris, bream fish and carp.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Yanxiu Spawning Site</td>
<td>At the reservoir area of this project, 2.3km long, 126hm², ~13.9km to the dam site and main spawning fishes are grass carp, snail carp, silver xenocypris, and carp.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Xiajiang Hilsa Herring Spawning Site</td>
<td>~30km long, located at <del>90km</del>120km downstream of the Shihutang dam, the main spawning fish is hilsa herring, its spawning time is between June and July each year.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Basic farmland</td>
<td>This project needs to permanently occupy 2829.8Mu farmland (including 701.85Mu paddy field, 2127.9Mu dry land, among which 198.27Mu is basic farmland.</td>
<td></td>
</tr>
</tbody>
</table>
Drawing No.1.7-2 Relative location sketch of Shihutang Dam Site and Xiajiang~Xingan

Hilsa Herring Spawning Site
1. General

County grade nature reserve of Zhujia Village of Tangzhou Township (Jintan Old Woods)

This county grade nature reserve is at the Kan Riverside at Zhujia Village of Tangzhou Township, with an area of 330Mu including 225Mu core area and 105Mu buffer area, the main protection objectives are the old camphor trees. In July 2002, Taihe County People’s Government issued a document No. [2002]106 “Official Reply on Agreeing to List Camphor Woods of Zhujia Village of Tangzhou Township as Nature Reserve, approved to set a nature reserve. The nature reserve plan is shown in DRAWING NO. 05.

The fending groyne line of the Yongchang Protection Area in the engineering design goes through the core area and buffer area of the nature reserve.

Old trees (camphor tree, cedar, sabina chinensis, bitter oak etc.)

Besides the county grade nature reserve of Zhujia Village of Tangzhou Township, there are old and large trees scattered at the dam site, surrounding of the reservoir area and 200m at both sides of the fending groyne line. The site survey result shows that old and large trees are scattered at Huanghangpengxia, Xinzhou, Shihutang, Jiangjiazhou, Xiabian Village, Yinxiajiang, Taipan, Zhangjia, Laohukeng, and Yanxi Village etc.

All the old trees within the assessment area belong to Grade 3 protected ones authenticated on site by experts organized by Greening Commission of Jiangxi Provincial Forestry Bureau.

Through site survey, no famous trees or state grade protected wild plants are found within the project area; There are 11 species of provincial grade protected plants within the project area as podocarpus macrophyllus, sweet osmanthus, camellia, coptis, horned holly, iron-colored holly, Chongyang tree, gentian, yellow sandalwood, soupberry and lucid asparagus.

Through site survey, no state grade protected wild animals are found within the project area; There are 20 species of provincial grade protected animals within the project area, including 4 species of amphibians, 3 species of reptiles, 12 species of birds and 1 species of beast.

There are three spawning sites at Baijiaxia, Taihe and Yanxidu distributed in the Kan River section of the project, the Taihe and Yanxidu spawning sites are located in the reservoir area of the project, which will be affected to variant degrees during construction period.

The protected species of the project are given in Table 1.7—6.
<table>
<thead>
<tr>
<th>Category</th>
<th>Sensitive objectives</th>
<th>Protection grade &amp; remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphibians</td>
<td>Bufo gargarizans</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Rana limnocharis</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Rana nigromaculata</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Microhyla ornata</td>
<td>Provincial grade</td>
</tr>
<tr>
<td>Reptiles</td>
<td>Pelodiscus sinensis</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Gekko japonica</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Zoacys dhumnades</td>
<td>Provincial grade</td>
</tr>
<tr>
<td>Terrestrial animals</td>
<td>Podiceps ruficollis</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Egretta alba</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Ardea cinerea</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Anas platyrhynchos</td>
<td>Provincial grade</td>
</tr>
<tr>
<td>Birds</td>
<td>Ring-necked Pheasant</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Hydrophasianus chirurgus</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Vanellus cinereus</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Alcedo atthis</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Halcyon smyrnensis</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Hirundo rustica</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Lanius cristatus</td>
<td>Provincial grade</td>
</tr>
<tr>
<td></td>
<td>Lanius schach</td>
<td>Provincial grade</td>
</tr>
<tr>
<td>Animals</td>
<td>Mustela sibirica</td>
<td>Provincial grade</td>
</tr>
</tbody>
</table>

| Terrestrial plants | Podocarpus macrophyllus, sweet osmanthus, camellia, coptis, horned holly, iron-colored holly, Chongyang tree, gentian, Yellow sandalwood, soupberry & Lucid asparagus | Provincial grade |


1.8 Identification of Environment Impacts and EIA Stresses
1.8.1 Main environment issues caused by the project
1.8.1.1 Environment impacts during construction
   - Impacts on water quality and aquatic ecological environment due to dam site excavation, reservoir area cleanup, earthwork excavation, temporary inundation etc.;
   - Impacts on water and soil erosion due to soil borrow and spoil;
1.0 General

- Impacts of construction garbage and constructors’ domestic garbage on the surrounding environment and sanitary conditions;
  - Impacts of construction machinery noise on local acoustic environment;
  - Impacts of domestic sewage discharge from construction ships and constructors on the surrounding water environment;
  - Impacts of construction of construction temporary road and camp buildings on surrounding environment;
  - Impacts on the existing channel traffic;
  - Impacts of land acquisition, relocation and resettlement on living quality of affected people.
1.8.1.2 Environment impacts during operation

- Impacts of the project on hydrological conditions (level, flow rate, flow, silt etc.);
- Impacts of inundation on land resource, farmland and terrestrial organism resource;
- Impacts of reservoir area inundation on surrounding terrestrial ecological environment and agricultural environment;
- Impacts on aquatic ecological environment, habitat, migration, spawning site, living habit of fishes;
- Impacts on reservoir water quality and eutrophication;
- Impacts of noise, garbage and waste water from ships on the environment;
- Impacts of reservoir area inundation on water supply and drainage facilities and fending groyne;
- Impacts of the Project on regional socioeconomy;
- Impacts on cultural landscape.

1.8.2 Environment Impact Identification Results

The impacts of the project on environment are involved in several environment factors as ecological environment, environment geology, local climate, hydrological regime (level, flow velocity, flow and silt etc.), water quality, ambient air, acoustic environment, land resource, land acquisition, relocation, resettlement, public health, cultural landscape, socioeconomy and etc. Matrix identification analysis method is applied to identify these key environment impact issues, the environment impact matrix analysis is shown in Table 1.8-1.

1.8.3 Assessment emphases

The assessment emphases are hydrological regime change, ecological environment, water environment, alternatives comparison and selection, social impact, public consultation and pollution prevention and treatment measures, especially impacts on the hydrological regime, the county grade nature reserve of Zhujia Village of Tangzhou Township (Jintan Old Woods), and impacts on the fish spawning sites distributed at the Kan River section of the Project, and impacts on the water quality and fishes of the reservoir area and water quality at intake of Taihe City and related pollution prevention measures.

1.9 EIA Methods

Mode calculation, analogy method, investigation and analysis are applied for environment impact assessment of the project.
### Table 1.9—1 Environment impact matrix analysis table

<table>
<thead>
<tr>
<th>Time</th>
<th>Impact factor</th>
<th>Natural environment</th>
<th>Social environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Local climate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrology</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water temp</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Plants</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land animals</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aquatic lives</td>
<td></td>
</tr>
<tr>
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<td>Ambient air</td>
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<td>Acoustic environment</td>
<td></td>
</tr>
<tr>
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<td>Land application</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>Land use</td>
<td></td>
</tr>
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<td></td>
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<td>Soil erosion</td>
<td></td>
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<tr>
<td></td>
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<td>Environment quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Natural landscape</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Public health</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Economic development</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Power transmission</td>
<td></td>
</tr>
<tr>
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<td>Living quality</td>
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<td>Anti-flood</td>
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<td>Irrigation water</td>
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</tr>
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<td>Natural landscape</td>
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<td>Public health</td>
<td></td>
</tr>
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<td></td>
<td>Economic development</td>
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<td>Preperation period</td>
<td>Excavation</td>
<td>□ □ □ □ □ □ □ □</td>
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<td></td>
<td>Traffic</td>
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<td></td>
<td>Reservoir bottom cleaning</td>
<td>□ □ □ □ □ □ □ □</td>
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</tr>
<tr>
<td>Construction period</td>
<td>Site construction</td>
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<td></td>
<td>Dam construction</td>
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<td></td>
<td>Maintenance</td>
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<td>□ □ □ □ □ □ □ □</td>
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<tr>
<td></td>
<td>Constructor</td>
<td>□ □ □ □ □ □ □ □</td>
<td>□ □ □ □ □ □ □ □</td>
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<tr>
<td></td>
<td>Waste slag</td>
<td>□ □ □ □ □ □ □ □</td>
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</tr>
<tr>
<td></td>
<td>Wastewater</td>
<td>□ □ □ □ □ □ □ □</td>
<td>□ □ □ □ □ □ □ □</td>
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<tr>
<td>Operation period</td>
<td>Inundation</td>
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<td>□ □ □ □ □ □ □ □</td>
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<tr>
<td></td>
<td>Reservoir level lowering</td>
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<td>□ □ □ □ □ □ □ □</td>
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<tr>
<td></td>
<td>Drain</td>
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<td>□ □ □ □ □ □ □ □</td>
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<tr>
<td></td>
<td>Power generation</td>
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<td>□ □ □ □ □ □ □ □</td>
</tr>
<tr>
<td>Land acquisition, relocation &amp; resettlement</td>
<td>□ □ □ □ □ □ □ □</td>
<td>□ □ □ □ □ □ □ □</td>
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<tr>
<td>Affected areas</td>
<td>Inundated area</td>
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<td>□ □ □ □ □ □ □ □</td>
</tr>
<tr>
<td></td>
<td>Construction area</td>
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<td>□ □ □ □ □ □ □ □</td>
</tr>
<tr>
<td></td>
<td>Resettlement area</td>
<td>□ □ □ □ □ □ □ □</td>
<td>□ □ □ □ □ □ □ □</td>
</tr>
<tr>
<td></td>
<td>Dam downstream area</td>
<td>□ □ □ □ □ □ □ □</td>
<td>□ □ □ □ □ □ □ □</td>
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<tr>
<td></td>
<td>Reservoir surrounding area</td>
<td>□ □ □ □ □ □ □ □</td>
<td>□ □ □ □ □ □ □ □</td>
</tr>
</tbody>
</table>

Notes: Blank—basically no impact, □—less impact, □—Serious impact
2.0 PROJECT OVERVIEW

2.1 Geographical Location of the Project

The Project is between the Ji’an City proper and Taihe County seat at the middle reaches of Kan River, the dam site is situated nearby Shihutang Village, 26km downstream the Taihe County Seat Road Bridge. It is a multipurpose project, which takes shipping as the main, gives consideration to power generation and flood control.

The Kan River is the first largest river of the Poyang Lake Water System of the Yangtze River drainage area, at the south bank of the middle and lower reaches of the Yangtze River, between 113°30’~116°40’E, 24°29’~29°11’N. The Kan River drainage area is with the Fu River as dividing line, the Wuyi Mountain Chain as dividing line with Fujian Province in the southeast, connecting with Guangdong Province in the south and with Hunan Province in the west, with the tributary of the Xiu River – the Liao River as dividing line in the northwest, connecting with the Poyang Lake to join the Yangtze River at the lake intake in the north. The Kan River drainage area is narrow in east-west direction and long in south-north direction, slightly like an inclined rectangle. The drainage area of the Kan River upstream the Waizhou Hydrologic Station is 80948km². Regional water system diagram is shown in DRAWING NO. 06.

2.2 Overviews of the Drainage Area and Related Plan

2.2.1 Brief introduction to the Kan River

The Kan River flows through the whole Jiangxi province from south to north and is the largest river in Jiangxi except the Yangtze River, its basin is situated at the south bank of middle and lower reaches of the Yangtze River, between 113°30’~116°40’E, 24°29’~29°11’N. The Kan River upstream Ganzhou City is called Gongshui River, after Zhang River affluxes in Ganzhou City, it is called the Kan River. It originates from the Wuyishan Mountain area, a common boundary of Jiangxi and Fujian, its headstream (main tributary) is near Shiliaodong, Shicheng County, flowing through Ganzhou, Ji’an, Zhangshu, Nanchang and Jiujiang from south to north, flowing into the Poyang Lake at Wucheng Township, Yongxiu County of Jiujiang City, then joining into the Yangtze River via the Xingziyu Lake intake. The catchment area at the lake intake is 162225km². The Kan River from Heyuan to Wucheng is 780km long in total, the drainage area of the Kan River into the Poyang Lake is 83500km², accounting for 51.5% of the total area of Jiangxi Province, receiving 13 tributaries of over 1000km² drainage area successively, within the said drainage area the navigable waterway is 2335km long and the average runoff into the lake is 67.2 billion m³.

Upstream Wanhe is the upstream of the Kan River, 350km long, 200~600m wide, traversing mountainous and hilly area, with higher topography, riverbed of mostly coarse sand and pebble, partly rock, average gradient at low water season 0.32‰, belonging to mountain river. In August 1990, the Wan’an Pivotal Project was completed at 2km upstream Wan’an County Seat, starting to impound water for power generation. The completion of the Wan’an Project has changed silting condition of the middle and lower reaches of the Kan River, obviously affecting 120km upstream
the dam and 110km downstream the dam. The flood peak downstream the dam is apparently cut down, prolonging moderate water season, causing extremely uneven instantaneous release flow at low water season, slight increase of daily average flow and greatly reduced coming silting in low water season.

The middle reaches from Wan’an to Zhangshu is 263km long, crossing the Jitai Basin, tableland and hilly land alternately at both banks, mostly tableland of sandy loam, long-term erosion makes the beach lines collapsed and the riverbed widened, the river is wide and shallow at low water season. The average gradient at low water season is 0.16‰, among which the average gradient from Wan’an to Ji’an is 0.18‰, from Ji’an to Zhangshu 0.15‰; the river is 500~1000m wide, deconcentrating its water flow to form many sandy transition section shallow banks, alternately gravel and pebble transition section shallow banks, secondly branch shallow banks and scattered shallow banks, as per the navigable depth requirement for low water season, the average shallow bank density reaches 2.45 banks/km.

The downstream from Zhangshu to Wucheng is 167km long, flowing through alluvial plain, having lower topography and embankment on the low-lying land at both banks, belonging to plain river, with riverbed of mostly moderate and coarse sand, average gradient at low water season 0.07‰, the river channel is slightly bending, wide and shallow at low water season, with central bars growing. Altogether there are 19 central bars with the total length about 70km, among which there are cottages and residents living in two central bars having flood control embankment. The ground elevations at both banks are lower, relying on continuous embankment for flood control. The Kan River enters the Poyang Lake rump after Nanchang, with its trunk firstly divided into two branches of the East River and the West River at YangziZhoutou of Nanchang City, then divided into four branches to join the lake, among which the East River is divided into middle branch and east branch at Jiaojitou, the middle branch flows through Nanxin Lake and Dakou Lake and joins the Poyang Lake at Zhugang with total length of 43km; the east branch is the trunk channel of the East River, flowing through Yelou, Chucha, and flowing into the Poyang Lake at Sanjiangkou after it joins with the Fu River and the Xin River, the river is 56km long; The West River is divided into the north branch and the west branch at Qiaoshe, the north branch trunk flows through Jiangbu and joins the middle branch at Zhugang with a length of 28km, by-passing only at moderate flood season, less flow at low water season; the west branch flows through Qiaoshe, Changyi and into the Poyang Lake at Wucheng, which is the main passage of the Kan River into the Poyang Lake and the Yangtze River. Wucheng to Hukou belongs to the Poyang Lake area, 81km long, average gradient in low water season 0.047‰, Chuxi river mouth 20km downstream Wucheng is the general converging port of water from five rivers of the Poyang Lake area.

2.2.2 Channel situation and shipping development plan

Currently, the navigable conditions of 606km channel section from Ganzhou to Hukou of the Kan River are as follows: Channel from Ganzhou to Wan’an is about 95km long, being the channel of the Wan’an Reservoir Area, when the normal impounding level of the Wan’an Reservoir at initial operation stage is 94.11m (Yellow Sea Elevation), it can reach Grade III
channel standard; According to the current operating and management mode of the Wan’an Reservoir, during flood control period, when the Wan’an Reservoir needs to empty out from the normal impounding level at initial operation stage 94.11m to 85.11m, 69km long channel upstream the Wan’an Project can reach Grade III channel standard, 26km long channel downstream Ganzhou is varying backwater zone. 112km long channel from Wan’an to Ji’an is Grade VI channel, mostly affected channel by the dam hydropower station, because the release flow of the hydropower station is not even, ships can just apply high water for navigation with bigger hidden safety troubles. 151km long channel from Ji’an to Zhangshu started to be regulated since 2003 as per Grade V channel standard and the regulation work was completed in March 2006, now reaching Grade V channel standard already. 92km long channel from Zhangshu to Nanchang has reached Grade V channel standard, in which 500DWT ships can be navigable during moderate flood season, started to be regulated since the end of 2005 as per Grade III channel standard, the regulation work is expected to complete in 2008; 156km long channel of the Kan River from Nanchang to Hukou has reached Grade III channel standard.

The river section of this project is located at downstream of the Wan’an Project, and mostly affected channel by the dam hydropower station, because the release flow of the hydropower station is not even, ships can just apply high water for navigation, the channel is only of Grade IV standard.

In accordance with the Jiangxi Inland River Shipping Development Plan, which passed the review of the Jiangxi Provincial People’s Government in February 2006, the 525km long section of the Kan River (Ganzhou to Wucheng) is graded as Grade III inland river waterway. According to the comprehensive cascade development of the Kan River trunk stream water resources and necessary waterway regulating measures, the 450km long waterway of the Kan River trunk stream from Ganzhou to Nanchang will reach Grade III waterway standard and the 156km from Nanchang to Hukou Grade II waterway standard before 2020. We try to commence the construction of the Shihutang Project before 2010, through channel regulation to make the channel from Nanchang to Hukou to reach Grade II channel standard, the channel from Zhangshu to Nanchang Grade III channel standard, the channel from Ji’an to Zhangshu Grade V channel standard. After 2010, through channeling and channel regulation, the whole Kan River channel can reach the planned channel standard.

Kan River Waterway Planned Grades is shown in DRAWING NO. 07.

2.2.3 Kan River Drainage Area Cascade Development Plan and Its Situation

2.2.3.1 Kan River Drainage Area Cascade Development Plan


The approved Jiangxi Kan River Drainage Area Planning Report recommends two trunk
stream cascade development plans I and V through analysis on antiflood, hydropower generation, shipping, water resource application, construction condition, investment, cost and benefit etc. Plan I is an eight-step development plan (Xiashan High Elevation Plan), from upstream to downstream is Xiashan, Maodian, Wanan, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan. Plan V is a ten-step development plan (Xiashan Low Elevation Plan), from upstream to downstream is Bai’e, Baikoutang, Xiashan, Maodian, Wanan, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan. The two plans are the same just at the river section downstream Ganzhou, i.e. six steps of Wanan, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan are arranged.

The planned preliminarily selected projects that will be implemented in the near future are the three steps of Taihe, Shihutang and Xiajiang, among which the preliminarily selected normal impounding level of Shihutang Project is 56.11m (Yellow Sea Elevation, the same below), the installed capacity is 120MW, and the ship lock dimension is 175×14×2.5m.

2.2.3.2 Kan River Drainage Area Cascade Development Situation

At present, among the planned 6 steps of the Kan River downstream Ganzhou, the Wan’an step was put into operation in 1993, because the two downstream steps of Yongtai and Longtoushan are situated at the flat country of lower reaches of the Kan River, having great impacts of reservoir area inundation, they are difficult to implement in the near future. In addition, among the three steps, the preparation work of the Taihe step between Wan’an and Shihutang Steps has been organized to do by power department; The Xiajiang step downstream the Shihutang step is the flood control project of the Kan River. The project proposal has been prepared by water conservancy department, the project is to commence to build within the Eleventh-Five-Year Plan; The Shihutang Project has been listed into the Eleventh-Five-Year Plan of the Ministry of Communications and into an important project of Eleventh-Five-Year Plan by the Jiangxi Provincial People’s Government; The State Development and Reform Commission will list this project into 2007~2009 alternative projects to use the World Bank loan, and has approved to establish this project in the document No. [2007]717 “Official Reply of the State Development and Reform Commission to the Proposal of the Shihutang Shipping and Hydropower Pivotal Project at the Kan River”, it is planned to commence construction of the project in 2008 and to put into operation in 2012.

- **Wan’an Water Conservancy Pivot**

The Wan’an Water Conservancy Pivot is located at 2km upstream Wan’an County Seat at middle reaches of the Kan River, its dam site is 83km away from the Shihutang dam site, 116km away from the Ji’an Jinggangshan Bridge, the catchment area controlled is 36900km², and the annual average flow is 953m³/s. The Project is a comprehensive application project mainly featured as a hydropower one and compromised to control flood, shipping, irrigation, and aquatic breeding and was built in 1993 as per the final design scale, the feature levels are as follows: 88.11m dead water level, 98.11m normal impounding level, 67.66m normal level of tailwater for power generating, 88.11m flood control level, 98.11m upper level for flood control, 98.81m design flood level, 101.71m maximum flood level; The total reservoir capacity is $2.14 \times 10^8$ m³, the beneficial reservoir capacity for flood control is $1.19 \times 10^8$ m³.
it is an incomplete balancing reservoir; Capacity of hydropower station: 5 water turbine power generating sets, 556m³/s unit flow rate, 500MW installed capacity, 15.16×10⁸kW·h annual average generating capacity, 60.4MW firm output, and 22.0m design head. Currently the reservoir is impounded to run as per the operating level of initial operation stage: 83.11m dead water level, 94.11m normal water level, 83.11m flood control level, 91.71m upper water level for flood control; the beneficial reservoir capacity for flood control is 7.98×10⁸m³; the annual average generating capacity is 11.5×10⁸kW·h, and the firm output is 47.0MW.

Taihe Water Conservancy Pivot

Power department is now engaged in the preparation work of the Taihe Water Conservancy Pivotal Project. The dam site is situated near Xilong Village of Taihe County, 42km away from upstream Wan’an dam site, about 15km from the downstream Taihe County Seat Road, with controlled catchment area of 40937km², annual average flow of 1050m³/s. The Project is a comprehensive application project mainly featured as a hydropower one and compromised to shipping and irrigation. As per the Feasibility Study Report of Jiangxi Taihe Hydropower Station at the Kan River: the reservoir has its normal water level of 68.0m, connecting with tailwater of the Wan’an Hydropower Station, with normal level of tail water for power generation 56.9m, design flood level 68.0m, and maximum flood level 70.35m, total capacity 5.50×10⁸m³, beneficial reservoir capacity 0.12×10⁸m³, only for daily regulation; The Hydropower Station is equipped with 6 water turbine power generating sets with unit flow rate of 402m³/s, installed capacity of 180MW, annual average power generating capacity of 6.52×10⁸kW·h, firm output of 34.4MW, design head of 8.7m and base flow released for shipping of 135m³/s.

Xiajiang Water Conservancy Pivot

Xiajiang Water Conservancy Pivot is located at the upstream gorge section of the old county seat (Baqiu Town) of Xiajiang County at the middle reaches of the Kan River, and it is a comprehensive application project mainly featured as a hydropower and flood control one and compromised to shipping and irrigation. At present the water conservancy department is carrying out its preparation work. The dam site is situated at 90km downstream the Shihutang dam site with controlled catchment area of 62710km² and annual average flow of 1660m³/s. In accordance with the Proposal of the Jiangxi Xiajiang Water Conservancy Pivotal Project: the project has the reservoir normal water level of 46.0m (lowered by 1.9m than the planned normal level because the reservoir area has a larger inundation area), not connecting with tailwater of the Shihutang Hydropower Station, dead level of 44.0m, flood control level of 45.0m, upper water level for flood control of 49.1m, design flood level of 49.22m, maximum flood level of 49.74m, total reservoir capacity of 16.65×10⁸m³, flood control capacity of 9.0×10⁸m³, beneficial reservoir capacity of 2.14×10⁸m³, the reservoir belongs to seasonal regulation reservoir; The Hydropower Station is equipped with 8 water turbine power generating sets with unit flow rate of 587m³/s, installed capacity of 360MW, annual average power generating capacity of 11.5×10⁸kW·h, firm output of 49.8MW, design head of 8.57m.

The Kan River Drainage Area Cascade Plan is shown in DRAWING NO. 07 and DRAWING
NO. 08. The main figures of the four step development plan schemes of Wan’an, Taihe, Shihutang and Xiajiang in the Jiangxi Kan River Drainage Area Planning Report are shown in Table 2.2—1.
### Table 2.2 — 1  Main figures of the four step development plan schemes

<table>
<thead>
<tr>
<th>Normal impounded level m</th>
<th>Dead water level m</th>
<th>Dam axis length m</th>
<th>Maximum dam height(m)</th>
<th>Reservoir capacity $10^8$m³</th>
<th>Maximum head m</th>
<th>Design head m</th>
<th>Firm output $10^4$kW</th>
<th>Installed capacity $10^4$kW</th>
<th>Annual inflow m³</th>
<th>Single running (kW)</th>
<th>Combined running (kW)</th>
<th>Single running (m³)</th>
<th>Combined running (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>92</td>
<td>1100</td>
<td>51.0</td>
<td>23.7</td>
<td>8.7</td>
<td>10.2</td>
<td>32.7</td>
<td>6.04</td>
<td>10.8</td>
<td>50</td>
<td>6.00</td>
<td>50</td>
<td>6.00</td>
</tr>
<tr>
<td>69</td>
<td>68</td>
<td>1796</td>
<td>33.0</td>
<td>5.6</td>
<td>0.56</td>
<td>11.8</td>
<td>8.7</td>
<td>2.36</td>
<td>4.1</td>
<td>18</td>
<td>4.19</td>
<td>18</td>
<td>4.19</td>
</tr>
<tr>
<td>58</td>
<td>57</td>
<td>2079</td>
<td>30.5</td>
<td>0.57</td>
<td>8.9</td>
<td>6.5</td>
<td>2.01</td>
<td>3.2</td>
<td>12</td>
<td>4.19</td>
<td>12</td>
<td>4.19</td>
<td>12</td>
</tr>
<tr>
<td>50</td>
<td>46</td>
<td>492.2</td>
<td>33.8</td>
<td>27.6</td>
<td>6.95</td>
<td>6.0</td>
<td>16.0</td>
<td>4.32</td>
<td>8.06</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

2.0 Project Overview
2.3 Freight Forecasting and Operating Organization Plan

2.3.1 Planned level year
The planned level year is 2020 (short-run) and 2030 (long-run).

2.3.2 Freight forecasting
The predicted volumes of passenger traffic through the dam in 2020 and in 2030 are respectively 392,000 mantimes and 477,000 mantimes. The predicted freights through the dam in 2020 and in 2030 are respectively 8.43 million t and 13.33 million t. The predicted freights through the dam of different level years are shown in Table 2.3—1.

Table 2.3—1 Predicted freights through the dam of different level years

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>2020</th>
<th></th>
<th>2030</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>Upbound</td>
<td>Downbound</td>
<td>Total</td>
</tr>
<tr>
<td>I. Volume of passenger traffic</td>
<td></td>
<td>39.2</td>
<td>19.6</td>
<td>19.6</td>
<td>47.7</td>
</tr>
<tr>
<td>II. Volume of freight handled</td>
<td>10^3t</td>
<td>843</td>
<td>377</td>
<td>466</td>
<td>1333</td>
</tr>
<tr>
<td>1. Coal &amp; its products</td>
<td>10^3t</td>
<td>150</td>
<td>150 150</td>
<td>230</td>
<td>230</td>
</tr>
<tr>
<td>2. Oil, natural gas and their</td>
<td>10^3t</td>
<td>50</td>
<td>50</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>products</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Metallic ore</td>
<td>10^3t</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>4. Iron and steel</td>
<td>10^3t</td>
<td>400</td>
<td>100</td>
<td>300</td>
<td>700</td>
</tr>
<tr>
<td>5. Mine construction materials</td>
<td>10^3t</td>
<td>8</td>
<td>8</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>6. Cement</td>
<td>10^3t</td>
<td>80</td>
<td>80</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>7. Timber</td>
<td>10^3t</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>8. Non-metallic ore</td>
<td>10^3t</td>
<td>31</td>
<td>31</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>9. Fertilizer and pesticides</td>
<td>10^3t</td>
<td>7</td>
<td>7</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>10. Salt</td>
<td>10^3t</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>11. Foodstuff</td>
<td>10^3t</td>
<td>25</td>
<td>15</td>
<td>10</td>
<td>35</td>
</tr>
<tr>
<td>12. Machinery, equipment and</td>
<td>10^3t</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>electric appliances</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Chemical feedstock and</td>
<td>10^3t</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Non-ferrous metal</td>
<td>10^3t</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>15. Light industrial and pharmaceutical products</td>
<td>10^4t</td>
<td>25</td>
<td>10</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>16. Products of agriculture, forestry, husbandry and fishery</td>
<td>10^4t</td>
<td>48</td>
<td>8</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>17. Others</td>
<td>10^3t</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>18. Containers</td>
<td>10^3t</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>20</td>
</tr>
</tbody>
</table>

2.3.3 Operating organization plan

Ship situation
The main features of Jiangxi transport ships are small capacity, many types, and low standardization degree. Except that 1000DWT or over ships are navigable in the downstream Nanchang at the lower reaches of the Kan River, the Poyang Lake area, and along the Yangtze River and 500DWT motor barges are navigable in the downstream Zhangshu at the
lower reaches of the Kan River, only 300~500DWT motor barges are navigable in upper Zhangshu at the middle and upstream of the Kan River at medium flood season, below 300DWT motor barges are navigable in low water season. In 2004, the average motor ship DWT of the whole Jiangxi province is only 188t.

Ship type and operating organization plan

The channel section downstream of Ganzhou at the Kan River in 2020 will reach Grade III inland river channel standard with average ship DWT of 500t. Recommended ship types and operating organization in 2020 are shown in Table 2.3—2.

The average ship DWT in 2030 will exceed 500t, the recommended ship types and operating organization are shown in Table 2.3—3.

**Table 2.3—2  Recommended ship types and operating organization in 2020**

<table>
<thead>
<tr>
<th>No</th>
<th>Ship type</th>
<th>Operating organization</th>
<th>Total length (m)</th>
<th>Molded breadth (m)</th>
<th>Draft (m)</th>
<th>Carrying capacity (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T97kW+FB2×300t</td>
<td>Segmented barge pusher train</td>
<td>18</td>
<td>8.2</td>
<td>1.5</td>
<td>600</td>
</tr>
<tr>
<td>2</td>
<td>T147kW+FB2×500t</td>
<td>Ditto</td>
<td>21</td>
<td>9.2</td>
<td>1.5</td>
<td>1000</td>
</tr>
<tr>
<td>3</td>
<td>T294kW+FB2×1000t</td>
<td>Ditto</td>
<td>25</td>
<td>9.2</td>
<td>1.6</td>
<td>2000</td>
</tr>
<tr>
<td>4</td>
<td>J147kW×300t+B500t</td>
<td>Motor barge pusher train</td>
<td>45</td>
<td>8.6</td>
<td>1.6</td>
<td>840</td>
</tr>
<tr>
<td>5</td>
<td>J40kW×100t</td>
<td>Single ship</td>
<td>31.5</td>
<td>6.3</td>
<td>1.2</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>J88kW×300t</td>
<td>Single ship</td>
<td>45</td>
<td>8.6</td>
<td>1.6</td>
<td>300</td>
</tr>
<tr>
<td>7</td>
<td>J147kW×500t</td>
<td>Single ship</td>
<td>47</td>
<td>10.3</td>
<td>1.9</td>
<td>550</td>
</tr>
<tr>
<td>8</td>
<td>J220kW×1000t</td>
<td>Single ship</td>
<td>67.5</td>
<td>10.8</td>
<td>2.0</td>
<td>1000</td>
</tr>
<tr>
<td>9</td>
<td>500t oil tanker</td>
<td>Single ship</td>
<td>55</td>
<td>10.8</td>
<td>1.6</td>
<td>500</td>
</tr>
<tr>
<td>10</td>
<td>1000t oil tanker</td>
<td>Single ship</td>
<td>67.5</td>
<td>12.8</td>
<td>2.0</td>
<td>1000</td>
</tr>
<tr>
<td>11</td>
<td>36TEU container ship</td>
<td>Single ship</td>
<td>55</td>
<td>9.8</td>
<td>1.8</td>
<td>36TEU</td>
</tr>
<tr>
<td>12</td>
<td>60TEU container ship</td>
<td>Single ship</td>
<td>62.5</td>
<td>10.8</td>
<td>2.2</td>
<td>60TEU</td>
</tr>
</tbody>
</table>

**Table 2.3—3  Recommended ship types and operating organization in 2030**

<table>
<thead>
<tr>
<th>No</th>
<th>Ship type</th>
<th>Operating organization</th>
<th>Total length (m)</th>
<th>Molded breadth (m)</th>
<th>Draft (m)</th>
<th>Carrying capacity (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T147kW+FB2×500t</td>
<td>Segmented barge pusher train</td>
<td>21</td>
<td>9.2</td>
<td>1.5</td>
<td>1000</td>
</tr>
</tbody>
</table>
2.0 Project Overview

<table>
<thead>
<tr>
<th></th>
<th>Pivotal project</th>
<th>Auxiliary work</th>
<th>Pivotal project</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>T294kW+FB2×1000t</td>
<td>Segmented barge pusher train</td>
<td>25  9.2  1.6  2000</td>
</tr>
<tr>
<td>3</td>
<td>300t motor barge</td>
<td>Single ship</td>
<td>38  9.2  1.6</td>
</tr>
<tr>
<td>4</td>
<td>500t motor barge</td>
<td>Single ship</td>
<td>45  10.8  1.9</td>
</tr>
<tr>
<td>5</td>
<td>1000t motor barge</td>
<td>Single ship</td>
<td>60  10.8  2.2</td>
</tr>
<tr>
<td>6</td>
<td>2000t motor barge</td>
<td>Single ship</td>
<td>72.5  10.8  2.8</td>
</tr>
<tr>
<td>7</td>
<td>500t oil tanker</td>
<td>Single ship</td>
<td>55.0  10.8  1.8</td>
</tr>
<tr>
<td>8</td>
<td>1000t oil tanker</td>
<td>Single ship</td>
<td>67.5  12.8  2.0</td>
</tr>
<tr>
<td>9</td>
<td>60TEU container ship</td>
<td>Single ship</td>
<td>55.0  62.5  10.8  2.2</td>
</tr>
<tr>
<td>10</td>
<td>90 TEU container ship</td>
<td>Single ship</td>
<td>62.5  67.5  10.8  2.2</td>
</tr>
</tbody>
</table>

2.4 Characteristics of the Project

Project name: Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River

Project nature: new project

Construction place: Shihutang Village, Taihe County, Ji’an City, Jiangxi Province

Project tasks: Mainly for shipping, minorly for hydropower generation and flood control

Construction scale: belonging to second-class large (2) type hydropower pivotal project, Ship lock, Grade III channel, Installed capacity of hydropower station of 117MW, reservoir inundation area of 2544.81hm², permanently occupied land of 2835.0hm², total investment of 2.227 billion yuan.

2.5 Setup of the Project

Setup of the Project is shown in Table 2.5—1. Assessment work of power transmission and transformation and electromagnetic radiation involved in this project is not included in this EIA, which will be authorized by the Owner to other qualified assessment unit.

Table 2.5—1  Setup and main technical figures of the Project

<table>
<thead>
<tr>
<th>I. Setup and main technical figures of the Project</th>
<th>Pivotal project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main work</td>
<td>Reservoir area protection, Reservoir area inundation, Pivot management area</td>
</tr>
<tr>
<td>Auxiliary work</td>
<td>Pivot construction, Construction firms and their facilities, Construction traffic, Material sites, spoil sites</td>
</tr>
</tbody>
</table>
2.0 Project Overview

<table>
<thead>
<tr>
<th>Permanently occupied land (hm²)</th>
<th>Pivotal work</th>
<th>Dike work</th>
<th>Drainage work</th>
<th>Engineering management area</th>
<th>Reservoir inundation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28.33</td>
<td>115.28</td>
<td>143.24</td>
<td>3.33</td>
<td>2544.81</td>
<td>2835.0</td>
</tr>
<tr>
<td>Temporarily occupied land (hm²)</td>
<td>Material sites</td>
<td>Construction road</td>
<td>Spoil sites</td>
<td>Resettlement area</td>
<td>Construction area</td>
<td>Farmland elevating</td>
</tr>
<tr>
<td></td>
<td>159.46</td>
<td>30.73</td>
<td>117.63</td>
<td>5.21</td>
<td>64.20</td>
<td>82.47</td>
</tr>
</tbody>
</table>

II. Amount of works ×10⁴ m³

<table>
<thead>
<tr>
<th>Project setup</th>
<th>Excavation</th>
<th>Fill</th>
<th>Application</th>
<th>Lend</th>
<th>Borrow</th>
<th>Spoil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pivotal project</td>
<td>272.19</td>
<td>286.73</td>
<td>160.07</td>
<td>34.15</td>
<td>112.12</td>
<td></td>
</tr>
<tr>
<td>Dike work</td>
<td>36.91</td>
<td>202.61</td>
<td>90.61</td>
<td>112</td>
<td>36.91</td>
<td></td>
</tr>
<tr>
<td>Drainage work</td>
<td>351.85</td>
<td>109.76</td>
<td>96.16</td>
<td>90.61</td>
<td>13.59</td>
<td>165.07</td>
</tr>
<tr>
<td>Total</td>
<td>660.95</td>
<td>599.1</td>
<td>346.84</td>
<td>90.61</td>
<td>159.74</td>
<td>314.10</td>
</tr>
</tbody>
</table>

2.6 Development Task and Project Scale

2.6.1 Development task

The Project is a comprehensive application project mainly featured as shipping one and compromised to generate hydropower and to control flood.

2.6.2 Project scale

The project belongs to second-class large (2) type project, with normal impounding level of 56.50m, total reservoir capacity of about 632 million m³, the reservoir area at normal level of 29.2km², backwater length of 38km, 6 water turbine power generating sets, installed capacity of 117MW, annual average power generating capacity of 4.8×10⁶ kW·h, water retaining height of 9.8m, belonging to low head building.

The main buildings of the pivot are flood discharge scouring sluice, ship lock, hydropower station, earth rockfill dam at left and right banks and the dam bridge; The main buildings of flood control area are flood dike, regulating sluices, guide drainage canals and electrical drainage pumping stations, with total protection dike line of 38.38km, total guide support canal (drainage canal) length of 61.33km. The main buildings of the project are flood discharge scouring sluice, ship lock water retaining part, powerhouse, earth rockfill dam sections at joint of left and right banks, which are designed as per Class 3 building standard, the secondary buildings are designed as per Class 4 building standard, the temporary buildings are designed as per Class 5 building standard.

The navigational standard is 1000t DWT Grade III inland river channel, the ship lock navigational grade is Grade III, the channel dimensions are as follows: design depth 2.2m, design width 60m, bending radius not smaller than 480m, guaranteed navigational rate of 95%, lock chamber dimension is 180×23×3.5m (length×width×water depth on sill).

The permanent water retaining and release structures of the project are to be designed on a 50-year-flood-reoccurrence period and a 300-year-check-flood-reoccurrence period basis; The design and check flood levels of the powerhouse and ship lock as part of retaining structure are the same with those of retaining structure; The energy dissipation and protection work downstream the release structure are to be designed on a 30-year-flood-reoccurrence period basis.
The main characteristics of the Project are shown in Table 2.6–1.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Hydrology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Drainage area</td>
<td>Km²</td>
<td>80948</td>
<td>Upper the Waizhou Hydrological Station</td>
</tr>
<tr>
<td>Whole drainage area</td>
<td>Km²</td>
<td>43770</td>
<td></td>
</tr>
<tr>
<td>Upper the Project dam</td>
<td>Year</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>2. Years of hydrological series applied</td>
<td>Year</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>3. Annual average runoff</td>
<td>10³m³</td>
<td>362.9</td>
<td></td>
</tr>
<tr>
<td>4. Representative flow</td>
<td>m³/s</td>
<td>1150</td>
<td></td>
</tr>
<tr>
<td>Actually measured maximum flow</td>
<td>m³/s</td>
<td>15300</td>
<td>June 17, 1964, Dongbei Hydrological Station</td>
</tr>
</tbody>
</table>
Table 2.6—1  Main characteristics of the Project  (Cont’d)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actually measured minimum flow</td>
<td>m³/s</td>
<td>47.9</td>
<td>Dec. 15, 2004, Dongbei Hydrological Station</td>
</tr>
<tr>
<td>Historic maximum flow</td>
<td>m³/s</td>
<td>21000</td>
<td></td>
</tr>
<tr>
<td>Normal (design) flood std.</td>
<td>P(□)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Abnormal (check) flood std.</td>
<td>P(□)</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>Construction diversion standard</td>
<td>P(□)</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Silt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual average suspended load sediment discharge</td>
<td>10⁴t</td>
<td>372</td>
<td></td>
</tr>
<tr>
<td>Annual average bed load sediment discharge</td>
<td>10⁴t</td>
<td>55.8</td>
<td></td>
</tr>
<tr>
<td>II. Reservoir</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check flood level</td>
<td>m</td>
<td>60.65</td>
<td></td>
</tr>
<tr>
<td>Design flood level</td>
<td>m</td>
<td>59.34</td>
<td></td>
</tr>
<tr>
<td>Normal water level</td>
<td>m</td>
<td>56.50</td>
<td></td>
</tr>
<tr>
<td>Dead water level</td>
<td>m</td>
<td>56.20</td>
<td></td>
</tr>
<tr>
<td>Reservoir area at normal water level</td>
<td>km²</td>
<td>29.2</td>
<td></td>
</tr>
<tr>
<td>Backwater length</td>
<td>km</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Total reservoir capacity (below check flood level)</td>
<td>10⁴m³</td>
<td>6.32</td>
<td></td>
</tr>
<tr>
<td>Reservoir capacity below normal water level</td>
<td>10⁴m³</td>
<td>1.491</td>
<td></td>
</tr>
<tr>
<td>Regulating reservoir capacity</td>
<td>10⁴m³</td>
<td>0.0847</td>
<td></td>
</tr>
<tr>
<td>Dead reservoir capacity</td>
<td>10⁴m³</td>
<td>1.046</td>
<td></td>
</tr>
<tr>
<td>Regulation storage coefficient</td>
<td></td>
<td>0.023</td>
<td></td>
</tr>
<tr>
<td>Regulation feature</td>
<td></td>
<td>Daily regulation</td>
<td></td>
</tr>
<tr>
<td>Water efficiency of hydropower station</td>
<td>%</td>
<td>79.03</td>
<td></td>
</tr>
<tr>
<td>III. Release flow &amp; downstream levels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum release flow at design flood level</td>
<td>m³/s</td>
<td>19140</td>
<td></td>
</tr>
<tr>
<td>Corresponding downstream level</td>
<td>m</td>
<td>59.13</td>
<td></td>
</tr>
<tr>
<td>Maximum release flow at check flood level</td>
<td>m³/s</td>
<td>23120</td>
<td></td>
</tr>
<tr>
<td>Corresponding downstream level</td>
<td>m</td>
<td>60.38</td>
<td></td>
</tr>
<tr>
<td>Regulation of flowrate P=90%</td>
<td>m³/s</td>
<td>293</td>
<td></td>
</tr>
<tr>
<td>Corresponding downstream level</td>
<td>m</td>
<td>47.16</td>
<td></td>
</tr>
<tr>
<td>Maximum application flow at full installed capacity</td>
<td>m³/s</td>
<td>2520</td>
<td></td>
</tr>
<tr>
<td>Corresponding downstream level</td>
<td>m</td>
<td>50.55</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2.6—1 Main characteristics of the Project (Cont’d)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV. Benefit figures of the project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Shipping benefit</td>
<td>km</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Length of channel improved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channel dimension</td>
<td>m</td>
<td>60×480×2.2</td>
<td>Beeline width×bending radius×water depth</td>
</tr>
<tr>
<td>Design fleet</td>
<td>t</td>
<td>2×1000</td>
<td></td>
</tr>
<tr>
<td>Annual trafficability</td>
<td>×10^4t/a</td>
<td>827</td>
<td></td>
</tr>
<tr>
<td>2. Hydropower benefit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed capacity</td>
<td>MW</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>Firm output (P=90%)</td>
<td>MW</td>
<td>21.61</td>
<td></td>
</tr>
<tr>
<td>Annual average generating capacity</td>
<td>10^8kW·h</td>
<td>4.80</td>
<td></td>
</tr>
<tr>
<td>Annual on-stream hours</td>
<td>h</td>
<td>4103</td>
<td></td>
</tr>
<tr>
<td>V. Inundation loss &amp; permanently occupied land by the project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Occupied farmland (P=50%)</td>
<td>Mu</td>
<td>2977.3</td>
<td></td>
</tr>
<tr>
<td>2. Occupied woodland</td>
<td>Mu</td>
<td>3468.4</td>
<td></td>
</tr>
<tr>
<td>3. Relocated population (P=10%)</td>
<td>Person</td>
<td>711</td>
<td></td>
</tr>
<tr>
<td>4. Relocated houses</td>
<td>m^2</td>
<td>45550</td>
<td></td>
</tr>
<tr>
<td>VI. Main buildings &amp; equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Type of water retaining structure</td>
<td>Open type barrage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundation feature</td>
<td></td>
<td>Mudstone</td>
<td></td>
</tr>
<tr>
<td>Basic earthquake intensity/design earthquake intensity</td>
<td>o</td>
<td>VI</td>
<td></td>
</tr>
<tr>
<td>Crest elevation</td>
<td>m</td>
<td>63.5</td>
<td></td>
</tr>
<tr>
<td>Maximum dam height</td>
<td>m</td>
<td>26.5</td>
<td></td>
</tr>
<tr>
<td>Crest length</td>
<td>m</td>
<td>584</td>
<td></td>
</tr>
<tr>
<td>2. Release structure type</td>
<td>Open type barrage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundation feature</td>
<td></td>
<td>Mudstone</td>
<td></td>
</tr>
<tr>
<td>Weir (sill) top elevation</td>
<td>m</td>
<td>47.00</td>
<td></td>
</tr>
<tr>
<td>Discharge per unit width</td>
<td>m^3/(s·m)</td>
<td>48.2</td>
<td></td>
</tr>
<tr>
<td>Energy dissipation mode</td>
<td>Energy dissipation by hydraulic jump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type, quantity &amp; size of gate</td>
<td>20×10-9.5×24 gates</td>
<td>Arc gate</td>
<td></td>
</tr>
<tr>
<td>Type, quantity &amp; capacity of headstock gear</td>
<td>QHLY-2×1600-6.2</td>
<td>20 hydraulic headstock gears</td>
<td></td>
</tr>
<tr>
<td>Design flood discharge flow</td>
<td>m^3/s</td>
<td>19140</td>
<td></td>
</tr>
</tbody>
</table>
2.0 Project Overview

<table>
<thead>
<tr>
<th>Check flood discharge flow</th>
<th>m³/s</th>
<th>23120</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>3. Navigational building</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Grade III ship lock</td>
<td></td>
</tr>
<tr>
<td>Foundation feature</td>
<td>Muddy siltstone, silty mudstone, entrained siltstone</td>
<td></td>
</tr>
<tr>
<td>Effective size</td>
<td>m</td>
<td>180×23×3.5</td>
</tr>
<tr>
<td>Upstream maximum navigable level</td>
<td>m</td>
<td>57.64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2.6-1 Main characteristics of the Project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corresponding flow</td>
<td>m³/s</td>
<td>14800</td>
<td>P=10% flood frequency</td>
</tr>
<tr>
<td>Downstream maximum navigable level</td>
<td>m</td>
<td>57.49</td>
<td></td>
</tr>
<tr>
<td>Upstream minimum navigable level</td>
<td>m</td>
<td>52.46</td>
<td>Minimum operating level of the reservoir</td>
</tr>
<tr>
<td>Downstream minimum navigable level</td>
<td>m</td>
<td>45.88</td>
<td></td>
</tr>
<tr>
<td>Maximum working head</td>
<td>m</td>
<td>10.62</td>
<td></td>
</tr>
<tr>
<td>Water transmission mode</td>
<td></td>
<td></td>
<td>Multiple hole on chamber wall long coursed way</td>
</tr>
<tr>
<td>Water transmission valve type</td>
<td></td>
<td>2.2×2.2-7.3</td>
<td>Submerged hole plane fixed roller gate</td>
</tr>
<tr>
<td>Type &amp; size of gate</td>
<td></td>
<td>23×11.9-6.58, 23×15.3-6.58</td>
<td>Miter gate</td>
</tr>
<tr>
<td>Type, model &amp; power of gate headstock gear</td>
<td></td>
<td>QRWY-500/400-5.6B, QRWY-630/500-5.6B</td>
<td>Horizontal hydraulic headstock gear</td>
</tr>
<tr>
<td>Type, model &amp; power of valve headstock gear</td>
<td></td>
<td>QPPYII-200-2.5</td>
<td>Vertical hydraulic headstock gear</td>
</tr>
<tr>
<td>4. Powerhouse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
<td>River channel type</td>
<td></td>
</tr>
<tr>
<td>Foundation feature</td>
<td></td>
<td>Weakly weathered mudstone</td>
<td></td>
</tr>
<tr>
<td>Powerhouse dimension (LxWxH)</td>
<td>m</td>
<td>145.015×88.89×62.19</td>
<td></td>
</tr>
<tr>
<td>Erection elevation of water turbine</td>
<td>m</td>
<td>38.0</td>
<td></td>
</tr>
<tr>
<td>5. Stepup substation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundation feature</td>
<td></td>
<td>Manual filling</td>
<td></td>
</tr>
<tr>
<td>Area (LxW)/storey</td>
<td>m²/storey</td>
<td>70×13</td>
<td></td>
</tr>
<tr>
<td>GIS switching station</td>
<td>m²</td>
<td>40×12</td>
<td></td>
</tr>
<tr>
<td>6. Main generating equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of water turbines</td>
<td>Set</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
<td>GZ□SHT1□-WP-730</td>
<td></td>
</tr>
</tbody>
</table>

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2.0 Project Overview

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated output</td>
<td>MW</td>
<td>20.10</td>
<td></td>
</tr>
<tr>
<td>Rated speed</td>
<td>r/min</td>
<td>71.4</td>
<td></td>
</tr>
<tr>
<td>Draught height</td>
<td>m</td>
<td>-8.78</td>
<td></td>
</tr>
<tr>
<td>Rotary wheel diameter</td>
<td>m</td>
<td>7.3</td>
<td></td>
</tr>
<tr>
<td>Maximum working head</td>
<td>m</td>
<td>9.80</td>
<td></td>
</tr>
<tr>
<td>Minimum working head</td>
<td>m</td>
<td>3.60</td>
<td></td>
</tr>
<tr>
<td>Rated head</td>
<td>m</td>
<td>5.35</td>
<td></td>
</tr>
<tr>
<td>Rated flow</td>
<td>m³/s</td>
<td>420</td>
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<tr>
<td>Number of generators</td>
<td>Set</td>
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<td></td>
</tr>
<tr>
<td>Unit capacity</td>
<td>kW</td>
<td>19.5</td>
<td></td>
</tr>
<tr>
<td>Generator power factor</td>
<td></td>
<td>0.90</td>
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Table 2.6—1 Main characteristics of the Project (Cont’d)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Transmission line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission voltage</td>
<td>kV</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>Number of loops</td>
<td>Loop</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Transmission destination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission distance</td>
<td>km</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>VII. Construction of main project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Quantities of main project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open soil excavation</td>
<td>10⁴m³</td>
<td>148.83</td>
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</tr>
<tr>
<td>Open stone excavation</td>
<td>10¹m³</td>
<td>46.36</td>
<td></td>
</tr>
<tr>
<td>Soil and stone fill</td>
<td>10⁴m³</td>
<td>131.66</td>
<td></td>
</tr>
<tr>
<td>Pouring of concrete &amp; RC</td>
<td>10⁴m³</td>
<td>92.11</td>
<td></td>
</tr>
<tr>
<td>Steel bar</td>
<td>t</td>
<td>23617</td>
<td></td>
</tr>
<tr>
<td>Installation of metal framework</td>
<td>t</td>
<td>8828</td>
<td></td>
</tr>
<tr>
<td>Curtain grouting</td>
<td>m</td>
<td>4828</td>
<td></td>
</tr>
<tr>
<td>Consolidation grouting</td>
<td>m</td>
<td>13167</td>
<td></td>
</tr>
<tr>
<td>2 Main construction materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timber</td>
<td>10⁴m³</td>
<td>18.7</td>
<td></td>
</tr>
<tr>
<td>Cement</td>
<td>10¹t</td>
<td>32.56</td>
<td></td>
</tr>
<tr>
<td>Steel bar</td>
<td>10⁴t</td>
<td>2.46</td>
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</tr>
<tr>
<td>3 Required labors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total mandays</td>
<td>10¹m</td>
<td>277.84</td>
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</tr>
<tr>
<td>Peak number of constructors</td>
<td>Person</td>
<td>1900</td>
<td></td>
</tr>
<tr>
<td>4 Construction temporary houses</td>
<td></td>
<td>19200</td>
<td></td>
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</table>
### 2.0 Project Overview

<table>
<thead>
<tr>
<th>5 Construction power</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply load kW</td>
<td>3226</td>
<td></td>
</tr>
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<table>
<thead>
<tr>
<th>6 Traffic (road)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance km</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Volume of freight $10^4$ t</td>
<td>53</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7 Construction diversion method</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>By stages</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8 Construction period</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation work Month</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Commissioning period Month</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Total construction period Month</td>
<td>51</td>
<td></td>
</tr>
</tbody>
</table>

### VIII. Economic figures

#### 1 Static investment $10^4$ yuan 212756.90

- **Incl Pivot buildings**: 59306.89
- **Flood control & drainage works**: 28070.23

<table>
<thead>
<tr>
<th>2 Contingent cost for price difference</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 3 Commitment fee $10^4$ yuan 1183.65 |  |  |

| 4 Loan interest during construction period $10^4$ yuan 9899.43 |  |  |

| 5 Preparatory current capital $10^4$ yuan 33.00 |  |  |

| 6 Total investment $10^7$ yuan 222689.32 |  |  |

### Table 2.6—1 Main characteristics of the Project (Cont’d)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Quantity</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land acquisition &amp; resettlement</td>
<td></td>
<td>20157.80</td>
<td></td>
</tr>
<tr>
<td>Other costs</td>
<td></td>
<td>16864.60</td>
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</tr>
<tr>
<td>Basic contingent cost</td>
<td></td>
<td>12573.92</td>
<td></td>
</tr>
<tr>
<td>Contingent cost for price difference</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Commitment fee</td>
<td>$10^4$ yuan</td>
<td>1183.65</td>
<td></td>
</tr>
<tr>
<td>Loan interest during construction period</td>
<td>$10^4$ yuan</td>
<td>9899.43</td>
<td></td>
</tr>
<tr>
<td>Preparatory current capital</td>
<td>$10^4$ yuan</td>
<td>33.00</td>
<td></td>
</tr>
<tr>
<td>Total investment</td>
<td>$10^7$ yuan</td>
<td>222689.32</td>
<td></td>
</tr>
<tr>
<td>Unit investment of hydropower station</td>
<td>Yuan/kw</td>
<td>8762</td>
<td></td>
</tr>
<tr>
<td>Unit electrical degree investment</td>
<td>Yuan/kw</td>
<td>2.36</td>
<td></td>
</tr>
<tr>
<td>Economical IRR</td>
<td></td>
<td>14.80</td>
<td></td>
</tr>
<tr>
<td>Financial IRR</td>
<td></td>
<td>3.83</td>
<td>Tax included</td>
</tr>
<tr>
<td>Financial IRR</td>
<td></td>
<td>3.13</td>
<td>Net of tax</td>
</tr>
<tr>
<td>Price of power to grid</td>
<td>Yuan/kW</td>
<td>0.291</td>
<td></td>
</tr>
<tr>
<td>Loan repayment years</td>
<td>Year</td>
<td>12.6</td>
<td></td>
</tr>
</tbody>
</table>
2.7 Pivot Management and Operating Mode

2.7.1 Reservoir Management and Operating Mode

In accordance with the function arrangement of the Jiangxi Kan River Drainage Area Planning Report on the Shihutang Project, the flood management and operation mode of the Project is decided as per the upstream incoming flow (release flow from the existing Wan’an Pivot and the Taihe Pivot to be built).

(1). Under normal condition, the water level in front of the dam is always controlled at normal impounded level (56.5m). When the flow at the Dongbei Hydrological Station at upstream is smaller than critical flow for closing sluice gates (Flow at the Shihutang dam site 4700m$^3$/s), close the sluice gates, incoming flow will be totally used for generating power and keeping normal impounded level operation. At this period, only 187m$^3$/s basic sluice flow is assured to satisfy the navigation requirement. In addition, flows to assure ship lock normal operation are 11.24m$^3$/s in the near future and 15.31m$^3$/s in the long-run.

(2). When Kan River incoming flow is smaller during dry season, Shihutang Hydropower Station is operated simultaneously with Wan’an Hydropower Station, and at the same time, downstream basic sluice flow 187m$^3$/s and flows to assure ship lock normal operation -- 11.24m$^3$/s in the near future and 15.31m$^3$/s in the long-run can be assured. The minimum control level is 56.2m (pivot dead water level, also equivalent to minimum level in front of dam)

(3). When the flow at the Dongbei Hydrological Station at upstream is bigger than or equal to critical flow for closing sluice gates -- 4330 m$^3$/s (Flow at the Shihutang dam site 4700m$^3$/s), open the flood gates, stop generating power, the river will basically resume to natural state until incoming flow smaller than 4700m$^3$/s, then control the gates to assure normal impounded level.

2.7.2 Ship lock Management and Operating Mode

The ship lock is a single line one of navigation grade III. The channel dimensions are design depth of 2.2m, width of 60m, bending radius not smaller than 480m, the navigation guarantee rate is 95%. The lock chamber size is 180×23×3.5m (L×W×Sill water depth), once-in-a-50-year-flood is applied for design and once-in-a-300-year-flood for check.

Ship lock upstream design maximum navigational level is 57.64m, the corresponding flow is 14800m$^3$/s; the ship lock downstream maximum navigational level is 57.49m.

Ship lock upstream design minimum navigational level is 52.46m (minimum reservoir operational level); Ship lock downstream design minimum navigational level is 45.88m.

Ship lock design operation parameters:

- Unit ship lock-passing time: 57min;
- Daily average shiplock-passing times: 23 times in 22 hours per day;
- Annual on-stream days: 347d;
2.0 Project Overview

- Groupage ship dimension: 160.0×10.8×2.2 (L×W×Design draft), freeboard height is taken from the ship of the same type in the Kan River -- 2.0m;
- Fleet groupage: 2×1000t, two fleets two rows and one line integrated barge pusher train for single direction shiplock passing;
- Ship lock single direction annual shiplock passing freight: 8.808mt;
- Release flows of ship lock normal operation are 11.24m³/s in the near future and 15.31m³/s in the long-run.

2.8 General Arrangement

2.8.1 Dam site plans
The engineering contractor has designed the dam sites of Shihutang and Fangzhou for comparison and selection of the project dam site.

The Shihutang dam site is recommended as the project dam site.

2.8.2 Arrangement plan of recommended dam site and dam line
The engineering contractor put forward two dam line plan of upper and down dam lines with distance of over 500m. Through comprehensive comparison and selection, the engineering contractor decided to recommend the upper dam line plan.

2.8.3 General arrangement of the project
The engineering contractor put forward two arrangement plans of the right ship lock and left powerhouse (Plan 1) and the right ship lock and right powerhouse (Plan 2) pertinent to the recommended upper dam site (Shihutang).

- Plan 1 (Right ship lock and left powerhouse plan)
Ship lock is arranged at the right bank so as to apply the concave bank to arrange approach channel; At the trunk channel at the left close to the ship lock are respectively arranged 21-hole flood gate and 3-hole scouring sluice; At the left bank close to scouring sluice are arranged 6-power-generating-set powerhouse dam section, earth rockfill dam section at both banks are connected with the bank slopes.

- Plan 1 (Right ship lock and right powerhouse plan)
At the right bank of the channel is arranged the ship lock, 6-power-generating-set powerhouse dam section is close to the ship lock, then 3-hole scouring sluice, 21-hole flood gate are arranged in order, earth rockfill dam section at both banks are connected with the bank slopes.

Through technoeconomic comparison, the engineering contractor recommends Plan 1.
The general arrangement of the project is shown in DRAWING NO. 09 and DRAWING NO. 10.
2.8.4 Main buildings and structures

Main buildings and structures of the project are flood release scouring sluice, powerhouse, ship lock, earth rockfill dam sections at both banks, and the bridge etc.

- Flood release scouring sluice

The scouring sluice is arranged close to the powerhouse, the flood gate is between the scouring sluice and the dockgate channel dam section, both the scouring sluice and the flood gate are of broad crested weir with weir crest elevation of 47.00m, so as to meet the requirements of desilting, diversion of sediment and flood release in front of the powerhouse. The release structures are composed of flood gate of 21-hole 20m×10m (W×H) and 3-hole 20m×10m (W×H) scouring sluice. 25m long dockgate channel dam section is arranged between the flood gate and the ship lock. The total length of this section is 584m.

The downstream energy dissipation method is to apply the underflow hydraulic jump for energy dissipation, the apron is 45～48m long.

0.4m thick C40HF or C40 concrete will be laid on the surface of the lock chamber floor slab in front of lock chamber working dockgate channel, 1.5m high scope of the piers and main wetted part.

- The ship lock

The main hydraulic structures of the ship lock include upper and down lock heads, internal and external lock chamber walls, and internal and external approach walls of upstream and downstream approach channels. The internal and external approach walls of upstream approach channel are 135m and 240m long respectively, the internal and external approach walls of downstream approach walls are 118m and 240m long respectively, all in gravity type or semi-gravity type structure. The upper and down lock heads, internal and external lock chamber wall are all in gravity type structure, the floor slabs are of separated pervious ones. The wall body is in concrete and reinforced concrete structure.

- The Powerhouse of the hydropower station

The powerhouse in river channel is arranged at the left side of the river channel, its main buildings are the main powerhouse (main machine room and erection room), auxiliary powerhouse (auxiliary production powerhouse and central control building), substation (step-up substation and switching station), entrance and exit structures (including feedwater canal, tailwater canal and sand blocking ridge) and access road.

The main machine room (dam section) is 145.02m long in total, total downstream width is 88.89m. Permanent joint is on one machine one joint basis, there are altogether four intermediate unit sections and two side unit sections, the intermediate unit section is 22.2m long, the left side unit section is 27.6m long, the right side unit section is 28.615m. In the downstream direction, the main machine room (dam section) is composed of respectively inlet section, main machine section and outlet section.

The erection room (dam section) is 47.3m long, the total downstream width is 68.35m. The erection clear width is 23.5m, the erection elevation is 60.8m, the superstructure and upstream wall are arranged just the same with the main machine section; base level elevation
is 42.0m, It is located on the weakly weathered mudstone layer, with maximum height bigger than 42.8m. Because the erection room is located at the left bank, the access road at the left bank can be applied, it is convenient to apply the horizontal straight access way; the access gate is located at the left side of the erection room with dimension of 8×9m (W×H).

The auxiliary powerhouse is 145.02m long, 14.0m wide (in downstream direction), composed of two stories with down storey elevation of 48.515m and upper storey elevation of 53.69m and top elevation of 60.8m. In addition, seepage and maintenance catch pit is inside the side wall of the right side of the main machine section with pit bottom elevation of 18.51m, drainage pumping house is arranged on the top of the said side wall.

The stepup substation is located at the downstream side of the erection room with plane dimension of 70.0×13.0m(L×W, the same below); the switching station (GIS room) is located at the downstream side of the stepup substation with plane dimension of 60.0×14.0m. The voltage class of the substation is 220KV. There is a circular communication passage within the substation, connecting with the outside via the access road and the road to the dam.

- **Check dam sections at the left and right banks**
  Check dam sections at the left and right banks are of grinding pebble composite dam, connecting with the slopes of both banks. The check dam section at the left bank is 325.00m long, including 25m long concrete check dam section; The check dam section at the right bank is 472.70m long, the crest elevations at both banks both are 69.20m, lowered to 63.5m in 4% gradient, the crest width is 10.00m, the ratio of upstream and downstream dam slopes is 1:2, 0.8m thick concrete impervious wall is applied for antiseepage, meanwhile, the right side of the concrete impervious wall earth rockfill dam section at the right bank is clay core earth rockfill dam, with clay core and foundation antiseepage soil to jointly form antiseepage body.

- **Bridge**
  There is a road to the ship lock at the downstream side of the earth rockfill dam at the right bank for the ship lock communications. The access road is set at the downstream side of the earth rockfill dam at the left bank, directly connected to inside of the powerhouse. A road bridge for crossing the dam is set on the dam, the bridge surface elevation is 69.20m. The bridge surface has 7m wide dual lane, with walkway width of 2×1.5m, 10m width in total. The joint dam at the left and right banks and the road bridge is about 1637m long in total.

2.9 Protection Work of the Reservoir Area

The protection work of the reservoir area is composed of five protection areas of Taihe County seat, Wanhe, Yongchang, Yanxi and Zhangtang.

2.9.1 Design standard of the protection works

- **Engineering grade and flood control standard**
  The village protection work is Grade IV, the protection work of the Taihe County seat is Grade III, their flood control standard reoccurrence periods are 10~20 years and 20~50 years respectively. The flood reoccurrence periods of the protection work of the Taihe County
seal and the village protection work are respectively 20 years and 10 years.

The Wanhe Drainage Pumping Station, the Yanxi Drainage Pumping Station, and the Jintan Drainage Pumping Station belong to middle scale pumping stations. The building grade of the said three pumping stations are the same with that of the fending groynes in which they are located, belonging to Grade 4, the design flood standard is once-every-10-year-flood. The building grade of Huangjiaba and Dongmen drainage pumping stations are the same with that of the fending groynes of the Taihe County seat, belonging to Grade 3, the design flood standard is once-every-20-year-flood.

The Zhangtang Regulating Sluice is of middle scale gate, Grade 3 building, with design flood standard of once-every-20-year-flood; The Wanhe Regulating Sluice is of small (1) type gate, Grade 4 building, with design flood standard of once-every-10-year-flood. The crest elevations of typical sections of fending groynes of each protection area are shown in Table 2.9-1.

Table 2.9—1  Crest elevations of typical sections of fending groynes of each protection area

<table>
<thead>
<tr>
<th>Protection area</th>
<th>Pile No.</th>
<th>Design flood reoccurrence period</th>
<th>Design flood level (m)</th>
<th>Crest elevation calculation value (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wanhe</td>
<td>Wanhe 3+144</td>
<td>10 years</td>
<td>58.27</td>
<td>59.27</td>
</tr>
<tr>
<td>Yanxi</td>
<td>Yanxi 1+927</td>
<td>10 years</td>
<td>58.72</td>
<td>59.72</td>
</tr>
<tr>
<td>Zhangtang</td>
<td>Zhangtang 0+135</td>
<td>10 years</td>
<td>59.21</td>
<td>60.21</td>
</tr>
<tr>
<td>Jintan</td>
<td>Jintan 11+233</td>
<td>10 years</td>
<td>62.04</td>
<td>63.04</td>
</tr>
<tr>
<td>Taihe</td>
<td>Taihe 2+064</td>
<td>20 years</td>
<td>61.74</td>
<td>62.74</td>
</tr>
</tbody>
</table>

Drainage design standard

For the protection area with villages and towns, the drainage standard is to apply a once-in-a-five-year 3-day rainstorm and drain to the inundation resistant depth within 3 days; the drainage standard of the Taihe County seat is to apply a once-in-a-10-year 1-day storm and drain to the elevation of main buildings non-inundated within 1 day, indicated in the Preliminary Design Report of Flood Control Work of the Taihe County Seat by Ji’an City Water Conservancy and Hydropower Plan and Design Institute; The drainage standard of the guide support canal within the protection area is to apply the corresponding drainage reoccurrence period standard of the protection area, the foreign water guide support canal (river) within the protection area is based on the design flood standard of the fending groyne of the protection area.
2.9.2 Arrangement of protection works
2.9.2.1 Comparison of protection work plans

□ Comparison of the axial line arrangement plans of the Wanhe Guide Drainage Canal
The engineering contractor put forward two plans according to the landform, geological condition of the Wanhe Protection Area and the guide drainage canal discharge—the Kan River level at the same frequency:

Plan 1: The guide drainage canal flows from Zhushan Village to the Zhangtang Protection Area, goes along the old waterway and mountain side to Pile No.14+000, then turns to close proximity of Liutang Village, through Tianduan Village and Jiangbian Village side to the downstream of the down dam site.

Plan 2: The canal axial line is the same before Pile No.14+000 with Plan 1, thereafter, the canal axial line goes further along the old waterway and mountain side to the place 300m downstream of the ship lock discharge of the recommended upper dam site.

Through technoeconomic comparison, the engineering contractor recommends Plan 2.

□ Comparison of guide draining operating and control level plans of the Zhangtang Protection Area
As per the population and house distribution above elevation 54.00 in the Zhangtang Protection Area, guide draining operating and control level plans of the Zhangtang Protection Area are compared under the condition of selected canal axial line, the corresponding levels of Plans 1, 2, 3 and 4 are 52.80m, 53.20m, 53.50m and 53.80m respectively.

Through technoeconomic comparison, the engineering contractor recommends Plan 3.

2.9.2.2 Arrangement of protection works
The engineering contractor has designed and arranged five protection areas of Wanhe, Yanxi, Zhangtang, Yongchang and Taihe County Seat. The total length of fending groyne lines of the protection works is 38.38km, including 3.36km Taihe Fending Groyne, 8.12km Wanhe Fending Groyne, 0.80km Zhangtang Fending Groyne, 15.79km Yongchang Fending Groyne and 10.32km Yanxi Fending Groyne, the total length of guide support canal is 61.33km, including 17.18km long county seat guide support canal to be dredged and resumed as per the original section, 14.45km Yongchang Guide Support Canal to be refit as per the design standard, 29.70km Yanxi and Wanhe guide support (drainage) canals to be built; 11.85km diversion canal to be refit; 6 new pumping stations with total installed capacity of 5456kW and 2 new regulating sluices.

The arrangement of all the protection works is shown in Table 2.9—2. Arrangement of fending groynes and drainage works of all the protection areas are shown in DRAWING NO. 11—DRAWING NO. 14.

□ Fending groyne design
The designed fending groyne types are as follows:

Wanhe Section: ~1km long fending groyne close to the pivot area is a clay core pebble one, flood wall is locally applied for earth rockfill fending groyne section with restriction, the remained part is earthen groyne.

Zhangtang Section: the whole section is made of homogeneous soil groyne.

Jintan Section: ~5km long homogeneous soil groyne is arranged near the excavated place of the Yunting River rerouting and along the upstream of the Yunting River, flood wall is locally applied for earth rockfill fending groyne section with restriction, the remained part is clay core pebble groyne.
## Table 2.9-2 Protection works arrangement

| No | Work name          | Name     | Length (km) | Design level (m) | Top elevation (m) | Top width (m) | Average raised height (m) | Name                                      | Length (km) | Design level (m) | Top elevation (m) | Top width (m) | Average raised height (m) | Name                                      | Length (km) | Design level (m) | Top elevation (m) | Top width (m) | Average raised height (m) | Name                                      | Length (km) | Design level (m) | Top elevation (m) | Top width (m) | Average raised height (m) | Name                                      | Length (km) | Design level (m) | Top elevation (m) | Top width (m) | Average raised height (m) | Name                                      | Length (km) | Design level (m) | Top elevation (m) | Top width (m) | Average raised height (m) | Name                                      | Length (km) | Design level (m) | Top elevation (m) | Top width (m) | Average raised height (m) |
|----|--------------------|----------|-------------|------------------|-------------------|---------------|------------------------|--------------------------|----------------|------------------|-------------------|---------------|-------------------------|--------------------------|----------------|------------------|-------------------|---------------|------------------------|--------------------------|----------------|------------------|-------------------|---------------|------------------------|--------------------------|----------------|------------------|-------------------|---------------|------------------------|--------------------------|----------------|------------------|-------------------|---------------|------------------------|--------------------------|----------------|------------------|-------------------|---------------|------------------------|--------------------------|----------------|------------------|-------------------|---------------|------------------------|--------------------------|----------------|------------------|-------------------|---------------|------------------------|--------------------------|----------------|------------------|-------------------|---------------|------------------------|
| 1  | Yanxi protection work | Yanxi Groyne | 10.32 | 58.4~60.06 | 59.4~61.06 | 4 | 4.04 | Yanxi Upper Guide Support Canal | 3.0 | 2.86~4.54 | 2.04 | 0.0005 | 61.65~60.00 | 62.36~60.71 | Yanxi Drainage Pumping Station | 900/12.80 | New canal |
|    |                    |          |           |                  |                   |               |                        | Yanxi Down Guide Support Canal | 6.8 | 1.56~4.55 | 2.05 | 0.0005 | 60.82~58.10 | 61.53~58.81 |
|    |                    |          |           |                  |                   |               |                        | Yanxi Diversion Canal | 2.0 | 3.94 | 1.77 | 0.0005 | 52.77~51.77 | 53.41~52.41 |
| 2  | Wanhe protection work | Wanhe Groyne | 8.12 | 57.75~59.27 | 58.75~60.27 | 4 | 3.55 | Wanhe Guide Drainage Canal (new) | 19.60 | 14.28 | 3.52 | 0.000165 | 50.27~53.50 | 51.35~54.58 | Wanhe Drainage Pumping Station | 2000/28.50 | Pump & sluice combined, Self drainage capacity 70m³/s at non-flood season |
|    |                    |          |           |                  |                   |               |                        | Wanhe Diversion Branch Canal (Refit) | 2.20 | 3.50 | 1.85 | 0.0005 | 50.59~51.69 | 51.25~52.35 |
|    |                    |          |           |                  |                   |               |                        |                         |                |          |          |          |                      |                          | Wanhe Regulating Sluice | 70 | Sluice passing flow |
| 3  | Zhangtang protection work | Zhangtang Groyne | 0.8 | 59.30~59.32 | 60.30~60.32 | 4 | 3.59 |                         |                     |                |          |          |          |                      |                          | Zhangtang Regulating Sluice | 993 | Sluice passing flow |
Table 2.9—2  Protection works arrangement (Cont’d)

<table>
<thead>
<tr>
<th>No</th>
<th>Work name</th>
<th>Fending groyne</th>
<th>Guide support canal/Drainage canal</th>
<th>Drainage pumping station/Regulating sluice</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Name</td>
<td>Length (km)</td>
<td>Design level (m)</td>
<td>Top elevation (m)</td>
<td>Top raised height (m)</td>
</tr>
<tr>
<td>4</td>
<td>Yongchang Protection Work</td>
<td>Yongchang Groyne</td>
<td>15.79 60.98~62.98</td>
<td>60.98~63.98</td>
<td>4 4.29</td>
</tr>
<tr>
<td></td>
<td>Name</td>
<td>Name</td>
<td>Name</td>
<td>Design level (m)</td>
<td>Top elevation (m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yunting River Rerouting</td>
<td>16.40 60 4.0</td>
<td>0.0004</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Upper Guide Support Canal</td>
<td>5.45 2.98~4.44</td>
<td>2.00 0.0005</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Down Guide Support Canal</td>
<td>9.00 0.50~4.80</td>
<td>2.16 0.0005</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Jintan Diversion Canal</td>
<td>3.65 3.51 2.05</td>
<td>0.0005</td>
</tr>
<tr>
<td>5</td>
<td>Taihe County Seat Protection Work</td>
<td>Taihe County Seat Groyne</td>
<td>3.36 61.40~61.97</td>
<td>62.40~62.97</td>
<td>4 4.02</td>
</tr>
<tr>
<td></td>
<td>Name</td>
<td>Name</td>
<td>Name</td>
<td>Design level (m)</td>
<td>Top elevation (m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Huangjiaba Drainage Pumping Station</td>
<td>6.58 3.44~5.11</td>
<td>2.30 0.0004</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Donggang Guide Support Canal</td>
<td>10.60 1.45~6.50</td>
<td>2.93 0.0002</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>County Seat Diversion Canal</td>
<td>4.00 5.24 2.36</td>
<td>0.0005</td>
</tr>
</tbody>
</table>

2km Yunting River rerouting section
Discharge at Yunting River, refit canal
Refit canal
Refit canal
Dredged canal
Dredged canal
Refit canal
2.0 Project Overview

Yanxi Section: ~1.6km long homogeneous soil groyne close to Yanxi Town with application of the existing groyne, flood wall and wave protection wall are locally applied for earth rockfill fending groyne section with restriction, the remained part is clay core pebble groyne.

Taihe Section: the whole section is made of clay core pebble groyne.

□ Groyne type design

Clay core pebble groyne: the inside and outside slopes are in gradient 1:1.8, the river-facing groyne is face protected with C15 prefabricated slab with protection slope thickness of 0.15m, downstream slope is of grassed slope, groyne top has cemented stone road and 0.6m high wave protection wall. The groyne body is built with pebble and with clay core for antiseepage, crest width of 2m, gradient of 1:0.25. C15 concrete drain ditch is set at the back of the groyne with depth of 0.5m and bottom width of 0.5m.

Homogeneous soil groyne: the river-facing groyne is face protected with C15 prefabricated slab with protection slope thickness of 0.15m and 0.15m thick bedding pebble, gradient of 1:2.5, downstream slope is of grassed slope, groyne top has cemented stone road and 0.6m high wave protection wall with gradient of 1:3. The groyne body is built with homogeneous clay for antiseepage. Drain ditch is also set at the back of the groyne.

Flood wall: C20 concrete gravity wall, top width of 1.5m and back slope gradient of 1:0.3.

□ Groyne foundation antiseepage

When the ground elevation of the protected object at back of the groyne is higher than the backwater elevation of the reservoir area at 4700 m³/s, impervious wall shall be built at the groyne foundation to assure the safety of the protection area.

□ Arrangement of drainage pumping stations (regulating sluices)

The drainage pumping stations (regulating sluices) of every protection area are set at the discharge of the original canal within the protection area. Considering when standard-exceeding flood happens, the protection area will be filled fully with water, which is required to drain out timely after flood, axial flow pumps will be applied, the pump house shall be of wet house type, composed of pump storey and motor storey, the ground elevation of pumping stations shall be filled up flush with groyne top.

□ Arrangement of guide support (diversion) canals

Guide support canal line, section guide drainage flow, landform, geology, houses and farmland distribution along the canal line will be decided as per related code, try to minimize house relocation, land occupation, and to make full use of the existing drainage canals. The longitudinal slope of canal normally i=0.00015~0.00050, earth canal at side slope of excavated canal m=1.5, stone canal m=0.75, fill canal m=1.50, flow in canal meets the condition of no scouring and no silting. The top width of fill section of guide support canal is 2.0m.
2.10 Reservoir Inundation and Land Occupation of the Project

2.10.1 Main inundated substances of the reservoir area

After the fending groynes and farmland elevating measures, the Project is still involved in inundation of five townships, forty-four administrative villages of Taihe County. Main inundated substances of the upper dam site plan (the recommended plan) at normal impounded level of the reservoir area 56.5m are as follows:

After the fending groynes and farmland elevating measures, the reservoir inundation and the bury of protection works will need to permanently occupy 2829.8Mu farmland (including 701.85Mu paddy field, 2127.9Mu dry land, among which there are 198.27Mu basic farmland), 104.4Mu garden plot, 3130.9Mu other types of land, 32588.6Mu water area; It is involved in relocation of 711 people, impacts of 8 enterprises and institutions, house relocation of $4.56 \times 10^{14} \text{m}^2$ and fence relocation of $6392.59 \text{m}^2$, $11610 \text{m}^2$ cement ground, 48 simple buildings, 8 wells, 161 pressing wells, 1 water tower, 221 tombs, 1576 odd fruit trees; 2.21km Grade 4 road, 10.71km tractor road, 18 ferries and docks, 8.62km aerial fiber cable, 5.84km underground cable, 2.48km CATV line, 5.03km 10kV transmission line, 7.55km 0.4kV transmission line, 3 transformers, 1 tiny hydropower station (200kW), 15 small electrical pumping stations, 1 water plant, 27 sand picking facilities and some other facilities.

The inundation area is involved in inundation of 1453.5Mu farmland and 28.05Mu garden plot, population resettlement of 524 people, and house relocation of $26,602.74 \text{m}^2$.

The protection work is involved in bury and occupation of 1376.25Mu farmland and 76.31Mu garden plot, population resettlement of 187 people, and house relocation of $18,947.46 \text{m}^2$.

The scope of the reservoir inundation is given in DRAWING NO. 15.

2.10.2 Land occupation

- The Project will permanently acquire 42525.1Mu, including 2977.3Mu farmland (incl. 198.27Mu basic farmland), 3468.4Mu woodland, and 36079.4Mu of other types.

- The Project will temporarily occupy 6895.65Mu (incl. 1237.05Mu by farmland elevating, 78.15Mu by resettlement area), including 2748.6Mu farmland, 1000.8Mu woodland, and 3146.25Mu of other types. Land occupied by the project is summarized in Table 2.10—1.
## Table 2.10 Summary of Land occupied by the project

<table>
<thead>
<tr>
<th>Nature of land occupied</th>
<th>Item</th>
<th>Total</th>
<th>Farmland</th>
<th>Paddy field</th>
<th>Dry land</th>
<th>Garden plot</th>
<th>Woodland</th>
<th>Uneven ground</th>
<th>Residents used land</th>
<th>Land not applied</th>
<th>Water surface</th>
<th>Land for traffic</th>
<th>Bottomland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanently occupied land</td>
<td>Pivot area</td>
<td>424.95</td>
<td>147.5</td>
<td>34.5</td>
<td>112.95</td>
<td>0</td>
<td>72.0</td>
<td>202.05</td>
<td>0</td>
<td>0</td>
<td>3.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Project management area</td>
<td>49.95</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>49.95</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protection works</td>
<td>3877.95</td>
<td>1376.25</td>
<td>402.6</td>
<td>973.65</td>
<td>76.35</td>
<td>1237.15</td>
<td>1017.0</td>
<td>10.2</td>
<td>56.4</td>
<td>104.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Area of reservoir inundation</td>
<td>38172.15</td>
<td>1453.5</td>
<td>299.25</td>
<td>1154.25</td>
<td>28.05</td>
<td>2159.25</td>
<td>1500.9</td>
<td>106.2</td>
<td>415.05</td>
<td>32484</td>
<td>25.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>42525.1</td>
<td>2977.3</td>
<td>736.35</td>
<td>2240.9</td>
<td>104.4</td>
<td>3468.4</td>
<td>2769.9</td>
<td>116.4</td>
<td>471.45</td>
<td>32592.1</td>
<td>25.5</td>
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</tr>
<tr>
<td>Temporarily occupied land</td>
<td>Widened road</td>
<td>48.0</td>
<td>531.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>48.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resettlement area</td>
<td>78.15</td>
<td>192.0</td>
<td>39.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>39.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Farmland elevating area</td>
<td>1237.05</td>
<td>283.65</td>
<td>1237.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction production &amp; residence areas</td>
<td>963.15</td>
<td>0</td>
<td>37.2</td>
<td>493.95</td>
<td>0</td>
<td>227.7</td>
<td>49.95</td>
<td></td>
<td></td>
<td></td>
<td>154.35</td>
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</tr>
<tr>
<td></td>
<td>Construction road</td>
<td>412.95</td>
<td>465.75</td>
<td>3.75</td>
<td>188.25</td>
<td>0</td>
<td>108.15</td>
<td>97.5</td>
<td></td>
<td></td>
<td></td>
<td>15.3</td>
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</tr>
<tr>
<td></td>
<td>Soil sites</td>
<td>517.95</td>
<td>1237.05</td>
<td>0</td>
<td>283.65</td>
<td>0</td>
<td>156.9</td>
<td>77.4</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gravel sites</td>
<td>1873.95</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>1873.95</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spoil sites</td>
<td>1764.45</td>
<td>39.0</td>
<td>13.95</td>
<td>451.8</td>
<td>0</td>
<td>508.05</td>
<td>732.6</td>
<td></td>
<td></td>
<td></td>
<td>58.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>6895.65</td>
<td>2748.6</td>
<td>1330.95</td>
<td>1417.65</td>
<td>0</td>
<td>1000.8</td>
<td>957.45</td>
<td>39.15</td>
<td>48.0</td>
<td>2101.65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.10.3 RAP

2.10.3.1 Resettlement and relocation

The population with farmland inundated and houses not inundated by this project can be resettled through farmland adjustment from the same village or other adjacent villages. Under current situation, the project area needs to resettle rural population of 2175 people (including land occupied by reservoir inundation, protection works, and pivot work), the production resettlement population at the design level year 2010 is 2271 people.

The population to be removed and resettled includes the population below the reservoir inundation line, the population with farmland inundated and houses not inundated needing to resettled in other places and the population affected by the protection works needing to be resettled. The resettled population of the project is those who need to be resettled due to the reservoir inundation or bury of the protection works, the current population to be resettled is 711 people and the population to be resettled in 2010 is 744 people.

2.10.3.2 Relocation and construction plan of affected resettlement point

The affected people will be resettled mainly in the same village, same team and same township, assuring all the affected households to have production conditions, house construction conditions, and infrastructure conditions of water and power supply and road which are not lower than before. There are 3 planned concentrated resettlement points, altogether 269 people resettled. Resettlement destinations of affected residents are shown in Table 2.10-2. Resettlement points distribution is shown in DRAWING NO. 15.

<table>
<thead>
<tr>
<th>Township</th>
<th>Administrative village</th>
<th>Number of Households</th>
<th>Population</th>
<th>Resettlement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yanxi Caoping</td>
<td>110</td>
<td>368</td>
<td>Partly concentrated resettlement, partly local resettlement and scattered resettlement</td>
<td></td>
</tr>
<tr>
<td>Gaping</td>
<td>2</td>
<td>10</td>
<td>Local resettlement and scattered resettlement</td>
<td></td>
</tr>
<tr>
<td>Yanxi Residents Committee</td>
<td>1</td>
<td>4</td>
<td>Local resettlement and scattered resettlement</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>113</td>
<td>382</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wanhe Pingshang</td>
<td>71</td>
<td>264</td>
<td>Partly concentrated resettlement, partly local resettlement and scattered resettlement</td>
<td></td>
</tr>
<tr>
<td>Gaozhang</td>
<td>9</td>
<td>26</td>
<td>Local resettlement and scattered resettlement</td>
<td></td>
</tr>
<tr>
<td>Huwei</td>
<td>6</td>
<td>21</td>
<td>Local resettlement and scattered resettlement</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>86</td>
<td>311</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chengjiang Yuye</td>
<td>1</td>
<td>5</td>
<td>Local resettlement and scattered resettlement</td>
<td></td>
</tr>
<tr>
<td>Mashi Shukou</td>
<td>6</td>
<td>46</td>
<td>Concentrated resettlement</td>
<td></td>
</tr>
<tr>
<td>Grand total</td>
<td>206</td>
<td>744</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.10.3.3 Relocation and construction plan of affected enterprises and institutions

According to the substance index survey results, there are 8 units involved in total house relocation area of 4373.71m². The affected enterprises and institutions are mainly involved in warehouse, processing plants and part of the firms, most of them are located at the scope affected by fending groynes or at the edge of the reservoir inundation line, part of the production and residence land and facilities of the enterprises and institutions are affected. Among the affected units, no one is required to wholly remove, all are just partly affected, and their main bodies are not affected. Relocation and construction plan of affected enterprises and institutions are given in Table 2.10—3.

Table 2.10—3 Relocation and construction plan of affected enterprises and institutions

<table>
<thead>
<tr>
<th>No</th>
<th>Unit</th>
<th>Relocated house area (m²)</th>
<th>Impact degree</th>
<th>Resettlement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Taihe Fenghuangtun Industry Co. Ltd.</td>
<td>351.45</td>
<td>Local</td>
<td>Demolition compensation</td>
</tr>
<tr>
<td>2</td>
<td>Jiangbian Plastics Factory</td>
<td>149.61</td>
<td>Local</td>
<td>Demolition compensation</td>
</tr>
<tr>
<td>3</td>
<td>Shiqian Sand Pickup Plant</td>
<td>39.50</td>
<td>Local</td>
<td>Demolition compensation</td>
</tr>
<tr>
<td>4</td>
<td>Yanxi Channel Administration Station</td>
<td>382.19</td>
<td>Local</td>
<td>Nearby resumption</td>
</tr>
<tr>
<td>5</td>
<td>Taihe Shipping Co. Ferry</td>
<td>16.91</td>
<td>Local</td>
<td>Demolition compensation</td>
</tr>
<tr>
<td>6</td>
<td>Brick Works</td>
<td>2259.96</td>
<td>Local</td>
<td>Partly demolition compensation, partly nearby resumption</td>
</tr>
<tr>
<td>7</td>
<td>Sand Works</td>
<td>376.86</td>
<td>Local</td>
<td>Demolition compensation</td>
</tr>
<tr>
<td>8</td>
<td>Wanhe Grain Supply Center</td>
<td>797.23</td>
<td>Local</td>
<td>Partly demolition compensation, partly nearby resumption</td>
</tr>
</tbody>
</table>

2.10.4 City residents’ removal plan

After the fending groynes are built, the project will not be involved in city residents’ removal.

2.10.5 Resumption and construction plan of special works

Land acquisition of the project is involved in 2.21km Grade 4 road, 10.71km tractor road, 18 ferries and docks, 82.47hm² land elevating area, which will be resumed as per the original scales and functions in the planned compensation modes.
2.11 Construction Organization Design

2.11.1 Construction diversion

□ Diversion standard

Diversion structure belongs to Grade 5 one, being earth rockfill cofferdam, the recommended diversion design flood standard is for withstanding a once-in-a-five-year flood.

The cofferdams of Stage 1 and Stage 2 both are earth rockfill overflow ones, in order to meet the inundation control condition of the upstream reservoir area and to reduce the protection load of the cofferdams, the Stage 1 overflow cofferdam is designed as per the standard for withstanding a once-in-a-3-year dry season flood with water retaining height designed for withstanding a once-in-a-5-year dry season flood (height of overflow cofferdam is raised); The hydropower station applies the Stage 2 cofferdam to retain water for generating power and for ship lock navigation. Therefore the Stage 2 overflow cofferdam is designed to meet the minimum navigational level and power generating flow requirement, with its water retaining height designed for withstanding a once-in-a-5-year dry season flood. The powerhouse and the diversion structures of the ship lock are designed for withstanding a once-in-a-5-year flood.

□ Diversion period

The hydrological features of the Kan River where the Project is situated are flood with high peak and big flow during flood season and big level amplitude at flood and dry seasons. Through construction method and progress analysis, together with hydraulic structure arrangement, landform condition, it possesses diversion condition at dry season. It is recommended to construct at dry season, from August to the next February.

The ship lock and the powerhouse are located at the left and right banks of the Kan River, the riverbed is wider at flood season. According to the principle that the ship lock and the powerhouse generating sets shall be put into operation as early as possible, it must be guaranteed that the powerhouse and the ship lock can be constructed all the year around, therefore, the powerhouse at the left bank and the ship lock at the right bank can be constructed all the year around with capacity of withstanding a once-in-a-5-year flood.

□ Diversion method

In accordance with the arrangement of hydraulic structures and landform condition, the project possesses the stage diversion condition at dry season, the diversion principle is as follows: At Stage 1, enclose the left bank and construct powerhouse and 11-hole scouring flood gate first, and at meantime, enclose the dam section of the ship lock, and dockgate channel at the right bank, applying the channel middle to overflow, small foundation pit cofferdam will be completed at the end of the first dry season; The powerhouse and the ship lock can be constructed all the year around under protection of the small foundation pit in the first flood season; In the second dry season, continue to enclose the 11-hole scouring flood gate and the powerhouse at the left bank, the dam section of the ship lock and dockgate channel at the right bank continue to construct under the protection of built cofferdam, using
the middle channel for overflow; In Stage 2, enclose the 13-hole flood gate at the middle, using the completed 11-hole scouring flood gate at the left bank for overflow, the powerhouse can use the retained water by Stage 2 cofferdam for generating power, at the end of the fourth dry season, the civil work of main project will be totally completed.

**Regulating structure**

The cofferdams will make full use of the excavated materials of the main project, the type of regulating structure – cofferdams is of earth rockfill and concrete. To lower overflowed upstream level to meet the temporary inundation control requirement of the reservoir area, cofferdams of Stage 1 and Stage 2 both are overflow ones, the upstream and downstream cofferdam crests are equipped with self-breach subcofferdams.

Stage 1 cofferdam: Mixed materials excavated from the main project will be applied for filling cofferdam body, whose upstream is anti-scoured with block stone revetment, and whose downstream is protected with bamboo cylinder filled block stone revetment. High pressure vibrating grouting mortar is applied for antiseepage of the cofferdam body and its foundation cover layer.

Stage 2 upstream and downstream cofferdams: The structure type of the cofferdams is the same with Stage 1. The flood gate piers and the heightened downstream concrete guide wall will be used as Stage 2 longitudinal cofferdam for construction of lock chamber section of flood gate, concrete guide wall will be used as cofferdam body for other part construction.

Ship lock cofferdam: According to the general layout, the upstream section at the left side of upstream and downstream transverse cofferdam connects with the planned spoil site (antiseepage treatment done) at the riverside, its downstream section connects with the original riverside flood dike (strengthening and antiseepage treatment done), its right side connects with the longitudinal cofferdam of the ship lock chamber to form a closed antiseepage ring. The cofferdam of upper and down lock heads and chamber of the ship lock will be of non-overflow one, its upstream wetted face of the whole cofferdam will be protected in block stone revetment, which will be heightened with straw bag earth for retaining water at flood season, high pressure vibrating grouting mortar are applied for antiseepage of cofferdam body and foundation.

Powerhouse cofferdam: Upstream section uses powerhouse silt arrester, downstream section applies powerhouse tailwater canal side wall, upstream cofferdam body is of concrete gravity type structure, directly heightened on hydraulic structure. As for powerhouse small foundation pit longitudinal cofferdam, upstream section applies powerhouse silt arrester, downstream section applies powerhouse tailwater canal side wall, and cofferdam body is of concrete gravity type structure. High pressure vibrating grouting mortar is applied for antiseepage of transverse cofferdam foundation cover layer at upstream and downstream of the powerhouse, its left side connects with the Wanhe flood dike and bank dike, the upstream section at its right side joins the powerhouse silt arrester, the downstream section at its right side joins the powerhouse tailwater canal side wall, forming a closed antiseepage ring.

**River closure**

The closure time of Stage 2 riverbed is early October of the third year, the closure flow is
2.0 Project Overview

944m³/s, the closure method is single-shoreup vertical closure method with maximum fall of 0.29m, average flow at closure gap of 1.95m/s, discharge per unit width of 3.63m³/s.m at closure gap. Middle stone and stone slag are applied to fill the closure gap, after triangle sections are applied, concrete tetrahedra, large block stones, or reinforced concrete cage to fill the closure gap.

□ Navigation during construction period

As per the construction diversion plan, as for Stage 1, enclose the left bank and construct the powerhouse and 11-hole scouring flood gate at the left bank first, at the same time, enclose the dam section of the ship lock, and dockgate channel at the right bank, apply the middle part of the channel for navigation. Because the channel is narrowed and flowrate is increased, it may obstruct the navigation during flood season, while it is good for navigation during dry season after the upstream is deepened. The navigation parameters of the planned channel are as follows: When river section average flow is smaller than 2.0m/s, ships can be self-propelled; When river section average flow is 2.0~3.0m/s, tug boat must be applied to help aiding navigation; When river section average flow is bigger than 3.0m/s, the river section is closed for navigation.

At Stage 2, the ship lock at the right bank has been completed and navigable. At the same time, 11-hole scouring flood gate at the left bank completed can be applied to control release flow, in order to the requirements of upstream and downstream navigational levels and flow conditions.

The Project will cause a short navigation interrupting time before and after closure of Stage 2 cofferdam, it is estimated that the navigation interrupting time is about 2 months.

The construction diversion plan arrangement is given in DRAWING NO. 16 and DRAWING NO. 17.

2.11.2 Construction of main project

The buildings and structures of the pivot from left to right are mainly composed of the joint dam, powerhouse, release structures (3-hole scouring sluice and 21-hole flood gate), dockgate channel dam section, and the ship lock at the left bank and the joint dam at the right bank, the hydropower station is equipped with 6×1.95MW through-flow type generating sets.

□ Construction road

The construction site road at the left bank will be applied for excavation of water part at the left bank, and for forking to foundation pit at upstream and downstream cofferdams, thus to form a circular traffic; The construction site road at the right bank will be applied for excavation of water part at the right bank, and for forking to foundation pit at upstream and downstream cofferdams, thus to form a circular traffic.

□ Construction method

Hydraulic back shovel digging and loading dump trucks will be applied for pebble excavation to transport spoils out, partly to heighten and thicken the cofferdams, the remained to the spoil sites at the left and right banks.
Foundation pit stones are excavated in two layers of steps, steps will be used for excavation separately at upstream and downstream. 100 type in-the-hole drill will be applied for drilling at a large area of excavation, millisecond electric blasting caps will be applied for split-second squeeze blasting, hand air drills are used to drill sides and corners, plain detonators are used for blasting (without underwater blasting), plane of reference and local part are manually cleaned up; For mudstone exposed place, drain ditch and collector well will be set at the surrounding to lower water table, meantime, concrete will be sprayed on the excavated plane of reference and slope to prevent from being weathered and expanded. Bulldozers are used to collect the excavated wastes which will be transported out by dump trucks, partly for filling Stage1 cofferdam, partly to stack in the spoil site at the left bank for backfill at late stage.

Materials for pebble or stone slags fill will come from the transit spoil site, with loaders for loading, dump trucks for transport, bulldozers for paving, vibratory rollers for compacting, and frog hammers for tamping sides and corners.

Concrete is blended in 3XJ3-1.5 concrete blending building, which will be transported by 6m³ concrete agitating lorry and 10t dump truck to the working plane.

The main powerhouse concrete comes from the concrete blending building at the left bank. At the upstream and downstream of the dam axial line are respectively arranged portal crane rails, 1 MQ600/30 type and 1 MQ1000 type overhead portal crane respectively for concreting of the main powerhouse and part of the auxiliary powerhouse. Concrete is taken from the concrete blending building at the left bank by 15t dump trucks. Trucks go down to the foundation pits along Stage 1 cofferdam at the upstream and downstream sides, dumping the horizontal tanks within the hoisting range of overhead portal crane; As for concrete of other project area, crawler crane is used to hoist horizontal tanks into bin, variable frequency vibrator is used to flatten and compact the bin surface with deburring machine for deburring.

Concrete of scouring sluice and flood gate is blended in 3XJ3-1.5 concrete blending building, which will be transported by 10t dump truck to the working plane. As for concrete of gate foundation and piers, MQ600/30 type portal crane is used to hoist horizontal tanks into bin, portal cranes are arranged at upstream and downstream separately, during flood season, two-way portal crane rail at the dam crest at elevation 53.00m at the upstream side of gate piers can be applied; as for concrete of stilling basin and guide wall, crawler crane is used to hoist horizontal tanks into bin.

As for concrete of part of the left side wall of the ship lock body and flood gate along the ship lock centerline, two MQ600/30 type portal cranes respectively at upstream and downstream are used to hoist tanks into bins; as for concrete of other part and upstream and downstream approach channels, crawler crane is used to hoist horizontal tanks into bin; Steel template and composite template are jointly applied, the bins are manually flattened with mechanical vibrating.

Sectional circulating injection process from up to down will be applied, 150 type exploration drill is used for drilling, BW-250/50 type slurry pump is used for grouting.

Steel bar fabrication and erection: below φ10mm disc steel bars will be straightened by windlass, above φ10mm steel bars will be straightened and flattened manually, bended and cut mechanically, transported by 5t dump truck to working plane, colligated and welded.
2.11.3 Construction transportation and construction factory facilities

2.11.3.1 Construction transportation

The existing roads at the left and right banks of the pivot will be extended to the construction work areas and construction working faces. The traffic lines within the project site include access road and dam crossing road, and special road to spoil sites with total length of new roads of 6km. Two steel trestles will be built at the lock chamber of the ship lock at the right bank when Stage 2 flood gate is constructed, which is 50m long and 5m wide (crossing upstream and downstream approach channels of the ship lock), construction vehicles can go to upstream and downstream cofferdam of Stage 2 via the ship lock, then to foundation pits.

Summary of construction roads within the main project site is detailed in Table 2.11-1. Summary of construction roads within the project site is detailed in Table 2.11-2.

Table 2.11-1  Summary of construction roads within the main project site

<table>
<thead>
<tr>
<th>No</th>
<th>Road</th>
<th>Length m</th>
<th>Road width m</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Left bank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>External road — 1# spoil site — Residence area at the left bank</td>
<td>1200</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>External road — aggregate handling system — aggregate handling dock</td>
<td>800</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Stage 1 upstream foundation pits — 1# spoil site</td>
<td>350</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Stage 1 downstream foundation pits — 2# spoil site</td>
<td>450</td>
<td>8</td>
</tr>
<tr>
<td>II</td>
<td>Right bank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>External road — aggregate handling system — aggregate handling dock</td>
<td>900</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>External road — electromechanic equipment warehouse — spoil site</td>
<td>1000</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Ship lock, Stage 2 upstream foundation pits — 3# spoil site</td>
<td>400</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Ship lock, Stage 2 downstream foundation pits — 4# spoil site</td>
<td>500</td>
<td>8</td>
</tr>
<tr>
<td>III</td>
<td>Others</td>
<td>400</td>
<td>8</td>
</tr>
</tbody>
</table>
Table 2.11—2 Summary of construction roads within the project site

<table>
<thead>
<tr>
<th>Item</th>
<th>Total</th>
<th>Nature</th>
<th>Length</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main pivotal project</td>
<td>10km construction road</td>
<td>Expanded</td>
<td>4km</td>
<td>8m wide incl. 4km permanent road</td>
</tr>
<tr>
<td>Fending groyne work</td>
<td>41km construction road</td>
<td>Expanded</td>
<td>22km</td>
<td></td>
</tr>
<tr>
<td>Drainage work</td>
<td>32km construction road</td>
<td>Expanded</td>
<td>17km</td>
<td></td>
</tr>
</tbody>
</table>

2.11.3.2 Construction factory facilities

- **Aggregate processing system**
  
  An aggregate processing system will be set at the left bank and the right bank separately.

- **Concrete aggregate processing system**
  
  Both a 4×0.8 m³ concrete blending station and a 3XJ₁₃-1.5 type concrete blending building will be set at the left bank and the right bank separately.

- **Mechanical maintenance system**
  
  Two mechanical maintenance stations and two truck garages will be set, each at the left and right banks.

- **Integrated processing system**
  
  Timber processing plant, steel bar processing plant and concrete prefabricated part plant will be set respectively at the left bank and the right bank.

- **Electromechanic equipment installation and metal framework consolidation shed**
  
  The main purpose of metal framework consolidation shed is for preassembly, consolidation, test and etc. of embedded parts, gates, headstock gears, press steel pipe, water turbine power generating set and their electrical equipment. Metal framework installation yard and electromechanic equipment storage yard will be set at the left bank, a metal framework installation yard at the right bank.

- **Construction air supply**
  
  The main drilling machines for excavation of the main project are hydraulic drilling machine, hand pneumatic drill. As per the project schedule and features, an air supply station will be set at the left and right banks respectively.

Quantities of construction temporary buildings are shown in Table 01.

2.11.4 General construction arrangement

According to the actual situation of the pivotal project, it is classified into two work areas.
2.0 Project Overview

Left bank work area: It serves construction of the main powerhouse, auxiliary powerhouse, 3-hole scouring sluice, 8-hole flood gate, joint dam at the left bank, stepup substation, permanent administration building, temporary buildings including aggregate processing plant, concrete blending system, steel bar and wood processing plant, mechanical maintenance system, parking lot and garage, warehouses, compressed air and water and power supply facilities, equipment storage yard, administrative and residence buildings etc.

Right bank work area: It serves construction of the ship lock, 13-hole flood gate, joint dam at the left bank, temporary buildings including aggregate processing plant, concrete blending system, steel bar and wood processing plant, mechanical maintenance system, parking lot and garage, warehouses, compressed air and water and power supply facilities, equipment storage yard, administrative and residence buildings etc.

The required total man days for the pivot area is 2.7784 million mandays, the peak labor number is 1900 people.

Dam site construction layout is shown in DRAWING NO. 18. Main construction machinery is detailed in Table 02.

2.11.5 General construction schedule
Preparation period: Altogether nine months from January to September of the first year.

Construction period of main project: Powerhouse is constructed from August of the first year to early January of the fourth year, the first power generating set is ready to apply the water retained by Stage 2 dry season cofferdam for generating power, altogether for 29 months; 11-hole scouring flood gate and ship lock at left and right banks are constructed from August of the first year to July of the third year, altogether for 21 months.

Construction completion period of the project: 13-hole flood gate at middle section of Stage 2 foundation pit is completed and the 5 followup generating sets are erected from January of the fourth year to end of March of the fifth year, altogether for 15 months.

The total construction period of the project is 51 months.

2.12 Earthwork balance, plan of borrow sites and spoil sites

2.12.1 Earthwork balance

Earthwork balance of the main project

The excavated material of the main project – pivot work is transported to the spoil site except part of them is used to fill cofferdam, joint dam and protection works, part of them need secondary extraction. Total excavated earthwork quantity of the main project is \(272.19 \times 10^4 \text{m}^3\), total fill earthwork quantity is \(152.27 \times 10^4 \text{m}^3\), converted into \(179.14 \times 10^4 \text{m}^3\). After earthwork balancing, \(98.35 \times 10^4 \text{m}^3\) slag at the left bank is required to dump, \(13.77 \times 10^4 \text{m}^3\) slag at the right bank is required to dump. Earthwork balances of the main project is shown in Table 2.12—1.
Table 2.12—1  Earthwork balances of the main project (M³)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Left bank</th>
<th>Right bank</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth &amp; pebble excavation</td>
<td>×10⁴m³</td>
<td>145.67</td>
<td>80.16</td>
<td>225.83</td>
</tr>
<tr>
<td>Stone excavation</td>
<td>×10⁴m³</td>
<td>38.32</td>
<td>8.04</td>
<td>46.36</td>
</tr>
<tr>
<td>Spoil from aggregate processing</td>
<td>×10⁴m³</td>
<td>8.25</td>
<td>7.99</td>
<td>16.24</td>
</tr>
<tr>
<td>Cofferdam demolition</td>
<td>×10⁴m³</td>
<td>24.31</td>
<td>51.45</td>
<td>75.76</td>
</tr>
<tr>
<td>Excavated material</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applied material</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cofferdam fill</td>
<td>×10⁴m³</td>
<td>16.34</td>
<td>43.05</td>
<td>59.39</td>
</tr>
<tr>
<td>Dam backfill</td>
<td>×10⁴m³</td>
<td>50.88</td>
<td>62.77</td>
<td>113.65</td>
</tr>
<tr>
<td>Concrete aggregate</td>
<td>×10⁴m³</td>
<td>50.98</td>
<td>28.06</td>
<td>79.04</td>
</tr>
<tr>
<td>Dumped material</td>
<td>×10⁴m³</td>
<td>98.35</td>
<td>13.77</td>
<td>112.12</td>
</tr>
</tbody>
</table>

Earthwork balance of protection works

Earthwork balance of protection works includes earthwork balances of fending groynes and drainage works.

Earthwork balance of fending groynes is detailed in Table 2.12—2.

Table 2.12—2  Earthwork balance of fending groynes (m³)

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Excavation</th>
<th>Fill</th>
<th>Excavation of drainage works to fending groynes</th>
<th>Borrow</th>
<th>Spoil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yanxi section</td>
<td>×10⁴m³</td>
<td>5.56</td>
<td>23.95</td>
<td>14.21</td>
<td>9.74</td>
<td>5.56</td>
</tr>
<tr>
<td>Taihe section</td>
<td>×10⁴m³</td>
<td>3.98</td>
<td>34.48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wanhe section</td>
<td>×10⁴m³</td>
<td>5.55</td>
<td>23.01</td>
<td>23.01</td>
<td>0.00</td>
<td>5.55</td>
</tr>
<tr>
<td>Zhangtang section</td>
<td>×10⁴m³</td>
<td>1.18</td>
<td>8.33</td>
<td></td>
<td>8.33</td>
<td>1.18</td>
</tr>
<tr>
<td>Jintan section</td>
<td>×10⁴m³</td>
<td>20.64</td>
<td>112.83</td>
<td>53.39</td>
<td>59.45</td>
<td>20.64</td>
</tr>
<tr>
<td>Subtotal</td>
<td>×10⁴m³</td>
<td>36.91</td>
<td>202.61</td>
<td>90.61</td>
<td>112.00</td>
<td>36.91</td>
</tr>
</tbody>
</table>

Drainage works have a large excavation load, having some surplus except for self balancing, part of the surplus close to fending groynes is used for filling fending groynes, the others are as wastes to dump. Earthwork balance of drainage works is shown in Table 2.12—3.
## Table 2.12–3

<table>
<thead>
<tr>
<th>Item</th>
<th>Excavation</th>
<th>Backfill</th>
<th>Lend to fending groynes</th>
<th>Self application</th>
<th>Lend</th>
<th>Application of drainage canal material</th>
<th>Borrow</th>
<th>Spoil</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drainage pumping stations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wanhe</td>
<td>5.20</td>
<td>2.47</td>
<td>2.47</td>
<td></td>
<td></td>
<td></td>
<td>2.73</td>
<td></td>
</tr>
<tr>
<td>Yanxi</td>
<td>0.93</td>
<td>0.29</td>
<td>0.29</td>
<td></td>
<td></td>
<td></td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>Jintan</td>
<td>0.38</td>
<td>10.29</td>
<td>0.38</td>
<td>9.92</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yongcheng</td>
<td>0.18</td>
<td>0.29</td>
<td>0.18</td>
<td>0.11</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dongmen</td>
<td>0.22</td>
<td>0.29</td>
<td>0.22</td>
<td>0.07</td>
<td>0</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Huangjiaba</td>
<td>1.51</td>
<td>7.38</td>
<td>1.51</td>
<td>5.87</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Guide support canal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yanxi Upper</td>
<td>9.34</td>
<td>1.75</td>
<td>6.54</td>
<td>1.75</td>
<td></td>
<td></td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>Yanxi Down</td>
<td>11.07</td>
<td>1.59</td>
<td>6.64</td>
<td>1.59</td>
<td></td>
<td></td>
<td>2.84</td>
<td></td>
</tr>
<tr>
<td>Jintan Upper</td>
<td>5.32</td>
<td>8.34</td>
<td>5.32</td>
<td>3.02</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jintan Down</td>
<td>13.10</td>
<td>18.24</td>
<td>13.1</td>
<td>5.14</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shangtian</td>
<td>1.46</td>
<td>10.89</td>
<td>1.46</td>
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<td>9.43</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Donggang</td>
<td>17.31</td>
<td>21.39</td>
<td>17.31</td>
<td>4.08</td>
<td>0</td>
<td></td>
<td>148.48</td>
<td></td>
</tr>
<tr>
<td>Wanhe</td>
<td>202.50</td>
<td>7.22</td>
<td>46.8</td>
<td>7.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drainage canals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yunting River Rerouting</td>
<td>44.18</td>
<td>4.12</td>
<td>29.6</td>
<td>4.12</td>
<td>10.03</td>
<td></td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Jintan</td>
<td>20.83</td>
<td>5.92</td>
<td>5.92</td>
<td>8.16</td>
<td></td>
<td></td>
<td>6.76</td>
<td></td>
</tr>
<tr>
<td>County Seat</td>
<td>10.33</td>
<td>4.05</td>
<td>4.05</td>
<td>5.94</td>
<td></td>
<td></td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>Zhoutou</td>
<td>1.50</td>
<td>0.88</td>
<td>0.88</td>
<td></td>
<td></td>
<td></td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td><strong>Regulating sluices</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zhangtang</td>
<td>2.44</td>
<td>1.43</td>
<td>1.43</td>
<td></td>
<td></td>
<td></td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>Wanhe</td>
<td>0.85</td>
<td>0.92</td>
<td>0.85</td>
<td></td>
<td>0.07</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Zhoutou</td>
<td>0.55</td>
<td>0.51</td>
<td>0.51</td>
<td></td>
<td></td>
<td></td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>351.85</td>
<td>109.75</td>
<td>90.61</td>
<td>72.04</td>
<td>24.13</td>
<td></td>
<td>13.59</td>
<td>165.07</td>
</tr>
</tbody>
</table>

Draining pumping stations: Wanhe and Yanxi pumping stations will use their own excavated material for backfill, the surplus part is dumped as spoil; Jintan and Yongchang pumping stations will use their own excavated material and the earthwork from Yunting River rerouting; Dongmen and Huangjiaba pumping stations will use their own excavated material and the excavated material of the County Seat Draining Canal.

Guide support canals: Yanxi and Wanhe guide support canals will use their own excavated material for backfill, the surplus part is transported to the dike or dumped as spoil; Jintan Upper, Shangtian and Donggang guide support canals will prefer to use their own excavated material for backfill, the insufficient part is from the borrow site; Jintan Down Guide Support
Canal will prefer to use their own excavated material and the excavated material from drainage canal for backfill, the insufficient part is from the borrow site.

Draining canals: Yanxi Drainage Canal will use its own excavated material for backfill, the surplus part is transported to the dike or dumped as spoil; the other canals will use its own excavated material for backfill, the surplus part is transported to the dike or for other use or dumped as spoil.

Fending groynes: Fending groynes will apply part of the excavated material of drainage works for fill, the other parts will be exploited from other place, the total quantity of materials to be exploited is $111.98 \times 10^4 \text{ m}^3$, the total spoil quantity is $36.91 \times 10^4 \text{ m}^3$.

Draining works will have some surplus after its own balancing, part of the surplus material is used for filling protection works, part for filling cofferdams of temporary works, part for dumping locally.

2.12.2 Plan of borrow and spoil sites

Altogether 17 borrow sites are planned for the project with land cover area of $159.46 \text{ hm}^2$, the main types of occupied land are farmland, woodland and wasteland. The basic situations of borrow sites are shown in Table 2.12—4, the distribution of borrow sites is given in DRAWING NO. 19.

Altogether there are 38 spoil sites planned for the project, with spoil quantity of $314.1 \times 10^4 \text{ m}^3$, and stacked spoil area of $117.61 \text{ hm}^2$; 4 spoil sites are set at the left and right banks of the pivot work, the terrace at both banks is flat, spoil sites belong to flat or valley, occupying part of dry land. Spoil sites of the fending groyne work and draining work will be mostly slope toe flat and bottomland. The main occupied land is wasteland, woodland and farmland.

Basic situations of spoil sites are shown in Table 2.12—5, Arrangement of spoil sites is shown in DRAWING NO. 20—DRAWING NO. 22.
### Table 2.12—4 Summary of planned borrow sites

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Description</th>
<th>Reserve ($\times 10^4 m^3$)</th>
<th>Exploitation area (hm$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Borrow site of pivot area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Pebble borrow site</td>
<td>High flood land at the right bank downstream of the dam site, mainly exploited from underwater</td>
<td>200</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Block stone borrow site</td>
<td>Selected and outsourced $2.99 \times 10^4 m^3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Shihutang</td>
<td>Stage II terrace at the right bank downstream of the dam site, now mainly as woods of pines &amp; China firs, partly as wasteland.</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Xiejia</td>
<td>Stage II terrace at the left bank of the dam site, now basically as dry land, partly as woods of pines and China firs.</td>
<td>96</td>
<td>3</td>
</tr>
<tr>
<td>II</td>
<td>Borrow sites of fending groynes at reservoir area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Xigang</td>
<td>Dry land, partly as woods of pines and China firs</td>
<td>96</td>
<td>5.80</td>
</tr>
<tr>
<td>7</td>
<td>Huangkeng</td>
<td>Low-lying hill with higher topography, pine tree woods</td>
<td>100</td>
<td>4.20</td>
</tr>
<tr>
<td></td>
<td>Zoukeng</td>
<td>Low-lying hill with higher topography, partly planted with pine trees and China firs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Shihutang</td>
<td>Stage II terrace at the right bank downstream of the dam site, now mainly as woods of pines &amp; China firs, partly as wasteland.</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Xiejia</td>
<td>Stage II terrace at the left bank of the dam site, now basically as dry land, partly as woods of pines and China firs.</td>
<td>96</td>
<td>3</td>
</tr>
<tr>
<td>III</td>
<td>Borrow sites of drainage works</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Bainigang</td>
<td>Low-lying hill, mostly pines, a small amount of dry land</td>
<td>80</td>
<td>2.00</td>
</tr>
<tr>
<td>11</td>
<td>Lijia</td>
<td>Ditto</td>
<td>80</td>
<td>2.00</td>
</tr>
<tr>
<td>12</td>
<td>Tianhong</td>
<td>Ditto</td>
<td>30</td>
<td>2.67</td>
</tr>
<tr>
<td>13</td>
<td>Aggregate</td>
<td>Outsourcing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>84.53</td>
</tr>
<tr>
<td>Location</td>
<td>Name</td>
<td>Area (hm²)</td>
<td>Qty (10⁴ m³)</td>
<td>Average stacking height m</td>
</tr>
<tr>
<td>----------------------</td>
<td>------</td>
<td>------------</td>
<td>--------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Spoil sites at pivotal area</td>
<td></td>
<td>13.33</td>
<td>112.12</td>
<td></td>
</tr>
<tr>
<td>Left bank</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1#</td>
<td></td>
<td>5.00</td>
<td>35.77</td>
<td>7.14</td>
</tr>
<tr>
<td>2#</td>
<td></td>
<td>3.73</td>
<td>28.57</td>
<td>7.65</td>
</tr>
<tr>
<td>Right bank</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1#</td>
<td></td>
<td>2.47</td>
<td>24.99</td>
<td>10.13</td>
</tr>
<tr>
<td>2#</td>
<td></td>
<td>2.13</td>
<td>22.85</td>
<td>10.71</td>
</tr>
<tr>
<td>Dike work</td>
<td></td>
<td>8.01</td>
<td>36.91</td>
<td></td>
</tr>
<tr>
<td>Wanhe</td>
<td></td>
<td>1.67</td>
<td>7.93</td>
<td>4.75</td>
</tr>
<tr>
<td>Zhangtang</td>
<td></td>
<td>0.20</td>
<td>0.98</td>
<td>4.90</td>
</tr>
<tr>
<td>Jintan</td>
<td></td>
<td>0.81</td>
<td>4.00</td>
<td>4.94</td>
</tr>
<tr>
<td>2#</td>
<td></td>
<td>0.80</td>
<td>3.00</td>
<td>3.75</td>
</tr>
<tr>
<td>3#</td>
<td></td>
<td>0.80</td>
<td>4.00</td>
<td>5.00</td>
</tr>
<tr>
<td>4#</td>
<td></td>
<td>1.06</td>
<td>5.30</td>
<td>5.00</td>
</tr>
<tr>
<td>Yanxi</td>
<td></td>
<td>0.90</td>
<td>4.50</td>
<td>5.00</td>
</tr>
<tr>
<td>2#</td>
<td></td>
<td>1.10</td>
<td>3.80</td>
<td>3.45</td>
</tr>
<tr>
<td>County seat</td>
<td></td>
<td>0.67</td>
<td>3.40</td>
<td>5.07</td>
</tr>
<tr>
<td>Drainage work</td>
<td></td>
<td>96.27</td>
<td>165.07</td>
<td></td>
</tr>
<tr>
<td>1#</td>
<td></td>
<td>1.00</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>2#</td>
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<td>0.53</td>
<td>1.60</td>
<td>3</td>
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<tr>
<td>3#</td>
<td></td>
<td>1.00</td>
<td>3.00</td>
<td>3</td>
</tr>
<tr>
<td>4#</td>
<td></td>
<td>2.13</td>
<td>6.40</td>
<td>3</td>
</tr>
<tr>
<td>5#</td>
<td></td>
<td>1.20</td>
<td>3.60</td>
<td>3</td>
</tr>
<tr>
<td>6#</td>
<td></td>
<td>38.67</td>
<td>28.21</td>
<td>1</td>
</tr>
<tr>
<td>7#</td>
<td></td>
<td>0.47</td>
<td>1.40</td>
<td>3</td>
</tr>
<tr>
<td>8#</td>
<td></td>
<td>3.33</td>
<td>14.00</td>
<td>3</td>
</tr>
<tr>
<td>9#</td>
<td></td>
<td>2.33</td>
<td>7.00</td>
<td>3</td>
</tr>
<tr>
<td>10#</td>
<td></td>
<td>2.33</td>
<td>7.00</td>
<td>3</td>
</tr>
<tr>
<td>11#</td>
<td></td>
<td>2.00</td>
<td>6.00</td>
<td>3</td>
</tr>
<tr>
<td>12#</td>
<td></td>
<td>8.67</td>
<td>19.00</td>
<td>3</td>
</tr>
<tr>
<td>13#</td>
<td></td>
<td>3.33</td>
<td>10.00</td>
<td>3</td>
</tr>
<tr>
<td>14#</td>
<td></td>
<td>2.00</td>
<td>6.00</td>
<td>3</td>
</tr>
<tr>
<td>15#</td>
<td></td>
<td>4.00</td>
<td>12.00</td>
<td>3</td>
</tr>
<tr>
<td>16#</td>
<td></td>
<td>3.33</td>
<td>10.00</td>
<td>3</td>
</tr>
<tr>
<td>17#</td>
<td></td>
<td>13.33</td>
<td>16.00</td>
<td>1.2</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>91.00</td>
<td>152.23</td>
<td></td>
</tr>
</tbody>
</table>
Table 2.12—5  Summary of planned spoil sites  

<table>
<thead>
<tr>
<th>Location</th>
<th>Name</th>
<th>Area (hm²)</th>
<th>Qty (10⁴m³)</th>
<th>Average stacking height (m)</th>
<th>Landform</th>
<th>Type of occupied land (hm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yanxi</td>
<td>1#</td>
<td>0.80</td>
<td>0.40</td>
<td>0.5</td>
<td>Mild slope</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>2#</td>
<td>0.67</td>
<td>1.01</td>
<td>1</td>
<td>Mild slope</td>
<td>0.67</td>
</tr>
<tr>
<td></td>
<td>3#</td>
<td>0.67</td>
<td>1.53</td>
<td>1.4</td>
<td>Mild slope</td>
<td>0.20 0.47</td>
</tr>
<tr>
<td></td>
<td>4#</td>
<td>1.67</td>
<td>1.83</td>
<td>1.1</td>
<td>Mild slope</td>
<td>1.67</td>
</tr>
<tr>
<td></td>
<td>5#</td>
<td>0.13</td>
<td>0.15</td>
<td>1.1</td>
<td>Channel</td>
<td>0.03 0.11</td>
</tr>
<tr>
<td></td>
<td>6#</td>
<td>0.60</td>
<td>0.66</td>
<td>1.1</td>
<td>Mild land</td>
<td>0.12 0.48</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>4.53</td>
<td>4.65</td>
<td>0.00</td>
<td>Mild land</td>
<td>0.15 0.20 4.19</td>
</tr>
<tr>
<td>County seat</td>
<td>1#</td>
<td>0.4</td>
<td>7.52</td>
<td>2</td>
<td>Flat at toe of slope</td>
<td>0.20 0.20</td>
</tr>
<tr>
<td>Zhoutou</td>
<td>1#</td>
<td>0.33</td>
<td>0.67</td>
<td>2</td>
<td>Ditto</td>
<td>0.17 0.17</td>
</tr>
<tr>
<td>38 spoil sites</td>
<td></td>
<td>117.61</td>
<td>314.10</td>
<td>31.04</td>
<td></td>
<td>33.87 48.84 3.87</td>
</tr>
</tbody>
</table>

2.13 Investment Estimate and Capital Raising

Total investment of the Project: 2.2268932 billion yuan.

The capital composition of the project is given by the Owner, it is expected that the Ministry of Communications and Jiangxi Province will jointly provide 1.26 billion yuan as statutory capital and 100 million USD loan will be applied from the World Bank, the insufficient part will be applied from load of domestic banks with interest rate of 6.156%, all the loans will be input pro rata in several years.
3.0 ENGINEERING ANALYSIS

3.1 Analysis on Environment Impacts during Construction

The main factors and sources of impacts of the project during construction are construction site arrangement, communications and transport, operation of construction machinery, construction temporary landuse, constructors’ activities, and wastes disposal etc. The construction of the Project will cause impacts on water environment, acoustic environment, ambient air, ecological environment and public health.

3.1.1 Ambient air

The main pollutant to atmospheric environment during construction is TSP, the main pollution operations are lime-soil blending and concrete blending, secondly material transport and stacking, earthwork excavation and backfilling. The above-said operations will cause TSP pollution impacts on the construction site under the action of wind force, the stronger the wind, the more severe the pollution.

The construction machinery of this project are face shovel, backacting shovel, bulldozer, dump truck, and construction ships etc., which consume diesel oil and gasoline, discharge waste gas pollutants as SO$_2$, NO$_x$, CO and hydrocarbons etc. The waste gas pollutant discharge quantities during construction are shown in Table 3.1-1.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Fuel oil consumption (t)</th>
<th>Pollutants</th>
<th>Emission factor (kg/t)</th>
<th>Discharge qty (t)</th>
<th>Total pollutant discharge quantities of construction machinery (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>649</td>
<td>SO$_2$</td>
<td>0.40</td>
<td>0.260</td>
<td>SO$_2$: 22.233</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO$_x$</td>
<td>28.13</td>
<td>18.256</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO</td>
<td>225.33</td>
<td>146.239</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C$_n$H$_m$</td>
<td>44.40</td>
<td>28.816</td>
<td></td>
</tr>
<tr>
<td>Diesel oil</td>
<td>5844</td>
<td>SO$_2$</td>
<td>3.76</td>
<td>21.973</td>
<td>NO$_x$: 323.547</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO$_x$</td>
<td>52.24</td>
<td>305.291</td>
<td>CO: 331.844</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO</td>
<td>31.76</td>
<td>185.605</td>
<td>C$_n$H$_m$: 59.088</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C$_n$H$_m$</td>
<td>5.18</td>
<td>30.272</td>
<td></td>
</tr>
</tbody>
</table>

3.1.2 Water environment

Waste water during construction comes from construction and domestic sewage, including sand and stone processing waste water, concrete blending waste water, foundation pit waste water, oil-contained waste water, construction ship bilge oil-contained water and domestic sewage etc.; The Main pollutant is SS, majority of waste water comes from sand and stone processing. Details of waste water discharge are shown in Table 3.1-2.

3.1.3 Acoustic environment

Noise sources during construction are divided into fixed source and movable source. Noises
of hole drilling and construction machinery belonging to fixed sources are from earthwork excavation, sand and stone processing, concrete blending etc. with features of strong sound source and continuous sound level. Noises of transport and construction vehicle engines and trumpets belonging to movable sources are with features of strong sound source and movability. The main construction noise source intensities of the project are shown in Table 3.1—3.

### Table 3.1—2  Summary of waste water discharges during construction

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Discharge intensity</th>
<th>Concentration of main pollutants</th>
<th>Environment impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sand &amp; stone processing waste water</td>
<td>Average 120m³/h</td>
<td>SS 50000mg/L</td>
<td>Discharge without treatment will cause pollution impacts on construction area and surrounding water environment to different extents.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peak 240m³/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Concrete blending station flushing waste water</td>
<td>0.5m³/time•tank</td>
<td>SS 5000mg/L/pH 12</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Concrete maintenance waste water</td>
<td>0.35m³/m³</td>
<td>SS 5000mg/L/pH 12</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Foundation pit waste water</td>
<td>Regular 320m³/h</td>
<td>SS 2000mg/L</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peak 5714m³/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Oil-contained waste water</td>
<td>Average 1.0m³/h</td>
<td>Oils 30mg/L/150mg/L</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peak 2.0m³/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Domestic sewage</td>
<td>Average 240.0m³/d</td>
<td>BOD 200mg/L/COD 300mg/L</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peak 312.0m³/d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Bilge oil-contained waste water</td>
<td>Average 0.4m³/d</td>
<td>Oils 5000mg/L</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peak 1.2m³/d</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 3.1—1 Main construction noise source intensity

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Noise level A [dB(A)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed source</td>
<td>Blender, blending station</td>
<td>75-88</td>
</tr>
<tr>
<td></td>
<td>Crusher, screener</td>
<td>95-100</td>
</tr>
<tr>
<td></td>
<td>Windlass, crane</td>
<td>85-90</td>
</tr>
<tr>
<td></td>
<td>Excavator</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Drilling machine</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>Air compressor</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>Explosive blasting</td>
<td>130</td>
</tr>
<tr>
<td>Movable source</td>
<td>Camion light-duty</td>
<td>82-90-76-84</td>
</tr>
<tr>
<td></td>
<td>Camion medium-duty</td>
<td>85-91-79-85</td>
</tr>
<tr>
<td></td>
<td>Camion heavy-duty</td>
<td>88-93-84-89</td>
</tr>
</tbody>
</table>

Note: noises inside and outside brackets are those of uniform speed (50km/h) and acceleration respectively.

### 3.1.4 Ecological environment

The main work contents of the project include structure construction of the dam site, fending groynes of five protection areas, 6 drainage pumping stations, 2 regulating sluices, and guiding support canal, temporary landuse of construction firms and facilities, temporary construction road landuse, landuse of material stacking site and waste dumping site. The main construction impacts on ecological environment include vegetation damage, farmland occupation, change of landform and topography to affect natural resources, construction waste water, gases and solids to cause change of surrounding environment quality, resulting in affecting habitat quality of animals and plants.

- **Water and soil erosion caused by construction**
  Construction activity will disturb the earth’s surface, damage the landform, change the original landform, topography and land application mode, destroy water and soil conservation facilities. The project construction to cause water and soil erosion are foundation excavation of the main work, construction road construction, construction site leveling, construction of auxiliary works, excavation of material sites, waste disposal etc., which will disturb the earth’s surface, damage the vegetation, cause discarded soil and slags due to excavation, it no measures are taken, it will cause water and soil erosion and impacts on the ecological environment at the construction site to different extents.

- **Reduction of vegetation and farmland**
  The Project will permanently acquire 42525.1Mu land, including 2977.3Mu farmland (inc. basic farmland 198.27Mu), 3468.4Mu woodland and 36079.4Mu of other land types.
  The Project will temporarily occupy 6895.65Mu (1237.05Mu by farmland elevating,
78.15 Mu by resettlement area), including 2748.6 Mu farmland, 1000.8 Mu woodland and 3146.25 Mu of other land types.

Land occupation by the project will directly destroy forest community and vegetation and cause loss of vegetation quantity; Total of permanent and temporary land use of 5725.9 Mu will cause impacts on agricultural production to a certain degree. Farmland elevating and vegetation resumption of temporary land use can compensate losses of vegetation and farmland to a certain extent.

**Impacts on terrestrial organisms**

Through site survey, no famous trees or state grade protected wild plants are found within the project area; There are 11 species of provincial grade protected plants within the project area as podocarpus macrophyllus, sweet osmanthus, camellia, coptis, horned holly, iron-colored holly, Chongyang tree, gentian, yellow sandalwood, soupberry and lucid asparagus.

Through site survey, no state grade protected wild animals are found within the project area; There are 20 species of provincial grade protected animals within the project area, including 4 species of amphibians, 3 species of reptiles, 12 species of birds and 1 species of beast.

**Impacts on the nature reserve and famous and old trees**

It is found through site survey that there are 215 grade 3 old trees within the project area, including 211 camphors, 2 Cupressus funebris, 1 Sabina chinensis, 1 Castanopsis sclerophylla. Old trees have formed a community at the county grade nature reserve of Zhujia Village of Tangzhou Township, and are scattered at Huanghangpengxia, Xinzhou, Shihutang, Jiangjiazhou, Xiabian Village, Yinxiang, Taipan, Zhangjia and Laohukeng etc. It is site authenticated by the experts organized by the Greening Commission of Jiangxi Provincial Forestry Bureau that all the old trees distributed within the project area belong to Grade 11 protected ones (Details are given in APPENDIX 5).

The fending groyne line of the Yongchang Protection Area in the engineering design goes through the core area and buffer area of the county grade nature reserve – Zhujia Village Camphor Woods, Tangzhou Township.

During construction, soil borrow for groyne building, construction of bunkerhouse and mechanical construction may cause direct mechanical damages to root system, trunk or crown of old trees nearby, especially the old trees at the fending groynes. If the newly filled groynes are over 1.2 m thick, this may cause adverse impacts on breathing of root systems of old trees, root crowns and the buried part of trunks of old trees are hard to germinate new root systems, causing severe impacts on growth of old trees.

**Impacts on aquatic organisms and fish spawning sites**

Cofferdam formation and foundation pit drainage etc. will cause turbidity and suspended solids of local water area increased and will cause short-run local impacts on habitat of fishes and planktons.

Cofferdam will occupy a very big flow cross section, reducing the area of flow cross section. Structures will disturb water flow form to a certain extent and change local flow field, causing phenomena of back water and level raising at the dam site, affecting the habitat of
fishes and planktons.

There are three spawning sites at Baijiaxia, Taihe and Yanxidu distributed in the Kan River section of the project, the Taihe and Yanxidu spawning sites are located in the reservoir area of the project, which will be affected to variant degrees during construction period.

- Impacts on landscape

Excavation and filling and reservoir area inundation will cause impacts on the natural landscape of the dam area and the reservoir area to a certain degree; Area change of different landforms will cause change of productivity and stability of natural ecological system of the region and cause impacts on the integrity of the ecological environment of the project area to a certain extent.

3.1.5 Solid waste

Main solid wastes during construction include construction garbage and domestic garbage from constructors, as per the quantity of constructors, based on 1kg/manday, the peak solid waste generating quantity is 3900kg/d during construction. The total construction garbage quantity generated during construction is about 200~300t.

3.1.6 Public health

The total construction time of the project is over four years, manpower at construction peak is 3900men per day. With increase of population density within the construction area during construction, constructors may carry in infectious disease pathogen, having adverse impacts on environmental sanitation and public health etc. Constructors from outside enter the new environment that are more vulnerable to local epidemic diseases over local people.

3.2 Inundation, Land Occupation and Resettlement

Inundated land by the reservoir area and permanent and temporary landuse of the project will cause a certain impact on agricultural production and fishery and on the normal production of firms and institutions to be relocated, and on normal work and daily life of the affected people to be resettled.

Under current conditions, the total agricultural population to be resettled of the project area (including land inundated by the reservoir, and landuse by protection work and the main project) is 2175 people, the population to be resettled in the design level year 2010 is 2271 people. The population to be resettled by the project is 711 people currently due to direct inundation of the reservoir or land occupation of protection work, the population to be resettled in the planned level year 2010 is 744 people.

New houses construction, infrastructure construction, land cultivation for resettlement will cause impacts on land resource, soil erosion and terrestrial ecology. Resettlement will also cause impacts on living quality, public health and social economy of the resettled people.

3.3 Analysis on Environment Impact during Operation

3.3.1 Hydrological regime

Waterpower is a production process to apply waterpower resource to produce energy,
operation of the project proper will not discharge any pollutants. But impounding for power
generation during operation will change the reservoir area scope, level, flow and flow rate
and etc. downstream the dam.

3.3.2 Water environment

□ Level elevating will change part of the original land at the reservoir area into water
area, increase volume of water body at backwater area and strengthen dilution capacity. But
due to slowdown of flow rate at the water area, it is not good for pollutant diffusion and self
purification, concentration of pollutants at local water area nearby discharge ports of the
pivot and back-water area will be increased.

□ Ship domestic sewage in the waterway of the reservoir area
The average sizes of navigating ships in the waterway in 2020 and 2030 are considered as
500t and 800t respectively. It is calculated that ship flows in the waterway in 2020 and 2030
are 16860 ship/time/a and 16663 ship/time/a respectively. 300t and 500t ships are manned as
4 persons/ship and 5 persons/ship, sewage is calculated on basis of 20l/person· ship/time, the
domestic sewage discharges of ships navigating in the waterway in 2020 and 2030 are
respectively 1079.1t/a and 1333.1t/a. Analogical analysis as per related information shows
that concentrations of COD and BOD$_5$ reach 300mg/l & 200mg/l respectively. It is forbidden
to discharge domestic sewage from ships into the waterway. The ship domestic sewage will
be collected by the sewage collecting device equipped in the ship and sent to sewage
reception ship or sewage reception unit at bank for treatment, then discharged after meeting
Grade 1 of the Comprehensive Waste Water Discharge Standard (GB8978-1996) (Concentrations of COD & BOD$_5$ reach 100mg/l & 20mg/l). The standard-meeting COD
discharges of sewage in 2020 and in 2030 from ships into the waterway are respectively
323.7kg/a and 399.9kg/a; The standard-meeting BOD$_5$ discharges of sewage in 2020 and in
2030 from ships into the waterway are respectively 215.8kg/a and 266.6kg/a.

□ Ship bilge oil-contained waste water into waterway in the reservoir area
The average oil concentration of bilge oil-contained waste water is 5000mg/l, bilge oil-
contained waste water quantities of 500t and 800t ships are calculated respectively on
0.14t/d•ship and 0.22t/d•ship. Bilge oil-contained waste water quantities of ships in the
waterway in the reservoir area in 2020 and in 2030 are respectively 393.4t/a and 611t/a. It is
forbidden to discharge bilge oil-contained waste water into the waterway. Bilge oil-contained
waste water will be collected by the oil-contained waste water collecting device equipped in
the ship and sent to oil-contained waste water reception ship or oil-contained waste water
reception unit at bank for treatment, then discharged after meeting Grade 1 (5mg/l) of the
Comprehensive Waste Water Discharge Standard (GB8978-1996). The standard-meeting oils
discharges of bilge oil-contained waste water in 2020 and in 2030 from ships into the
waterway are respectively 2.0kg/a and 3.1kg/a.

□ Domestic sewage of the staff of the Project Management Department
Domestic sewage of the staff is calculated as per the following formula:

$$Q_s=(K·q_1·V_1)/1000$$
3.0 Engineering Analysis

Where:  
Qs——Domestic sewage discharge, t/d;
q——Water consumption per manday, l/manday;
V——Staff number;
K——discharge factor, taking 0.8.

The staff of the Project Management Department is based on 129 persons and water consumption is 150 l/manday, domestic sewage discharge quantity is calculated as per 80% of water consumption, then the total sewage discharge quantity is 7062.75t/a. The main pollution factors COD and BOD$_5$ are based on 300mg/l and 200mg/l, then COD and BOD$_5$ quantities are respectively 2118.83kg/a and 1412.55kg/a, which will be discharged after taking treatment measures and meeting Grade 1 of the Comprehensive Waste Water Discharge Standard. The discharge concentrations of COD and BOD$_5$ are respectively 100mg/l and 20mg/l, then COD and BOD$_5$ quantities are respectively 706.28kg/a and 141.26kg/a.

3.3.3 Ambient air

A small amount of waste gas discharged from ships in the waterway has a certain pollution impact on the ambient air. Ship waste gas discharge is calculated with the recommended calculated method of Lloyd’s Register of Shipping, that is, 1t fuel oil will produce 7.2kg NO$_2$ and 10kg SO$_2$, the fuel consumption of ships in 2020 and in 2030 are based on 4.65g/t•km and 3.72g/t•km respectively. According to the water transport freight volume forecast of this waterway, the fuel consumption of ships in 2020 is 843×10$^4$t, and the fuel consumption of ships in 2030 is 1333×10$^4$t. On these data basis, it is worked out that the waste gas discharge quantities of ships in the waterway in the reservoir area are 11.0t NO$_2$ and 15.29t SO$_2$ in 2020 and 13.92t NO$_2$ and 19.34t SO$_2$ in 2030.

3.3.4 Acoustic environment

The main noise sources during operation are hydropower generating noise at the powerhouse area and noise of communications from navigating ships in the waterway. Noise impact of hydropower generation is only limited within the boundary of the powerhouse; ship average radiated sound levels are shown in Table 3.3—1.

<table>
<thead>
<tr>
<th>Ship type</th>
<th>300t—500t</th>
<th>500t—1000t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average exposure sound level [dB(A)]</td>
<td>71</td>
<td>73</td>
</tr>
</tbody>
</table>

3.3.5 Ecological environment

Impounding at the reservoir will change the hydrological regime and habitat condition of the water area. After the reservoir is impounded, its main impacts on ecological environment are
changes of species and distribution of aquatic organisms and fish resource due to increase of aquatic organisms’ habitat area. The pivotal project will obstruct the migration passage of migratory fish and semi-migratory fish. Increase of reservoir water area will lead to loss of terrestrial vegetation, change of quantity and species of plants; impounding of the reservoir area will slowdown water flow, resulting in corresponding change of quantities and biomasses of plankton, aquatic plants, zoobenthos and resident fishes.

Level elevating may cause serious impacts on the normal living environment of 7 old trees inside inundated area and 181 old trees (including the county grade nature reserve of Zhujia Village of Tangzhou Township) outside inundated area beyond the fending groyne, and 6 old trees on the fending groynes at both banks of the Kan River in the reservoir area, and 14 old trees at the scope of 50m within fending groynes.

3.3.6 Social environment

Class of waterway of the Kan River section where the project is located will be upgraded, promoting shipping development, having power generating benefit and advantageous impacts on development of local social economy.

3.3.7 Solid waste

- Domestic garbage of staff of the Project Management Department

The daily and annual domestic garbage produced by the staff of the Project Management Department is respectively about 193.5kg/d and 70.63t/a on 129 persons and 1.5kg/manday basis.

- Annual domestic garbages produced by the ships within the waterway in the reservoir area in 2020 and in 2030 are respectively about 13.49t and 16.67t.
4.0 PLAN HARMONY ANALYSIS & ENVIRONMENT ALTERNATIVES COMPARISON

4.1 Coordination Analysis of Engineering Construction & Relevant Planning

4.1.1 Analysis on Consistency with the State Industry Policies
The Shihutang Navigation and Hydropower Project is deemed as Class I project (under encouragement) in accordance with Index of Industry Structure Adjustment (2005) (No 40 of State Development & Reform Committee of PRC under the item of Construction of Deepwater Channel & Inland Water Stem Channel and Navigation Structure: Comprehensive Hydraulic Projects. In other words, this Project does not belong to the sunset industry as listed in Class II (under restriction) or Class III (under disposal).
To sum up, this Project is consistent with relevant state industry policy.

4.1.2 Analysis on Consistency with River Basin Planning in Kan River
In Oct of 1990, a review was made from the State Planning Committee in the document NO [1990] 1452 in the title of Approval to River Basin Planning Report in Kan River. Up to now, Jiangxi Kan River Drainage Area Planning Report has not yet been modified, therefore, the EIA work on this Plan has not yet commenced.
Jiangxi Kan River Drainage Area Planning Report, after comprehensive analysis in terms of flood control, navigation, water resources exploitation, execution conditions, investment, cost and benefit, made recommendation for cascade development of Program I and V in the main river channel. Program I is of 8-cascade development, namely, development in such areas as Xiashan, Maodian, Wan’an, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan. Program V is of 10-cascade development, namely in such areas as Bai’e, Baikoutang, Xiashan, Wan’an, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan. Of the two programs, the development planning is identical since the reach of Kanzhou District, that is, there will be six cascades in development, namely development in Wan’an, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan.
In the trunk stream, three cascade development programs are planned for near-sighted construction, that is, Taihe, Shihutang and Xiajiang. Of them, the normal water level in the Shihutang Cascade Development is 56.11m (Huanghai Sea EL), with an installed capacity of 120 MW, and a sluice dimension of 175×14×2.5m. For detail see Attached Drawing 07 and 08.
In accordance with the approved River Basin Planning Report in Kan River, the upper stream Taihe Cascade Development Program has a normal water level of 67.11m and the downstream Xiajiang Cascade Development Program has a normal water level of 48.11m. In line with the planned dam sites and normal water level, reservoir backwater level in the Shihutang Cascade will not be compatible with the tail water out of the Taihe Cascade Program, while tail water out of the Shihutang Project is compatible with the reservoir backwater level of downstream Xiajiang Cascade program. So the Feasibility Report recommended that the normal water level for Shihutang Cascade be at 56.5m, so that its
reservoir backwater is compatible with the tail water out of the Taihe Cascade.

In line with Project Proposals for Xiajiang Hydraulic Project, to decrease reservoir inundation impact, the recommended normal water level at the Xiajiang Project is 46.0m (or 1.9m lower than originally planned level) and dead water level is 44.0m. If based on original dam site, the reservoir backwater in Xiajiang Cascade matches tail water out of Shihutang Cascade Project. In case of dead water level at 44.0m, there will be 17km of channel unsuitable for navigation. In accordance with the approved River Basin Planning Report in Kan River, planned normal water level reaches 56.11m; in line with Development Planning in Inland Waterway in Jiangxi Province, navigable grade for this Project is Grade III, whose navigable channel is 2.2m deep and 60m wide, with a bending radius no less than 480m. At the normal water level of 56.11m, if the water level facing the dam remains steady at 56.2m, the river channel basically satisfies the requirement for navigation. In case of synchronous peak modulation for the Jiangxi Province Power Network from the Shihutang and Wan’an Project, water level will be lowered by 0.2 to 0.3m, in which case the normal water level (56.2m) can not meet the need for normal navigation. That is to say, only at normal water level of 56.5m can normal navigation be guaranteed.

In accordance with River Basin Planning Report in Kan River, one-lane single life lock will be adopted in Shihutang Project, with a lock of 175×14×2.5m, which is not in line with Grade III as stimulated in state standard Inland River Channel Navigation Standard concerning locks, hence in the Feasibility Report the sluice is recommended at 180×23×3.5m (L×W×D).

To sum up, the Shihutang Project will have a normal water level at 56.5m, with an installed capacity of 117MW, with a sluice of 180×23×3.5m, basically the same as described in the said Planning Report. So construction of this Project satisfies requirement in the Report.

4.1.3 Analysis Corresponding to Development Planning in Inland Navigation in Jiangxi Province & in Kan River

In accordance with Development Planning in Inland Navigation in Jiangxi Province [DPINJ] and Navigation Planning in Kan River [NPGR], the 525km-long channel (from Ganzhou to Wucheng) is classified as Grade III inland navigation channel. Due to cascade development and other auxiliary river regulation, by 2020 the channel from Ganzhou to Nanchang in the main stream of Kan River will meet Grade III. By 2010 the Shihutang Project will be under construction. After 2010, by way of canalization and river regulation, the whole Kan River will be made navigable. Navigation grade planning for the River is listed in Attached Drawing 08.

The main purpose of the Shihutang Project is to achieve the goal as set in the Development Planning in Inland Navigation in Jiangxi Province and Navigation Planning in Kan River. In line with this Project the navigation grade is determined at Grade III for 1000-tonnage inland navigation, with a lock of Grade III and a channel of 2.2m (Deep) and 60m (wide) and a bending radius of no less than 480m, at a navigation probability of 95%. The sluice has a size of 180×23×3.5m (L×W×D), in line with stimulation in DPINJ and NPGR.
Construction of the Shihutang Project satisfies the planning DPINJ and NPGR.

4.1.4 Brief Introduction to *Environment Impact Report from DPINJ*

On July, 2006, 5 experts as invited by the Environment Protection Bureau of Jiangxi Province, together with representatives from provincial Ministry of Communications, Ministry of Land & Resources, Ministry of Water Conservation, and Ministry of Construction, held a conference concerning *Environment Impact Report from DPINJ*, to outline a review (See Attached Drawing 8).

4.1.4.1 Major Conclusion out of Environment Assessment

*Development Planning DPINJ* meets the need for a well-off society and modernization in Jiangxi Province due to reasonable layout, in line with state communication planning, in coordination with Jiangxi provincial planning, with full consideration to environment protection, therefore to attract widespread support and popularity from the public.

Despite some negative impact upon the environment in the course of execution of the project, if effective measures be adopted concerning environment protection, the project will harvest social benefit, environment benefit and economic profits.

4.1.4.2 Buffering Programs & Proposals

- **Buffering Programs & Proposals concerning Eco-Impact**
  - There will be reasonable construction schedule so that all underwater operation will be completed during the dry season and that there will be no such operation as reef explosion, dredging or rubbish disposal during fish migration and reproduction seasons.
  - Environment protection will be under study in terms of macro-perspectives, with focus on river basin nature reserve and spawning sites as well as migration passage, to help overcome negative impact from block and achieve biodiversity.

- **Buffering Programs & Proposals concerning Aquatic Environment**
  - In construction of terminals and docks, all production waste, domestic sewage and rain water shall be under separate drainage, with the former two under collection and treatment before drainage in line with standard to urban drainage system or directly to the water body. There shall be facilities to receive and treat residual oils, waste oils, oily domestic sewage, night soil and rubbish.
  - It is recommended that by 2010 there will be facilities to receive and treat waste from ships and boats in such ten terminals as Nanchang, Jiujiang and Ganzhou, Ji’an, Zhangshu, and Jindezhen, etc. By 2020 all terminals shall be equipped with necessary facilities to treat wastes.

- **Buffering Programs & Proposals concerning Solid Waste**
All ships and boats shall be equipped with special rubbish reservoir filling and transportation facilities, with rubbish recollection centers in terminals as a part of local rubbish treatment system to prevent rubbish disposal to water body.

There shall be boats especially for clean-up of floating objects in the main channel to enhance treatment of rubbish in the channel.

Buffering Programs & Proposals concerning Social-Environmental Impact
Coordination shall be enhanced with the fishery department to improve comprehensive exploitation of water resources. There shall be locks in where there is migration of fish, shrimp and crabs. In case there might be severe impact upon fishing resources, there shall be fishing structure or other measures for the sake of speedy recovery of fishing resources.

Resettlement shall be made under reasonable arrangement to promote their economy development in a sustainable manner.

Risk Analysis & Emergency Measures
There shall be strict regulations concerning transportation of such dangerous materials as oil and chemicals. There shall be enhanced regulations and prevention countermeasures concerning emergent pollution in the channels and emergency programs against marine incidents, with necessary training to personnel engaged in relevant operations so that they perform their duty with necessary license, for the sake of standard operation.

Salvage and aid system shall be perfected. With improvement in navigation and increase in numbers of transportation ships, salvage and aid organization shall be enhanced equipped with relevant facilities, for the sake of effective salvage and assistance.

Standard ships will be promoted to replace old-fashioned ones so as to improve safety on the whole.

4.1.4.3 Suggestions to Environmental Assessment in Lower-level Construction & Planning

Under impact from in-depth planning, numerous inland navigation planning fail to deal with detailed problems concerning environmental impact assessment, which shall be conquered in the next stage.

Eco-environment
Environmental impact assessment of Routine Construction Works
Local eco-impact assessment without involving sensitive areas shall be made in line with standards concerning environment assessment, with regard to impact upon such factors as agro-ecological environment, land exploitation, soil erosion, and wild animals and plants protection, with to-the-point measures concerning protection of soil, farmland, wild animals and plants, and water and soil conservation.
Eco-impact assessment for water body shall be made in line with relevant standards concerning environment assessment, with focus on impact produced during construction stages, or on underwater dredging, reef exploitation and disposal of spoil, with emphasis upon impact of such performance upon aquatic ecosystem, aquatic biodiversity and spawning sites.
During operation such assessment shall be focused upon impact from risk of oil spill. For expansion and reconstruction project, superimposition impact shall be attended in assessment of impact out of pollutants upon water quality. Measures shall be formulated concerning aquatic eco-environment protection during construction and against oil spill and emergent measures during operation stage.

Environmental Impact Assessment of Nature Reserve
For any works involving nature reserves, eco-impact assessment for water body shall be made in line with relevant standards concerning environment assessment, with effective measures for protection of spawning sites and rare fishes, to make sure that during operation there will be pollution control countermeasures concerning the major channel, with relevant approvals from involved departments.

Aquatic Environment
- The location between next planning and specific works and drinking water protection areas, intake and aquiculture shall be made clear, with prediction made concerning sensitive water body and relevant buffering measures.
- Hydrological characters shall be under analysis concerning the river reach where the works is located, with prediction of impact from works construction upon aquatic environment, including pollutant discharge, impact regions, above-norm range and impact degree, etc, in line with such parameters as dredging, reef exploitation, and earthwork volume.
- Assessment shall be made concerning risk of aquatic environment in line with relevant assessment stipulations, to determine the environmental rationality between the terminal layout and berth of hazardous articles, with prediction concerning pollution range, degree and impact upon targeted objects.

Acoustical Environment
Assessment concerning acoustical environment is made mainly by prediction in line with relevant standards and regulations, to predict the impact range and degree from noise upon sensitive objects.

Solid Waste
Quantitative calculation shall be made concerning various solid wastes to formulate effective measures concerning management, collection and disposal thereof during construction stage.

Soil Conservation
Water conservation proposals shall be made for works of terminals and navigation channel construction in line with requirement concerning contents and depth of such conservation, to the satisfaction of water conservation laws and technical specifications.

- Social Environment
- Protection of Land & Bulkhead Line Resources
  In line with the planning and design in the lower level concerning specific works, acquisition of land, especially of farmland, shall be under analysis to forward specific measures for protection of such resource. Assessment shall be made concerning bulkhead line resources to make proposals concerning optimized programs in terms of environment protection.

- Flood Control
  Compatibility shall be analyzed concerning planning or construction works with flood control objectives, to make proposals concerning site selection of hydraulic structures and structure forms from the eye of flood control.

- Resettlement
  Detailed analysis shall be made concerning resettlement orientation and manners, with preliminary programs for resettlement.

- Preservation of Cultural Relics
  Preservation of cultural relics shall be proposed upon the basis of detailed investigation concerning works in the next stage.

4.1.4.4 Issues for Attention in Shihutang Project

- Site selection shall be carefully made to avoid any impact upon drinking water conservation district.

- For any works that might involve nature reserves, all measures shall be adopted to avoid the core and buffering regions of the reserve as well as the experiment zones. In case of impossibility to do so, negative impact shall be reduced to the minimum by performance and construction in proper seasons and proper process.

- Construction schedule shall be proper so that underwater operation will be mostly made in dry seasons.

- Night whistling shall be under regulation for ships close to urban areas to avoid any noise pollution to nearby residents.

- There shall be special ships responsible for collection of floating objects in the main channel to strengthen management of such waste.
Coordination shall be enhanced with department of fishery administration to improve comprehensive benefits of water resources. For lock and dam construction in the migration passage of fish, shrimp and crabs, if such construction will produce severe impact, there shall be fish pass facilities or other measures to resume fishing resources as soon as possible.

Resettlement shall be properly and reasonably made to guarantee sustainable development in the resettlement regions.

Salvage and aid system shall be perfected. With improvement in navigation and increase in numbers of transportation ships, salvage and aid organization shall be enhanced equipped with relevant facilities, for the sake of effective salvage and assistance.

4.1.5 Coordination with Urban Master Plan of Taihe County 1999-2020

Urban Master Plan of Taihe County 1999-2020 says that

Taihe will develop into the political, economic and cultural center of the county, with focus on food handling and village construction, in addition to tourism and trade.

Orientation: north of Chengjiang and south of Wentian will be united into one, with control on development eastward or westward.

Taihe city general layout is “double sector” group type in urban layout. The city is divided into two districts and 8 groups for close structure, definite function definition and coordinative development. Wentian District: made up of such group as Guihua Group, Baifeng Group, and Luohu Group, to total 10.23 km$^2$, to function as transport junction and door to Jinggangshan and economic development zone. Chengjiang District: consisting of Laochen Group, Center Group, Chengjiang Group, Gongxi Group, and Nanmeng Group, to total 9.42 km$^2$, to function as cultural, educational and resident center.

For detail of Urban Master Plan of Taihe County 1999-2020, see Attached Drawing 23.

Water Supply Planning

Daily water demand in Taihe County totaled 8×104t in 2005. According to the planning, the Wentian Water Plant and the Chengjiang Water Plant will be under expansion, so that daily water supply capacity reaches 6×104t/d and 2×104t/d respectively. Far planning says that Shangtian Water Plant will be constructed on the northern side of State Highway No 105, to have a capacity of 4×104t/d; while Chengjiang Water Plant will be expanded in the second stage to have a capacity of 5×104t/d. Then there will be three water plants, with a capacity of 6×104t/d, of which Chengjiang Water Plant contributes 5×104t/d; Shangtian 4×104t/d, to have a total capacity of 15×104t/d.

For detail of urban water supply planning 1999-2020, see Attached Drawing 24.

Draining Scheme
If calculated at 80% of daily water consumption, then urban domestic sewage will total 6.4×10^4 t/d, or 12×10^4 t/d in 2020.

Chengjiang Domestic Sewage Treatment Works is planned for construction on the east of Jinggangshan Street and No One Draining Gulch, while Wentian Domestic Sewage Treatment Works will be constructed on the east side of the Beijing-Kowloon Railway. Designed capacity for the two plants reaches 1.5×10^4 t/d and 3×10^4 t/d respectively to handle 60% and 80% of urban domestic sewage with a planning capacity of 5×10^4 t/d and 7×10^4 t/d to handle 100%. Domestic sewage is under second treatment in the two plants, with treated water to be discharged to Kan River.

For detail of urban draining in Taihe County 1999-2020, see Attached Drawing 25. The Shihutang Project is located outside of Taihe County Town, beyond the master plan of Taihe Master Plan. Existing flood control for the dykes along the planed Project is determined at 5-year recurrence, with a large section of the city under no embankment protection. Flood control works in this Project will greatly improve flood control capacity along the reservoir, to improve the 2-3-year recurrence flood to 10-20-year recurrence flood (20-year recurrence flood in Taihe County Town).

Execution of this Project will greatly improve local finance, navigation and produce certain benefit in power generation, beneficial to local economy. After completion the Project will offer financial assurance to achievement of Urban Master Plan of Taihe County, of water Supply Planning and Domestic sewage Draining Planning in Taihe County.

The dam side is far away from the intake and water conservation district in Taihe County, in line with relevant laws and regulations, with limited impact upon water quality. After reservoir filling the water level will be increased to transform some part of land into water body, but water volume will increase in the reservoir backwater body, thus to improve dilution. But due to slow water movement in this reach, it is unfavorable for pollutants to scatter and self-purification, so that pollutant intensity near the domestic sewage discharge will rise.

The Shihutang Project is in line with Master Plan of Taihe County 1999-2020 as a whole.

4.1.6 Analysis of Coordination with Urban Environmental Protection in Taihe County 1999-2020

Urban Environmental Protection in Taihe County 1999-2020 says that:

Domestic sewage treatment is determined at Grade II, with 60% to 80% of domestic sewage under treatment in the near future and 100% in far future. After treatment the water will be discharged directly into Kan River.
4.0 Plan Harmony Analysis & Environment Alternatives Comparison

95% of waste will be transported while 70% under non-hazardous treatment in the near future and 90% in far future. Of industrial and medical hazardous waste, 80% will be under treatment in the near and 100% in far future.

For detail of environmental function classification see Attached Drawing 26. The project construction will produce some pollution to local environment, but necessary and proper measures will minimize such impact. During operation, there shall be proper environment protection measures and monitor to keep in line with the Urban Environmental Protection in Taihe County 1999-2020. Construction of this Project is in line with Urban Environmental Protection in Taihe County 1999-2020 and environment function classification in Taihe County.

4.1.7 Analysis of Coordination with Jiangxi Provinicial Surface Water (Environment) Function Zoning (1999-2020)

Jiangxi Provinicial Surface Water (Environment) Function Zoning (1999-2020) says that: The water environment function zone of the Kan River section where the Shihutang Dam Site is situated belongs to reserved zone; The water environment function zone of the Kan River section where the Shihutang reservoir area is situated belongs to reserved zone, industrial water zone, drinking water source protected zone; the Kan River section within 33km downstream of the dam site belongs to reserved zone and drinking water source protected zone.

Dam construction will cause a certain water environment pollution to the Kan River section where the dam site is located. After necessary environment protection measures are taken, impacts of the dam construction on water environment can be minimized, basically without causing pollution impacts on drinking water source protected zone upstream and downstream of the dam site. During operation, necessary environment protection measures will be taken and environment management and monitoring plan will be framed and executed, which can minimize the impacts of project operation on the environment. Implementation of this project will not change the water environment function of the Kan River section where the project is located and can meet the requirements of Jiangxi Provinicial Surface Water (Environment) Function Zoning (1999-2020).

In a word, Shihutang Project satisfies relevant planning and regulations.

4.2 Environmental Alternative Options

4.2.1 Dam Site Environmental Options

4.2.1.1 Engineering Comparison of Dam Site
The Project makes a comparison between upper stream site in Shihutang and downstream site in Fangzhou. For detail of engineering design see Table 4.2-1; for detail of engineering volume, see Table 4.2-2.

Both the upper site and downstream site enjoy geological conditions for construction of dam and locks of low and medium water head. In comparison, the upper site enjoys better topography and geological conditions, with more advantages in construction conditions of ship lock, sluice gate and powerhouse operation and construction diversion and temporary navigation. The downstream site suffers from worse geological conditions and challenging geological conditions, unfavorable for engineering layout and for increase in construction of 5-km-long flood control dyke, in resettlement and land inundation, thus to increase investment.

Comprehensive comparison determines the upper stream site (Shihutang site) as recommended site.
### Table 4.2 Comparison of Dam Site

<table>
<thead>
<tr>
<th>Item</th>
<th>Upper Stream Site (Shihutang)</th>
<th>Down Stream Site (Fangzhou)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topography</td>
<td>Located at the downstream of S-type stream, with a width of about 1150m.</td>
<td>Located at the downstream of sharp bend stream, with a width of about 600m.</td>
</tr>
<tr>
<td>Geological structure</td>
<td>With 4 developed faults, with rather developed joint fissure and intercalated weak seam. No developed cast.</td>
<td>With one fault and developed joint fissure and carst caves and rock holes.</td>
</tr>
<tr>
<td>Geological Problems</td>
<td>No developed dissolved caves or carst caves; developed joint fissures.</td>
<td>Developed dissolved caves and carst caves; rather developed joint fissures.</td>
</tr>
<tr>
<td></td>
<td>Both dam sites are desirable for water retaining structure construction of medium or low water head. In comparison, the upper stream site enjoys wider valley, thus favorable for layout of sluice structure; there are more challenges in the downstream site.</td>
<td>Both sites meet the need for layout of pivotal structure, with both sluice gats located at the middle of the channel. In comparison, the upper stream site enjoys better topography and both the lock and the power house enjoys better operation conditions; while the downstream site requires too much excavation with much larger engineering volume in foundation treatment.</td>
</tr>
<tr>
<td>Layout &amp; Operation Conditions</td>
<td>Though closer to the bend in the upper stream, the upper stream site may achieve smooth connection between the approach channel and the main channel. Some engineering shall be made upon the right bank gulch, to avoid any danger to the approach channel wall; the power house intake and outlet enjoys smooth connection with the upper and downstream channel.</td>
<td>The downstream channel is relatively narrower to satisfy the need for sluice structure, the right bank lock and power house requires larger range of excavation; the dam site is too close to the sharp bend, there is difficulty in layout of upper stream and downstream approach channel. The sluice gate on the left bank suffers impact from a stream, and its foundation will suffer from limestone carst.</td>
</tr>
<tr>
<td>Reservoir Inundation</td>
<td>It is about 6km from the upper site to the downstream site, with basically the same catchment area and hydrological properties. Both the downstream site will mean an increased land inundation by 4545 mu and affected population by 923. In terms of reservoir protection works, the Wanhe Draining Gulch and flood control dyke will mean an increase in investment by 47.60 million Yuan. Meanwhile the upper stream site demands less acquisition of land.</td>
<td></td>
</tr>
</tbody>
</table>
4.2.1.2 Environmental Comparison & Selection of Dam Site Schemes

The upper dam site scheme (Shihutang) and down dam site scheme designed by the engineering contractor are applied for comparison. See Table 4.2.2.

From the angle of environment protection, both the upper dam site scheme and the down dam site scheme are environmentally feasible. Through integrated environment comparison, this EIA recommends the upper dam site scheme from the angle of environment protection, which is the same as the scheme recommended by the engineering contractor.

### Table 4.2.2 Major Engineering Volume between Upper & Downstream Site

<table>
<thead>
<tr>
<th></th>
<th>Upper Site</th>
<th>Downstream Site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right ship lock &amp; left power house</td>
<td>Right ship lock &amp; right power house</td>
</tr>
<tr>
<td></td>
<td>Dam power house Ship lock Total</td>
<td>Dam power house Ship lock Total</td>
</tr>
<tr>
<td>Earthwork ×10^4 m³</td>
<td>53.75</td>
<td>153.87</td>
</tr>
<tr>
<td>Backfill ×10^4 m³</td>
<td>92.09</td>
<td>11.71</td>
</tr>
</tbody>
</table>
### Table 4.2/3 Environmental Comparison & Selection of Dam Site Schemes

<table>
<thead>
<tr>
<th>Item</th>
<th>Down Dam Site (Fangzhou)</th>
<th>Upper Dam Site (Shihutang)</th>
<th>Environmental Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resettled population Person</td>
<td>1634</td>
<td>711</td>
<td>The Upper Dam Site is obviously superior to the Down Dam Site</td>
</tr>
<tr>
<td>Relocated Housing m²</td>
<td>77923.40</td>
<td>41176.50</td>
<td>ditto</td>
</tr>
<tr>
<td>Permanently occupied land area mu</td>
<td>49611.4</td>
<td>42050.1</td>
<td>ditto</td>
</tr>
<tr>
<td>Permanent acquisition of farmland mu</td>
<td>7826.86</td>
<td>2977.3</td>
<td>ditto</td>
</tr>
<tr>
<td>Acquisition of basic farmland mu</td>
<td>680</td>
<td>198.27</td>
<td>ditto</td>
</tr>
<tr>
<td>Earthwork 10³m³</td>
<td>317.47</td>
<td>272.19</td>
<td>ditto</td>
</tr>
<tr>
<td>Quantity of relocation of other facilities</td>
<td>The downstream site: superior</td>
<td></td>
<td>ditto</td>
</tr>
<tr>
<td>Aquatic environment protection objects</td>
<td>The upper dam site is far away from intake and water conservation districts, in line with relevant laws and regulations. The down dam site is 6.0km more far away from the intake and water conservation districts than the upper dam site.</td>
<td>The Down Dam Site is slightly superior to the Upper Dam Site</td>
<td></td>
</tr>
<tr>
<td>Ecological environment protection objects</td>
<td>There are 200 camphor trees for protection in the upper dam site and slightly more in the down dam site.</td>
<td>The Upper Dam Site is slightly superior to the Down Dam Site</td>
<td></td>
</tr>
<tr>
<td>Hydrological properties</td>
<td>The upper dam site is 6km away from the down dam site, with basically the same catchment area and hydrological properties.</td>
<td>Basically identical.</td>
<td></td>
</tr>
<tr>
<td>Water &amp; soil Conservation</td>
<td>The down dam site requires larger range of excavation, with an increase in flood control dyke by 5 km, more borrow and spoil, to produce more water loss and soil erosion.</td>
<td>The Upper Dam Site is obviously superior to the Down Dam Site</td>
<td></td>
</tr>
<tr>
<td>Temporary acquisition of land</td>
<td>The down dam site suffers from more spoil and excavation volume, thus it requires greater land for borrow and spoil. The down dam site has larger engineering volume, thus in need of larger area for temporary acquisition of land for construction.</td>
<td>The Upper Dam Site is obviously superior to the Down Dam Site</td>
<td></td>
</tr>
<tr>
<td>Ecological impact</td>
<td>The down dam site suffers from acquisition of more farmland and woodland, thus to produce more bio-loss and crop loss.</td>
<td>The Upper Dam Site is obviously superior to the Down Dam Site</td>
<td></td>
</tr>
</tbody>
</table>
4.0 Plan Harmony Analysis & Environment Alternatives Comparison

<table>
<thead>
<tr>
<th>Maximum acceptable contamination [MAC]</th>
<th>The down dam site enjoys larger water body and environmental capacity, thus it has larger MAC.</th>
<th>The Down Dam Site is superior to the Upper Dam Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>In terms of environmental protection, both are environmentally feasible, through integrated environmental comparison, the Upper Dam Site is superior to the Down Dam Site.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommendation</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

4.2.2 Environmental Comparison & Selection of Recommended Dam Site

4.2.2.1 Engineering Comparison & Selection

Engineering design is made on the basis of the recommended site with proposal of upper and downstream dam. See Table 4.2-4.

After comprehensive comparison, the upper dam is selected.

4.2.2.2 Environmental Comparison & Selection

The upper dam and the downstream dam site are 500m away, with basically the same environmental factors. But due to difficulty in approach channel for the ships during operation there will be more risks of marine incidents in the downstream site, therefore the upper site is under recommendation.

Table 4.2-4 Comparison & Selection of Recommended Dam Site

<table>
<thead>
<tr>
<th>Item</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology</td>
<td>According to geological boring, the upper and the downstream dam site have almost identical geological conditions, with no large range of sandstone. But the lower head of the downstream site is closer to F1 fault, unfavorable for stability of the structure. Meanwhile, the bedrock exposed in the right bank of the downstream dam axis is lower in elevation than in the upper stream, there will be more concrete engineering volume in gate dam and ship lock.</td>
</tr>
<tr>
<td>General layout</td>
<td>Both the upper and the downstream dam axis satisfy the need for general layout of the structure, but the downstream dam axis is closer to the rather bending channel, thus unfavorable for approach channel, to create difficulty for ships to approach the lock.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Both the upper and the downstream dam axis satisfy the need for general layout of the structure, but in terms of topography, geology and general layout of the structure, the upper dam axis is superior, thus under recommendation.</td>
</tr>
</tbody>
</table>

4.2.3 Environmental Comparison & Selection of Water Line

4.2.3.1 Engineering Comparison of Water Line

Against the normal water level the Project proposed four water levels, namely 56.0m, 56.2m, 56.5m, and 56.8m. Of the four proposals, the Shihutang project enjoys identical design flood
level and check flood level in the reservoir and other permanent structure. In terms of 
satisfaction of navigation, power generation, inundation index in kind, and economic 
evaluation index, in terms of impact upon cascade power plant in Taihe and upon Taihe 
County Town, a comprehensive comparison is made upon the four normal water levels, to
determine the water level at 56.5m as recommended normal water level.

Major engineering and economic index in Shihutang Project is listed in Table 4.2—5.

Table 4.2—5 Major Engineering & Economic Index in Shihutang Project

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Scheme 1</th>
<th>Scheme 2</th>
<th>Scheme 3</th>
<th>Scheme 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal water level</td>
<td>Huanghai·m</td>
<td>56.0</td>
<td>56.2</td>
<td>56.5</td>
<td>56.8</td>
</tr>
<tr>
<td>Installed capacity</td>
<td>MW</td>
<td>105</td>
<td>110.4</td>
<td>117</td>
<td>123</td>
</tr>
<tr>
<td>Decrease in power generation in Taihe</td>
<td>104kW·h</td>
<td>0</td>
<td>109</td>
<td>590</td>
<td>1284</td>
</tr>
<tr>
<td>Decrease in average Water Head in Taihe</td>
<td>m</td>
<td>0</td>
<td>0.02</td>
<td>0.11</td>
<td>0.20</td>
</tr>
<tr>
<td>Resettlement after completion</td>
<td>Persons</td>
<td>711</td>
<td>711</td>
<td>711</td>
<td>1004</td>
</tr>
<tr>
<td>Inundated farmland after completion</td>
<td>Mu</td>
<td>3219.6</td>
<td>3331.2</td>
<td>2977.3</td>
<td>3715.1</td>
</tr>
</tbody>
</table>

4.2.3.2 Environmental Comparison & Selection of Water Line
For detail of environmental comparison and selection of water line in Shihutang Project see Table 4.2—6.

After comparison at the four water levels, the Report makes recommendation from the eye of 
environmental protection at 56.5m as normal water level, identical to the level concluded 
from engineering design.

4.2.4 Environmental Comparison & Selection of General Layout of Structure

4.2.4.1 Engineering Comparison & Selection of Recommended Dam Site & General Layout

There are two schemes concerning general layout of the structure, which are:
Scheme I: with the ship lock located on the right bank and the powerhouse on the left.

In accordance with the features of the topography, the ship lock will be located on the right 
shore with the approach channel made up of the concave bank; 21 spillway gates and 3 sand 
sluicing gates will be located in good order in the left main channel adjacent to the ship lock; 
there will be a powerhouse of 5 sets of generators located on the left bank adjacent to the 
sand sluicing gates. The right bank and the left bank are under connection from earth and 
rockfill dam and bank slope.
Scheme II: with the ship lock and the power house located on the right bank

The ship lock will be located on the right shore and a power house of 5 sets of generators adjacent to the ship lock, followed by 21 spillway gates and 3 sand sluicing gates. The right and the left bank are under connection from earth and rockfill dam and bank slope.

The right bank and the left bank are under connection from earth and rockfill dam and bank slope.

For detail of quantities of main works, see Table 4.2\[7\].

After comprehensive comparison, there seems to be no obvious disadvantages for both schemes. In terms of investment and intervention during construction stage and convenient operation, Scheme I is under recommendation.

Table 4.2\[7\] Quantities of Main Works

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Scheme I</th>
<th>Scheme II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthwork</td>
<td>10^4 m³</td>
<td>272.19</td>
<td>309.36</td>
</tr>
<tr>
<td>Backfill</td>
<td></td>
<td>131.66</td>
<td>124.15</td>
</tr>
</tbody>
</table>

4.2.4.2 Environmental Comparison & Selection of Layout

For detail of such comparison and selection see Table 4.2\[8\].

After environmental comparison and selection of general layout, this report recommends Scheme I, identical to the scheme out of engineering comparison.
### Table 4.26 Environmental Comparison & Selection of Normal Water Level in Shihutang Project

<table>
<thead>
<tr>
<th>EL（Yellow Sea Elevation）m</th>
<th>Environ-influence factor</th>
<th>Probability of Marine Incidents &amp; Environmental Risks</th>
<th>Water utilization factor %</th>
<th>Impact upon draining in Taihe County Town m compared with the scheme at 56.11m</th>
<th>Annual average shipping economics 10^4 Yuan</th>
<th>Environmental comparison</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>56.0</td>
<td></td>
<td>In case of no fluctuation of water level in the upper dam, the level basically meets the need for navigation. In case of synchronous peak modulation with Wan’an Hydro-power Station, water level will decrease by 0.2~0.3m, in this case normal water level does meet the need for navigation, so there is great probability for marine incidents and environmental risks.</td>
<td>78.92</td>
<td>0</td>
<td>6096.9</td>
<td>The major purpose of this Project is to construct a Grade III channel, while two schemes fail to satisfy the need for navigation due to shallow water depth, to invite great probability for marine incidents and environmental risks. There is no meaning in such works.</td>
<td>No</td>
</tr>
<tr>
<td>56.2</td>
<td></td>
<td>The water level meets the need for Grade III channel, so there is little probability for marine incidents or environmental risks.</td>
<td>79.05</td>
<td>0.02</td>
<td>6096.9</td>
<td>56.5m~56.8m</td>
<td>No</td>
</tr>
<tr>
<td>56.5</td>
<td></td>
<td>When the normal water level is 56.5m and 56.8m, both schemes are ideal; scheme at 56.2m is superior to scheme at 56.0m: while both schemes are undesirable.</td>
<td>79.03</td>
<td>0.11</td>
<td>6096.9</td>
<td>56.0m<del>56.2m</del>56.5m~56.8m</td>
<td>No</td>
</tr>
<tr>
<td>56.8</td>
<td></td>
<td>56.8m<del>56.5m</del>56.2m~56.0m</td>
<td>78.93</td>
<td>0.20</td>
<td>6096.9</td>
<td>56.2m<del>56.5m</del>56.8m~56.0m</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Basically identical</td>
<td>1004</td>
<td>56.0m<del>56.2m</del>56.5m~56.8m</td>
<td>6096.9</td>
<td>56.5m~56.8m</td>
<td>No</td>
</tr>
</tbody>
</table>

- **Installed capacity（MW）**: 105, 110.4, 117, 123
- **Permanent land acquisition (41546.1, 41818.5, 42050.1, 42883.6)**
- **Permanent farmland acquisition (3119.56, 3216.76, 2977.3, 3486.06)**
- **Quantities of removal and other facilities**: Basically identical for four schemes
- **Resettlement after completion (711)**
- **Impact upon draining in Taihe County Town compared with the scheme at 56.11m**: 0, 0.02, 0.11, 0.20
- **Annual average shipping economics 10^4 Yuan**: 6096.9, 6096.9, 6096.9, 6096.9
- **Environmental comparison**: The major purpose of this Project is to construct a Grade III channel, while two schemes fail to satisfy the need for navigation due to shallow water depth, to invite great probability for marine incidents and environmental risks. There is no meaning in such works.
Table 4.2-8  Environmental Comparison & Selection of Layout

<table>
<thead>
<tr>
<th>Items</th>
<th>Scheme I</th>
<th>Scheme II</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthworks</td>
<td>272.19</td>
<td>309.36</td>
<td>Scheme I: superior</td>
</tr>
<tr>
<td>Land for spoil</td>
<td>Scheme I will mean acquisition of less land by 100 \textit{mu} than Scheme II.</td>
<td>Scheme I: superior</td>
<td></td>
</tr>
<tr>
<td>Eco-impact</td>
<td>Scheme II will create more loss to vegetation than Scheme I.</td>
<td>Scheme I: superior</td>
<td></td>
</tr>
<tr>
<td>Impact upon ambient air</td>
<td>Due to greater earthworks in Scheme II, more dust during construction and along the construction roads will be created.</td>
<td>Scheme I: superior</td>
<td></td>
</tr>
<tr>
<td>Impact upon acoustics</td>
<td>Due to greater earthworks in Scheme II, more noise during construction and more traffic noise will be created.</td>
<td>Scheme I: superior</td>
<td></td>
</tr>
<tr>
<td>water and soil conservation</td>
<td>There will be more water loss and soil erosion in Scheme II.</td>
<td>Scheme I: superior</td>
<td></td>
</tr>
<tr>
<td>Conclusion</td>
<td>Both Scheme I and Scheme II are feasible from the eye of environmental protection. Comprehensive comparison concludes that Scheme I is superior to Scheme II.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Recommendation? Yes No

4.2.5 Environmental Comparison & Selection of Ship Lock Dimensions

4.2.5.1 Engineering Comparison & Selection of Ship Lock Dimensions

Three schemes are offered in engineering design concerning the size of ship lock.

- **Scheme I**: effective Dimensions at 180×23×3.5m
- **Scheme II**: effective Dimensions at 260×18×3.5m
- **Scheme III**: effective Dimensions at 260×16×3.5m

Comparison of the three schemes are listed in Table 4.2-9.

Table 4.2-9  Comparison of Ship Lock Dimension

<table>
<thead>
<tr>
<th>No</th>
<th>Comparison</th>
<th>Scheme I</th>
<th>Scheme II</th>
<th>Scheme III</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Trafficability</td>
<td>Near future</td>
<td>5.09 million ton</td>
<td>4.85 million ton</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Far future</td>
<td>8.27 million ton</td>
<td>7.80 million ton</td>
</tr>
<tr>
<td>2</td>
<td>Water consumption</td>
<td>Near future</td>
<td>11.24 m$^3$/s</td>
<td>12.04 m$^3$/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Far future</td>
<td>15.31 m$^3$/s</td>
<td>16.16 m$^3$/s</td>
</tr>
</tbody>
</table>

Comprehensive comparison concluded that the three schemes all satisfy the need for passing dam volume and for shipping programs until 2020 and 2030. While Scheme II and III recommend an effective dimension of 260m for the ship lock, with more investment, only to
allow one line of ship passing once due to limited width of the lock. Scheme I is superior to other schemes in passing capacity, layout and investment.

Ship lock dimension in Scheme I: it consists of a ship lock of three cascades, with an effective dimension of 180×23×3.5m (Effective L×Effective W×Depth), with an annual passing capacity of 5.09 million ton in 2020 and 8.27 million ton in 2030.

4.2.5.2 Environmental Comparison & Selection of Ship Lock Dimensions

For detail of such comparison see Table 4.2-10.

In terms of environmental protection, both Scheme II and III are feasible, while Scheme I is superior to the other two schemes. Therefore Scheme I 180×23×3.5m is recommended, the same conclusion as out of engineering design.

Table 4.2-10  Environmental Comparison & Selection of Ship Lock Dimensions

<table>
<thead>
<tr>
<th>Items</th>
<th>Contents</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthworks</td>
<td>Earthworks in Scheme I is far less than in Scheme II or Scheme III.</td>
<td>Scheme I: obviously superior to Scheme II and III.</td>
</tr>
<tr>
<td>Land for spoil</td>
<td>Land for spoil in Scheme I is far less than in Scheme II and III.</td>
<td>Scheme I: obviously superior to Scheme II and III.</td>
</tr>
<tr>
<td>Eco-impact</td>
<td>More vegetation loss due to lock excavation and land for spoil is larger in Scheme II and III than in Scheme I.</td>
<td>Scheme I: obviously superior to Scheme II and III.</td>
</tr>
<tr>
<td>Air impact</td>
<td>Earthworks in Scheme II and III are far larger than in Scheme I, there will be more dust during construction and along the road.</td>
<td>Scheme I: obviously superior to Scheme II and III.</td>
</tr>
<tr>
<td>Acoustic impact</td>
<td>Earthworks in Scheme II and III are far larger than in Scheme I: there will be more noise during construction.</td>
<td>Scheme I: obviously superior to Scheme II and III.</td>
</tr>
<tr>
<td>Water conservation</td>
<td>Scheme II and III will produce more water loss and soil erosion.</td>
<td>Scheme I: obviously superior to Scheme II and III.</td>
</tr>
<tr>
<td>Passing capacity</td>
<td>Scheme I enjoys more passing capacity than Scheme II and III and shortens the passing duration. In waiting for passing, less waste fume and noise is produced in Scheme I than in Scheme II and III.</td>
<td>Scheme I: obviously superior to Scheme II and III.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Both Scheme II and III are feasible from the eye of environmental protection. Comprehensive comparison concludes that Scheme I is superior to Scheme II and III.</td>
<td></td>
</tr>
<tr>
<td>Recommendation</td>
<td>Scheme I</td>
<td></td>
</tr>
</tbody>
</table>

4.2.6 Environmental Comparison & Selection of Ship Lock Chamber’s Clear width
4.2.6.1 Engineering Comparison of Lock Chamber’s Clear width
There are three schemes concerning lock Chamber’s clear width, namely 15m, 20m and 22m. For detail of bills of quantities corresponding to the three schemes see Table 4.2-11.

Engineering design concludes that with increase in clear width there will be less investment. But if the lock chamber is more than 20m in width, there will be increase in bills of quantities and investment, mainly due to increase in cost out of lock concrete and metal structure and hoisting device. Taking all into consideration, Scheme II is recommended as clear width.

4.2.6.2 Environmental Comparison & Selection of Ship Lock Clear width
For detail of comparison of lock chamber clear width, see Table 4.2-12. a comparison is made of the three schemes, namely Scheme I 15m, Scheme II 20m and Scheme III 22m, to recommend Scheme II, identical to conclusion out of engineering design.

**Table 4.2-11 Comparison of Bill of Quantities & Direct Investment of Chamber Clear Width**

<table>
<thead>
<tr>
<th>Items</th>
<th>Unit</th>
<th>Scheme I 15m</th>
<th>Scheme II 20m</th>
<th>Scheme III 22m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthworks</td>
<td>(10^4 \text{ m}^3)</td>
<td>41.88</td>
<td>38.49</td>
<td>39.45</td>
</tr>
<tr>
<td>Backfill</td>
<td>(10^4 \text{ m}^3)</td>
<td>2.56</td>
<td>2.41</td>
<td>2.42</td>
</tr>
</tbody>
</table>
Table 4.2.12  Environmental Comparison & Selection of Ship Lock Chamber Clear Width

<table>
<thead>
<tr>
<th>Items</th>
<th>Contents</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthworks</td>
<td>Earthworks in Scheme II are slightly less than in Scheme Scheme III or I.</td>
<td>Scheme II is slightly superior to Scheme I or III.</td>
</tr>
<tr>
<td>Land for spoil</td>
<td>Land for spoil in Scheme I is slightly less than in Scheme II or Scheme III.</td>
<td>Scheme I is slightly superior to Scheme II or III.</td>
</tr>
<tr>
<td>Eco-impact</td>
<td>More vegetation loss due to lock excavation and land for spoil is larger in Scheme I and III than in Scheme II.</td>
<td>Scheme II is slightly superior to Scheme I or III.</td>
</tr>
<tr>
<td>Impact upon ambient air</td>
<td>Due to larger earthworks in Scheme I and III, there will be more dust during construction and along the road in Scheme I or III than in Scheme II.</td>
<td>Scheme II is slightly superior to Scheme I or III.</td>
</tr>
<tr>
<td>Impact upon acoustics</td>
<td>Earthworks in Scheme I and III are far larger than in Scheme II, there will be more noise during construction.</td>
<td>Scheme II is slightly superior to Scheme I or III.</td>
</tr>
<tr>
<td>water and soil conservation</td>
<td>Scheme I and III will produce more water loss and soil erosion than in Scheme II.</td>
<td>Scheme II is slightly superior to Scheme I or III.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>Both Scheme I and III are feasible from the eye of environmental protection. Comprehensive comparison concludes that Scheme II is superior to Scheme I and III.</td>
<td>Scheme II</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Scheme II</td>
<td></td>
</tr>
</tbody>
</table>

4.2.7 Environmental Comparison & Selection of Flood Control Works
There will be flood control works in such five districts as Taihe County Town, Wanhe, Yongchang, Yanxi and Zhangtang. Comparison is made of various schemes concerning flood control and numerous schemes.

4.2.7.1 Environmental Comparison & Selection of Flood Control Works in Zhangtang
There are two schemes in engineering design in Zhangtang concerning flood control and inundation, with Scheme I under recommendation.

For detail of environmental comparison of various schemes, see Table 4.2-13. Out of comparison of two schemes involving flood control or inundation, this report recommends Scheme I (flood control), the same conclusion as out of engineering design.

Table 4.2.13  Environmental Comparison & Selection of Flood Control Works in Zhangtang

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme I (flood control)</th>
<th>Scheme II (Inundation)</th>
<th>Conclusion</th>
</tr>
</thead>
</table>
### 4.0 Plan Harmony Analysis & Environment Alternatives Comparison

#### 4.2.7.2 Environmental Comparison & Selection of Flood Control Works in Taihe County Town

Comparison is made of two schemes concerning flood control and inundation in Taihe County Town, with Scheme I (flood control) for recommendation.

For detail of environmental comparison of the two schemes, see Table 4.2-14. Out of comparison of two schemes involving flood control or inundation, this report recommends Scheme I (flood control), the same conclusion as out of engineering design.

#### Table 4.2-14 Environmental Comparison & Selection of Flood Control Works in Taihe County Town

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme I (flood control)</th>
<th>Scheme II (Inundation)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection benefit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection area(\text{km}^2)</td>
<td>10.98</td>
<td>11.16</td>
<td></td>
</tr>
<tr>
<td>Inundation area(\text{km}^2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10^4) persons</td>
<td>0.325</td>
<td>0.33</td>
<td>Scheme I is obviously better than Scheme II, Scheme II is not feasible.</td>
</tr>
<tr>
<td>Farmland (10^4) mu</td>
<td>0.747</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Population (10^4)</td>
<td>0.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing (10^4) m(^2)</td>
<td>14.74</td>
<td>14.93</td>
<td></td>
</tr>
<tr>
<td>Earthworks (10^4) m(^3)</td>
<td>68.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquisition of land (\text{mu})</td>
<td>168.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmland (\text{mu})</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (10^4)</td>
<td>0.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing (10^4) m(^2)</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmland (10^4) mu</td>
<td>0.056</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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4.2.7.3 Environmental Comparison & Selection of Flood Control Works in Wanhe

Comparison is made of two schemes concerning flood control and inundation in Wanhe Flood Control District, with Scheme I (flood control) for recommendation.

For detail of environmental comparison of the two schemes, see Table 4.2-15.

Out of comparison of two schemes involving flood control or inundation, this report recommends Scheme I (flood control), the same conclusion as out of engineering design.

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme I (flood control)</th>
<th>Scheme II (Inundation)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection area (km²)</td>
<td>27.98</td>
<td>28.43</td>
<td>Scheme I is obviously better than Schene II.</td>
</tr>
<tr>
<td>$10^4$ persons</td>
<td>1.84</td>
<td>1.9</td>
<td>Scheme II is not feasible.</td>
</tr>
<tr>
<td>Earthworks ($10^4$m³)</td>
<td>105.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquisition of land ($mu$)</td>
<td>266</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmland ($mu$)</td>
<td>0.014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmland inundated ($10^4$ $mu$)</td>
<td>0.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing ($10^4$m²)</td>
<td>505.03</td>
<td>505.03</td>
<td></td>
</tr>
<tr>
<td>Inundation will affect population ($10^4$)</td>
<td>8.21</td>
<td>8.21</td>
<td></td>
</tr>
</tbody>
</table>
### Environmental Comparison & Selection of Flood Control Works in Yanxi

Comparison is made of two schemes concerning flood control and inundation in the Yanxi protection area, with Scheme I (flood control) for recommendation.

For detail of environmental comparison of the two schemes, see Table 4.2-16.

Out of comparison of two schemes involving flood control or inundation, this report recommends Scheme I (flood control), the same conclusion as out of engineering design. For detail see Table 4.2—17.

#### Table 4.2-16  Environmental Comparison & Selection of Flood Control Works in Yanxi

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme I (flood control)</th>
<th>Scheme II (Inundation)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection benefit</td>
<td>Protection area (\text{km}^2)</td>
<td>9.41</td>
<td>Inundation area (\text{km}^2)</td>
</tr>
<tr>
<td></td>
<td>(10^4) persons</td>
<td>0.493</td>
<td>Inundation will affect population(10^4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scheme I is obviously better than Scheme II, Scheme II is</td>
</tr>
</tbody>
</table>

| Bill of quantity      | Earthworks \(10^4\text{m}^3\) | 70.48                  | Acquisition of land \(\text{mu}\) | 663                      |
| AFFECTED substance    | Population\(10^4\)            | 0.06                   | Housing \(10^4\text{m}^2\)        | 3.97                     |
|                       | Farmland \(\text{mu}\)       | 0.027                  |                                    |                          |
## 4.0 Plan Harmony Analysis & Environment Alternatives Comparison

### Farmland Inundation Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme I (flood control)</th>
<th>Scheme II (Inundation)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Farmland</strong> &amp; <strong>Housing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmland $\times 10^4$ mu</td>
<td>0.91</td>
<td>0.94</td>
<td>not feasible.</td>
</tr>
<tr>
<td>Housing $\times 10^4$ m$^2$</td>
<td>22.16</td>
<td>25.57</td>
<td></td>
</tr>
</tbody>
</table>

### Earthworks Bill of Quantity

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme I (flood control)</th>
<th>Scheme II (Inundation)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthworks $\times 10^4$m$^3$</td>
<td>42.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acquisition of land $\times$ mu</td>
<td>930</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Affected Substances

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme I (flood control)</th>
<th>Scheme II (Inundation)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population $\times 10^4$</td>
<td>0.067</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing $\times 10^4$m$^2$</td>
<td>3.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmland $\times$ mu</td>
<td>0.032</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Engineering Conclusion

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme I (flood control)</th>
<th>Scheme II (Inundation)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme II will mean too much inundation of arable land with too many people under influence, thus unfeasible; while Scheme I is feasible.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Conclusion

<table>
<thead>
<tr>
<th>Scheme I (flood control)</th>
<th>Scheme II (Inundation)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommended</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not recommended</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 4.2.7.5 Environmental Comparison & Selection of Flood Control Works in Yongchang

Comparison is made of two schemes concerning flood control and inundation in Yongchang Nature Reserve, with Scheme I (flood control) for recommendation.

For detail of environmental comparison of the two schemes, see Table 4.2-17.

Out of comparison of two schemes involving flood control or inundation, this report recommends Scheme I (flood control), the same conclusion as out of engineering design. For detail see Table 4.2—17.

### Table 4.2-17  Environmental Comparison & Selection of Flood Control Works in Yongchang

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme I (flood control)</th>
<th>Scheme II (Inundation)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protection Benefit</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection area $\times$ km$^2$</td>
<td>22.583</td>
<td>Inundation area $\times$ km$^2$</td>
<td>23.5 4</td>
</tr>
<tr>
<td>$10^4$ persons</td>
<td>1.84</td>
<td>Inundation will affect population $\times$</td>
<td>1.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Scheme I is obviously better than Scheme II, Scheme II is</td>
</tr>
</tbody>
</table>
4.0 Plan Harmony Analysis & Environment Alternatives Comparison

<table>
<thead>
<tr>
<th>Farmland $10^4$ mu</th>
<th>Farmland inundated: $10^4$ mu</th>
<th>Housing $10^3$m$^2$</th>
<th>Housing inundated: $10^4$m$^2$</th>
<th>Bill of quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.096</td>
<td></td>
<td>96.10</td>
<td></td>
<td>Earthworks: $10^4$m$^3$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>125.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stone works</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Acquisition of land</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1436</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Population: $10^7$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Housing: $10^4$m$^2$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Farmland: $10^4$mu</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.038</td>
</tr>
</tbody>
</table>

In accordance with the engineering topography, geology and drainage outlet in Wanhe Nature Reserve, there are two proposals:

Scheme I: The Drainage Gulch passes through Zhushan Township to Zhangtang Nature Reserve, along the original river channel until to benchmark No 14+000 before turning to Liutang Township, by way of Tianduan Township and Jiangbian Township to the downstream of the downstream dam site.

Scheme II: with the same axis as Scheme I before benchmark 14+000, after which the gulch axis goes along original river channel until to 300m downstream of the ship lock (upper stream dam site).

For detail of the two schemes see Chart 4.2.1.
Technical and economic comparison recommends Scheme II in design.

For detail of environmental comparison in this gulch see Table 4.2-18.

Of the two schemes in engineering design, this Report recommends Scheme II in terms of environmental protection, the same conclusion as out of engineering design.

Table 4.2-18  Environmental Comparison of Two Schemes of Draining Gulch Axis in Wanhe

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Scheme I</th>
<th>Scheme II</th>
<th>Environmental comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rock works</td>
<td>$10^4$ m$^3$</td>
<td>38.20</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Earth works</td>
<td>$10^4$m$^3$</td>
<td>199.41</td>
<td>192.85</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Sand works</td>
<td>$10^4$m$^3$</td>
<td>22.50</td>
<td>22.50</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Backfill</td>
<td>m$^3$</td>
<td>10.01</td>
<td>8.71</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Acquisition of land</td>
<td>$mu$</td>
<td>945.39</td>
<td>924.16</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Inundation of land</td>
<td>$mu$</td>
<td>278.9</td>
<td>278.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Engineering conclusion</td>
<td></td>
<td></td>
<td></td>
<td>Recommended</td>
</tr>
<tr>
<td></td>
<td>Environmental conclusion</td>
<td></td>
<td>Not recommended</td>
<td>Recommended</td>
<td></td>
</tr>
</tbody>
</table>

4.2.9  Environmental Alternatives of Jintan Section Dyke Axis of Yongchang Protection Area

In terms of dyke orientation of Yongchang Protection Area, the engineering design proposes that the axis pass through the core and buffering zone of the county grade nature reserve –
4.0 Plan Harmony Analysis & Environment Alternatives Comparison

Jintan Old Woods of Zhujia Village of Tangzhou Town (See Attached Drawing 05). The Report concludes that this proposal is not feasible from the eye of environmental protection. This EIA gives out an environmental alternative for the said dyke from the angle of environment protection (see Attached Drawing 05). Details are shown in Chapter 7.0.

4.2.10 Environment reasonability analysis on construction diversion scheme

Diversion scheme: Stage diversion, two stages and three sections for construction. The diversion procedure is as follows: At Stage 1 (August of the first year ~ February of the third year), enclose the left bank and construct powerhouse and 11-hole scouring flood gate first, and at meantime, enclose the dam section of the ship lock, and dockgate channel at the right bank, applying the channel middle to overflow, small foundation pit cofferdam will be completed at the end of the first dry season; The powerhouse and the ship lock can be constructed all the year around under protection of the small foundation pit in the first flood season; In the second dry season, continue to enclose the 11-hole scouring flood gate and the powerhouse at the left bank, the dam section of the ship lock and dockgate channel at the right bank continue to construct under the protection of built cofferdam, using the middle channel for overflow; In Stage 2 (August of the third year ~ May of the fourth year), enclose the 13-hole flood gate at the middle, using the completed 11-hole scouring flood gate at the left bank for overflow, the powerhouse can use the retained water by Stage 2 cofferdam for generating power, meanwhile, the ship lock is open to traffic, at the end of the fourth dry season, the civil work of main project will be totally completed. Diversion period is from August to the next February.

As per the construction diversion plan, as for Stage 1, enclose the left bank and construct the powerhouse and 11-hole scouring flood gate at the left bank first, at the same time, enclose the dam section of the ship lock, and dockgate channel at the right bank, apply the middle part of the channel for navigation. Because the channel is narrowed and flowrate is increased, it may obstruct the navigation during flood season, while it is good for navigation during dry season after the upstream is deepened. Because it is not totally damming off the whole river, thus it will not cause normal water intaking and consumption of water consumers, nor will it cause obvious obstruction impacts on fishes.

At Stage 2, the ship lock at the right bank has been completed and navigable, the minimum navigable levels at upstream and downstream of the ship lock are respectively 52.46m and 45.88m. At the same time, 11-hole scouring flood gate at the left bank completed can be applied to control release flow, in order to meet the requirements of upstream and downstream navigational levels. But during construction of the cofferdam in the second stage, with development of the berm, original channel will no longer be too narrow to be available for navigation, while the permanent structure will not function until the water is raised to certain level, thus there will be a period not open to navigation for about two months. To solve the problem, it is recommended that cooperation with the maritime and navigation departments concerned be established to apply for temporary blockage with necessary notice in advance, for the sake of safety during construction. Because 11-hole scouring flood gate of stage 2 can overflow, and powerhouse can apply the retained water by stage 2 cofferdam for generating
power, and the ship lock is open to navigation, thus it will not cause normal water intaking and consumption of water consumers downstream of the dam, nor will it cause obstruction impacts on fishes (fish pass has been completed).

In a word, construction diversion scheme will have smaller impacts on navigation and normal water intaking and consumption of water consumers downstream of the dam and will not cause obvious obstruction impacts on fishes. This construction diversion scheme is environmentally feasible.

4.2.11 Comparison of Environmental Impact between with and without Shihutang Project

- Environmental properties of with and without Shihutang Project
  Prior to construction of the Project, the river flows in a natural way. After completion of the Project, upper stream water will flow in decreased speed, therefore there will be change in original flow.

- Comparison of Environmental Impact of with and without Shihutang Project
  Whether the Project shall be constructed, consideration shall be taken of flow state, water level change, and environmental impact upon aquatic beings and old trees. For detail see Table 4.2—19.
<table>
<thead>
<tr>
<th>Influence factor</th>
<th>Construction of Shihutang Project</th>
<th>Not construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecoenvironment</td>
<td>Water level will rise to inundate farmland and woodland along the bank.</td>
<td>Considering construction of a thermal power plant of the same installed capacity, flyash and slag of the thermal power plant there will occupy a great deal of land and farmland.</td>
</tr>
<tr>
<td>Inundation Impact</td>
<td>Inundation and embankment protection works will mean permanent acquisition of farmland totaling 2829.8 mu, gardens totaling 104.4 mu, and other types of land totaling 3130.9 mu, resettlement totaling 711 persons and dismantle of 8 enterprises and institutions, removal of housing totaling $4.56 \times 10^4$ m$^2$ and dismantle of other facilities.</td>
<td>No impact from inundation</td>
</tr>
<tr>
<td>Bank stability</td>
<td>Local bank collapse may happen.</td>
<td>Almost no bank collapse</td>
</tr>
<tr>
<td>Aquatic organism</td>
<td>Phytoplankton and zooplankton will change in types and quantity. After reservoir impounds water, the flow will decrease so that migratory fishes will decrease due to block from the dam. Water quality in the upper stream will improve during low season. Existing two spawning sites will be affected.</td>
<td>Following the original eco-balance rule</td>
</tr>
<tr>
<td>Water quality</td>
<td>After reservoir storage, there will be a water body in the upper stream like a lake, where water flow speed will decrease. But increase in water volume will improve water quality during low water period, if compared with the same period prior to construction of the Project.</td>
<td>Water quality is worse than the water upstream of the dam after the construction of the Project during low water period.</td>
</tr>
<tr>
<td>Social environment</td>
<td>In construction of Shihutang Project, construction will commence of approach road to the dam site and road bridge over the dam, which will improve traffic in the region and promote economic development.</td>
<td>Traffic jam</td>
</tr>
<tr>
<td>Air &amp; Noise</td>
<td>Dust will be produced during construction in addition to noise (for short duration)</td>
<td>Large discharge of dust, S02 and CO2 from the thermal power plant, to pollute the air; with much noise along the road.</td>
</tr>
<tr>
<td>Silting</td>
<td>There will be sediment accumulation impact at upstream of the dam</td>
<td>No impact</td>
</tr>
<tr>
<td>Flood control</td>
<td>Flood control standard: to improve to 10-year-recurrence so that arable land along the shore and residents and infrastructures are under protection. Annual average flood control benefit is estimated to be 22.831 million Yuan.</td>
<td>Current flood control standard is low, to suffer a lot from flood and waterlogging. Flood loss includes loss to individuals, collectives and the state in agriculture, forestry, engineering facilities and traffic.</td>
</tr>
<tr>
<td>Land exploitation</td>
<td>After treatment the land may be proper for grain crops and diversified economy, to create desirable economic and social benefits.</td>
<td>At present there are 12695 mu of farmland under no exploitation (below 10-year recurrence flood), with no harvest.</td>
</tr>
<tr>
<td>Communications &amp; transport</td>
<td>Completion of the Shihutang Project will transform the 38-km-long upper stream channel into reservoir channel, to create sound condition to turn the main channel in Kan River into Grade III navigable channel. This will optimize traffic networks to promote reasonable adjustment of communications structure in Jiangxi Province. In the near future the Project will save a lot of investment in channel improvement and maintenance and in the far future the Project will result in shipping upsizing and reduce traffic cost.</td>
<td>Due to current low navigation grade and poor channel, the Kan River fails to play her role and advantage in water carriage.</td>
</tr>
</tbody>
</table>
Table 4.2 (Cont’d) Comparison of Environmental Impact between with and without the Shihutang Project

<table>
<thead>
<tr>
<th>Influence factor</th>
<th>Construction</th>
<th>No Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall evaluation</td>
<td>Completion of the Shihutang Project will create some negative impacts upon eco-environment, inundation, bank stability, aquatic beings, air, noise and sediment accumulation, in addition to positive role in scenery and social benefits. From the eye of power generation, if compared with a thermal power plant of the same installed capacity, the thermal plant will bring much more pressure to highway transport and noise along the highway; meanwhile the plant will mean a lot of acquisition of land and farmland, will discharge a lot of SO2 and CO2, thus to produce a lot of negative impact upon the environment. Judged from environment, the Shihutang Project is not as favorable. But from the point of social benefits, enough attention shall be paid to environment protection during construction to minimize negative impact upon environment, the Project is beneficial and significant.</td>
<td></td>
</tr>
</tbody>
</table>
5.0 ENVIRONMENT BASELINE SURVEY & ASSESSMENT

5.1 Survey of Natural Environment

5.1.1 Drainage & Channel Characteristics

The Kan River rises in Shiliaodong (located between the boundary of Jiangxi Province and Fujian Province), flowing from eastward to westward through Ruijing County and Huichang County (where joined by a tributary Xiang River), to converge into Lian River in Luokou Town. It converges into Mei River about 2km above Yudu County Town, joined by Ping River and Tao River in Gan County. She is not called Kan River until converged by Zhang River in Ganzhou City; flowing out of the city, Kan River runs northward to be joined by Suichuan River in Luotang, by Su River in Taihe County, by Gu River in Ji'an County, by Wu River in Jishui County, by Yuan River in Zhangshui City, by Jin River in Nanchang County, to flow into Poyang Lake in four tributaries, the main in Wucheng Town, Yongxiu County after converge with Xiu River.

From the riverhead to Wucheng Town, Kan River lasts 780km. Above Wan'an is the upper stream, 350km long and 200–600m wide. Here Kan River flows through mountainous and hilly areas, the bed mainly of coarse sand and gravel and partially of reef, where the gradient of stream averages 0.32‰ typical of mountain torrent. From Wan'an to Zhangshu City, it is the middle reach, 263km in length and 600–900m in width, flowing through Jitai Basin, featured by mesas (mainly of sandy soils) and hilly areas. Due to long current scour, there is frequent bank failure only to broaden the riverbed. During low water period the river is wide and shallow, with a gradient of stream averaging 0.16‰. Her downstream begins from Zhangshu to Wucheng Town, lasting 167km, flowing through alluvial plain, low in elevation, with polder embankment along the dyke. Here the riverbed, 1000m in width, is mainly of middle ground shoal and coarse sand, with a gradient of stream averaging 0.07‰ in dry season. From Wuchang to Hokou is the Poyang Lake area, 81km long, with a gradient of stream averaging 0.047‰ in dry season. Zexi Estuary, 20km downstream Wucheng, is where the five tributaries of Poyang Lake converge.

The Shihutang Project is located in the middle reach of Kan River, with the dam site situated adjacent to Shihutang Township, 26km downstream of Taihe County Town. The river is usually 600–800m wide near the dam site, with a gradient of about 0.2‰. In the upper stream of the reservoir there are three tributaries, Sui River, Guanyuan River and Yunting River. Sui River has a catchment of about 1305km², flowing into Kan River about 30km and 35km upper stream of the Shihutang dam site to join Kan River. Yunting River has a catchment of 763 km², to join Kan River from the right bank, 17km upper stream of Shihutang dam site, while Guanyuan river has a catchment area of 558 km², to join Kan River from the right bank, 10km upper stream of Shihutang dam site. Regional water system is shown in DRAWING NO.06.

5.1.2 Basin Properties
There are numerous mountains and hills in the upper stream and its major tributaries, including Jiulin Mountain on the north, Dagen Mountain and Julian Mt on the south, Guangchang Mt, Le’an Mt and Nanfeng Mt on the east, Luoxiao Mt and Zhuguang Mt on the west; Wuyi Mt on the southeast, with developed basin within the mountainous ranges and valleys. Most of the boundary of the basin and southern basin is made up of hilly areas, generally at 400m in EL, with a peak of over 1000m. The middle of the basin is mixed hilly areas and basin (depression), among which Jitai Basin is the largest. In the northern basin there is the fluvial plain fluvial plain Ganfu Plain.

Kan River is the largest tributary of Poyang Lake, whose catchment area makes up almost half of the territory of Jiangxi Province. There are numerous river systems in Kan River, with 14 tributaries whose catchment area totals more than 1000km$^2$. Longitudinal slopes are smooth in Kan River basin, with developed depression, dense population and farmland. Kan River is rich in water resources, with annual precipitation ranging 1300–1800mm, despite uneven distribution in seasons and over years. There is much change in runoff during the flood season and dry season.

5.1.3 Resources in Kan River Basin
Potential waterpower resource in Kan River totals 3600MW, or 52% of the power in Jiangxi Province. There may be 313 power stations with an installed capacity over 500 kW for exploitation, to total 3437.5MW in installed capacity or 67.3% of the capacity in Jiangxi Province. In Kan River there are 8 hydropower stations with an installed capacity of 2267MW, with annual generation of 78.27×108 kW·h.

5.1.4 Weather
Kan River basin falls within the moist subtropical belt, with abundant rainfall (average annual rainfall: 1300–1800mm), but rainfall is severely uneven in seasons. In accordance with representative Meteorological Stations, rainfall from April to June makes up 41%–51% of the whole year.

There are frequent rainstorms in the basin. In accordance with precipitation stations in the basin storms mainly fall in April to September, while from May to June rainfalls mainly in frontal rain, which makes cloudburst more frequent. From July to September storms are caused mainly by Typhoon.

Annual average evaporation reaches 1294–1765mm, annual mean temperature ranges 17.2–19.3°C, with extremely highest temperature at 41.6°C Yichun Meteorological Station, Aug 16, 1953 and extremely low temperature at -14.3°C Fengchen Meteorological Station, Feb 29, 1991. Annual average humidity is 76%–82% and minimum relative humidity goes to 6%–7% Xiajiang Meteorological Station, Nov 28, 1978. Annual mean wind velocity reaches 1.1–2.9m/s with maximum speed at 30m/s Taihe Meteorological Station, Apr 24, 1977. Annual average sunshine totals 1628–1875h, annual average frost-free period lasts 252–288 days. Taihe Meteorological Station, closest to Shihutang Project dam site, records maximum wind velocity at 1.8m/s and annual maximum wind velocity at 13.4m/s.
For detail of characteristic parameters in each Meteorological Station in Kan River basin, see Table 5.1.
Table 5.1 | Statistics of Characteristic Parameters in Meteorological Stations (Representative) Adjacent to Project Site

<table>
<thead>
<tr>
<th>Name</th>
<th>Annual mean rainfall(mm)</th>
<th>Annual Max rainfall (mm)</th>
<th>In the year of</th>
<th>Annual min rainfall(mm)</th>
<th>In the year of</th>
<th>Annual mean evaporation (mm)</th>
<th>Annual mean temperature (℃)</th>
<th>Extreme high (℃)</th>
<th>Occurred on (Year/Month/Day)</th>
<th>Extreme low (℃)</th>
<th>Occurred on (Year/Month/Day)</th>
<th>Annual mean relative humidity(%)</th>
<th>Annual mean wind speed (m/S)</th>
<th>Annual mean sunshine(h)</th>
<th>Annual mean frost-free period (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ganzou</td>
<td>1426.8</td>
<td>2183.8</td>
<td>1961</td>
<td>897.6</td>
<td>1986</td>
<td>1616.0</td>
<td>19.4</td>
<td>41.2</td>
<td>1953.8.10</td>
<td>-6.0</td>
<td>1955.1.12</td>
<td>76</td>
<td>1.8</td>
<td>1813.6</td>
<td>282</td>
</tr>
<tr>
<td>Wan’nan</td>
<td>1401.3</td>
<td>2078.2</td>
<td>2002</td>
<td>741.6</td>
<td>1963</td>
<td>1618.8</td>
<td>18.5</td>
<td>40.7</td>
<td>1992.7.31</td>
<td>-6.5</td>
<td>1967.1.16</td>
<td>80</td>
<td>2.6</td>
<td>1739.6</td>
<td>284</td>
</tr>
<tr>
<td>Taihe</td>
<td>1383.0</td>
<td>2371.2</td>
<td>2002</td>
<td>821.5</td>
<td>1986</td>
<td>1407.1</td>
<td>18.7</td>
<td>41.5</td>
<td>2003.8.2</td>
<td>-6.0</td>
<td>1991.12.29</td>
<td>80</td>
<td>1.8</td>
<td>1694.0</td>
<td>288</td>
</tr>
<tr>
<td>Ji’an</td>
<td>1495.9</td>
<td>2183.1</td>
<td>1953</td>
<td>982.8</td>
<td>1963</td>
<td>1546.1</td>
<td>18.4</td>
<td>40.3</td>
<td>1991.7.18</td>
<td>-8.0</td>
<td>1972.2.9</td>
<td>78</td>
<td>2.2</td>
<td>1737.3</td>
<td>281</td>
</tr>
<tr>
<td>Xiajiang</td>
<td>1629.9</td>
<td>2243.5</td>
<td>1953</td>
<td>919.2</td>
<td>1963</td>
<td>1432.4</td>
<td>17.6</td>
<td>40.6</td>
<td>1971.7.31</td>
<td>-9.1</td>
<td>1991.12.29</td>
<td>82</td>
<td>1.8</td>
<td>1687.9</td>
<td>277</td>
</tr>
<tr>
<td>Fencheng</td>
<td>1617.5</td>
<td>2460.5</td>
<td>1973</td>
<td>984.3</td>
<td>1971</td>
<td>1385.6</td>
<td>17.6</td>
<td>39.7</td>
<td>1963.9.1</td>
<td>-14.3</td>
<td>1991.12.29</td>
<td>82</td>
<td>2.4</td>
<td>1787.6</td>
<td>266</td>
</tr>
<tr>
<td>Nanchang</td>
<td>1608.9</td>
<td>2628.2</td>
<td>1954</td>
<td>1044.2</td>
<td>1963</td>
<td>1764.6</td>
<td>17.5</td>
<td>40.6</td>
<td>1961.7.23</td>
<td>-9.7</td>
<td>1991.12.29</td>
<td>77</td>
<td>2.9</td>
<td>1841.8</td>
<td>274</td>
</tr>
</tbody>
</table>
Kan River is of flood storm river, the flood is caused by storms, therefore the flood season coincident with storm season. Usually beginning from April there is flood in the basin, without much peak discharge. From May to June, especially on June, it is the main flood season, when large-scale flood would be caused by heavy storm. From July to Sept, due to influence from typhoon, there may be medium-scaled flood, which might occur occasionally in March and Oct.

5.1.6 Topographical Features
Shihutang Reservoir is located in the middle reach of Kan River, expanding outward from Kan River, with topographical features represented by alluvial flat, terrace, hilly areas and mountainous regions, laid out in cascade, in a trend of higher topography in southeast and lower in northwest, typical of low hilly areas.

The dam site is situated 26km downstream of Taihe County Town, in valley of the middle reach of Kan River, which flows from east to west with much bends at a width of 1150m at 46m EL in dry season. The riverbed is covered with pebbles, 6 to 8 m in thickness. The main stream is on the left bank, which is of floodplain 400 to 800m wide, adjacent to second terrace, at about 65 m EL. The right bank is of second bottom, which borders low hilly areas in the rear, at 75 to 83 m El. The dam site is made up of calcilute, mudstone, conglomerate and sand gravel.

At the normal water level of 56.50m, the backwater terminal is adjacent to Guojia Township, Mashi Town. Here the geomorphic unit is mainly of low hilly areas and fluvial erosion of tectonic denudation, and there is no developed unfavorable physical geological structure. Along the river there are multiple terraces, of which the second bottom and the second terrace are fairly developed. Generally the second bottom is at 54 to 60m EL and the second terrace at 60 to 70m EL. The third terrace is not developed, with remains of red downy top of Cretaceous System. The second bottom and the second terrace approaches the low hilly areas in the rear, with a peak of 80 to 250 m EL. Bare land in the reservoir is manly of Ganzou group and Guanxi group of Cretaceous System, with limited Tertiary, Permian, Carbonic and Devonian System stratum. The alluvial deposit of Quaternary System scatters in the terraces along Kan River and her tributaries, generally of dualistic structure, no more than ten meter in thickness.

The reservoir lies in mid-south of Jitai Basin, mainly of superficial fault of syn-sedimentary faults and delayed fracture of Cretaceous Period, usually small in scale, extending several metes to a few km, in the direction of north to east, north to west, east to west or south to north. Only the blind fault form Pinglin to Wenxi, from Mashi to Bainigang is large in scale, extending more than 20 km.

The embankment protection project is located in the low hilly areas and fluvial erosion of tectonic denudation, along Kan River and her tributaries the second bottom and the second terrace are fairly developed, with fairly low elevation. Generally the project is located in the
front edge of the second bottom, of cohesive soil at top and sand, gravel at bottom, thus of
dualistic structure. In some areas there is small-scaled dyke, low in elevation and poor in
quality, failing to make up a complete embankment protection system.

5.1.7 Engineering geology
Geomorphologic unit in Shihutang is mainly of hills and hillock plains of tectonic denudation and
accumulation plain of fluvial erosion. Kan River runs meanderingly from south to north
through Shihutang, where the overall topography is featured by higher surroundings and lower
center, sloping gradually toward the center from south to north and from edge to the center.
The edge is surrounded by hills, with dissected topography ranging from 10 to hundreds of
meters in depth. Kan River valley is smooth and wide, with the bed ranging from one hundred
to one thousand meters in width, floodplain scattered everywhere. Unpaired terrace (second
bottom and second terrace) is distributed along the banks, while the second bottom is usually
52—61m in height, the second terrace generally 58—70m, to suffer a lot from gulley erosional
cutting to develop partial rolling hills.

The stratum is mainly of the Recent Epoch of quaternary system, of vermiform reticulate
laterite of Jinxian Group cretaceous Hongningang Group (K$_2hg$), Zhoutian Group (k$_2z$) and
Maodian Group (k$_2m$).

The engineering site is located in Ji’an Fault Tectonic Element of South China fold system, of
central and south Jiangxi elevation, and of depression in southwest Jiangxi. This area has
suffered from such tectogenetic movement as Caledonian, Variscan–Indo-Chinese epoch,
Yanshanian and Himalayan. The Sinian Period–Cambrian Period stratum is mainly of gilfo
arenaceous, siliceous sediments, greywacke and mudstone. After ESN Caledonian
compressional movement the NE to NEE fold–arched structure and the NNE faulted structure
are developed, to produce minute regional metamorphism to form the foundation base. Late
Paleozoic Era–Permian (period) stratum is mainly of clastic rock accumulation, which, due to
tectogenetic movement during Variscan–Indo-Chinese epoch, develops folding and uplift so
that open fold is formed whose axial and tectonic line runs east-westward, accompanied by a
series of NW brittle fracture. During Mesozoic Era the NW fracture further develops under
downslide and traction, until into stratum during the Jurassic Period into NW tilt-block basin.
Yanshanian tectogenetic movement creates partial plaiting out of stratum developed in Jurassic
Period, to develop NE to NEE fault with small-scaled igneous intrusion. During Himalayan
tectogenetic movement uplift plays the major role, with NE and NEE and NW revitalized fault
network in form of thrusting, marked by basin uplift under erosion and by minute refraction in
the faulted basin. Meanwhile along the fault and gulch develops a NE, NNE river, which
suffers from frequent stagnated diversion. Here the accumulation is typical of clay stone of
swamp facies, Hunaqiao Group, typical of unconsolidated sediment of Quaternary System, to
develop into multiple erosion terraces.

Basin-dominant fault mainly develops and scatters at the edge of the basin, in form of
discordogenic fault and fault zone, where the tectonic line runs NE, NNE and NW. in the
southeast the Suichuan-Dexing Deep-seated Fault lasts about 540km, being a series of NE
compression thrust or shearing oblique thrust, about 250—300m in width, about 25km from
the dam site. On the northwest side Xin’gan—Hukou Deep-seated Fault lasts several hundreds of kilometers, covered with red loam on the marginal basin, about 45km from the dam site. The NE Jishui Deep-seated Fault is made up of a series of NW shear skewing parallel normal faults, to last about 90km, dozens to hundreds of meters in width, about 30km from the dam site.

Close to the dam site the major petrographic category is of clastic rock and loose soil.

5.1.8 Earthquake
In accordance with Seismic Zoning in China (GB18306-2001) the seismic peak acceleration at the dam site is less than 0.05g corresponding to smaller than VI degrees in earthquake intensity, with an Eigen-period of 0.35s in earthquake dynamic response spectrum.

5.1.9 Underground water
On the basis of lithological character, the underground water survival condition and hydraulic characteristic of the water-bearing formation, underground water in Shihutang region may be classified into unconsolidated rock pore water and bedrock fracture water.

- **Unconsolidated rock pore water**
  Such water is distributed along the bank of Kan River and her tributaries, with the water-bearing rock made up of alluvial deposit of quaternary system (Holocene and mid- Pleistocene series). Such alluvial deposit is the major water bearing strata, whose top layer is of clayey loam, sandy loam and reticulated laterite, fine in structure with a thickness ranging 5~7m; the bottom is made up of sand, sand gravel, and pebble bed about 5~10m in thickness. Submergence is the major hydraulic characteristics, with partial slight load bearing, whose artesian head reaches 0.66~4.79m, with a mean bury depth of 2.91~6.20m, and individual well water inflow totals 5815.12~3614.55t/d, and maximum inflow may reach 6778.01t/d, thus abundant in water resources. Water quality is identical to HCO$_3$\neg Cl\neg Ca(Mg)\neg K+Na whose degree of mineralization ranges 0.03~0.08g/l, PH 5.6~6.6, total hardness 0.84~3.352.

- **Bedrock fracture water**
  Based on regional data, the bedrock fracture water is mainly of red clasolite of Cretaceous System, where the sand gravel is moderately weathered, rich in water; in comparison, siltite are filled with pelyte in the fracture, thus the zone of weathering bears little water, and the underground water exists mainly in fracture and pore or weathered submergence under tectonization and mechanical weathering. Here individual well water inflow totals 0.1~19.777t/d, and fountain flow may amount to 0.011~0.079l/s, modulus of runoff averages 0.023~1.55l/s·km$^2$, which means there is rare water bearing stratum. Water quality is identical to HCO$_3$\neg Ca\neg (K+Na) & HCO$_3$\neg (SO$_4$)\neg K+Na (Ca) and the degree of mineralization ranges 0.12~0.08g/L, PH 5.4~10.3, total hardness 0.20~34.78.

5.2 Survey of Social Environment

5.2.1 Local Social & Economic Situation
The channel from Ganzou to Hukou lasts 606km, while the Shihutang Project lies in the upper reach of Kan River in Ji’an City, to produce direct influence upon Ji’an City, Ganzou City and the middle and downstream reach of Kan River.

Ganzou City
Ganzou City is located in the upper reach of Kan River, to border Fujian Province in the east, Guanxi Autonomous region in the south and Hunan Province in the west, Ji’an City and Fuzhou City on the north. To be exact, it lies at 113°54′ to 116°38′E and 24°29′ to 27°09′N, to be 219km wide from east to west and 295km long form north to south. It has have jurisdiction over two cities and 16 counties, with an area of 39379km².

National economy sped up in 2004, whose GDP totaled 39.801 billion Yuan, to rise by 12.7%, 0.2% more than last year, the highest speed since 1997. of the GDP, industry contributed 11.40 billion Yuan, to rise by 4.2%; the second industry contributed 13.297 billion Yuan, to rise by 17.6%; the third industry contributed 15.122 billion Yuan, to rise by 14.5%. Fast development was achieved due to harmonious development of all trades and industries, of which the first, second and third industry contributed 1.2%, 6.0% and 5.5% respectively. Industry structure is under further optimization.

There are 106 types of minerals in Ganzhou, of which 57 proves to be of commercial reserve, composed of 28 large-scale mineral deposit, 60 medium-scale deposit and 712 small-scaled deposit. Such resources are of variety and concentration and high exploitability. There are 52 types of mineral reserve listed on the agenda of commercial exploitation, of which tungsten makes up 61.3% in resource extent coal 36.4%tin 73.4%heavy rare earth 8%light rare earth 80.8%lead and zinc 15%gold 48.1%silver 24%tantalum 16.5%and niobium 13.8%.

The basic objective of economic development is to dramatically improve economy, so that GDP will increase by 12% annually to double the economic aggregate by 2010 when GDP per capita reaches ten thousand Yuan; and financial income will rise by 15% annually, fixed asset investment by 20%. Economic structure will be further optimized, so that the three industries will reach a percentage of 16: 46: 38, of which added value will contribute more than one third in the second industry and high-tech will make up more than 20% in total industry. Capital investment from abroad will rise by 10% annually. The central urban will occupy more than 70km² with more than 700,000 residents, of whom over 40% will live in urban areas. People’s living standard will greatly improve and eco-environment will turn a new leaf and the whole society will become more harmonious.

Ji’an City
Ji’an has a jurisdiction over 2 cities and 11 counties, 218km in length from east to west and about 208km in width from north to south. In 2004 her GDP totaled 24.265 billion Yuan, rising by 14.5%, more than 0.5 % more than last year, the highest speed in last 9 years. The primary industry 7.428 billion Yuan, rising by 8.0%; the second industry 7.868 billion Yuan, rising by
19.7%; the third industry 8.951 billion Yuan, rising by 14.9%. Here GDP per capita totaled 5220 Yuan, 745 Yuan more than last year, rising by 13.8%.

The basic goal for economic development is to develop economy steadily so that national economy will rise by 13% annually to reach 60.7 billion Yuan; actual use of foreign investment will rise by 15% annually, and export by 30%. Economic structure adjustment will be fruitful, so that the three industries percentage will reach 16: 50: 34, of which added value will contribute 37% in the heavy industry and six pillar industries will make up more than 70% in added value in the whole industry. The town system will be perfected. By 2010 urbanization will reach 41.3%, to occupy an area of 190km². Public service facilities will be improved greatly and so are people’s living standards and eco-environment construction.

Taihe County
Taihe County is located in the hinterland of Jitai Pendi (Basin) in central Jiangxi Province, with an area of 2665.4km² with jurisdiction over 16 towns and 6 townships and 290 villages and six communities. According to statistics in 2005, the population totaled 515655, of whom 418412 live in rural areas (agricultural labor force aggregates 249187). Here population density reaches 193 persons per km². The county has a total cultivated area of 0.661 million mu, averaging 1.8 mu per capita; total forest area amounts to about 2.42 million mu and aquatic area 0.17 million mu.

County GDP totaled 3.711 billion Yuan, of which the primary industry contributed 32.15% to total 1.193 billion Yuan, the secondary industry 38.15% to reach 1.416 billion Yuan (of which traditional industry made up 1.061 billion Yuan), and the tertiary industry 29.7% to aggregate 1.102 billion Yuan. Gross product of agriculture, forestry, animal husbandry, fisheries at current prices totaled 2.111 billion Yuan. Of cultivation area, the grain totaled 81952 hectare, oil plants 19950 hectare and vegetable crop 11079 hectare.

5.2.2 Survey of Local Traffic

5.2.2.1 Local Traffic
Ji’an enjoys four traffic means, railway, highway, waterway and airway. During the Tenth Five-Year Plan Period, Ji’an has enjoyed fast development in traffic infrastructure, with highway coverage improved dramatically, railway speeding up, waterway in Kan River under regulation, inland terminals construction hastened, traffic means structure adjustment under acceleration, traffic capacity improved greatly, service quality improved a lot so that traffic bottleneck is greatly relieved.

There are 7970 km of roads open to traffic, of which Class 2 roads last for 913 km, Class 3 roads for 698 km, Class 4 roads for 3475km and other roads for 2876km, with a road density of 64.2km/km².

Taihe County enjoys better traffic infrastructure, with State Highway No 105 and No 319 traversing and Beijing-Kowloon Railway and Guangzhou—Nanchang Expressway through the
county. Advanced program-controlled optical cables communication is available to each rural household.

Due to different navigable grade in Kan River, in addition to decreased rainfall in the basin, navigation capacity in the river has been reduced considerably. As a result waterway is severely restricted and carrier improves slowly, whose percentage in the whole traffic capacity drops every year. Meanwhile transport in the waterway is limited to timbre, sand and stones, cement, oil, fertilizer, feed and food. Passenger transport is mainly in form of waterway sightseeing and short-distance travel, while long-distance travel gradually goes outdated.

The main features of Jiangxi transport ships are small capacity, many types, and low standardization degree. Except that 1000DWT or over ships are navigable in the downstream Nanchang at the lower reaches of the Kan River, the Poyang Lake area, and along the Yangtze River and 500DWT motor barges are navigable in the downstream Zhangshu at the lower reaches of the Kan River, only 300~500DWT motor barges are navigable in upper Zhangshu at the middle and upstream of the Kan River at medium flood season, below 300DWT motor barges are navigable in low water season. In 2004, the average motor ship DWT of the whole Jiangxi province is only 188t.

5.2.2.2 Local Traffic Development Planning
In terms of highway, Taihe will develop a system made up of “Two longitudinal, two horizontal and two connective highways” as backbone, “three longitudinal, three horizontal and one ring as main highway, county to county highway as branch, to develop a traffic system of optimized structure, perfect function and reasonable layout. By 2020 the roads open to traffic will last 28600km with classified roads totaling 20000km of which express highway lasts 1000km first road 900km secondary road 3000km tertiary highway 2000km quaternary highway 13100km and other highway 8600km with a highway density of 72km/100km², of which grade highway reaches 50km/100km².

In terms of railway, in accordance with the medium- and long-term development plan in Jiangxi Province, a cross-type structure consisting of Beijing--Kowloon Railway, Ganzhou—Long Railway and Ganzhou—Saoshan Railway will come into being, which will connects Beijing—Colon Railway, Beijing—Guangzhou Railway, Zhejiang—Jiangxi Railway, Yingtan—Xiamen Railway, and Hangzhou—Shenzhen Railway.

In terms of waterway, in accordance with the state inland navigation development planning, there will be waterway network, which goes to the Yangtze River in the north, Pearl River in the south and the sea in the east. By 2020, a waterway system will develop with Ganzhou as the focus, with all channels up to grade navigation standard. Inland terminals will achieve mechanization, to develop a system of containers and of roll-on and roll-off ships for transport of petroleum and liquid gas, coal and mineral and automobile.
In terms of airway, by way of expanded project in Gold Airport, traffic connection will be strengthened to develop a 3-dimension traffic system by cooperation with railway, highway and waterway.

5.2.3 Existing Hydraulic Projects
Wan’an Hydraulic Project in the main channel of Kan River has been completed, which is located in the middle reach of Kan River, about 2km in the upper reach of Wan’an County Town, with a catchment of 36900 km². This project functions as a comprehensive project capable of flood control, navigation and irrigation. The normal water level reaches 98.11m (preliminary operation level is 94.11m), with a storage capacity of 22.14×10⁸ m³.

There are 15 large-scaled and 99 medium-scaled reservoirs in the tributaries of Kan River, with a catchment of 54624 km² and a total storage capacity of 24.63×10⁸ m³. Most of the reservoirs play the role mainly of irrigation or power generation complimented by flood control, with an installed capacity of 767.5 MW and an irrigation area of 46.54 million mu.

Quangang Flood Diversion, Storage & Reclamation Works is located in the downstream of Kan River, within the boundary of Zhangshu, Fengcheng and Gao’an, made up of intake sluices and Lingzou Dyke. The intake sluice is situated in outlet of the Xiao River, southeast of Quangang Town, completed in 1958, under expansion in 2001 to 2003. After that the flood control standard has improved to one-hundred-year recurrence, with maximum flood diversion at 2000 m³/s, with a storage area totaling 131 km² in the pondage area and an effective storage of 2.0×10⁸ m³. This Works is capable of lowering water level in the downstream of Kan River to offer safety to Nanchang and east valley of the river.

In the Kan River basin there are two grade polder embankments, namely Fudayo Dyke and Gandong Dyke, for protection of the capital city Nanchang and Ganfu Plain, with seven polder embankments each of which to protect more than 100000 mu of farmland, 10 dykes each of which to protect over 50000 mu of farmland, 47 dykes each of which to protect 100 to 500 thousand mu of farmland.

5.2.3 Brief introduction to regional water resource application

5.2.3.1 Regional water consumption characteristics

In order to meet the requirement of regional economic and social development, water resource integrated development and application within the Kan River drainage area includes agricultural irrigation, city residents’ domestic water, industrial water, hydropower, channel navigational condition improvement etc. Water consumption within the region is separated into several categories as city residents’ domestic water consumption, industrial water consumption and agricultural irrigation water consumption. Agricultural irrigation is a major water consumer of Jiangxi Province, approximately accounting for 4/5 of total productive and domestic water consumption of the whole province. With economic development and technical
improvement, agricultural irrigation water consumption is at down trend, while residents’
domestic water consumption and industrial water consumption are growing.

In the Kan River drainage area, water source for irrigation is mainly from water impounding
projects, especially centralized irrigation water consumption at dry season; Most of the water
intake sources of the residents’ domestic water supply and industrial water supply of Jiangxi
Province are surface water, taking water directly from rivers, general industrial water
consumption comes from their own water sources, but most of firms come from city water
supply pipeline network, own water sources come mostly from surface water too. Underground
water as water source for domestic water and general industrial water has a very small
proportion, only 5.5 of the total water consumption. Water consumption for cooling of Jiangxi
thermal (nuclear) power comes from surface water, taking water directly from rivers,
productive wastewater is drained into the original river course at downstream of the water
intakes. But there are no existing thermal (nuclear) power plants at the Kan River drainage area
at upstream of the Shihutang Project. Water for generating power is instream water use,
basically causing no water consumption or new pollution on the river course. Except that
runoff type hydropower station has no regulation and impounding capacity on incoming water,
other reservoir hydropower stations, through the regulation and impounding function of
reservoir, have supplementary function to the instream flow at dry season. It is investigated
that there are no projects of water diversion for power generation across Grade III water
resource region within the drainage area at upstream of the Shihutang dam site.

5.2.3.2 Water impounding projects within the drainage area at upstream of the Shihutang dam
site

Water impounding project belongs to an integrated water resource application one, with the
general functions as power generation, irrigation, flood control, shipping etc., its reservoir has
a certain regulating performance, and may reallocate river runoff in a year and among years.
Water impounding projects at upstream of the Shihutang dam site will have a certain impacts
on the dam site runoff, therefore, the analysis scope for water impounding project development
mode to apply water resource is the drainage area at upstream of the Shihutang dam site.

Because the rainfalls and runoffs within the drainage area at upstream of the Shihutang dam
site in a year and among years are distributed unevenly, flood and drought often occur, causing
life and property losses of the people and grain output reduction. In order to improve the living
environment, and to develop and apply water resource, to develop industrial and agricultural
production and national economy within the region, a lot of key water control projects have
been built within the drainage area since liberation of 1949. In 1993, Wan’an Pivot was
completed at the main stream of the Kan River, which is located at upper section of the middle
reaches of the Kan River, the dam site is located about 2km at upstream of Wan’an County
Seat, with controlled drainage area of 36900km$^2$, it is an integrated water resource application
project with power generation as main purpose and also for flood control, shipping and
irrigation. From 1950’s to 1970’s, six large reservoirs of Changgang, Youlukou, Tuanjie,
Laoyingpan, Shangyoujiang and Longtan with total reservoir capacity of $16.97 \times 10^8$ m$^3$. 

regulating (beneficial) reservoir capacity of $9.09 \times 10^8$ m$^3$, installed capacity of 122.32MW. And 30 middle-scale water impounding projects have been built within the drainage area after another, with total reservoir capacity of $7.04 \times 10^8$ m$^3$ regulating (beneficial) reservoir capacity of $4.01 \times 10^8$ m$^3$ and installed capacity of 92.25MW. The total regulating (beneficial) reservoir capacity of 37 large and middle scale reservoirs is $23.29 \times 10^8$ m$^3$ the total installed capacity of 37 hydropower stations is 719.57MW. The beneficial reservoir capacity of small reservoir and installed capacity of smaller hydropower station are limited, water resource application amount of other water control projects is not much. The application rate of water resource of the drainage area at upstream of the Shihutang dam site is still low.

5.2.3.3 Water consumers within the area affected by the Shihutang Project

Most of the pumping projects within the drainage area at upstream of the Shihutang dam site are to provide water source for irrigation, residents’ domestic water and industrial water, irrigation water is the main water consumer within the region, while its water source is mostly from water impounding projects, pumping projects for irrigation are scattered and small, therefore, water intake amount of pumping projects within the drainage area at upstream of the Shihutang dam site is not big.

The possible affected region with pumping projects by the Shihutang Project is the Shihutang reservoir area and the river section from the Shihutang dam site to the Ji’an City Railway Bridge of Beijing~Kowloon Railline at the downstream.

As per the survey, pumping stations for farmland anti-drought with the affected area of the Shihutang Project are scattered and very small, most of them are water plants to supply residents’ domestic water and industrial water of Taihe County Seat and Ji’an City. The water intaking flow of the existing water plants at the downstream river section of the Shihutang dam site is $2.28$ m$^3$/s (because a majority of water of Phase I of the Jinggangshan Power Plant returns to the river course in a short time, therefore, only water loss of $0.2$ m$^3$/s is considered) plus some scattered and small irrigation pumping projects, the water intaking flow of pumping projects of the said river section is smaller.

5.2.3.4 Existing main problems of regional water resource development and application

- Low application rate due to uneven space-time distribution of water resource

Though the middle reaches and upstream of the Kan River are of rich waterpower resources and have abundant rainfall, but the rainfalls are asymmetrically distributed in a year and among years, which is very detrimental to development and application of waterpower resources, most of runoff in the water resource is not applied and flows away in vain. Less of the planned cascade pivotal projects are implemented as scheduled, especially the planned five step pivotal projects at the middler and lower reaches of the Kan River trunk stream, because they are situated at the famous Jitai Basin and the downstream plain, the reservoir area has a severe inundation impact, so it is difficult to implement as scheduled, thus causing low application level of the water resources of this region.
5.0 Environment Baseline Survey & Assessment

- Low repeating utilization factor and large water consumption of industrial and agricultural water consumption
  Low repeating utilized water of productive water of industrial and mining firms in this region is less, the water consumption per ten thousand yuan output value is bigger, domestic water saving apparatus are of low popularization rate, flooding irrigation is widely applied for agricultural water consumption with a large water resource waste.

- More and more serious water pollution
  At present, counties, cities and districts within the drainage area basically have no wastewater treatment plants, a large amount of untreated wastewater and contaminated water are drain at will, plus excessive pesticides application and fertilizers, which has polluted not only water sources but soil. Because the water is polluted, it has affected ecological environment and human physical and mental health.

5.2.4 Regional Population Health Status
  In accordance with Statistics of Monitoring of Infectious Diseases in Taihe County in 2005, Taihe County in 2005 reported 15 kinds of infectious disease (including virus hepatitis, measles, hemorrhagic fever, hydrophobia, diarrhea, pulmonary tuberculosis, typhia, paratyphoid, tetanus of newborn, gonorrhoea, syphilis, influenza, mumps, epidemic roseola, acute hemorrhagic conjunctivitis and infectious diarrhea), to amount to 1408 cases at a disease rate of 264.78/105, 4.22% more than last year. Seventeen died, at a mortality rate of 3.2/105; there are other 5 kinds of infectious disease (gonococcal urethritis, verruca acuminate, herpes genitalis, chicken pox, and tuberculous pleurisy) to total 25 cases. The most reported cases are TB (886 cases), contributing to 62.3%, followed by virus hepatitis (377 cases), or 26.78% of all.

5.2.5 Antiquities Preservation
  Jiangxi Provincial Institute of Cultural Relics and Archaeology, as only one specialized organ of Jiangxi Province, is able to independently carry out archaeological exploitation and unearthing work, entrusted by Navigational Affair Administration of Jiangxi Provincial Communications Bureau to organize specialized personnel for cultural relics exploitation work at the inundation area of the Shihutang reservoir since December 9, 2006 and completed the exploitation work on January 3, 2007 smoothly. On the basis of the site exploitation and unearthing work, Jiangxi Provincial Institute of Cultural Relics and Archaeology completed preparation of Cultural Relics Investigation Report of Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River at the end of January 2007.
  According to the research findings of Cultural Relics Investigation Report of Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River, in the inundation area of the reservoir, one ancient ferry (Huangkeng Ancient Ferry does not belong to cultural relics protected unit of different grades) was found; at the vicinity of the inundation area, two ancient city sites were found (Baikou Ancient City Site, state grade cultural relics protected unit); In addition, Gouzi Pagoda (county-level cultural relics protected unit) and Ouyang Ancestral Hall
(under application for province-level cultural relics protected unit) were found in a scope with a certain distance from the inundation area. Distribution of the cultural relics and historic sites of the Project is shown in DRAWING NO.03.

The reservoir area of this Project is involved in seven townships of Taihe County of Ji’an City – Wanhe, Zhangtang, Yanxi, Tangzhou, Chengjiang, Xilong and Mashi and low-lying area of Taihe County Seat.

- **Wanhe Township**: no ancient cultural relics are found at Shengkou, Kuangjia, Duxia and Shihutang at upper and down areas of the dam site and at Jiangjiazhou, Xiabian and Shaxi at the inundation area.
- **Zhangtang Township**: Through survey, the Guabang Mountain at the bank of the Kan River was the battlefield of national hero Wen Tianxiang of late Song Dynasty to fight with Yuan, an ancient ferry was found in the inundation area.

- **Huangkeng Ancient Ferry**

Huangkeng Ancient Ferry is located at southwest of Huangkeng Village, 2km southwest of Zhangtang Polder, its age is about Qing Dynasty. Nearby the ferry, there is a road to the ancient street. This ferry is not very important and does not belong to cultural relics protected unit of different grades.

- **Yanxi Township**: Through survey, no cultural relics are found at Hetou and Lingbei and down areas of the dam site and at
Tongluobei, Mopanxing, Zhangjiapeng, Heshupeng, Xinzhou, Guabang, Huangkengpengxia, Gaoping, Gangboyao and Jiangqian Village at the inundation area. There is a Gouzinao Pagoda (picture on the right) of Qing Dynasty atop the Gouzinao Mountain, 60m away from the inundation area, which belongs to county grade cultural relics protected unit, the pagoda bottom elevation is far higher than design flood level. Project construction and reservoir area inundation will not cause damage or impact on it.

Tangzhou Township: Through survey, two ancient city sites are found in the inundation area.

Ancient City Site
Ancient City Site is situated at Luojia, Xiamu Village of Hejiang Villagers Committee, 2km north of Tangzhou Township (Yongchang City). The site is basically in square shape, about 397m east-west long and about 387m south-north wide, with total area of about 160,000 square meters. The northeast wall is well protected, adjacent to the Kan River and the Zhulin River; South and west walls are sporadically existing, there is a moat outside the south wall, and city gate outside the west wall. It is analyzed as per the county annals and cultural deposit of the site that the age of this city site is at about Nan Dynasty. This city site is 40m away from the south bank of the Kan River, with elevation of the side close to the Kan River is over 60.68m, higher than design flood level 58.65m, which will not be affected by level rise of the Kan River. But the Foundation elevation of part of the east wall of the city wall close to the Zhulin River is 56.7m, about 0.2m higher than normal impounded level 56.5m, lower than design flood level 58.65m due to rerouting of the Zhulin River, thus about 250m long wall foundation will be affected by level rise of the Zhulin River, this city site does not belong to cultural relics protected unit of different grades.

Baikou City Site
Baikou City Site is located at the south bank of the Kan River, Zhoutou Village of Tangzhou Township, 3km southwest of Taihe County Seat with an area of 230,000m², in converse cascade shape, divided into inner and outer cities. The outer city is 1941m long in total, except that part of northwest of the outer city is damaged, most of the outer city is well protected. The inner city is in square shape, at north side of the Baikou City, 861m long in total, with an area of 43,000m². The outer city now has seven openings, the inner city has three openings, like city gates. Northwest gate of the inner city is of concave structure, like small town outside the city gate. The city wall is built with earth, there is a moat outside the city, flowing into the Kan River from south to north. Archaeological information shows that the Baikou City was built at early West Han Dynasty and was used till East Jin Dynasty. This Site was listed into the sixth lot of state grade key cultural relics protected units by the State Council. Site survey shows that this Site is now 25m away from the south bank of the Kan River, the bank elevation of the side of the Site close to the Kan River is over 59.3m, higher than design flood level 58.65m, which will not be affected by the level rise of the Kan River and be consistent with the regulations of Cultural Relics Protection Law of P.R. China.

Chengjiang Township: no cultural relics are found through survey.

Xilong Township: no cultural relics are found in the inundation area through survey.
5.0 Environment Baseline Survey & Assessment

Ancient city site relief map  Ancient city site plan sketch

Northwest of the ancient city site  South city wall and moat of the ancient city site

Small town at southeast of the ancient city site  Small town at northwest of the ancient city site

East wall and the Zhulin River of the ancient city site  Wall section of the ancient city site
5.0 Environment Baseline Survey & Assessment

- Protection sign of the Baikou city site
- Relief map of the Baikou city site
- Panorama of the Baikou city site
- Plan sketch of the Baikou city site

■ Mashì Township: no cultural relics are found in the inundation area through survey. Shuijianggu Village of Mashì Township has Ouyang Ancestral Hall of Qing Dynasty, about 1.5km away from the Kan River, under application for provincial grade cultural relics protected unit, because Ouyang Ancestral Hall is far away from the inundation area of the project, the Project construction and the reservoir area inundation will not cause damage or impacts on it.

5.2.6 Mineral resources
The stratum here is simple in structure in the permanent acquisition of land by the Project, mainly composed of cretaceous Maodian Group (k₂m), Zhoutian Group (k₂z) and Hongningang Group (k₂hg) of red clasolite; of gravel and vermiform reticulate laterite of Jinxian Group of Pleistocene series of quaternary system; of alluvial gravel, sandy loam and clay soil of Holocene. There is no metallic mineral resource or non-metallic resource, except for such non-vital minerals as building sand, rocks and clay soil, etc.

5.3 Investigation of Pollution Sources

5.3.1 Air Pollution
In accordance with the data obtained in Ji’an Environment Detection Station in 2006, industrial fume in 2006 in Ji’an amounted to 37.4115 billion m³, with air pollution mainly rooting from Jiangxi Taihe Yuhua Cement Company LTD, whose industrial fume contributed to 89.9% in local regions. Domestic and other SO₂ discharge quantity is 1097t, mainly from Jiangxi Taihe Yuhua Cement Company LTD, Taihe Brick Firm Group and Jiangxi Luqing Nitro-cotton
Company. Domestic and other NO\textsubscript{x} discharge quantity is 435t. For details, see Table 5.3-1 and Table 5.3-2.

Table 5.3-1  Local Industrial Waste Gas

<table>
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<tr>
<th>No</th>
<th>Enterprise Name</th>
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<td>6</td>
<td>Taihe Rongtai Package Com LTD</td>
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<td>7</td>
<td>Jiangxi Tianlan Plant Extracts Com LTD</td>
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<td>Taihe Songtai Forestry Com LTD</td>
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<td>16</td>
<td>Jiangxi Yuhuan Spice Co. LTD</td>
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Table 5.3-2  Major Waste Air Quantity

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<td>2</td>
<td>Taihe Brick Group Co.</td>
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<td>5</td>
<td>Taihe Rongtai Package Co. LTD</td>
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5.3.2 Investigation of Water Pollution Source

In accordance with the pollution sources data obtained in Ji’an Environment Detection Station in 2006 and with site investigation, from the dam site to the terminal of backup (38.19km), there are three waste drains -- Taihe County Seat drain, industrial garden drain and Yanxi Wastewater Treatment Plant drain, waste water from Taihe County Seat drain is domestic sewage, while waste water from the industrial garden drain and Yanxi Wastewater Treatment Plant drain is industrial wastewater.

In 2006 industrial waste water totaled $1.52054 \times 10^4$ t/a of which domestic sewage aggregated $5.7115 \times 10^4$ t/a and industrial waste water totaled $9.4939 \times 10^4$ t/a. COD and NH3-N discharge quantities in domestic sewage are $3212.73$ t/a and $249.88$ t/a.

The major pollution sources come from Jiangxi Jinshui Paper Com LTD, Jiang Zhetai Industry Com LTD, Jiangxi Xiangtai Paper Com LTD and Taihe Rongtai Package Com LTD, the four of which contributed to $92.1$ % of the total waste water. For detail see Table 5.3-3, and for major drains of the reservoir area, see Attached Drawing 03.
Table 5.3

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<th>No</th>
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<th>Percentage</th>
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<td>0.43</td>
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<tr>
<td>10</td>
<td>Jiangxi Hangtian Chemical Co. LTD</td>
<td>42500</td>
<td>2278</td>
<td>0.07</td>
</tr>
<tr>
<td>11</td>
<td>Taihe Songtai Forestry Co. LTD</td>
<td>40800</td>
<td>12500</td>
<td>0.39</td>
</tr>
<tr>
<td>12</td>
<td>Taihe Guangtai Chemical Co. LTD</td>
<td>30556</td>
<td>7945</td>
<td>0.25</td>
</tr>
<tr>
<td>13</td>
<td>Jiangxi kang’an Chinese Medicine &amp; Health Products Co. LTD</td>
<td>12240</td>
<td>2526.9</td>
<td>0.08</td>
</tr>
<tr>
<td>14</td>
<td>Jiangxi Tianlan Plant Extracts Co. LTD</td>
<td>10400</td>
<td>8840</td>
<td>0.28</td>
</tr>
<tr>
<td>15</td>
<td>Jiangxi Baishineng Yard-dyed Fabric Co. LTD</td>
<td>6800</td>
<td>1768</td>
<td>0.06</td>
</tr>
<tr>
<td>16</td>
<td>Jiangxi Yuhuan Spice Co. LTD</td>
<td>4250</td>
<td>1275</td>
<td>0.04</td>
</tr>
<tr>
<td>17</td>
<td>Jiangxi Wande chemical Tech Co. LTD</td>
<td>3350</td>
<td>536</td>
<td>0.02</td>
</tr>
<tr>
<td>18</td>
<td>Taihe Goose Cotton Spinning Co. LTD</td>
<td>323</td>
<td>17.1</td>
<td>0.001</td>
</tr>
</tbody>
</table>

In addition, non-point source pollution comes from such aspects as follows:

- **Agricultural pollution source**

Agriculture is the pillar industry in the assessment region, lack of effective drainage engineering, the seepage is drained to township gulches and canals, so that waste water seepages while the pollutants accumulate in the gulches or canals, with a lot of solid waste.
accumulated in township surface. Such solid waste includes daily waste and crops, which under rainfall flush transfer to the water body. The farm chemicals and fertilizer applied in great amounts are partly absorbed and quite a large percentage of them are transferred to Kan River to produce negative impact upon aquatic environment.

Surface Runoff in Towns
Pollutants out of such surface runoff come mainly from rainfall, with surface deposit constituting the majority of pollutant in surface runoff. Such surface deposit is mainly of rubbish, atmosphere dust, rubbish accumulation, animal and plant relics, fallen leaves and traffic derelics. The major factors upon pollutant loading amount come from waterproof area, storm-water drain system, traffic impact, curb height and street sweeping.

N/P Feed into River
Such nutrient substance in Kan River comes mainly from domestic sewage and agricultural activities, in three forms, namely domestic sewage, water loss and soil erosion and farm chemicals and fertilizers.

Residents are dens in Chengjiang Town, Taihe County Town. In accordance with investigation concerning water resources, N/P fed into the river at County Town Drain Outlet reached 189.4 t and 69.6 t respectively. Agricultural pollution is mainly in the form of farm chemicals and fertilizers. Soil into the reservoir due to water loss and soil erosion aggregates 1,067,400 t annually. Calculated at an average of 1.5% of soil organic matter, then gross organic matter loss reached 16000 t annually; calculated at 0.1% of N and 0.12% of P, then N and P into reservoir aggregate 16.01 ton and 19.21 t respectively. N/P in water migration and reservoir movement will suffer from absorption, assimilation, precipitation, volatilization and retrogradation. Calculated at a consumption percentage of 70% for N and 95% for P, N/P that flows into reservoir amounts to 4.8t and 0.96t respectively.

In accordance with the spastics in 2005 for Taihe County, the major fertilizer applied includes nitrogenous fertilizer, phosphate fertilizer, potash fertilizer and compound fertilizer, of which the N makes up the majority, or 60% of all, at 34.19kg/mu. Calculated at 44014 mu of farmland around the reservoir, annual application of N totals 1536.53 5, so pure nitrogen applied to the land totals 424.08 t and P 110.63 t annually.

N/P loss amount, if estimated according to nutrient substance loss formula, does as follows:

\[ EN.P = FN.P \cdot (1-x) \cdot y \]

Of which:

- \( EN.P \) — estimated N/P loss amount
- \( FN.P \) — N/P content in fertilizer
- \( x \) — crop’s absorption factor of fertilizer--N: 30%; P: 15%
- \( y \) — fertilizer loss rate after feeding into soil and water body--N:30%; P:5%

Calculation indicates that N/P entering water body totals 89.06t/a and 4.70t/a respectively.
To sum up, N/P from domestic sewage, water loss and soil erosion and fertilizers fed into Kan River aggregates 194.86t/a and 42.76t/a respectively.

### 5.4 Status Quo & Assessment of Water Environment

#### 5.4.1 Investigation of Existing Water Environment

**Detection Period & Section**
Existing water environment was under observation twice on 13 and 19 March, 2007.
There were 6 sections under observation. For detail see table 5.4—1 and Attached Drawing 02.

**Sampling Items**
Observation was made concerning water temperature, pH, suspended substance, permanganate index, BOD5, DO, NH3-N, petroleum, mercury, volatile phenol, total phosphorus, total nitrogen, hexavalent chrome and coli-group.

**Analytic Procedure**
For detail see Table 5.4—2.

**Conclusion**
For detail see Table 5.4—3 and Table 5.4—4.

Of the twice observation, there was no detection of petroleum, mercury, volatile phenol or hexavalent chrome.

### Ji’an Perennial routine monitoring results

The main pollutants monitoring results of the drinking water source water quality of Ji’an downtown in 2006 (at 28km–33km downstream of the dam site) provided by Ji’an City Environment Monitoring Station are shown in Table 5.4-5.

The main pollutants routine monitoring results of the water quality of Shenggangshan Section (Shengkong) (at ~33km downstream of the dam site) of Ji’an City in 2006 and the first half of 2007 provided by Ji’an City Environment Monitoring Station are shown in Table 5.4-6.

#### Table 5.4—1 Detection Sections & Sampling Points of Surface Water Environment

<table>
<thead>
<tr>
<th>Item</th>
<th>Sections</th>
<th>Criteria</th>
<th>Sampling Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>1#</td>
<td>Backwater edge, 100m upper stream</td>
<td>Surface Water Environmental Quality Standards (SWEQS), Grade III (GB3838-2002)</td>
<td>In section channel line and on the left/right side of the line there would be a sampling vertical.</td>
</tr>
<tr>
<td>2#</td>
<td>Taihe County Town Drainage Outlet</td>
<td>SWEQS, Grade III (GB3838-2002)</td>
<td></td>
</tr>
<tr>
<td>3#</td>
<td>Gouzinao Intake, 100m upper stream</td>
<td>SWEQS, Grade II (GB3838-2002)</td>
<td></td>
</tr>
<tr>
<td>4#</td>
<td>200m upper stream of dam site</td>
<td>SWEQS, Grade III (GB3838-2002)</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>Location</td>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>----------------------------------------------</td>
<td>-------------------------------</td>
<td></td>
</tr>
<tr>
<td>5#</td>
<td>1km downstream of dam site</td>
<td>SWEQS, Grade III (GB3838-2002)</td>
<td></td>
</tr>
<tr>
<td>6#</td>
<td>100m downstream of Wanhe Drainage Sluice</td>
<td>SWEQS, Grade III (GB3838-2002)</td>
<td></td>
</tr>
</tbody>
</table>
Table 5.4.2 Analytical Procedure & Instrumentation of Water Quality Detection

<table>
<thead>
<tr>
<th>Item</th>
<th>Analytical Procedure</th>
<th>Instrumentation &amp; Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>glass electrode □ GB 6920-86 □</td>
<td>PXS-270 ion(o)meter</td>
</tr>
<tr>
<td>Suspended substance</td>
<td>gravimetric method □ GB 11901 □</td>
<td>AB104-N Mettler balance</td>
</tr>
<tr>
<td>permanganate index</td>
<td>acid process □ GB 11892-89 □</td>
<td>—</td>
</tr>
<tr>
<td>BOD5</td>
<td>Dilution &amp; inoculation □ GB 7488-87 □</td>
<td>—</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>Electrochemistry probe method □ GB 11913-89 □</td>
<td>OX1315I/SET dissolved oxygen meter</td>
</tr>
<tr>
<td>Ammonia n</td>
<td>Nessler’s reagent photometry □ GB 7479-87 □</td>
<td>VIS-7220 visible spectrophotometer</td>
</tr>
<tr>
<td>Petroleum</td>
<td>infrared spectrophotometer □ GB/T16488-1996 □</td>
<td>JDS-100Z infrared ullage meter</td>
</tr>
<tr>
<td>Volatile phenol</td>
<td>4 amino-antipyrine extraction spectrophotometric method □ GB 7490-87 □</td>
<td>VIS-7220 visible spectrophotometer</td>
</tr>
<tr>
<td>Total phosphorus</td>
<td>Molybdenum &amp; stibium spectrophotometer □ GB 11893-89 □</td>
<td>TAS-990 Super atomic absorption spectrophotometer</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>potassium peroxodisulfate ultraviolet spectrophotometric method □ GB 11894-89 □</td>
<td>TV-1800/1800S ultraviolet spectrophotometer</td>
</tr>
<tr>
<td>Hexavalent chrome</td>
<td>dinitrodi phenyl carbazide spectrophotometric method □ GB 7467-87 □</td>
<td>VIS-7220 visible spectrophotometer</td>
</tr>
<tr>
<td>Coli -- group</td>
<td>Multistream zymotechnics in line with Water &amp; Waste Water Analytic Procedure (4th edition)</td>
<td>—</td>
</tr>
</tbody>
</table>


Table 5.4 3 Conclusion of Water Quality Detection

<table>
<thead>
<tr>
<th>Items</th>
<th>Observation result</th>
<th>13 March, 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Quality</td>
<td>Clear</td>
<td>Clear</td>
</tr>
<tr>
<td>Water (%) temperature</td>
<td>16.0</td>
<td>15.9</td>
</tr>
<tr>
<td>PH</td>
<td>7.12</td>
<td>7.04</td>
</tr>
<tr>
<td>Suspended solid</td>
<td>25.0</td>
<td>29.0</td>
</tr>
<tr>
<td>Permanganate index</td>
<td>2.03</td>
<td>2.85</td>
</tr>
<tr>
<td>BOD5</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>7.70</td>
<td>7.67</td>
</tr>
<tr>
<td>Ammonia n</td>
<td>0.168</td>
<td>0.178</td>
</tr>
<tr>
<td>Petroleum</td>
<td>0.001L</td>
<td>0.001L</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.000005L</td>
<td>0.000005L</td>
</tr>
<tr>
<td>Volatile phenol</td>
<td>0.002L</td>
<td>0.002L</td>
</tr>
<tr>
<td>Total phosphorus</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>1.46</td>
<td>1.57</td>
</tr>
<tr>
<td>Hexavalent chrome</td>
<td>0.004</td>
<td>0.004</td>
</tr>
<tr>
<td>Coli --group</td>
<td>9400</td>
<td>7900</td>
</tr>
</tbody>
</table>

*Note: L means no such substance was detected.
Table 5.4 Evaluation of Water Quality Detection

Unit: mg/L(PH: zero dimension)

<table>
<thead>
<tr>
<th>Items</th>
<th>Observation result</th>
<th>On 13 March, 2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Quality</td>
<td>Clear</td>
<td>Clear</td>
</tr>
<tr>
<td>Water (°C) temperature</td>
<td>16.2</td>
<td>16.1</td>
</tr>
<tr>
<td>PH</td>
<td>7.08</td>
<td>6.99</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>26.0</td>
<td>31.0</td>
</tr>
<tr>
<td>Permanganate index</td>
<td>2.09</td>
<td>2.98</td>
</tr>
<tr>
<td>BOD5</td>
<td>1.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>7.72</td>
<td>7.39</td>
</tr>
<tr>
<td>Ammonia nitrogen</td>
<td>0.162</td>
<td>0.168</td>
</tr>
<tr>
<td>Petroleum</td>
<td>0.001L</td>
<td>0.002</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.000005L</td>
<td>0.000005L</td>
</tr>
<tr>
<td>Volatile phenol</td>
<td>0.002L</td>
<td>0.002L</td>
</tr>
<tr>
<td>Total phosphorus</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>1.50</td>
<td>1.59</td>
</tr>
<tr>
<td>Hexavalent chrome</td>
<td>0.004 L</td>
<td>0.004L</td>
</tr>
<tr>
<td>Coli — group</td>
<td>9400</td>
<td>7900</td>
</tr>
</tbody>
</table>

*Note: L means no such substance was detected.

5.4.2 Assessment of Current Water Environment

Analytic Procedure & Standard

The designation number method is applied in assessment of existing water environment, calculated as follows:

\[ S_{i,j} = \frac{C_{i,j}}{C_{si}} \]

Of which \( S_{i,j} \) —— the designation number of factor j in section i
\[ C_{i,j} \] —— measured concentration of factor \( j \) in section \( i \), mg/L

\[ C_{\text{sl}} \] —— evaluation criterion of factor \( j \), mg/L

The designation number of pH is calculated as follows:

\[
S_{pH,j} = \begin{cases} 
7.0 - \frac{pH_j}{7.0 - pH_{sl}} & \text{if } pH_j \leq 7.0 \\
\frac{pH_j - 7.0}{pH_{su} - 7.0} & \text{if } pH_j > 7.0 
\end{cases}
\]

Of which:

\[ S_{pH,j} \] —— The designation number of pH

\[ pH_j \] —— measured value of pH in section \( j \)

\[ pH_{su} \] —— upper limit value and lower limit value of pH

For water-dissolved oxygen (DO) it is calculated as follows:

\[
S_{DO,i} = \frac{|DO_j - DO_i|}{DO_f - DO_i} \quad \text{if } DO_i \neq DO_f \\
S_{DO,i} = 10 - 9 \frac{DO_j}{DO_s} \quad \text{if } DO_i = DO_f \\
DO_f = 468/(31.6 + T)
\]

Where,

\[ S_{DO,i} \] —— The designation number of dissolved oxygen in section \( i \), mg/L

\[ DO_i \] —— dissolved oxygen concentration in section \( I \), mg/L;

\[ DO_f \] —— saturated dissolved oxygen concentration in site temperature and salt content, mg/L;

\[ DO_s \] —— evaluation criterion value of dissolved oxygen, mg/L

Evaluation criterion adopts Grade II and III in accordance with different sections in line with Surface Water Environmental Quality Standards (SWEQS), Grade III (GB3838-2002) (Section No 3 belongs to Grade II and the rest to Grad III).
<table>
<thead>
<tr>
<th>Section</th>
<th>Item</th>
<th>pH</th>
<th>Total N</th>
<th>Permanganate index</th>
<th>Volatile phenol</th>
<th>Oils</th>
<th>Coliform flora pcs/L</th>
<th>NH3-N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yangming Water Works</td>
<td>Average value</td>
<td>7.46</td>
<td>1.07</td>
<td>1.64</td>
<td>0.001</td>
<td>0.001</td>
<td>2521</td>
<td>0.138</td>
</tr>
<tr>
<td></td>
<td>Content range</td>
<td>6.80—8.0</td>
<td>0.77—1.92</td>
<td>0.8—2.35</td>
<td>0.001—0.001</td>
<td>0.001—0.004</td>
<td>700—7900</td>
<td>0.03—0.291</td>
</tr>
<tr>
<td></td>
<td>Std. Exceeding rate [%]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Month of peak value</td>
<td>3</td>
<td>8</td>
<td>12</td>
<td>2</td>
<td>7—12</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Jifu Water Works</td>
<td>Average value</td>
<td>7.45</td>
<td>0.98</td>
<td>1.79</td>
<td>0.001</td>
<td>0.007</td>
<td>2728</td>
<td>0.132</td>
</tr>
<tr>
<td></td>
<td>Content range</td>
<td>7.0—8.1</td>
<td>0.61—1.28</td>
<td>1.1—2.44</td>
<td>0.001—0.001</td>
<td>0.001—0.046</td>
<td>490—17000</td>
<td>0.05—0.355</td>
</tr>
<tr>
<td></td>
<td>Std. Exceeding rate [%]</td>
<td>0</td>
<td>8.8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8.8</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Month of peak value</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Hedong Water Works</td>
<td>Average value</td>
<td>7.48</td>
<td>1.38</td>
<td>1.63</td>
<td>0.001</td>
<td>0.003</td>
<td>5220</td>
<td>0.140</td>
</tr>
<tr>
<td></td>
<td>Content range</td>
<td>7.20—7.9</td>
<td>1.02—2.01</td>
<td>0.90—2.16</td>
<td>0.001—0.001</td>
<td>0.001—0.018</td>
<td>180—35000</td>
<td>0.010—0.29</td>
</tr>
<tr>
<td></td>
<td>Std. Exceeding rate [%]</td>
<td>0</td>
<td>17.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>25.6</td>
<td>0</td>
</tr>
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<td>Month of peak value</td>
<td>3</td>
<td>8</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.4—5 Water quality monitoring result of main drinking water sources of Ji’an City in 2006 Unit: mg/L, except pH
## Table 5.4-6  Water quality monitoring result of Shengangshan Section of the Kan River in 2006 and the first half of 2007

**Unit: mg/L, except pH**

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>Water T.</th>
<th>pH</th>
<th>Dissolved O2</th>
<th>Permanganate Index</th>
<th>COD</th>
<th>BOD</th>
<th>NH3-N</th>
<th>Total P</th>
<th>Cr&lt;sup&gt;+&lt;/sup&gt;</th>
<th>Volatile phenol</th>
<th>Oils</th>
<th>Coliform flora pcs/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>2</td>
<td>9</td>
<td>8.9</td>
<td>6.96</td>
<td>10.4</td>
<td>2.08</td>
<td>12.10</td>
<td>2.6</td>
<td>0.278</td>
<td>0.01</td>
<td>0.002</td>
<td>0.001</td>
<td>0.012</td>
<td>1400</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>4</td>
<td>21.0</td>
<td>7.04</td>
<td>8.2</td>
<td>1.93</td>
<td>3.12</td>
<td>2.2</td>
<td>0.298</td>
<td>0.06</td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>790</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>8</td>
<td>22.6</td>
<td>7.27</td>
<td>8.0</td>
<td>2.16</td>
<td>6.96</td>
<td>0.4</td>
<td>0.152</td>
<td>0.06</td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>790</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>9</td>
<td>29.8</td>
<td>7.28</td>
<td>7.2</td>
<td>1.99</td>
<td>6.28</td>
<td>2.5</td>
<td>0.080</td>
<td>0.04</td>
<td>0.002</td>
<td>0.001</td>
<td>0.005</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>22.9</td>
<td>7.04</td>
<td>7.1</td>
<td>1.46</td>
<td>5.46</td>
<td>1.1</td>
<td>0.101</td>
<td>0.02</td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>2300</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>12</td>
<td>12.2</td>
<td>7.68</td>
<td>10.3</td>
<td>2.31</td>
<td>5.22</td>
<td>1.6</td>
<td>0.137</td>
<td>0.037</td>
<td>0.002</td>
<td>0.001</td>
<td>0.007</td>
<td>4900</td>
</tr>
<tr>
<td>2007</td>
<td>2</td>
<td>5</td>
<td>11.0</td>
<td>7.65</td>
<td>10.2</td>
<td>2.35</td>
<td>3.08</td>
<td>0.6</td>
<td>0.065</td>
<td>0.02</td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>1100</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>9</td>
<td>17.7</td>
<td>7.20</td>
<td>7.8</td>
<td>2.40</td>
<td>4.46</td>
<td>0.3</td>
<td>0.127</td>
<td>0.01</td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>1100</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>8</td>
<td>26.6</td>
<td>6.62</td>
<td>5.5</td>
<td>2.35</td>
<td>4.25</td>
<td>0.8</td>
<td>0.155</td>
<td>0.01</td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>1300</td>
</tr>
</tbody>
</table>
5.0 Environment Baseline Survey & Assessment

Assessment Conclusion of Existing Water Quality

The current water quality monitoring results are listed in Table 5.4. From the monitoring results, it is clear that all the values of pH, permanganate index, BOD₅, DO, NH₃—N, total phosphorus, and coli-group are within the standard values with a standard exceeding rate of zero. As a result, the current water environment of the Kan River satisfies Grade II and III of water quality standard.

The main pollutants monitoring results of the drinking water source water quality of Ji’an downtown in 2006 (at 28km–33km downstream of the dam site) show that the standard exceeding items of the drinking water source water quality of Ji’an downtown are coliform flora and total N at 8.3% and 7.5% respectively, the other item do not exceed the standard values and that Yangming Water Works has no monitoring items exceeding the standard values all the year around, coliform flora and total N of Jifu Water Works exceed the standard values with the same standard exceeding rate of 8.8%, coliform flora and total N of water source of Hedong Water Works exceed the standard values with the standard exceeding rates 7.9% and 17.0% respectively.

The main pollutants routine monitoring results of the water quality of Shengangshan Section (Shengkong) (at ~33km downstream of the dam site) of Ji’an City in 2006 and the first half of 2007 indicate that the water quality of the said river section has no pollutants exceeding the standard (Grade III) with good water quality all the year around.

Table 5.4-7 Statistics of Designation Number of Water Quality Assessment Factors

<table>
<thead>
<tr>
<th>Items</th>
<th>Date</th>
<th>Backwater 100m upper stream in 1# reservoir</th>
<th>Taihe County Town rain Outlet 2#</th>
<th>100m upper stream in 3# Gouzinao Intake</th>
<th>200m upper stream in 4# dam site</th>
<th>1km downstream in No 5# dam site</th>
<th>1km downstream in No 6# Wanhe Drain Sluice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanganate index</td>
<td>2007.3.13</td>
<td>0.06</td>
<td>0.02</td>
<td>0.09</td>
<td>0.08</td>
<td>0.1</td>
<td>0.095</td>
</tr>
<tr>
<td></td>
<td>2007.3.19</td>
<td>0.04</td>
<td>0.01</td>
<td>0.08</td>
<td>0.09</td>
<td>0.08</td>
<td>0.095</td>
</tr>
<tr>
<td>Permanganate index</td>
<td>2007.3.13</td>
<td>0.34</td>
<td>0.48</td>
<td>0.54</td>
<td>0.38</td>
<td>0.41</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td>2007.3.19</td>
<td>0.35</td>
<td>0.50</td>
<td>0.55</td>
<td>0.36</td>
<td>0.40</td>
<td>0.41</td>
</tr>
<tr>
<td>Permanganate index</td>
<td>2007.3.13</td>
<td>0.33</td>
<td>0.30</td>
<td>0.90</td>
<td>0.35</td>
<td>0.25</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>2007.3.19</td>
<td>0.38</td>
<td>0.33</td>
<td>0.67</td>
<td>0.33</td>
<td>0.28</td>
<td>0.35</td>
</tr>
<tr>
<td>Permanganate index</td>
<td>2007.3.13</td>
<td>0.44</td>
<td>0.45</td>
<td>0.64</td>
<td>0.50</td>
<td>0.50</td>
<td>0.51</td>
</tr>
<tr>
<td>Permanganate index</td>
<td>2007.3.19</td>
<td>0.43</td>
<td>0.50</td>
<td>0.55</td>
<td>0.45</td>
<td>0.49</td>
<td>0.51</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>2007.3.13</td>
<td>0.17</td>
<td>0.18</td>
<td>0.19</td>
<td>0.13</td>
<td>0.12</td>
<td>0.08</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>2007.3.19</td>
<td>0.16</td>
<td>0.17</td>
<td>0.19</td>
<td>0.12</td>
<td>0.12</td>
<td>0.09</td>
</tr>
<tr>
<td>Ammonian</td>
<td>2007.3.13</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Ammonian</td>
<td>2007.3.19</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.05</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>Total phosphorus</td>
<td>2007.3.13</td>
<td>0.94</td>
<td>0.79</td>
<td>0.10</td>
<td>0.05</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Total phosphorus</td>
<td>2007.3.19</td>
<td>0.94</td>
<td>0.79</td>
<td>0.10</td>
<td>0.05</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Coli –group</td>
<td>2007.3.13</td>
<td>0.94</td>
<td>0.79</td>
<td>0.10</td>
<td>0.05</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Coli –group</td>
<td>2007.3.19</td>
<td>0.94</td>
<td>0.79</td>
<td>0.10</td>
<td>0.05</td>
<td>0.05</td>
<td>0.02</td>
</tr>
</tbody>
</table>
5.0 Environment Baseline Survey & Assessment

5.5 Investigation & Evaluation of Existing Ambient Air

5.5.1 Investigation & Evaluation of Existing Ambient Air

□ Monitor Factor & Sampling Points
There were three monitor points, as indicated in Table 5.1—1 and Attached Drawing 02, to monitor such factors as TSP, NO2 and SO2.

□ Monitor Period & Frequency
The sampling was taken on 14 to 18 March, 2007 continuously for five days, when sampling for TSP lasted over 12 hours and for SO2 and NO2 18 hours a day.

□ Monitor & Analytic Procedure
For detail see Table 5.5-2.

Table 5.5-1 Sampling Points of Ambient Air Conditions

<table>
<thead>
<tr>
<th>No</th>
<th>Location</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1#</td>
<td>Shihutang Township—right bank of dam site</td>
<td>Grade II as described in Quality Criteria for Ambient Air</td>
</tr>
<tr>
<td>2#</td>
<td>Xiaying Township—left bank of dam site</td>
<td></td>
</tr>
<tr>
<td>3#</td>
<td>Roadway in Jiangjia Township (the road for use in construction period)</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.5-2 Analytic Procedure of Ambient Air

<table>
<thead>
<tr>
<th>Items</th>
<th>Analytic Procedure</th>
<th>Instrumentation &amp; Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Melamine-absorptive rosiniline spectrophotometry</td>
<td>KC-6120 Atmospheric Sampling Instrument</td>
</tr>
<tr>
<td></td>
<td>Ethylene diamine hydrochloride colorimetry</td>
<td>KC-120 Atmospheric Sampling Instrument</td>
</tr>
<tr>
<td></td>
<td>Gravimetric method</td>
<td>KC-6120 Atmospheric Sampling Instrument</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AB104-N Mettler Balance</td>
</tr>
</tbody>
</table>

□ Conclusion of Ambient Air Monitoring
See Table 5.5-3.
Table 5.5-3 Conclusion of Ambient Air Monitor

<table>
<thead>
<tr>
<th>Sample Points</th>
<th>Date</th>
<th>SO2</th>
<th></th>
<th></th>
<th>NO2</th>
<th></th>
<th></th>
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<tr>
<td></td>
<td></td>
<td>Hour mean value</td>
<td>Day mean value</td>
<td>Hour mean value</td>
<td>Day mean value</td>
<td>Hour mean value</td>
<td>Day mean value</td>
</tr>
<tr>
<td>1#</td>
<td>2007.3.14</td>
<td>0.017</td>
<td>0.039</td>
<td>0.027</td>
<td>0.011</td>
<td>0.039</td>
<td>0.026</td>
</tr>
<tr>
<td></td>
<td>2007.3.15</td>
<td>0.020</td>
<td>0.047</td>
<td>0.030</td>
<td>0.003</td>
<td>0.040</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>2007.3.16</td>
<td>0.017</td>
<td>0.037</td>
<td>0.026</td>
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<td>0.036</td>
<td>0.02</td>
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<tr>
<td></td>
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<td>0.017</td>
<td>0.030</td>
<td>0.024</td>
<td>0.005</td>
<td>0.029</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>2007.3.18</td>
<td>0.018</td>
<td>0.029</td>
<td>0.025</td>
<td>0.006</td>
<td>0.036</td>
<td>0.021</td>
</tr>
<tr>
<td>2#</td>
<td>2007.3.14</td>
<td>0.018</td>
<td>0.054</td>
<td>0.038</td>
<td>0.008</td>
<td>0.039</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>2007.3.15</td>
<td>0.016</td>
<td>0.043</td>
<td>0.028</td>
<td>0.013</td>
<td>0.040</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>2007.3.16</td>
<td>0.014</td>
<td>0.032</td>
<td>0.023</td>
<td>0.006</td>
<td>0.043</td>
<td>0.026</td>
</tr>
<tr>
<td></td>
<td>2007.3.17</td>
<td>0.014</td>
<td>0.040</td>
<td>0.024</td>
<td>0.014</td>
<td>0.045</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>2007.3.18</td>
<td>0.016</td>
<td>0.029</td>
<td>0.022</td>
<td>0.012</td>
<td>0.045</td>
<td>0.032</td>
</tr>
<tr>
<td>3#</td>
<td>2007.3.14</td>
<td>0.015</td>
<td>0.055</td>
<td>0.035</td>
<td>0.013</td>
<td>0.053</td>
<td>0.034</td>
</tr>
<tr>
<td></td>
<td>2007.3.15</td>
<td>0.013</td>
<td>0.059</td>
<td>0.033</td>
<td>0.011</td>
<td>0.047</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>2007.3.16</td>
<td>0.013</td>
<td>0.062</td>
<td>0.034</td>
<td>0.009</td>
<td>0.049</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>2007.3.17</td>
<td>0.015</td>
<td>0.056</td>
<td>0.033</td>
<td>0.009</td>
<td>0.052</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>2007.3.18</td>
<td>0.013</td>
<td>0.057</td>
<td>0.034</td>
<td>0.006</td>
<td>0.048</td>
<td>0.0028</td>
</tr>
</tbody>
</table>

5.5.2 Assessment of Existing Ambient Air

- **Evaluation Criteria**
  Ambient air is under evaluation in line with *Quality Criteria for Ambient Air* (modified) (GB3095-1996) of Grade II. See Table 1.4-3.

- **Analytic Procedure**
  Ambient air is under evaluation through designation number, in such formula as follows:

  $$ P_i = \frac{C_i}{C_{oi}} $$

  Where,
  - $P_i$ — the designation number of evaluation factor $i$
  - $C_i$ — measured concentration of factor $i$ mg/m$^3$
  - $C_{oi}$ — criteria of factors mg/m$^3$

- **Conclusion**

  See Table 5.5-4.
From the table it is known that all monitor factors fall within the criteria in hour mean value and day mean value, with the designation number less than 1, to satisfy Grade II in *Quality Criteria for Ambient Air* (modified) (GB3095-1996), to indicate good air quality.

Table 5.5-4  Conclusion of Ambient Air Evaluation

<table>
<thead>
<tr>
<th>Sampling Points</th>
<th>SO2</th>
<th>NO2</th>
<th>TSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shihutang</td>
<td>Mean h value</td>
<td>0.034</td>
<td>0.094</td>
</tr>
<tr>
<td>Village right bank of dam site</td>
<td>Mena D value</td>
<td>0.160</td>
<td>0.200</td>
</tr>
<tr>
<td>Xiyinxia</td>
<td>Mean h value</td>
<td>0.028</td>
<td>0.108</td>
</tr>
<tr>
<td>Village left bank of dam site</td>
<td>Mena D value</td>
<td>0.147</td>
<td>0.253</td>
</tr>
<tr>
<td>Side of Jiangjiazhou Village Road</td>
<td>Mean h value</td>
<td>0.026</td>
<td>0.124</td>
</tr>
<tr>
<td></td>
<td>Mena D value</td>
<td>0.220</td>
<td>0.233</td>
</tr>
</tbody>
</table>

5.6 Investigation & Assessment of Acoustical Environment

5.6.1 Investigation of Acoustical Environment

□ Sampling Points
There were three sampling points, the same as in monitor of ambient air. See Table 5.5-1 and Attached Drawing 02.

□ Monitor Period, Frequency & Procedure
The detection was performed from 13 to 14 March 2007, continuously for two days, once at daytime and once at night.

Detection is made in line with *Monitor Procedure for Urban Ambient Noise* GB14623-93.

□ Detection Result
See Table 5.6-1.
Table 5.6-1                   Result of Noise Monitoring

<table>
<thead>
<tr>
<th>Sampling Points</th>
<th>Monitor Period</th>
<th>Day</th>
<th>Night</th>
<th>Day</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>No 1: Shihutang Village, right bank of dam site</td>
<td>2007.3.13</td>
<td>44.0</td>
<td>37.6</td>
<td>45.6</td>
<td>38.3</td>
</tr>
<tr>
<td>No 2: Xiayinxia Village, left bank of dam site</td>
<td>2007.3.14</td>
<td>42.6</td>
<td>36.4</td>
<td>43.9</td>
<td>36.7</td>
</tr>
<tr>
<td>No 3: Side of Jiangjiazhou Village Road</td>
<td>2007.3.13</td>
<td>47.8</td>
<td>38.7</td>
<td>48.3</td>
<td>38.5</td>
</tr>
</tbody>
</table>

5.6.2 Evaluation of Current Acoustical Environment

□ Evaluation Criteria
Grade I in *Monitor Procedure for Urban Ambient Noise* GB14623-93 is introduced as evaluation criteria. See Table 1.4-5.

□ Conclusion of Evaluation
From the data it is clear that the noise value in the construction site satisfies the criteria Grade I of *Monitor Procedure for Urban Ambient Noise* GB14623-93 without standard exceeding phenomena and with good current acoustical environment.

For detail of noise pollution index, see Table 5.6-2.

Table 5.6-2              Statistics of Noise Pollution Index

<table>
<thead>
<tr>
<th>Sampling Points</th>
<th>Monitor Period</th>
<th>Day</th>
<th>Night</th>
<th>Day</th>
<th>Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>No 1: Shihutang Village, right bank of dam site</td>
<td>2007.3.13</td>
<td>0.800</td>
<td>0.836</td>
<td>0.829</td>
<td>0.851</td>
</tr>
<tr>
<td>No 2: Xiayinxia Village, left bank of dam site</td>
<td>2007.3.14</td>
<td>0.775</td>
<td>0.809</td>
<td>0.798</td>
<td>0.816</td>
</tr>
<tr>
<td>No 3: Side of Jiangjiazhou Village Road</td>
<td>2007.3.13</td>
<td>0.869</td>
<td>0.860</td>
<td>0.878</td>
<td>0.856</td>
</tr>
</tbody>
</table>

5.7 Investigation of Existing Eco-environment

5.7.1 Evaluation Range of Eco-environment
In accordance with the characteristics of the planned works and local eco-environmental status and social-economic features, in line with the basic principle of ecology, with full
consideration to interactive relationship and inter-impact among each factor in the ecological system, the range of eco-environmental evaluation for this works goes as follows:

Project Planning Inundation
In terms of engineering planning, engineering inundation starts from about 38 km upper stream of Kan River (calculated from Shihutang), at the normal water level of 56.5m, inundation will cover the protection embankment and 3.0km surroundings, or, to be exact, to cover such 6 townships as Yanxi Town, Chengjiang Town, Wanhe Town, Mashi Town, Tangzhou Town and Guanxi Town.

Acquisition of Land for Engineering Construction
Such land covers the dam site, including protection embankment, borrow pits, sand pits, gravel deposit, rock block pits, spoil sites, construction sites and passageways, etc.

Downstream of Dam Site
It refers mainly to the 33-km-long channel in downstream channel of Kan River down the dam site.

Camphor Protection Zone in Zhujia Township, Tangzhou Town

5.7.2 Analytical Procedure of Eco-environment

5.7.2.1 Collection of Basic Information Available
Such information collection covers project feasibility data, engineering drawings, 1:50000 topographic maps, Land Sat7—TM images, background data of bio-diversity, county annals, county statistic yearbooks, and master plan of land utilization, etc.

5.7.2.2 Inventory Survey

Plant & Vegetation
Key places together with their geographical coordinates will be under record in line with design schemes and remote sensing image.

Along the river there will be surveys made to make record of all plants in sight, with focus on typical biotic community. Quadrates for arbor community will cover 20×20m², for shrub community 5×5m² for herbaceous 2×2m². Record shall cover all types of living beings and analysis shall be made of gregariousness, in addition to sampling elevation, with coordinate under record from GPSmap76.

On the basis of remote sensing mapping concerning land utilization within the evaluation region, verification shall be made upon site set point.

Terrestrial Animal Resources
Abundance of all animals will be measured by estimated rank method.

Rank method: usually “+++” means there are numerous animals which are locally dominant species; “++” means there are considerably large population which are locally common species; “+” means the population is very limited (locally rare species). See Table 5.7.1.

<table>
<thead>
<tr>
<th>Species Status</th>
<th>Signal</th>
<th>Estimated quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locally dominant</td>
<td>+++</td>
<td>Numerous</td>
</tr>
<tr>
<td>Locally common</td>
<td>++</td>
<td>Considerably large</td>
</tr>
<tr>
<td>Locally rare</td>
<td>+</td>
<td>Rare</td>
</tr>
</tbody>
</table>

Aquatic Organism

Plankton survey: sampling shall be made at different positions and different depths, by No. 25 plankton net to obtain a sample of 1000 ml (1/2 transparent). After filter in the net the sampling shall be moved into the glass, to add formalin for settlement. After 24 hours of deposit, the sampling will be under concentration by siphon to 30 ml. Plankton sampling shall be under identification by types, for quantitative and qualitative analysis.

Fish stocks survey: One motor survey boat and one small wooden boat are equipped for collecting fish spawns, 80cm large spawn net will be equipped on the motor boat for collecting spawns. Fish catch will be purchased directly from the fishing boats or from the market for identification, for routine bio-measurement and under analysis from biological thermatology.

Ecosystem Mapping

Satellite image By LandSat 7-TM with a precision of 30m. See Attached Drawing No. 27.

Mapping of land utilization by remote sensing image and 1:50000 topographic map with reference to land utilization planning map by territorial resource department. Classification and statistics shall be made by ArcGIS.

Vegetation type map Classification shall be made by Erdas Imagine 8.6 concerning remote sensing images, with help from site surveying for accuracy test.

Landscape variation map In line with engineering scheme, with consideration of land utilization and inundation after storage, such a map can be drawn with help from ArcGIS, with focus upon reflection of change in land utilization.

Scatter diagram of rare animals/plants, animals/plants under protection, fish spawning sites: by way of coordinates these will be marked on remote sensing images.
5.7.3 Inventory Survey & Evaluation of Plant Resources

5.7.3.1 Flora
On the basis of site surveying of flora in Shihutang and of systematic collection of flora data, it is known that vascular plants total 126 families, 296 genera and 392 species, of which ferns total 13 families, 15 genera and 17 species; gymnosperm aggregates 5 families, 8 genera and 9 species, while angiosperms amount to 108 families, 273 genera and 366 species. See Table 5.7.2 for detail.

Table 5.7.2 Statistics of Vascular Plants in Shihutang

<table>
<thead>
<tr>
<th></th>
<th>Ferns</th>
<th>Gymnosperm</th>
<th>Angiosperms</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Family</td>
<td>Genera</td>
<td>species</td>
<td>Family</td>
</tr>
<tr>
<td>Site</td>
<td>13</td>
<td>15</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Jiangxi</td>
<td>49</td>
<td>114</td>
<td>432</td>
<td>8</td>
</tr>
<tr>
<td>State</td>
<td>65</td>
<td>204</td>
<td>2600</td>
<td>11</td>
</tr>
<tr>
<td>% of Jiangxi</td>
<td>26.5%</td>
<td>11.2%</td>
<td>3.9%</td>
<td>62.5%</td>
</tr>
<tr>
<td>% of state</td>
<td>20%</td>
<td>3.4%</td>
<td>0.7%</td>
<td>45.5%</td>
</tr>
</tbody>
</table>

5.7.3.2 Geographic Range of Spermatophyte
According to Wu Zhengyi (1991) concerning geographic range of spermatophyte in China, spermatophyte in Shihutang Project district is classified into 14 ranges and 10 derivatives. See Table 5.7.3 for detail.
Table 5.7-3  Statistics of Geographic Range of Spermatophyte in Shihutang

<table>
<thead>
<tr>
<th>Range Type</th>
<th>Genera</th>
<th>% in all</th>
<th>State Genera</th>
<th>% in state</th>
<th>tropical/extra-tropical*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. World range</td>
<td>51</td>
<td></td>
<td>104</td>
<td>49.04</td>
<td></td>
</tr>
<tr>
<td>II. Pan-tropical distribution &amp; derivatives</td>
<td>65</td>
<td>28.26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Pan-tropical distribution</td>
<td>61</td>
<td>26.52</td>
<td>316</td>
<td>19.30</td>
<td></td>
</tr>
<tr>
<td>2-1 Tropical Asia, Oceania, and South America (Disjunctive)</td>
<td>3</td>
<td>1.30</td>
<td>17</td>
<td>17.65</td>
<td></td>
</tr>
<tr>
<td>2-2 Tropical Asia, Africa, and South America (Disjunctive)</td>
<td>1</td>
<td>0.43</td>
<td>29</td>
<td>3.45</td>
<td></td>
</tr>
<tr>
<td>III. 3 Tropical Asia and tropical America (Disjunctive)</td>
<td>4</td>
<td>1.74</td>
<td>62</td>
<td>6.45</td>
<td></td>
</tr>
<tr>
<td>IV. Old world tropical distribution &amp; derivatives</td>
<td>13</td>
<td>5.65</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Old world tropical distribution</td>
<td>12</td>
<td>5.22</td>
<td>147</td>
<td>8.16</td>
<td></td>
</tr>
<tr>
<td>4-1. Of disjunctive distribution in tropical Asia, Africa &amp; South America</td>
<td>1</td>
<td>0.43</td>
<td>30</td>
<td>3.33</td>
<td></td>
</tr>
<tr>
<td>V. 5. Distribution in Asia to tropical Oceania</td>
<td>8</td>
<td>3.48</td>
<td>147</td>
<td>5.44</td>
<td></td>
</tr>
<tr>
<td>VI. 6. Distribution in tropical Asia and tropical Africa</td>
<td>6</td>
<td>2.61</td>
<td>149</td>
<td>4.03</td>
<td></td>
</tr>
<tr>
<td>VII. Distribution in tropical Asia and derivatives</td>
<td>16</td>
<td>6.97</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VII. Distribution in tropical Asia</td>
<td>13</td>
<td>5.65</td>
<td>422</td>
<td>3.08</td>
<td></td>
</tr>
<tr>
<td>7-1 Java, Himalayan, South China &amp; Southwest China</td>
<td>2</td>
<td>0.87</td>
<td>30</td>
<td>6.67</td>
<td></td>
</tr>
<tr>
<td>7-2. Burma, Thailand to Southwest China</td>
<td>1</td>
<td>0.43</td>
<td>29</td>
<td>3.45</td>
<td></td>
</tr>
</tbody>
</table>

The percentage indicates percentage of the genera of tropical geographical distribution in total genera.
### Table 5.7.3 (Continued) Statistics of Geographic Range of Spermatophyte in Shihutang

<table>
<thead>
<tr>
<th>Range Type</th>
<th>Genera</th>
<th>% in all</th>
<th>State</th>
<th>% in state</th>
<th>tropical/extra-tropical*</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIII. North temperate zone distribution &amp; derivatives</td>
<td>54</td>
<td>23.48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. North temperate zone</td>
<td>43</td>
<td>18.70</td>
<td>213</td>
<td>20.19</td>
<td></td>
</tr>
<tr>
<td>8-4. Of disjunctive distribution Of disjunctive distribution in north/south temperate zone</td>
<td>10</td>
<td>4.35</td>
<td>57</td>
<td>17.54</td>
<td></td>
</tr>
<tr>
<td>8-5. Of disjunctive distribution in Europe, Asia and South America</td>
<td>1</td>
<td>0.43</td>
<td>5</td>
<td>20.00</td>
<td></td>
</tr>
<tr>
<td>IX. 9. Of disjunctive distribution in East Asia &amp; North America</td>
<td>13</td>
<td>5.65</td>
<td>123</td>
<td>10.57</td>
<td></td>
</tr>
<tr>
<td>X. Distribution in Old World temperate zone &amp; derivates</td>
<td>14</td>
<td>6.09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Distribution in Old World temperate zone</td>
<td>11</td>
<td>4.78</td>
<td>114</td>
<td>9.65</td>
<td></td>
</tr>
<tr>
<td>10-1. Of disjunctive distribution in Mediterranean, west Asia &amp; northeast Asia</td>
<td>3</td>
<td>1.30</td>
<td>25</td>
<td>12.00</td>
<td></td>
</tr>
<tr>
<td>XI. 1 Distribution in Asia temperate zone</td>
<td>3</td>
<td>1.30</td>
<td>55</td>
<td>5.45</td>
<td></td>
</tr>
<tr>
<td>XII. 12. Distribution in Mediterranean, west Asia &amp; central Asia</td>
<td>1</td>
<td>0.43</td>
<td>152</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>XIII. 13. Distribution in central Asia</td>
<td>—</td>
<td>—</td>
<td>69</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>XIV. Distribution in East Asia &amp; derivatives</td>
<td>29</td>
<td>12.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Distribution in East Asia</td>
<td>18</td>
<td>7.83</td>
<td>73</td>
<td>24.66</td>
<td></td>
</tr>
<tr>
<td>14-1. China- Himalaya (SH)</td>
<td>3</td>
<td>1.30</td>
<td>141</td>
<td>2.13</td>
<td></td>
</tr>
<tr>
<td>14-2. Sino-Japan (SJ)</td>
<td>8</td>
<td>3.48</td>
<td>85</td>
<td>9.41</td>
<td></td>
</tr>
<tr>
<td>XV.15. Peculiar species in China</td>
<td>4</td>
<td>1.74</td>
<td>257</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>281</td>
<td>100.00</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

*Excluding world distribution genera.

- Of dispersed genus there are 51 genera that are distributed almost over the world, mostly of hydrophyte and helophyte, including Potamogeton, Naias, Lemna, Spirodea, Wolffia, Juncus, Carex, Cyperus, Eleocharis, Ammannia, Jussiaea, , Myriophyllum, Callitrich, Polygonum, Ceratophyllum, Lepidium, and Cardamine, etc. There are numerous auxiliary species and surface weeds, including Rorippa Scop, Viola, Polygala, Stellaria, Phytolacca, Chenopodium, Amaranthus, Geranium, Oxalis, Rubus, Erigeron, Gnaphalium, Senecio, Xanthium and Lysimachia, etc.

- Of pan-tropical distribution there are 65 genera (including related derivatives) making up 28.26% of total genera in Shihutang Project district, as the largest genus in the region. To this
genus belong such genera as Celosia, Buxus, Cuscuta, Verbena, Vitex, Smilax, Dioscorea, Bothriochloa, Cynodon, Paspalum, Setaria and Imperata, etc, most of which are herbaceous plants.

There are two derivatives in the region three genera are of disjunctive distribution in tropical Asia, Oceania and South America, including Podocarpus, Centipeda and Wahlenbergia one genus is of disjunctive distribution in tropical Asia, Oceania and South America, Bambusa.

Four genera (1.74% of local genera) are of disjunctive distribution in tropical Asia and tropical South America, including Mirabilis, Eurya, Sapindus and Soliva.

Of old world tropical distribution there are 13 genera (including related derivatives) making up 5.65% of total genera in Shihutang Project district, including Stephanie, Syzygium, Osbeckia, Grewia, Mallotus, Albizia, Loranthus, Viscum, Cayratia and Melia, etc, mostly of shrub and liane. There is one derivative of disjunctive distribution in tropical Asia, Africa and South America, Rostellularia.

Of distribution in tropical Asia and tropical Oceania there are 8 genera making up 3.48% of total genera in Shihutang Project district, including Cinnamomum, Trichosanthes, Melastoma, Mazus, Hydrilla, Eremochloa, Lophatherum, and Zoysia. Camphor is the dominant species.

Of distribution in tropical Asia and tropical Africa there are 6 genera making up 2.61% of total in Shihutang Project district, including Arthraxon, Themeda, Ricinus, Hedera, Cymbopogon and Miscanthus.

Of distribution in tropical Asia there are 16 genera making up 6.79% of total genera in Shihutang Project district, including Broussonetia, Ixeris, Michelia, Lindera, Cyclea, Diploclisia, Menispermum, Pericampylus, Camellia, Duchesnea, Pueraria, Paederia and Indocalamus.

Here there are derivatives two genera are distributed in Java, Himalayan, south China and West China, including Schima and Bischfia one genus: Actinostemma is distributed only in Burma, Thailand and Southwest China.

Of distribution in the north temperate zone there are 54 genera, making up 23.48% of total genera in Shihutang Project district (the second richest genus), including Pinus, Cupressus, Sabina, Capsella, Populus, Salix, Quercus, Ulmus, Morus, Agrimonía, Rhus, Lonicera, Artemisia, Sonchum, Lithospermum, Scrophularia, Prunella, Bromus, Echinochloa and Eragrostis, etc.

Here there are relative derivatives there are ten genera of disjunctive distribution in north and south temperate zone, 4.35% in total, including Sedum, Arenaria, Cerastium,
There is only one genus of disjunctive distribution in temperate zones in Europe, Asia and South America, that is Alopecurus.

13 genera are distributed in east Asia and North America, 5.65% in total, including Antenoron, Photinia, Gleditsia, Lespedea, Wisteria, Liquidambar, Castanopsis, Parthenocissus, Trachelospermum, Aletris, and Brachyelytrum. Such a distribution indicates the genetic relationship between East Asia and North America in geologic history and modern distribution origin.

14 genera are distributed in old world temperate zones, 6.09% in total, including Cucubalus, Dianthus, Myosoton, Daphne, Pyrus, Oenanthe, Dendranthema, Adenophora, Leonurus, Cleistogenes, and Roegneria. There is only one derivative of three genera of disjunctive distribution in Mediterranean Sea, west Asia and east Asia, including Paliurus, Torilis and Ligustrum.

There are 3 genera of distribution in Asian temperate zones, making up 1.30% of total genera in Shihutang Project district, which are Caragana, Kalimeris and Trigonotis.

There is only one genus of disjunctive distribution in Mediterranean Sea, west Asia and middle Asia--Coriandrum, 0.43% in total.

29 genera and derivatives are distributed in east Asia, 12.61% in total, including Vernicia, Eriobotrya, Rhaphiolepis, Acanthopanax, Damacanthis, Patrinia, Hemistepta, Rhynchospermum, Youngia, Caryopteris, Perilla, Ophipogon, Tricyrtis, Lycoris, Phyllostachys, and Pogonatherum.

There are two derivatives here.

Three genera of China--Himalayan distribution (1.3% of total) including Corchoropsis, Firmiana, and Choerospondias.

There are eight genera of Sino-Japan distribution, including Semiaquilegia, Kummerowia, Sageretia, Euscaphis, Serissa, Paulownia, and Phaeosperma. Some of them are relic genus, such as Houttuynia, Loropetalum and Pterocarya.

There are four peculiar species in China, making up 1.74% in total, which are Cunninghamia, Metasequoia, Ginkgo and Poncirus, all of which are culture species.

Located in central semitropical, Shihutang Project district, mainly of plain, is rich in hydrothermal condition. Here there are 114 genera of tropical geographical components, the majority of which is not limited to distribution in tropical areas, instead some of the species extend northward to semitropical or even to temperate zones. on the whole, temperate zone geographical components make up the majority, with the tropical geographical components represented mainly in form of shrub, herbal plant, hydrophyte and helophyte. Most of the percentage between tropical geographical components and temperate zone geographical components reaches 0.098. In a word, plants here are mainly of temperate zone geographical
components, though plants of tropical geographical components make up a considerable percentage.

5.7.3.3 Plant resource

Wild plant resources in Shihutang Project district may be classified into 13 types. See Table 5.7-4.

Table 5.7-4 Classification of Wild Plants in Shihutang

<table>
<thead>
<tr>
<th>Types</th>
<th>Survey</th>
<th>Main Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Trees</td>
<td>Several hundreds of old trees over 100 years old near Yuanjiang Township</td>
<td>camphor, sweet oak, Quercus serrata, spice bush, sweetgum, yellow sandalwood, Schima superba, Xylosma racemosum, Photinia serrulata, privet, gingko, cypress tree, Podocarpus macrophyllus</td>
</tr>
<tr>
<td>Timbre Plant</td>
<td>Over 60 types of arbor available as timbre along the bank behind Yanjiang Village</td>
<td>Gingko, fir, Chinese red pine, slash pine, cypress tree, sweetgum, camphor, Elaeocarpus, eucalyptus, bishopwood, kingwood, sweet oak, Choerospondias axillaris</td>
</tr>
<tr>
<td>Officinal</td>
<td>More than 117 types of herbaceous plants in the woods, shrub, reclamation land</td>
<td>Japanese fern spore, Drynaria fortunei, gingko, Clematis chinensis, Menispermacaeae, cordate houttuynia herba, giant knotweed, chemoplodium ambrosioides, Celosia argentea, lilac daphne, St.Johns wort, Ardisia japonica, cat’s foot, cogongrass, Asiatic plantain</td>
</tr>
<tr>
<td>Nectariferous Plant</td>
<td>Over 50 types of plants available as nectariferous plant</td>
<td>Canola plant, Eurya japonica, Schima superba, Sapium sebiferum, Castanea mollissima, Chinese milk vetch, honeysuckle, privet, motherwort</td>
</tr>
</tbody>
</table>
### Table 5.7 Classification of Wild Plants in Shihutang

<table>
<thead>
<tr>
<th>Types</th>
<th>Survey</th>
<th>Main Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants for embankment</td>
<td>Flood-control and sand binding plant flora has developed out of all types of arbor, shrub and greenery.</td>
<td>Willow, Sapium sebiferum, wire grass, zoysia, Japanese silvergrass, Chinese ash, fernleaf hedge bamboo</td>
</tr>
<tr>
<td>Wild forage feed</td>
<td>Herbaceous plant out of Gramineae and leguminosae has developed into large grove of grass shoal and beach.</td>
<td>Wire grass, Dallis grass, Japanese silvergrass, zoysia, annual bluegrass, vervain, common lespedeza, bush clover, azolla, Malan Straw</td>
</tr>
<tr>
<td>Food</td>
<td>There are groves of Quercus glanca, Quercus serrata, Castanea mollissima, jujube and wild persimmon.</td>
<td>Sweet oak, Quercus serrata, chestnut, persimmon, kudzu vine, Chinese date</td>
</tr>
<tr>
<td>Coumarin plant</td>
<td>Some plants contain sweet monosodium glutamate, available for extraction of Sweetening agent.</td>
<td>Actinostemma racemosum, perilla, cogongrass</td>
</tr>
<tr>
<td>Glechma hederacea</td>
<td>Some plants are rich in aromatic substance, available for extraction of essential oil for industry and daily life.</td>
<td>camphor, sweetgum, matico, pomelo, cypress, wild chrysanthemum, Chinese fevervine, Atractyloides macrocephala, Cyperus rotundus, Kyllinga brevifolia, citronella eucalyptus</td>
</tr>
<tr>
<td>Resin plant</td>
<td>There are, along the slopes and foothills, groves of redpine, slash pine and sweetgum, available for extraction of resin.</td>
<td>Chinese red pine, slash pine, Sapium sebiferum, sweet gum, bishopwood</td>
</tr>
<tr>
<td>Tannin plant</td>
<td>There are more than 10 types of plants rich in tan in the slopes and foothills.</td>
<td>Rumex madaio, yellow dock, cherokee rose, sanguisorba, silk tree, sweet gum, Quercus sclerophylla, sweet oak and wild Diospyros kaki</td>
</tr>
<tr>
<td>National-level protection species</td>
<td>In line with the China's Rare Species under Protection by the State Environmental Protection Bureau and by Plant Research Institute of Chinese Academy of Science in 2002.</td>
<td>Metasequoia *(1), gingkgo *(2), kapor *(2)</td>
</tr>
</tbody>
</table>

*Of culture plant
5.0 Environment Baseline Survey & Assessment

Wild plants in Shihutang are of such features as variety in types, limit in quantity, shortage of resources superiority or exploitability or peculiar species. Of plant resources, only the old trees serve as natural and cultural relic for seed and tourism; pines (Pinus spp) as source of resin, meadow as feed to cattle and as firewood to local residents.

In Shihutang Project district there is no wild plant or famous wood species under state protection. Trees cultivated include yellow cinnamon, metasequoia and gingkgo, in addition to wingceltis (second class protection) and Chinese cress (second class protection) (The latter two are only recorded in files, undiscovered in this investigation).

There are 11 genera of provincial protective plants, including podocarpus macrophyllus, sweet osmanthus, camellia, rhizoma coptidis, Chinese holly, Ilex rotunda, bishopwood, gentianella, kingwood, soap nut tree, radix asparagi, etc. These species exist mainly in the herb layer of shrub and in broad leaved forest adjacent to villages.

There are numerous old trees scattered along Kan River, including Cinnamomum camphora, Schima superba, Castanopsis sclerophylla, Cupressus funebris, Photinia davidsoniae, Ligustrun lucidum, Xylosma japonicum, and Laurus nobilis. Among them the first two makes up the majority, to form tree mass in some unique areas.

5.7.3.4 Vegetation Distribution
Shihutang Project district is mainly of plains and low hillock plain. There are dense villages that have been producing violent activities upon nature so that there is no native vegetation whatsoever. Instead, secondary plant and artificial vegetation makes up the majority. Density of cover from natural vegetation reaches 56%. For detail see Attached Drawing 04.

Cover Type
In accordance with the classification in Chinese Vegetation, on the basis of field investigation, the cover type in Shihutang Project district is classified into 9 types and 35 plant formations. See Attached Drawing 03.

Type Properties of Major Plant Community & Distribution

Evergreen broad-leaved forest
The evergreen broad-leaved forest is of zonal vegetation in central Asian moderate zone. But due to human activities there are few groves adjacent to villages. These forests, protected in the name of geomantic trees, are small-scaled in areas, discontinuous in distribution, incomplete in plant community, simple in species, poor in replacement. Such communities are mainly of:

1) Form Cinnamomum camphora
This species is distributed in dozens of villages along Kan River, with the largest grove discovered in Lingbei, Xiayinxia and Xinzhou of Yanxi Town, in Shihutang, Xiabian and
Zhangjia of Wanhe Town. For detail see the thematic assessment of impact from old trees in Chapter Seven of this report.

2) Form Schima superba
This species is distributed in Tongluo Township of Yanxi Town, or, to be exact, in E115°00´34.01" N26°53´11.40" at EL 63m. Here there are also such trees as sawtooth oak, soap pod, and Xylosma, with no undergrowth or herb layer.

3) Form Castanopsis sclerophylla
This species is distributed in Shangyinxia Village, or E115°00´27.5" N26°53´47.6", mainly of Castanopsis sclerophylla, 26 inside the site, in addition to 14 camphor and 8 Photinia serrulata outside the sampling site. There is rare species of undergrowth, except for wild jasmine, capejasmine. Of herb layer there is only limited sedge (sp).

□ Evergreen Broad-leaved Deciduous Forest
This is also under artificial protection, small in area, simple in structure, discovered only in several villages as Caoping and Cangling, in such forms as follows:

4) Form Cinnamomum camphora- Quercus chenii

□ Broad-leaved Deciduous Forest
There are two types of broad-leaved deciduous forests, one is under artificial protection, mainly of Quercus chenii of Fagaceae, another mainly of bank vegetation distributed along the embankment of Kan River.

5□ Form Quercus chenii
This species is discovered in such villages as Cangling, Zhangjiapeng and Zengjiapeng, small in community, with Quercus chenii as majority, whose diameter is about 50cm at a height of 15m.

6□ Form Salix matsudana
This species is distributed in alluvial flat and alluvial shoal, with sampling site at Xinluo Shoal, where the soil is of sandy loam, at E114°57´35.3", N26°47´25.8". The community is mainly of hankow willow, where shade density reaches 60%, with the trees averaging 10m in height. The companion species include Chinese tallow tree and bead tree, with rare undergrowth, except for barbas. Coverage of herb layer averages 90%, with wheatgrass as dominant species, whose companion species consist of water buckwheat, Mazus rugosus, Cardamine, lesser swine-cress, and yellow dock.

7□ Form Sapium sebiferum
This species is distributed in Jintan Township, a part of nature reserve, adjacent to old camphor grove. The community is made up of Chinese tallow trees, where shade density reaches 80%, with the trees averaging 9--11m in height. This community also includes such
evergreen trees as camphor, Schima superba, and spice bush and such deciduous tree as bead tree, sweet gum and elm.

- Coniferous forest
Coniferous forest is the generic terms for communities mainly of needle evergreen. The conifers here enjoy warm and moist environment, typical of temperate zone coniferous forest, distributed all over the hillock plains. There are two plant formations: Form Pinus massoniana and artificial Form Pinus elliottii.

8 Form Pinus massoniana
Redpine community is orderly in outlook, but spare in distribution and poor in growth, with a diameter of 5—15cm at a height of 5—9 m. The community is almost all of redpine, with rare sweet gum, albizia kaldora and camphor, in a density cover of 60% to 80 %. The undergrowth varies due to artificial interference, so that the undergrowth is rarer when interference is more serious. Interference originates mainly from residents’ acquisition of firewood. Coverage from undergrowth reaches 20% to 50%, usually at 1m in height, mainly of Glochidion pubetum, Chinese loropetalum, barbas, rhododendron, Japanese eurya, hairy holly root, capejasmine, oriental blueberry, etc. There are limited renewal broadleaf seedlings, including mainly of kapor and needle wood. The coverage of herb layer is considerable, averaging 60-85%, with such dominant species as sedge and loosestrife, etc. Under incomplete canopy there usually are such fern species as Polytrichales, hypnum moss, etc. There is not much extra-zonal vegetation, except for chinaroot greenbrier, rhizoma smilacis glabrae, and Japanese fern spore. Living soil covering consists of Polytrichales and foliaceous lichen; there is limited ground cover, poor in decomposition. Semi-zonality results from frequent artificial activities.

9 Form. Pinus elliottii
This community is artificial, out of aerial seeding. Slash pine grows better than redpine, thicker in diameter. In such community usually there is redpine, and occasionally sweet gum. There is limited undergrowth, including barbas, capejasmine and Japanese eurya. The herb layer is adjacent to Form Pinus massoniana.

- Bamboo Grove
Bamboo is of quality commercial timbre species and also of ornamental plantation. There are four species of bamboo, of which Phyllostachys edulis and Phyllostachys sulphurea var. viridis make up the majority. They are small-scaled in areas, with the Phyllostachys edulis distributed on village slopes under artificial plantation, and Phyllostachys sulphurea var. viridis in zonal distribution along the second bottom.

10 Form Phyllostachys edulis
11 Form Phyllostachys sulphurea var. viridis

- Shrub & Underbrush
This species is usually located in the hillock plains and the second bottom and second terrace. Development of this species is closely related with frequent artificial interference and timber mining. In the community there is rarely-scattered redpine seedling, therefore the community is unstable in structure, indefinite in layers, uneven in plant species, changeable in dominant species. Companion species usually consist of ferns. Common communities are as follows:

12. Form Paliurus ramosissimus, usually distributed in the alluvial flat or alluvial shoal.

13. Form. Vitex negundo var. cannabifolia

14. Form. Miscanthus floridulus

15. Form. Arundinella setosa

16. Form. Pteridium aquilinum var. latiusculum

Meadow

This is usually seen in the low wet alluvial flat in flood season, in zonal distribution, pure in composition, uniform in color, flat and even in physiognomy, dense in coverage (90%). Here the soil is of sand soil, water-rich and sound in air permeability, with little humus accumulation. Meadow is usually for feeding of cattle. Common communities include Cynodon dactylon Ass. and Eremochloa ophiuroides Ass., and there are such communities in water-rich areas as Paspalum distichum Ass., and Beckmannia syzigachne Ass, with a height less than 20cm. Common companion species include needle spikesedge, Kyllinga brevifolia, moneywort, Chinese violet herba violae, water pepper and yellow dock.

17. Cynodon dactylon Ass.

18. Eremochloa ophiuroides Ass.


20. Paspalum distichum Ass.


Aquatic Vegetation

There is rich aquatic vegetation, usually distributed in the mini-ponds along Kan River, in the shoal where river flows slowly, in the gulches and in some of the alluvial flats and alluvial shoals. No aquatic vascular plant has ever been discovered in this survey. There are varieties of aquatic vegetation, but generally small-scaled in distribution and variable in coverage, mainly including:
5.0 Environment Baseline Survey & Assessment

22) Azolla imbricata Ass.
23) Form Jussiaea repens Ass.
24) Form Callitriche stagnalis Ass.
25) Form Scirpus juncoides Ass.
26) Form Polygonum thunbergii Ass.
27) Form Eichhornia crassipes Ass.
28) Form Limnanthemum nymphaoides Ass.
29) Form Spirodeia polyrhiza Ass.

Artificial community
Owing to large numbers of residential areas, long-time human activities and developed agricultural utilization, artificial communities are large in areas, to play a dominant role. Artificial community is divided into such types as follows, of which Form Populus lasiocarpa is mainly of sapling due to returning of farming land to forestry, located along the terrace of Kan River, with the largest grove in Wanhe Town:

30) Farm field
31) Tea garden
32) Form. Camellia oleifera
33) Orange garden
34) Garden
35) Form Populus lasiocarpa

Such vegetation is of special features in horizontal distribution, namely, distributed along Kan River in alluvial flats is meadow; in alluvial shoals are hankow willow and Form Paliurus ramosissimus; in second terrace are garden and Form Populus lasiocarpa due to returning of farming land to forestry; in hillock plains are coniferous forest and underbrush; in villages along Kan River are broad-leaved forest serving as geomantic trees; in the plain is artificial vegetation; in the mini-ponds and gulches is aquatic vegetation.

5.7.3.5 Overall Evaluation of Vegetation in Shihutang
There are 9 vegetation forms and 35 plant formations. On the whole, vegetation is simple in structure, monotonous in composition, mostly of secondary succession. Under frequent artificial interference the Form Pinus massoniana and underbrush has transformed into semi-zonal vegetation of disturbance climax. As a result, such vegetation is featured by poor productivity, low bio-diversity and ill renewal. But it is not difficult to trace back the original outlook from the small evergreen broad-leaved forest relict adjacent to villages. Evergreen broad-leaved forest and evergreen broad-leaved deciduous forest had once been the dominant vegetation in this area.

Of vegetation in the future, human activities can not be ignored. Under existing economic and social conditions, it is difficult to achieve natural orthodromic succession. Residents’ living manners and resource utilization manners have to be changed until natural succession is possible. Construction of the Shihutang Project is a desirable approach.
5.7.4 Profile of Agriculture & Forestry & Land Utilization

5.7.4.1 Agricultural land and industrial structure
Shihutang Project will involve 6 townships in Taihe County. For detail of agriculture see Table 5.7-5 for percentage of agriculture, forestry, animal husbandry, fisheries see Table 5.7-6 for detail of crop production in 2005 see Table 5.7-7.

The townships here depend upon agriculture and husbandry so that agriculture plays the major role in crop farming, which lives upon grain and oil crops. Grain consists mainly of rice, complimented from sweet potatoes and soybean. To cash crops belong canola plant, peanut, Sesamum indicum, potato, sugarcane, watermelon, semen plantaginis, tea, and oranges, etc. Husbandries play the second role, composed mainly of pigs and cattle, with limited poultry, cow and sheep. Fisheries and forestry make up little contribution. Aquatic culture is mainly in form of reservoir and pond fish-farming, complimented from fishing in Kan River. Income from forestry comes mainly from nursery stock.

Table 5.7-5  Fundamental State of Agriculture

<table>
<thead>
<tr>
<th>Township</th>
<th>Population</th>
<th>Rural</th>
<th>Gross land (Hectare)</th>
<th>Agricultural acreage (hm²)</th>
<th>Total forestry</th>
<th>Acreage per capita (mu/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Paddy fields</td>
<td>Dry land</td>
<td></td>
</tr>
<tr>
<td>Yanxi</td>
<td>20428</td>
<td>19305</td>
<td>9503.6</td>
<td>2378 1655</td>
<td>723</td>
<td>3398.2</td>
</tr>
<tr>
<td>Chengjiang</td>
<td>90207</td>
<td>25786</td>
<td>12714</td>
<td>2127 1955</td>
<td>172</td>
<td>4189.6</td>
</tr>
<tr>
<td>Wanhe</td>
<td>46577</td>
<td>44072</td>
<td>16720.7</td>
<td>4790 4315</td>
<td>475</td>
<td>5136.9</td>
</tr>
<tr>
<td>Mashi</td>
<td>36245</td>
<td>34062</td>
<td>13670.5</td>
<td>4007 3451</td>
<td>556</td>
<td>3763.2</td>
</tr>
<tr>
<td>Tangzhou</td>
<td>31977</td>
<td>29531</td>
<td>12923.1</td>
<td>3345 2482</td>
<td>863</td>
<td>3494.4</td>
</tr>
<tr>
<td>Guanxi</td>
<td>24638</td>
<td>24794</td>
<td>16880.7</td>
<td>3478 3220</td>
<td>258</td>
<td>9067.9</td>
</tr>
<tr>
<td>Total</td>
<td>25007</td>
<td>21755</td>
<td>82412.6</td>
<td>20125 17078</td>
<td>3047</td>
<td>29050.2</td>
</tr>
</tbody>
</table>

Based upon Taihe County Statistics Yearbook of 2005

Table 5.7-6  Percentage of Agriculture, Forestry, Animal Husbandry & Fisheries Unit×10⁴ Yuan

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP</th>
<th>Crop farming</th>
<th>Forestry</th>
<th>Husbandry</th>
<th>Fisheries</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Output</td>
<td>%</td>
<td>Output</td>
<td>%</td>
<td>Output</td>
<td>%</td>
</tr>
<tr>
<td>2003</td>
<td>16390 3</td>
<td>76851</td>
<td>46.89</td>
<td>5677</td>
<td>3.46</td>
<td>64272</td>
</tr>
<tr>
<td>2004</td>
<td>20051 4</td>
<td>10105 3</td>
<td>50.4</td>
<td>10157</td>
<td>5.07</td>
<td>67201</td>
</tr>
<tr>
<td>2005</td>
<td>21109 8</td>
<td>10331 7</td>
<td>48.94</td>
<td>10751</td>
<td>5.09</td>
<td>71189</td>
</tr>
</tbody>
</table>

Based upon Taihe County Statistics Yearbook of 2005
5.7.4.2 Present Land Utilization
By interpretation of remote sensing images, based on county statistic yearbook and county-level overall land use planning, in accordance with dam site actual conditions, land use is divided into woodland, underbrush, meadow, paddy fields, dry land, water body, land for urban and rural buildings, and unused land. Such land is under analysis from ArcGIS software. See Table 5.7-8 and Chart 5.7-1 and Attached Drawing 28 for detail. Land use statistics is listed in Table 5.7-9.
### Table 5.7.7 Crop production of Taihe County and Affected Townships in 2005

<table>
<thead>
<tr>
<th>County/Township</th>
<th>Agricultural acreage (mu)</th>
<th>Population</th>
<th>Gross Acreage per capita (rural) (mu)</th>
<th>Multiple-cropping index</th>
<th>Percentage of grain crops</th>
<th>Gross grain output per mu Yield per capita</th>
<th>% of cash crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taihe County</td>
<td>660210</td>
<td>515655</td>
<td>1.58</td>
<td>2.83</td>
<td>64.9</td>
<td>35748</td>
<td>268</td>
</tr>
<tr>
<td>Wanhe</td>
<td>71850</td>
<td>46577</td>
<td>1.63</td>
<td>2.49</td>
<td>59.8</td>
<td>17567</td>
<td>331</td>
</tr>
<tr>
<td>Yanxi</td>
<td>35670</td>
<td>20428</td>
<td>1.85</td>
<td>2.72</td>
<td>65.4</td>
<td>28932</td>
<td>324</td>
</tr>
<tr>
<td>Tangzhou</td>
<td>50175</td>
<td>31977</td>
<td>1.70</td>
<td>2.93</td>
<td>58.4</td>
<td>18246</td>
<td>328</td>
</tr>
<tr>
<td>Chengjiang</td>
<td>31905</td>
<td>90207</td>
<td>1.24</td>
<td>2.61</td>
<td>67.9</td>
<td>36396</td>
<td>339</td>
</tr>
<tr>
<td>Mashi</td>
<td>60105</td>
<td>36245</td>
<td>1.85</td>
<td>2.72</td>
<td>64.1</td>
<td>136889</td>
<td>312</td>
</tr>
<tr>
<td>Sum</td>
<td>249705</td>
<td>225434</td>
<td>1.65</td>
<td>2.72</td>
<td>64.1</td>
<td>136889</td>
<td>312</td>
</tr>
</tbody>
</table>

### Table 5.7.8 Present Land Use in Shihutang

<table>
<thead>
<tr>
<th>Administrative region</th>
<th>Gross land</th>
<th>Farmland</th>
<th>Garden</th>
<th>Forestry</th>
<th>Urban building land</th>
<th>Rural building land</th>
<th>Industrial land</th>
<th>Water body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taihe County</td>
<td>268068.7</td>
<td>66519.1</td>
<td>14038.1</td>
<td>161837.8</td>
<td>20497.7</td>
<td>11021.5</td>
<td>1970.4</td>
<td>10632.1</td>
</tr>
<tr>
<td>Yanxi</td>
<td>9503.6</td>
<td>3908</td>
<td>602.3</td>
<td>2986.2</td>
<td>52.1</td>
<td>957</td>
<td>75.5</td>
<td>922.5</td>
</tr>
<tr>
<td>Chengjiang</td>
<td>12714</td>
<td>4235.4</td>
<td>536.8</td>
<td>5086.6</td>
<td>1105.3</td>
<td>476.8</td>
<td>488.7</td>
<td>758.4</td>
</tr>
<tr>
<td>Wanhe</td>
<td>16720.7</td>
<td>7941.9</td>
<td>688.5</td>
<td>5535.7</td>
<td>75.8</td>
<td>893.6</td>
<td>58.5</td>
<td>636.2</td>
</tr>
<tr>
<td>Mashi</td>
<td>13670.5</td>
<td>5882</td>
<td>909</td>
<td>4457.4</td>
<td>78.8</td>
<td>1189.7</td>
<td>0</td>
<td>1153.6</td>
</tr>
<tr>
<td>Tangzhou</td>
<td>12923.1</td>
<td>4567.1</td>
<td>250</td>
<td>5164.2</td>
<td>278</td>
<td>630</td>
<td>100</td>
<td>1933.8</td>
</tr>
<tr>
<td>Guanxi</td>
<td>16880.7</td>
<td>4230</td>
<td>2391.5</td>
<td>9067.9</td>
<td>0</td>
<td>723</td>
<td>34</td>
<td>434.3</td>
</tr>
<tr>
<td>Sum</td>
<td>82412.6</td>
<td>30764.4</td>
<td>5378.1</td>
<td>32298</td>
<td>1590</td>
<td>4870.1</td>
<td>756.7</td>
<td>5838.8</td>
</tr>
<tr>
<td>%</td>
<td>37.33</td>
<td>6.53</td>
<td>39.19</td>
<td>1.93</td>
<td>5.91</td>
<td>0.92</td>
<td>7.08</td>
<td></td>
</tr>
</tbody>
</table>

Based upon the data from *Overall Planning of Land Use (1997-2010)* from Taihe County Land & Resources Bureau
Table 5.7-9 Land Use in Shihutang Project Area

<table>
<thead>
<tr>
<th>Land Type</th>
<th>Numbers</th>
<th>Average</th>
<th>Total $\text{km}^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forestry</td>
<td>326</td>
<td>0.99</td>
<td>323.88</td>
</tr>
<tr>
<td>Shrub &amp; underbush</td>
<td>42</td>
<td>2.60</td>
<td>109.35</td>
</tr>
<tr>
<td>Water body</td>
<td>37</td>
<td>1.19</td>
<td>43.93</td>
</tr>
<tr>
<td>Land for rural &amp; urban residents</td>
<td>57</td>
<td>0.17</td>
<td>9.83</td>
</tr>
<tr>
<td>Paddy fields</td>
<td>87</td>
<td>2.10</td>
<td>182.69</td>
</tr>
<tr>
<td>Dry land</td>
<td>118</td>
<td>1.25</td>
<td>146.95</td>
</tr>
<tr>
<td>Unused land</td>
<td>27</td>
<td>2.91</td>
<td>78.54</td>
</tr>
</tbody>
</table>

Land use is of such features: each township depends on farmland and forestry, usually the farmland makes up 37.33% and forestry 39.19%. Water body contributes in limited percentage, mainly composed of Kan River basin; there are some hillock plains and alluvial flats along the Kan River, under reclamation for gardens for plantation of vegetables.

Forestry totals 323.88 km$^2$, or 36.18% of gross eco-system in Shihutang as the major type in this region. Water body totals 65.66 km$^2$, or 4.91% of gross area in Shihutang. Farmland (including paddy fields and dry land) aggregate 329.64 km$^2$, 36.83% of local gross land.

5.7.5 Inventory Survey & Evaluation of Terrestrial Animals

5.7.5.1 Species, quantity & Status of Amphibians
5.0 Environment Baseline Survey & Assessment

On the basis of survey and record in reference, analysis is made to conclude that:

- Species: there are 9 species of amphibians (See Table 5.7-10) classified into 4 families, of which Ranidae makes up the majority (Altogether 5 species, 62.5% of gross amphibians).

- Eco-behavior & Distribution of Major Species
  Bufo gargarizana: nicknamed “toad”, mainly inhabit in dark and moist wood underbrush, farmland, gulches and villages. This species is widely distributed in inundated area.

  Ranani gromaculata: they swallow a lot of insect pest in the wood and therefore serve as prey to flesh-eaters, so directly or indirectly to supply largest quantity of meat to flesh-eaters.

  Rana limnocharis: in breeding seasons they place spawning in static water; they float in water, large in size, to serve as food or bio-tests and play a significant role in ecological balance.

Based upon the investigation it can be concluded that the community of amphibians in Shihutang Project district is very limited.

Table 5.7-10 Directory of Amphibians in Shihutang Project district

<table>
<thead>
<tr>
<th>Name</th>
<th>Species</th>
<th>Living Environment</th>
<th>Flora</th>
<th>Protection level</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Anura</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Bufo</td>
<td>1. Bufo gargarizana</td>
<td>Riverside and ridge of fields, house surroundings, or under the rock or soil caves</td>
<td>Dispersed species</td>
<td>Province - level</td>
</tr>
<tr>
<td>Bufonidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Hylaanchiangesis</td>
<td></td>
<td>Widely inhabit in marshy ground, jungle, pond or wetland</td>
<td>Oriental species</td>
<td></td>
</tr>
<tr>
<td>3. Rana guentheri</td>
<td></td>
<td>Inhabiting in paddy fields, ponds or water holes; often hiding in aquatic plants or weedery</td>
<td>Oriental species</td>
<td></td>
</tr>
<tr>
<td>4. Rana limnocharis</td>
<td></td>
<td>Paddy fields, wetland and vegetable garden</td>
<td>Oriental species</td>
<td>Province - level</td>
</tr>
<tr>
<td>5. Rana adenopleura</td>
<td></td>
<td>Pond, water hole, gulch and weedery</td>
<td>Oriental species</td>
<td></td>
</tr>
<tr>
<td>6. Ranani gromaculata</td>
<td></td>
<td>Pond, paddy fields, gulch, lakes, streams and wetland</td>
<td>Dispersed species</td>
<td>Province - level</td>
</tr>
<tr>
<td>(III) Microhylidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Microhyla ornata</td>
<td></td>
<td>paddy field, water holes, soil caves close to gulches or weedery.</td>
<td>Oriental species</td>
<td>Province - level</td>
</tr>
<tr>
<td>(VI) Rhacophoridae e</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Rhacophorus megacephalus</td>
<td></td>
<td>Inhabiting in paddy fields, weedery or muddy holes, or in ridge of field or adjacent to shrub or weedery or surface fallen leaves</td>
<td>Oriental species</td>
<td></td>
</tr>
</tbody>
</table>

5.7.5.2 Species, Quantity & Distribution of Reptiles
5.0 Environment Baseline Survey & Assessment

On the basis of survey and record in reference, analysis is made to conclude that there are 3 orders, 5 families and 9 genera of reptiles (See Table 5.7-11) none of which is under state protection.

Ophidia black snake, of colubrid, is widely distributed, as the major cash snakes, which feeds mainly on frogs, in addition to fish and lizard. Most often this species inhabits underneath the shrub or underbrush or in the farmland.

5.7.5.3 Species, Quantity & Distribution of Avifauna
On the basis of survey and record in reference, analysis is made to conclude that:

- **Species composition**: There are 26 species of birds, divided into 8 orders and 17 families (See Table 04), of which Passeriformes makes up the majority, with 9 species, or 34.62% of all birds. There is no bird under state protection.

- **Avifauna**: of the 26 species, there are 9 classified as oriental species, or 34.62% of all; 7 as Palearctic realm, or 26.92% in total; 10 as dispersed species, 38.46% in all.

- **Non- migratory bird**: of the mentioned 26 species of birds, non- migratory birds total 14 species, or 53.85% of all; summer migrant aggregates 7 species, 26.92% of all; winter residents total 5 species, 19.23% of all.
Table 5.7.11 Directory of Reptiles in Shihutang Project district

<table>
<thead>
<tr>
<th>Name</th>
<th>Species</th>
<th>Living Environment</th>
<th>Flora</th>
<th>Protection level</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Testudinata</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Trionychidae</td>
<td>Pelodiscus sinensis</td>
<td>Pond, river, marsh and gulches</td>
<td>Dispersed</td>
<td>Province -level</td>
</tr>
<tr>
<td>(ii) Emydidae</td>
<td>2 Chinemys reevesii</td>
<td>Low-relief terrain, hills, plain and embankment, in sandy gulches, paddy field and reservoir, pond; semiaquatic</td>
<td>Dispersed</td>
<td></td>
</tr>
<tr>
<td>II. Lacertiformes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iii) Gekkonidae</td>
<td>3 Gekko japonica</td>
<td>Underbush and meadow</td>
<td>Dispersed</td>
<td>Province -level</td>
</tr>
<tr>
<td>III. Serpentiformes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV. Colubridae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Rhabdophis tigrinus</td>
<td>Gulches, pond, paddy field and meadow, wood and roadside</td>
<td>Dispersed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Sinonatrix annularis</td>
<td>Often inhabiting in streams, marsh, pond, paddy field</td>
<td>Oriental</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Gloydius brevicaudus</td>
<td>Muck pile, slope shrub, field and adjacent to houses</td>
<td>Dispersed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Zoacys dhumnades</td>
<td>Gulches, shrub and meadow, paddy field, roadside and adjacent to houses</td>
<td>Oriental</td>
<td>Province -level</td>
<td></td>
</tr>
<tr>
<td>8. Dinodon rufozonatum</td>
<td>Adjacent to houses and ponds</td>
<td>Dispersed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viperidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Deinagkistrodonacutus</td>
<td>Forest, underbrush, rocks or fallen leaves or meadow near streams, firewood adjacent to houses</td>
<td>Oriental</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.7.5.4 Species, Quantity & Distribution of Beasts
On the basis of survey and record in reference, analysis is made to conclude that:

- There are 7 orders, 7 families and 7 genera of beasts in Shihutang Project district (See Table 5.7.12). There is no beast under state protection.

- Rodents are the largest in numbers and species in this area, as the vital companion animals of human beings. Gonorhynchidae overlaps a lot in inhabitation with human beings’ economic activity areas, and some of the species are the sources of natural focal infection. Lepus sinensis and sewer rats are large in quantity.
Table 5.7-12 Directory of Beasts in Shihutang Project district

<table>
<thead>
<tr>
<th>Latin Names</th>
<th>Flora Protection level</th>
<th>Living environment</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Insectivora</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Erinaceus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>europaeus</td>
<td>Palaearctic</td>
<td>Various; nest in root, fallen trees, rock joints and underbrush</td>
<td>+</td>
</tr>
<tr>
<td>II. Chiroptera</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) Vespertilion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipistrellus abрамus</td>
<td>Oriental species</td>
<td>In roof, eves, walls, window aperture</td>
<td>+++</td>
</tr>
<tr>
<td>III. Lagomorpha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iii) Leporidae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Lepus sinensis</td>
<td>Dispersed</td>
<td>Mainly in shrub, meadow close to farmland or gulches, in hilly shrub or forest fringe</td>
<td>+</td>
</tr>
<tr>
<td>IV. Rodentia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iv) Muridae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. R. novégicus</td>
<td>Oriental</td>
<td>Various, usually as companion to human beings</td>
<td>+++</td>
</tr>
<tr>
<td>(V) Sciuridae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Callosciurus</td>
<td>Oriental</td>
<td>Inhabiting in hilly forest, broad leaved forest and coniferous forest</td>
<td>+</td>
</tr>
<tr>
<td>ergthraeus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V. Canivora</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(vi) Mustelelidae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Mustela sibirica</td>
<td>Oriental Provin</td>
<td>In valleys, earth slope, marsh and graves, adjacent to villages</td>
<td>+</td>
</tr>
<tr>
<td>level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VI. Artiodactyla</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(vii) Suidae</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VII. Sus scrofa</td>
<td>Dispersed</td>
<td>In winter they enjoy inhabiting in adret slopes, in summer they live close to water</td>
<td>++</td>
</tr>
</tbody>
</table>

5.7.5.5 Status & Assessment of Wildlife under Key Protection
There is no wildlife under state protection of terrestrial vertebrate, despite to 20 species under province-level protection in Jiangxi Province. See Table 1.7-2. Of the 20 species, there are 4 species of amphibians, 3 of reptiles, 12 of Avifauna and 1 species of beasts. These are of dispersed species, large in quantity Jiangxi Province, with no peculiar species. They are widely scattered in Shihutang Project district, mainly inhabiting in farmland, gulches and underbrush.

5.7.5.6 Resources Status & Assessment of Terrestrial Wildlife

Amphibians
Amphibians are classified into 1 order, 4 families and 8 genera, with no species under state protection. Investigation indicates that there are numerous Bufo gargarizana, but generally speaking amphibians are limited in community in Shihutang Project district.
5.0 Environment Baseline Survey & Assessment

□ Reptiles
There are 3 orders, 5 families and 9 genera of reptiles, with no species under state protection. Zoacys dhumnades are large in quantity.

□ Avifauna
There are 26 species of birds, classified into 8 families and 17 genera. Passerine are largest in quantity, totaling 9 species, or 34.62% of all. There is no bird under state protection. Of the 26 species of birds, 9 belong to oriental species; or 34.62% in total 7 belong to Palearctic realm, or 26.92% of all 10 species are of dispersed species, 38.46% of all species. non- migratory birds total 14 species, or 53.85% of all; summer migrant aggregates 26.92% of all Winter residents total 19.23% of all.

□ Beasts
There are 7 orders, 7 families and 7 genera of beasts in Shihutang Project district. There is no beast under state protection. Rodents are the largest in numbers and species in this area, as the vital companion animals of human beings. Gonorhynchidae overlaps a lot in inhabitation with human beings’ economic activities, part of which is the source of natural focal infection. Lepus sinensis and sewer rats are large in quantity.

□ Wildlife under Key Protection
Of all terrestrial vertebrates, there is no species under state protection. There are 20 species under province-level protection in Jiangxi Province, widely scattered in quantity in Shihutang Project district.

5.7.6 Inventory Survey & Assessment of Aquatic Organism

5.7.6.1 Sampling Points
There are 5 sampling points. See Table 5.7 and Attached Drawing 27.
5.0 Environment Baseline Survey & Assessment

### Table 5.7.13 Sampling Points of Aquatic Organism

<table>
<thead>
<tr>
<th>No</th>
<th>Sampling Points</th>
<th>Position by GPS</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Zhongjia</td>
<td>26°57'37.1&quot; N 115°00'50.4&quot; E 50 m</td>
<td>Downstream reach of recommended dam site</td>
</tr>
<tr>
<td>2</td>
<td>Shihutang</td>
<td>26°54'31.9&quot; N 114°59'52.2&quot; E 52.4</td>
<td>Spawning ground</td>
</tr>
<tr>
<td>3</td>
<td>Yanxidu</td>
<td>26°48'46.7&quot; N 114°58'42.8&quot; E 57.1</td>
<td>Spawning ground</td>
</tr>
<tr>
<td>4</td>
<td>Chengjiang</td>
<td>26°46'48.7&quot; N 114°54'33.5&quot; E 58.9</td>
<td>Spawning ground</td>
</tr>
<tr>
<td>5</td>
<td>Tongjia</td>
<td>26°42'37.2&quot; N 114°49'22.1&quot; E 60.27</td>
<td>Terminal of backup water</td>
</tr>
</tbody>
</table>

5.7.6.2 Plankton

Water is sampled in different positions and different depths, by No 25 plankton net to obtain a sample of 1000 ml (1/2 transparent). After filter in the net the sampling shall be moved into the glass, to add formalin for settlement. After 24 hours of deposit, the sampling will be under concentration by siphon to 30 ml. plankton sampling shall be under identification by types, for quantitative and qualitative analysis, to come to the conclusion that:

- **Species**
  - There are 8 phyla and 47 species of plankton, 30 species of Cryophyte, 10 species of Chlorophyta, 1 species of Euglenophyta and pyrophyta and xanthophyta, and 1 species of Cryptophyta. For detail see Attached Table 05-09; for detail of quantitative analysis of plankton see Table 5.7.14.
Table 5.7.14  Quantitative Analysis of Plankton

<table>
<thead>
<tr>
<th>Species</th>
<th>Chengjiang ×10^4/L</th>
<th>Shihutang dam site ×10^4/L</th>
<th>Yanxi Town ×10^4/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asterionella formosa</td>
<td>18</td>
<td>46</td>
<td>34</td>
</tr>
<tr>
<td>Cyclotella</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Fragilaria</td>
<td>6</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td>Melosira granulata</td>
<td>3</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Gomphonema</td>
<td>2</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Cymbella</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Stauroneis</td>
<td>3</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Surirella variabilis A.Cl</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Navicula</td>
<td>3</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Pinnularia</td>
<td>1</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Tabellaria fenestriata</td>
<td>6</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Draparnaldia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ulotrichales</td>
<td>3</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Scenedesmus quadricanda</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankistrodesmus sp.</td>
<td>6</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Cryptomonadales</td>
<td>Cryptomonadales</td>
<td>34</td>
<td>17</td>
</tr>
<tr>
<td>Euglena</td>
<td>Phacus</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>chrysophyte</td>
<td>Ochromonadaceae</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Cyanophytes</td>
<td>Chroococcales</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Composition of Species

Of plankton in the region the diatom plays the major role, followed by chlorella and Cryptomonadales. In biomass diatom makes up the majority.

The dominant species is Fragilaria, Navicula, Synedra, Gomphonema of bacillariophyta; Asterionella Formosa, Navicula of Chrysophytax; and Ulotrichales, Anthithamnion of chlorophyta; Cryptomonadales of Cryptophyta. This indicates the inorganic salt in the reach of Kan River meets the nutrition need for alga, which is desirable food to fishes. The change of alga is not only the basis to assess primary production of certain water, but also determines the productivity of plankton, thus to play a vital role in fishery industry. In addition, cryptophyta in large quantity indicates poor water quality in this reach of Kan River.

5.7.6.3 Zoobenthos

In February and July 2007, site investigations were done, investigation points were located in Shihutang site; Zhongjia, Yanxi, Chengjiang and Tongjiazhuang, by way of triangle trail net and Peterson sediment samplers to make qualitative and quantitative sampling of zoobenthos, in addition to picking up at the shore, to make such conclusion as follows;
Species

All together the investigation collected 24 species of zoobenthos, classified into 2 phyla, 3 classes and 11 families. Of them most are of mollusk totaling 20 species, making up 83.33% of zoobenthos only 4 species of arthropod 16.67% of all zoobenthos. For details see Attached Table 10. For detail of record of investigation see Table 5.7.15-5.7.16.

Table 5.7.15 Record of Investigation of Zoobenthos

<table>
<thead>
<tr>
<th>Sampling place</th>
<th>Zongjia Dam site</th>
<th>Yanxi</th>
<th>Chengjiang</th>
<th>Tongjiazhuang</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE</td>
<td>2007.2.10</td>
<td>2007.2.10</td>
<td>2007.2.9</td>
<td>2007.2.9</td>
</tr>
<tr>
<td>ALTITUDE</td>
<td>50.0</td>
<td>52.4</td>
<td>57.1</td>
<td>58.9</td>
</tr>
<tr>
<td>TEMP.</td>
<td>17</td>
<td>17</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>EAST LONGITUDE</td>
<td>115°05′04″</td>
<td>114°59′22″</td>
<td>114°58′28″</td>
<td>114°58′53″</td>
</tr>
<tr>
<td>NORTH LATITUDE</td>
<td>26°57′53″</td>
<td>26°54′39″</td>
<td>26°48′56″</td>
<td>26°49′58″</td>
</tr>
<tr>
<td>TEMP.</td>
<td>12</td>
<td>12</td>
<td>12.5</td>
<td>12.5</td>
</tr>
<tr>
<td>PH</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>WATER BODY</td>
<td>SANDSTONE+ MUDDY STONE</td>
<td>FINE SAND + PEBBLE</td>
<td>SANDSTONE + PEBBLE</td>
<td>SANDSTONE</td>
</tr>
<tr>
<td>DEPTH</td>
<td>220</td>
<td>150</td>
<td>120</td>
<td>200</td>
</tr>
<tr>
<td>FLOW</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td>MODERATE</td>
</tr>
<tr>
<td>MAIN ZOOBENTHOS SPECIES</td>
<td>Rivularia auriculata</td>
<td>Bellamya aeruginosa</td>
<td>Bellamya aeruginosa</td>
<td>Bellamya aeruginosa</td>
</tr>
<tr>
<td></td>
<td>Semisulcospira peregrinorum</td>
<td>Rivularia auriculata</td>
<td>Semisulcospira peregrinorum</td>
<td>Semisulcospira peregrinorum</td>
</tr>
<tr>
<td></td>
<td>Corbicula fluminea</td>
<td>Sinopotamon denticulatum</td>
<td>Corbicula fluminea</td>
<td>Unio douglasiae</td>
</tr>
<tr>
<td></td>
<td>Macrobrachium nipponense</td>
<td></td>
<td></td>
<td>Corbicula fluminea</td>
</tr>
<tr>
<td></td>
<td>Lanceolaria gladiola</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lamprotula caveata</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Species Composition

Most of the zoobenthos are Bellamya aeruginosa, Rivularia auriculata, Semisulcospira peregrinorum, Corbicula fluminea and Unio douglasiae, with the former three species usually inhibiting in shallow water (0.7-1.5m) where most of the bottom is of humus. This is related to their behavior of feeding upon alga or humus while inhabiting on shore rock or pebble. Sandy bottom material is suitable for growth of Corbicula fluminea, available for commercial fishing in fishery off-season, as one of cash farming. Other species of mussel serve as food to birds in low water seasons, thus mollusk plays a vital role in food chain of aquatic ecosystem.

Swaying mosquitos larvae are quite sensitive to water pollution, just a few amount of species can withstand pollution to a certain extent. Appearance of swaying mosquitos larvae shows that the water quality and flowability of Taihhe section of the Kan River are good.

Table 5.7.16 Record of Investigation of Zoobenthos

<table>
<thead>
<tr>
<th>Sampling place</th>
<th>Zongjia Dam site</th>
<th>Yanxi</th>
<th>Chengjiang</th>
<th>Tongjiazhuang</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALTITUDE</td>
<td>50.0</td>
<td>52.4</td>
<td>54</td>
<td>57</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
<td>------</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>TEMP.</td>
<td>115°00'50.4&quot;</td>
<td>114°59'52.2&quot;</td>
<td>114°58'42.8&quot;</td>
<td>114°54'33.5&quot;</td>
</tr>
<tr>
<td>EAST LONGITUDE</td>
<td>26°57'37.03&quot;</td>
<td>26°54'31.9&quot;</td>
<td>26°48'46.7&quot;</td>
<td>26°46'48.7&quot;</td>
</tr>
</tbody>
</table>

**LOCATION**

**TEMP.**

<table>
<thead>
<tr>
<th>BED SEDIMENT</th>
<th>SANDSTONE + MUDDY STONE</th>
<th>FINE SAND + PEBBLE</th>
<th>SANDSTONE + PEBBLE</th>
<th>SANDSTONE</th>
<th>SAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEPTH (CM)</td>
<td>2.2</td>
<td>2.1</td>
<td>2.7</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td>FLOW</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td>MODERATE</td>
<td>MODERATE</td>
</tr>
</tbody>
</table>

**MAIN ZOOBENTHOS SPECIES**

- Rivularia auriculata
- Semisulcospira peregrinorum
- Unio douglasiae
- Corbicula fluminea
- Sinopotamon denticulatum
- Macrobrachium nipponense
- Bellamya aeruginosa
- Corbicula fluminea
- Unio douglasiae
- Acuticosta chinensis
- Corbicula fluminea
- Bellamya aeruginosa
- Semisulcospira peregrinorum
- Sinopotamon denticulatum
- Bellamya aeruginosa
- Corbicula fluminea
- Unio douglasiae
- Lamprotula caveata

**Biomass**

The density and biomass of zoobenthos at the assessment area vary at different seasons, the density and biomass of zoobenthos in winter is bigger than than in summer. Main species of big density and biomass of zoobenthos are Bellamya aeruginosa averagely with 334/m² and a biomass of 1080g/m². Rivularia auriculata 896/m² and a biomass of 1681g/m². Corbicula fluminea 160/m² and a biomass of 126g/m².

**Adaptability of Zoobenthos to environment**

In Chengjiang: including Southgate Ferry and Eastgate Ferry, where it is resident’s area with dense population, where the bottom material in the mid-current of fine pebblestone is destroyed, to discover no shell. There are huge and small rocks close to Southgate Ferry, in the rock are attached numerous Semisulcospira peregrinorum, while in the north bank only Bellamya aeruginosa was discovered.

In Yanxi Town: there is unique environment here, with the mid-current made up of fine sand, suitable for Corbicula fluminea, whose density reaches 160/m², available for fishing in large quantities in June to July in flood seasons, as an important source of income. Close to the shore the bottom material is of gravel, with large amounts of Bellamya aeruginosa with a biomass of 334/m² in addition to considerable Semisulcospira peregrinorum and Unio douglasiae, which feed upon alga attached to gravel and serve as good food to carp cyprinoid and herring.

In Zhongjia: the mid-current bottom material is of sand mixed with scree, with limited Corbicula fluminea whose density reaches 53/m². The shore is of mudstone, with unique
species of Rivularia auriculata with a density of 896/m² and a biomass of g/m², in addition to limited Semisulcospira peregrinorum. This reach is rich in crab and shrimp, too.

Dam Site: the mid-current bottom material is of fine sand, with Corbicula fluminea making up the majority. The shore is of scree, with large quantity of ivularia auriculata, and Semisulcospira peregrinorum, with a mean biomass of 76.4g/m².

Tongjiazhuang: this point is richest in shell in this investigation, to total 15 species. The sampling occurred in the driest season with average water depth to reach about 1m, to see the bottom everywhere. In the mid-current there is rare shell, except for Corbicula fluminea, which averages 112/m² in the east bank of sand bottom. The rock contains large quantity of Bellamya aeruginosa, while in the shallow shoal there were numerous species of shell, including Unio douglasiae, Lamprotula caveata, Lanceolaria gladiola, Anodonta globosula, Cuneopsis heudei, Lanceolaria gladiola and Arconaia lanceolata.

5.7.6.4 Profile of Fishery, fish resource, and main fish spawning sites

See Chapter 8.0 of this EIA – SPECIAL ASSESSMENT ON FISHES AND SPAWNING SITES.

5.7.6.5 Conclusion of Aquatic Organism Evaluation

□ Conclusion of Plankton

In Shihutang Project district there are 8 phyla and 47 species of plankton, 30 species of Chrysophyta, 10 species of Chlorophyta, 1 species of Euglenophyta and pyrrophyta and xanthophyta, and 1 species of Cryptophyta. Of plankton in the region the diatom plays the major role, followed bychlorella and Cryptomonadales. In biomass diatom makes up the majority.

□ Conclusion of Zoobenthos

All together the investigation collected 21 species of zoobenthos, of which dominant species consist of Bellamya aeruginosa, Corbicula fluminea, Rivularia auriculata, Semisulcospira peregrinorum and Unio douglasiae. Some of the benthonic organisms are beneficial to human beings, like Bellamya aeruginosa, Corbicula fluminea and Unio douglasiae, which serve as food and feed to poultry and domestic animals, and some are harmful like Semisulcospira peregrinorum and Sinopotamon denticulatum, which is harmful to human as innermost of lung fluke.

5.7.7 Analysis of Primary Productivity of Natural System

Vegetation is the most important and most sensitive element in ecological environment, to produce decisive role in eco-system evolution and balance.net vegetation productivity refers to the organic mass accumulated in a period in certain area of green plants, the gross mass created out of photosynthesis after deduction of consumption in phytotrophy respiration. This
index directly reflects the productivity of vegetation community in natural environment, to serve as vital parameter to evaluate status quo of ecological system. Biomass is the gross carbon in certain area of plants.

Vegetation sampling in Shihutang Project district is made by way of field investigation, satellite image interpretation, indoor analysis and collected literature. Satellite image interpretation goes as follows: for chosen TM data, interpretation is under way through remote sensing software ERDAS (geometric accurate correction, image enhancement and amalgamation). On the basis of environmental data and relevant image software interpretation, relevant data and ecological images are obtained concerning ecological study in Shihutang Project district.

On the basis of field investigation and satellite image interpretation, the surface vegetation status and vegetation stratus are divided into seven types, whose net productivity is listed in Table 5.7—17.

From the table it is clear that based on mean net productivity applicable to terrestrial eco-system, the mean net productivity reaches 505.85gC/(m^2.a), less than global average [214.15gC(m^2.a)], to indicate that vegetation productivity is lower in Shihutang, where water body makes up considerable area.
Table 5.7.17 Natural Net Primary Productivity of Vegetation

<table>
<thead>
<tr>
<th>Types</th>
<th>Typical Plants</th>
<th>Area [k m²]</th>
<th>Percent [%]</th>
<th>NMP [gC/(m².a)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad-leafed Forestry</td>
<td>Form. Cinnamomum camphora, Form. Schima superba, Form. Castanopsis sclerophylla</td>
<td>27.48</td>
<td>3.07%</td>
<td>936</td>
</tr>
<tr>
<td>Coniferous forestry</td>
<td>Redpine and slash pine</td>
<td>81.07</td>
<td>9.05%</td>
<td>587</td>
</tr>
<tr>
<td>Bush &amp; underbush</td>
<td>Form. Paliurus ramosissimus Form. Vitex negundo var. cannabifolia</td>
<td>287.56</td>
<td>32.09%</td>
<td>426</td>
</tr>
<tr>
<td>Bamboo</td>
<td>Phyllostachys</td>
<td>11.73</td>
<td>1.31%</td>
<td>626</td>
</tr>
<tr>
<td>Meadow</td>
<td>Cynodon dactylon Ass., Eremochloa ophiuroides Ass.</td>
<td>13.68</td>
<td>1.53%</td>
<td>236</td>
</tr>
<tr>
<td>Farmland</td>
<td>Rice, canola plant, tuber crops, legume, vegetables</td>
<td>440.11</td>
<td>49.11%</td>
<td>405</td>
</tr>
<tr>
<td>Wetland</td>
<td>Aquatic vascular plant, alga</td>
<td>34.47</td>
<td>3.85%</td>
<td>325</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td>896.1</td>
<td>100%</td>
<td>505.85</td>
</tr>
<tr>
<td>Criteria</td>
<td></td>
<td></td>
<td></td>
<td>720</td>
</tr>
</tbody>
</table>

NMP: Net Mean Productivity

5.7.8 Quality Assessment of Landscape Eco-system

In classification of natural system, Shihutang belongs to manage landscape eco-system, including artificial landscape (vegetation under improvement) and artificial operation landscape (soil under improvement), field landscape and urban landscape. Artificial landscape consists mainly of river ecosystem, forestry ecosystem, shrub and meadow ecosystem and underbrush ecosystem. Artificial operation landscape is composed of paddy fields, dry land; urban landscape refers to combination of ecosystem in the county, towns, townships and villages. Shihutang Project district is of terrace by the river and hillock plain, under severe interference from human activities, so that the ecosystem is secondary, with focus upon water utilization, complimented from land utilization.

Quality of landscape depends upon natural environment within the region and upon the complex relationship between all types of living beings and human society. In terms of landscape ecology and function, the rationality of structure determines superiority or inferiority of the landscape. Of all composition of landscape, matrix is the background to landscape out of wide-scattered, relatively homogeneous, strongest in connectivity, dominant soil overlay type. Such a type to a great degree determines the nature of landscape, to play a leading role in landscape. Matrix in Shihutang adopts landscape ecosystem methods, namely out of the degree of dominance (Do), frequency (R_f) and landscape percentage (L_p).

\[ R_d = \frac{\text{number of splits i}}{\text{gross splits}} \times 100\% \]
\[ R_f = \frac{\text{quadrate number of splits i}}{\text{gross quadrate number}} \times 100\% \]
\[ L_p = \frac{\text{area of split i}}{\text{gross quadrate number}} \times 100\% \]
5.0 Environment Baseline Survey & Assessment

Do=0.5×[0.5×(R_d + R_f)+ L_p ]×100%

For detail of landscape composition see Table 5.7—18.

Table 5.7—18  Landscape Composition in Shihutang

<table>
<thead>
<tr>
<th>Types</th>
<th>Area  km²</th>
<th>Percent</th>
<th>Splits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland</td>
<td>323.88</td>
<td>36.18%</td>
<td>338</td>
</tr>
<tr>
<td>Meadow</td>
<td>109.35</td>
<td>12.22%</td>
<td>40</td>
</tr>
<tr>
<td>Waters</td>
<td>43.93</td>
<td>4.91%</td>
<td>40</td>
</tr>
<tr>
<td>Land for urban, rural and mineral building</td>
<td>9.83</td>
<td>1.10%</td>
<td>57</td>
</tr>
<tr>
<td>Paddy fields</td>
<td>261.23</td>
<td>29.18%</td>
<td>97</td>
</tr>
<tr>
<td>Dry land</td>
<td>146.95</td>
<td>16.42%</td>
<td>115</td>
</tr>
<tr>
<td>Total</td>
<td>895.17</td>
<td>100.00%</td>
<td>687</td>
</tr>
</tbody>
</table>

Based on such parameters the degree of dominance is calculated as follows on Table 5.7—19.
Table 5.7.19 Degree of Dominance of Each Split

<table>
<thead>
<tr>
<th>Type</th>
<th>Rd</th>
<th>Rf</th>
<th>Lp</th>
<th>Do</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodland</td>
<td>46.94</td>
<td>48.81</td>
<td>36.18</td>
<td>42.03</td>
</tr>
<tr>
<td>Underbush</td>
<td>5.56</td>
<td>72.31</td>
<td>12.22</td>
<td>25.57</td>
</tr>
<tr>
<td>Waters</td>
<td>5.56</td>
<td>7.16</td>
<td>4.91</td>
<td>5.63</td>
</tr>
<tr>
<td>Land for urban, rural &amp; mineral building</td>
<td>7.92</td>
<td>35.29</td>
<td>1.10</td>
<td>11.35</td>
</tr>
<tr>
<td>Paddy fields</td>
<td>13.47</td>
<td>49.71</td>
<td>20.41</td>
<td>26.00</td>
</tr>
<tr>
<td>Dry land</td>
<td>15.97</td>
<td>56.23</td>
<td>16.42</td>
<td>26.26</td>
</tr>
<tr>
<td>Unused land</td>
<td>4.58</td>
<td>9.24</td>
<td>8.77</td>
<td>7.84</td>
</tr>
</tbody>
</table>

From Table 5.7.19 it is clear that among the Do in all splits, the woodland enjoys a Do of 42.03%, a (R_d) of 46.94%, R_f of 48.81% and L_p of 36.18%, all of which are higher than in other splits, to serve as the matrix in Shihutang Project district and as the ecosystem to control landscape, followed by dry land L_p of 26.26%, paddy fields L_p of 26.00%, and underbrush L_p of 25.57%. In a word the ecosystem in Shihutang Project district is closely related to human activities, under severe human interference, poor in capacity of resisting disturbance and in adjustability.

5.7.9 Water & Soil Erosion & Water & Soil Conservation

5.7.9.1 Water & Soil Erosion in Affected County

This Project is located in Taihe County of Jiangxi Province, which, based on Soil Corrosion Classification & Gradation Standards (SL190-96), falls into south China hilly areas of red loam, where the soil corrosion is mainly of water erosion. In line with Key Preventive & Rehabilitative Efforts against Soil Erosion in Jiangxi Province from People’s Government, the project is located in this key engineering area, where allowed value for water and soil erosion reaches 500t/Km².a.

Based on remote sensing of water and soil erosion in 1996 in Jiangxi Province, the whole county has a gross water and soil erosion area of 629.76km², or 23.6% of total land. Of the land, lightly eroded area totals 155.35km², and moderately eroded area 174.63km², and strongly and extremely eroded area reaches 299.78km², to contribute 24.7%, 27.7% and 47.6% respectively to the gross water and soil erosion area (See table 5.7-20). Status quo of water and soil erosion see Chart 5.7-2. soil corrosion modulus is 1023.07t/km².a. Water and soil erosion is featured by surface erosion, with partial gully erosion.
Table 5.7—20 Status of Water & Soil Erosion in Taihe County  Unit: \( \text{km}^2 \)

<table>
<thead>
<tr>
<th>District</th>
<th>Acreage</th>
<th>Light</th>
<th>Medium</th>
<th>Deep</th>
<th>Severe</th>
<th>Violent</th>
<th>Total</th>
<th>Percent of water and soil erosion area in gross area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taihe</td>
<td>2665.4</td>
<td>155.35</td>
<td>174.63</td>
<td>262.32</td>
<td>34.95</td>
<td>2.51</td>
<td>629.76</td>
<td>23.6</td>
</tr>
</tbody>
</table>

5.7.9.2 Status Quo of Water & Soil Erosion in Shihutang Area

Shihutang Project is located at hilly areas of red loam in Southern China, abundant in rainfall, where water and soil erosion is mainly of water erosion. Among the construction area, water and soil erosion area makes up 21% of total land for construction (excluding reservoir inundation or land for sand and other building materials). Of the land light water and soil erosion area makes up 58% of the total, medium water and soil erosion 40%, strong erosion area 2%. Within the range of construction acquisition of land, mean soil corrosion modulus is 853t/km².a.

Existing water and soil erosion is listed in Table 5.7—21; the mean soil corrosion modulus under different topography for different engineering items is listed in Table 5.7—22.
Chart 5.7—21 Status of Water & Soil Erosion in Taihe County
### Table 5.7 Status of Water & Soil Erosion

<table>
<thead>
<tr>
<th>Item</th>
<th>Acreage</th>
<th>Light</th>
<th>Medium</th>
<th>Deep</th>
<th>Percent of water &amp; soil erosion area in gross area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nodal region</td>
<td>28.33</td>
<td>4.95</td>
<td>2.10</td>
<td>7.05</td>
<td>25%</td>
</tr>
<tr>
<td>Embankment protection</td>
<td>258.53</td>
<td>27.99</td>
<td>14.06</td>
<td>0.53</td>
<td>42.58 16%</td>
</tr>
<tr>
<td>Project management site</td>
<td>3.33</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
<td>10%</td>
</tr>
<tr>
<td>Borrow pits</td>
<td>34.53</td>
<td>4.61</td>
<td>1.51</td>
<td>6.12</td>
<td>18%</td>
</tr>
<tr>
<td>Spoil sites</td>
<td>117.62</td>
<td>21.60</td>
<td>15.52</td>
<td>37.12</td>
<td>32%</td>
</tr>
<tr>
<td>Construction &amp; living quarters</td>
<td>64.2</td>
<td>10.61</td>
<td>12.18</td>
<td>2.06</td>
<td>24.86 39%</td>
</tr>
<tr>
<td>Roads/highways</td>
<td>30.73</td>
<td>6.34</td>
<td>5.01</td>
<td>11.35</td>
<td>37%</td>
</tr>
<tr>
<td>Host area</td>
<td>5.21</td>
<td>2.61</td>
<td>2.61</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Lifting the field</td>
<td>82.47</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td>624.95</td>
<td>76.45</td>
<td>52.99</td>
<td>2.59</td>
<td>132.02 21%</td>
</tr>
</tbody>
</table>
Table 5.7-22  Background Level of Soil Corrosion Modulus

<table>
<thead>
<tr>
<th>Engineering site</th>
<th>Use of land (hm²)</th>
<th>Status quo</th>
<th>Soil corrosion modulus [t/km²·a⁻¹]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nodal region</td>
<td>28.33</td>
<td>Acquisition of land in the nodal region is mainly of paddy fields, dry land and forestland and unused land; soil corrosion is mainly of medium erosion.</td>
<td>860</td>
</tr>
<tr>
<td>Embankment protection</td>
<td>258.53</td>
<td>Acquisition of land is of paddy fields, dry land, forest land and unused land; flat as a pancake, where soil corrosion is of light and slight erosion.</td>
<td>753</td>
</tr>
<tr>
<td>Project management site</td>
<td>3.33</td>
<td>Mainly of forest land and unused land; and soil corrosion of medium erosion</td>
<td>600</td>
</tr>
<tr>
<td>Borrow pits</td>
<td>34.53</td>
<td>There are 13 borrow pits that all come from the hillside; existing vegetation is of forest, meadow and dry land.</td>
<td>743</td>
</tr>
<tr>
<td>Spoil sites</td>
<td>117.62</td>
<td>There are excavation waste dumps of which is located in existing gulch or valley mainly of waste land with deep erosion; 10 located as gentle slope spoil sites, to use farmland as such sites where soil corrosion is medium and light; the rest of the spoil sites use flat paddy fields or dry land as spoil sites, with medium or light soil corrosion</td>
<td>1014</td>
</tr>
<tr>
<td>Construction area/living quarters</td>
<td>64.2</td>
<td>Acquisition of land for temporary works is mostly of gentle surface relief with desirable vegetation out of grass and shrubs, where soil corrosion is deep.</td>
<td>1284</td>
</tr>
<tr>
<td>Roads &amp; highways</td>
<td>30.73</td>
<td>Acquisition of land for temporary works is mostly of gentle surface relief with desirable vegetation out of grass and shrubs, where soil corrosion is light.</td>
<td>1114</td>
</tr>
<tr>
<td>Host area</td>
<td>5.21</td>
<td>Acquisition of land is mainly of paddy fields, forestland, with light soil corrosion.</td>
<td>1752</td>
</tr>
<tr>
<td>Lifting the field</td>
<td>82.47</td>
<td>Acquisition of land is mainly of paddy fields, with limited dry land.</td>
<td>500</td>
</tr>
</tbody>
</table>

5.7.9.3 Types of Water & Soil Erosion

In the project area the types of water and soil erosion is mainly of surface erosion and gulley erosion, where water and soil erosion makes up over 80% of gross land, with very little gravity erosion from landsliding and bank sloughing. Surface erosion mostly occurs in barren hills and waste slope in arable land and arable land forest land, which is over 5° in gradient, which suffers from partial damage. Gulley erosion comes from surface erosion due to runoff concentration and rill erosion occurs mainly in slope arable land and in loose sheet erosion, usually in downsea slope arable land and barren hills. Shallow gully erosion and gully erosion are common, seen in runoff gathering where gulch and hillside joins. Gravity erosion occurs usually during gullywasher, mostly distributed in inclined or abrupt slopes.
5.7.9.4 Cause of Water & Soil Erosion

Water and soil erosion is out of combined action of natural elements and artificial activities, closely related to such factors as topography, soil, rainfall, land use patterns, and vegetation. Natural factors are the major causes of water and soil erosion, while human activities aggravate water and soil erosion.

- Rainfall is abundant and concentrated, and storm intensity is very unusual, as the direct force to cause water and soil erosion. Shihutang area is mainly of red loam, followed by purple soil, both of which are undesirable in resistance. The bare soil is open to rain drop erosion, thus the soil is ready to be eroded and moved, to result in water and soil erosion.

- There is developed water system, with numerous streams and creeks and brooks densely distributed, with gulch under deep and narrow cutting, with abrupt and long slopes, which is favorable for development of water and soil erosion.

- The density of population in this area is very high and cultivation index is very high, which is one of the causes of water and soil erosion. Density of population amounts to 187 people/km², mainly of rural population who are engaged in blind deforestation. Such over-use of land and predatory activities will damage vegetation to make some hills into bare ones, only to aggravate water and soil erosion.

- There is severe wanton cutting of forests, which seriously destroys vegetation. Despite some measures to plant trees, but poor management harvests little benefit, so that every year sees planting of trees while to see no formation of grove at all, so that timber can not meet the demand, and forest cover decreases year by year, which of course worsen water and soil erosion.

- Cropping pattern is outdated, which will add to gradient of arable land to create fresh water and soil erosion.

- During infrastructure there is not enough attention to water and soil conservation. In construction and production, the importance of water and soil conservation has been ignored to the extent of wanton damage of surface vegetation and wanton disposal of sand, stones or waste residue so that large amounts of waste residue are directly disposed of to the river to block the channel and thus aggravate water and soil erosion.

By the end of 2002, Taihe County brought an area of 160.2km² that used to suffer from water and soil erosion under control.

5.7.10 Profile of Regional Soil

Within the same bioclimatic zone the soil shows no difference in horizontal distribution, except for vertical distribution. There is such soil as red loam, paddy soil, purple soil, moisture soil and yellow soil. Red loam is typical of regional soil, to rise in elevation from valley terrace in Kan River southeastward, to develop into moisture soil or paddy soil (in valley plain) to red loam, to lateritic soil, to purple soil and gulch paddy soil (in low and middle-elevation hillock plains), until to mountain red soil and corresponding paddy soil (in middle and high-elevation hills and low-relief terrain) or mountain yellow brown soil.

- Distribution of Mountain Soil

Mountain red soil is distributed in ring along the low-relief terrain and some middle or high hills (over 200m), large in areas. Its lower limit borders low EL red soil or partial rocky soil, while its upper limit (over 700m EL) is of mountain yellow brown soil, limited in mountain paddy fields, distributed in narrow valley or some small depression.
Distribution of Hilly Soil
Hilly soil in Taihe is divided into two types:
The first type is distributed in the middle or low-relief terrains out of fuchsia cretaceous waste, in form of purple soil or red loam. Present vegetation is mainly of meadow or shrub, with partial artificial pine, with a cover density of less than 10%, suffering from water loss and earth erosion.

The second type is of red loam or lateritic soil, concentrated in Yanxi, Shangtian, Wanhe, Mashi, Tangzhou and other monticles or terrace. There is little coverage and severe water loss and earth erosion. Low gulch of red loam is one of the major rice yield sources, distributed in parallel, mostly lack of water sources.

Distribution of Soil in Valley Plain
Valley plain under influence of topographical structure is not large in area, only 2 to 3 km in width, obviously of green sandy clay or green sand of gravel bed. Here the soil changes to paddy soil near the hill edge.

Soil nutrition varies corresponding to topography, with brown soil richest in nutrition, followed by red loam, mountain brown soil and purple soil, in a range of 10 times. For detail of soil fertility see Table 5.7—23.
<table>
<thead>
<tr>
<th>Type</th>
<th>Class</th>
<th>Major soil</th>
<th>Distribution &amp; Utilization</th>
<th>Major Features</th>
<th>Remarks</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>☐</td>
<td>Rock waste: mostly of organic medium-thick or thick yellow soil or red loam</td>
<td>Of hilly areas at EL 300m in Zhonglong, Shuiguo, Laoyinpan, and Qiaotou, etc. dominant by arbor and shrub, cash forest and oily and tea forest</td>
<td>Relative ly thick soil and fertile</td>
<td>Suitable for various crops</td>
<td>Sasanqua forest; open to improved density by way of forest conservation planning felling and renewal</td>
</tr>
<tr>
<td>Meadow</td>
<td>☐</td>
<td>Quartziferous waste: with organic medium-thick or thick yellow soil or red loam; argillaceous slate waste: Full of organic medium-thick or thick red loam</td>
<td>Distributed in hilly areas or hillock plains. Above EL300 m dominated by arbor and shrub, with certain area of Sasanqua forest</td>
<td>The soil is usually thick with little lithosol and humus</td>
<td>Limited in forestry adaptability. Medium-fertile soil</td>
<td>Great attention shall be paid to development of forestry and firewood, and it is suitable to develop cash trees where it adjacent to villages and the slope is slow</td>
</tr>
<tr>
<td>Wasteland</td>
<td>☐</td>
<td>Fuchsia conglomerate waste: with little organic medium-thick or thick lateritic soil or red loam</td>
<td>Mainly distributed in low and medium-high hilly areas, dominated by meadow or shrub, with sporadic red pines</td>
<td>Thin soil stratum , with the bed rock visible below the surface soil</td>
<td>Low fertility</td>
<td>Shall be under preservation</td>
</tr>
<tr>
<td>Wasteland</td>
<td>☐</td>
<td>Red clay of Quaternary period: With little organic red loam or lateritic soil</td>
<td>Mainly distributed in Yanxi, Shangtian, Tangzhou, Zhangshu and Yuanqian. With little vegetation</td>
<td>Under severe erosion. The bedrock or rix matrices exposed</td>
<td>Little nutrient content. Barren land</td>
<td>Unsuitable for exploitation</td>
</tr>
</tbody>
</table>
6.0 ENVIRONMENTAL IMPACT ASSESSMENT

6.1 Hydrologic Conditions

6.1.1 Hydrological Regime of the Shihutang Section under Natural Condition

6.1.1.1 Flow at the Shihutang dam site under natural condition

Shihutang Project has a catchment of 43770km². In accordance with the distribution of upstream and downstream hydrological stations of the dam site and hydrological information, Dongbei Station and Linkeng Station at upstream of the Shihutang dam site are selected as the basis of annual and monthly runoff calculation of the Shihutang dam site. The annual and monthly runoff in Shihutang dam site is computed on the basis of the actual annual and monthly runoff of Dongbei Station and Linkeng Station from 1957 to 2005. After reservoir filling the runoff here is not influenced by Wan’an Reservoir. For many years the average flow is 1150m³/s, the average runoff volume is 362.9×10⁸m³, the average runoff is 828.9 mm deep and the annual runoff modulus is 26.27L/km²/s.

(1) Runoff Properties at Shihutang dam site under natural condition

During 49 years from 1957 to 2005, its runoff volume is relatively rich; the annual runoff varies a lot from year by year. The maximum annual average flow is 1940m³/s (in 1975), then 1930m³/s (in 1973), the minimum annual average flow is 405m³/s (in 1963), and the maximum annual average flow is 4.79 times of the minimum annual average flow. The runoff is not evenly distributed during a year, the runoff volume during the 5 successive months of rainy season (from March to July) accounts for 65.6 percent of the total annual runoff volume, of which, the maximum rainfall occurs in June, which accounts for 18.99 percent of the total. Its dry season lasts from October to February of the next year, and the runoff volume of the 5 successive months is only 19.61 percent of the annual runoff volume, of which, the runoff volume in December is the minimum, which only accounts for 3.03 percent of the total annual runoff volume. The maximum monthly average flow 6190m³/s (in June, 1959) is 39.7 times of the minimum monthly average flow 156m³/s (observed in Feb. 1987). The distribution conditions of monthly runoff volume are shown in Table 6.1-1.

| Table 6.1-1 Monthly Average Runoff Distribution of Shihutang dam site |
|-------------------|---|---|---|---|---|---|---|---|---|---|---|
| Item              | Jan  | Feb  | Mar  | April | May  | June | July | Aug  | Sept | Oct  | Nov  | Dec  | Whole year |
| Annual average flow (m³/s) | 457 | 676 | 1212 | 1841 | 2176 | 2623 | 1242 | 1080 | 931  | 651  | 506  | 418  | 1150      |
| % of annual runoff | 3.31 | 4.90 | 8.77 | 13.33 | 15.75 | 18.99 | 8.99 | 7.82 | 6.74 | 4.71 | 3.66 | 3.03 | 100       |
| Monthly average max. flow | 1256 | 2349 | 4715 | 5109 | 5219 | 6191 | 3321 | 3192 | 4644 | 1999 | 2013 | 1359 | 1940      |
(2) Design Annual Runoff at Shihutang dam site under natural condition

Average annual runoff for design at Shihutang dam site will be calculated in line with the value from 1992 to 1993, from 1982 to 1983, from 1990 to 1991, from 1966 to 1967 and from 1986 to 1987 during high flow year, design wet year, design normal year, design low year and dry year. For detail of the characteristics of the values at Shihutang dam site concerning designed mean annual flow, designed mean flow in dry years and in typical years and mean flow during dry periods, see Table 6.1-2; for detail of monthly mean flow see Table 6.1—3 in the five typical years.

Table 6.1—2 Average Flow Comparison between Dam Design Stage & Design Typical Year

<table>
<thead>
<tr>
<th>Frequency (%)</th>
<th>Design average flow (m³/s)</th>
<th>Design typical year</th>
<th>Stage average flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hydro-</td>
<td>Oct.-</td>
<td>Nov.-</td>
</tr>
<tr>
<td>10</td>
<td>1660</td>
<td>948</td>
<td>803</td>
</tr>
<tr>
<td>25</td>
<td>1380</td>
<td>675</td>
<td>572</td>
</tr>
<tr>
<td>50</td>
<td>1110</td>
<td>468</td>
<td>397</td>
</tr>
<tr>
<td>75</td>
<td>877</td>
<td>339</td>
<td>287</td>
</tr>
<tr>
<td>90</td>
<td>699</td>
<td>279</td>
<td>236</td>
</tr>
<tr>
<td>Mean</td>
<td>1145</td>
<td>542</td>
<td>459</td>
</tr>
<tr>
<td>Mean value during 49 years from 1957 to 2005 at Shihutang dam</td>
<td>1150</td>
<td>543</td>
<td>464</td>
</tr>
</tbody>
</table>

Table 6.1—3 Runoff Distribution in Typical Design Years in Shihutang dam site under natural condition

<table>
<thead>
<tr>
<th>Items</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Whole year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992-1993 (P=10%)</td>
<td>4211</td>
<td>3335</td>
<td>3041</td>
<td>2743</td>
<td>2682</td>
<td>902</td>
<td>820</td>
<td>439</td>
<td>376</td>
<td>354</td>
<td>409</td>
<td>282</td>
<td>1640</td>
</tr>
<tr>
<td>1982-1983 (P=25%)</td>
<td>1341</td>
<td>1343</td>
<td>2365</td>
<td>2778</td>
<td>1234</td>
<td>891</td>
<td>706</td>
<td>516</td>
<td>807</td>
<td>859</td>
<td>1190</td>
<td>2029</td>
<td>1330</td>
</tr>
<tr>
<td>1990-1991 (P=50%)</td>
<td>1019</td>
<td>2658</td>
<td>1378</td>
<td>1866</td>
<td>926</td>
<td>1304</td>
<td>1570</td>
<td>716</td>
<td>659</td>
<td>408</td>
<td>550</td>
<td>457</td>
<td>1130</td>
</tr>
<tr>
<td>1966-1967 (P=75%)</td>
<td>457</td>
<td>1423</td>
<td>1180</td>
<td>3400</td>
<td>1313</td>
<td>544</td>
<td>349</td>
<td>400</td>
<td>305</td>
<td>312</td>
<td>254</td>
<td>637</td>
<td>877</td>
</tr>
<tr>
<td>1986-1987 (P=90%)</td>
<td>1027</td>
<td>1623</td>
<td>1178</td>
<td>2034</td>
<td>1126</td>
<td>490</td>
<td>385</td>
<td>264</td>
<td>369</td>
<td>252</td>
<td>183</td>
<td>155</td>
<td>758</td>
</tr>
<tr>
<td>Mean flow</td>
<td>1611</td>
<td>2076</td>
<td>1828</td>
<td>2564</td>
<td>1456</td>
<td>826</td>
<td>766</td>
<td>467</td>
<td>503</td>
<td>437</td>
<td>517</td>
<td>712</td>
<td>1147</td>
</tr>
<tr>
<td>Max daily flow</td>
<td>13791</td>
<td>10122</td>
<td>5962</td>
<td>9032</td>
<td>11644</td>
<td>4316</td>
<td>6176</td>
<td>1535</td>
<td>2525</td>
<td>2357</td>
<td>3309</td>
<td>6181</td>
<td>13791</td>
</tr>
<tr>
<td>Typical years</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Wet</td>
<td>Wet</td>
</tr>
</tbody>
</table>
6.0 Environment Impact Assessment

<table>
<thead>
<tr>
<th>Min daily flow</th>
<th>Low</th>
<th>Low</th>
<th>Low</th>
<th>Low</th>
<th>Low</th>
<th>Low</th>
<th>Normal</th>
<th>Low</th>
<th>Low</th>
<th>Low</th>
<th>Dry</th>
<th>Dry</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>212</td>
<td>532</td>
<td>360</td>
<td>755</td>
<td>387</td>
<td>280</td>
<td>179</td>
<td>149</td>
<td>226</td>
<td>193</td>
<td>160</td>
<td>124</td>
<td>124</td>
</tr>
</tbody>
</table>

**Note:** the data in the table is under measurement at m³/s.

6.1.1.2 Water level at Shihutang dam site under natural condition
Calculated from Table 6.1—2 the water level—runoff curve can be obtained concerning mean annual flow, maximum monthly flow and minimum monthly flow at Shihutang dam site, see Table 6.1—4. On the basis of design mean flow in typical years/months at Shihutang dam site concerning water level—flow curve, mean monthly water level is shown in Table 6.1—5.

### Table 6.1—4 Water level at Shihutang dam site under natural condition

<table>
<thead>
<tr>
<th>Item</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Whole year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean annual water level</td>
<td>47.61</td>
<td>48.09</td>
<td>48.99</td>
<td>49.82</td>
<td>50.20</td>
<td>50.66</td>
<td>49.04</td>
<td>48.80</td>
<td>48.55</td>
<td>48.04</td>
<td>47.72</td>
<td>47.51</td>
<td>48.90</td>
</tr>
<tr>
<td>Mean monthly high level</td>
<td>49.06</td>
<td>50.38</td>
<td>52.42</td>
<td>52.70</td>
<td>52.77</td>
<td>53.42</td>
<td>51.30</td>
<td>51.19</td>
<td>52.36</td>
<td>50.00</td>
<td>50.02</td>
<td>49.20</td>
<td>49.93</td>
</tr>
<tr>
<td>Mean monthly low level</td>
<td>46.67</td>
<td>46.65</td>
<td>46.96</td>
<td>47.41</td>
<td>47.45</td>
<td>48.22</td>
<td>47.44</td>
<td>47.08</td>
<td>46.96</td>
<td>46.70</td>
<td>46.83</td>
<td>46.65</td>
<td>47.48</td>
</tr>
</tbody>
</table>

### Table 6.1—5 Summary of Mean Monthly Water Level at Shihutang Dam Site

<table>
<thead>
<tr>
<th>Item</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Whole year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992〜93 (P=10%)</td>
<td>52.04</td>
<td>51.32</td>
<td>51.05</td>
<td>50.77</td>
<td>50.72</td>
<td>48.50</td>
<td>48.36</td>
<td>47.56</td>
<td>47.40</td>
<td>47.34</td>
<td>47.49</td>
<td>47.12</td>
<td>49.57</td>
</tr>
<tr>
<td>1982〜83 (P=25%)</td>
<td>49.18</td>
<td>49.18</td>
<td>50.40</td>
<td>50.81</td>
<td>49.03</td>
<td>48.49</td>
<td>48.15</td>
<td>47.75</td>
<td>48.34</td>
<td>48.43</td>
<td>48.96</td>
<td>50.03</td>
<td>49.16</td>
</tr>
<tr>
<td>1990〜91 (P=50%)</td>
<td>48.70</td>
<td>50.69</td>
<td>49.23</td>
<td>49.85</td>
<td>48.54</td>
<td>49.13</td>
<td>49.48</td>
<td>48.17</td>
<td>48.05</td>
<td>47.48</td>
<td>47.82</td>
<td>47.61</td>
<td>48.87</td>
</tr>
<tr>
<td>1966〜67 (P=75%)</td>
<td>47.61</td>
<td>49.29</td>
<td>48.95</td>
<td>51.37</td>
<td>49.14</td>
<td>47.81</td>
<td>47.32</td>
<td>47.46</td>
<td>47.19</td>
<td>47.21</td>
<td>47.03</td>
<td>48.01</td>
<td>48.46</td>
</tr>
<tr>
<td>1986〜87 (P=90%)</td>
<td>48.71</td>
<td>49.55</td>
<td>48.94</td>
<td>50.04</td>
<td>48.87</td>
<td>47.69</td>
<td>47.42</td>
<td>47.06</td>
<td>47.38</td>
<td>47.02</td>
<td>46.77</td>
<td>46.65</td>
<td>48.25</td>
</tr>
<tr>
<td>Average</td>
<td>49.54</td>
<td>50.09</td>
<td>49.80</td>
<td>50.69</td>
<td>49.33</td>
<td>48.37</td>
<td>48.26</td>
<td>47.63</td>
<td>47.72</td>
<td>47.56</td>
<td>47.75</td>
<td>48.16</td>
<td>48.90</td>
</tr>
<tr>
<td>Highest daily level</td>
<td>57.19</td>
<td>55.60</td>
<td>53.27</td>
<td>55.06</td>
<td>56.29</td>
<td>52.12</td>
<td>53.41</td>
<td>49.44</td>
<td>50.56</td>
<td>50.39</td>
<td>51.29</td>
<td>53.42</td>
<td>57.19</td>
</tr>
<tr>
<td>Years</td>
<td>High year</td>
<td>High year</td>
<td>High year</td>
<td>Low year</td>
<td>High year</td>
<td>Normal year</td>
<td>Normal year</td>
<td>Normal year</td>
<td>Wet year</td>
<td>Wet year</td>
<td>Wet year</td>
<td>Wet year</td>
<td>High year</td>
</tr>
<tr>
<td>Lowest daily level</td>
<td>46.88</td>
<td>47.78</td>
<td>47.35</td>
<td>48.24</td>
<td>47.43</td>
<td>47.12</td>
<td>46.75</td>
<td>46.62</td>
<td>46.93</td>
<td>46.81</td>
<td>46.67</td>
<td>46.50</td>
<td>46.50</td>
</tr>
<tr>
<td>Years</td>
<td>Low year</td>
<td>Low year</td>
<td>Low year</td>
<td>Low year</td>
<td>Normal year</td>
<td>Low year</td>
<td>Low year</td>
<td>Low year</td>
<td>Dry year</td>
<td>Dry year</td>
<td>Dry year</td>
<td>Dry year</td>
<td>Dry year</td>
</tr>
</tbody>
</table>

**Note:** the data is based on Yellow Sea base level.

From Table 6.1—4 it is clear that the average annual water level is 48.90m at Shihutang dam site, and the highest monthly water level reaches 50.66 m in June while the lowest level 47.51m occurs in December. The highest monthly water level is 53.42 m (in June 1959) and the minimum 49.06 m occurred in January 1998 and therefore the highest annual mean
variation amounts to 4.36 m. The lowest monthly water level is 48.22 m maximum (in June 1963), and the lowest level 46.65 m occurred in December 1958, thus mean monthly level varies by 1.57 m. The water level difference between the maximum highest water level and the minimum lowest minimum water level amounts to 6.77 m.

From Table 6.1-5 it can be seen that the average annual water level is 48.90m at Shihutang dam site under natural condition during the typical years, and the highest monthly average water level reaches 52.04 m that occurs in March of the wet years while the lowest monthly average water level 46.65 m occurs in the dry years in February, thus the difference between the highest monthly average water level and the lowest monthly average water level totals 5.39 m. The maximum daily average water level is 57.19 m in wet years in March 28 for the design typical years, while the lowest daily average level 46.50 m occurs on February 21st in the dry season, thus the difference between the highest mean daily water level and the lowest level is 10.69 m.

6.1.2 Load Prediction of Power System in Jiangxi Province
On the basis of the feasibility studies concerning the Shihutang Project, the said Project will supply power to the whole Jiangxi Province. Based upon the social and economic data and upon the power demand and supply data, a prediction is made concerning power demand and supply in the Province, that in design year of 2015 Jiangxi Province will demand a power supply totaling 845.9 × 108kW • h, and the largest electricity load totals 16859 MW. Taking into consideration the transmission loss and works load, it is estimated that power demand in Jiangxi Province will total 909 × 108kW • h, and the largest electricity load totals 18123 MW. On the basis of daily load in the said Province in summer and winter in 2005, the representative load curve is described as follows in Table 6.1-6 concerning load curve in 2015.

<table>
<thead>
<tr>
<th>Time</th>
<th>1 am</th>
<th>2 am</th>
<th>3 am</th>
<th>4 am</th>
<th>5 am</th>
<th>6 am</th>
<th>7 am</th>
<th>8 am</th>
<th>9 am</th>
<th>10 am</th>
<th>11 am</th>
<th>12 am</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>load %</td>
<td>75.9</td>
<td>72.5</td>
<td>69.5</td>
<td>67.0</td>
<td>65.4</td>
<td>64.9</td>
<td>66.7</td>
<td>64.7</td>
<td>70.2</td>
<td>76.2</td>
<td>81.2</td>
<td>86.2</td>
</tr>
<tr>
<td>MW</td>
<td>13755</td>
<td>13139</td>
<td>12595</td>
<td>12412</td>
<td>11852</td>
<td>11762</td>
<td>12088</td>
<td>11726</td>
<td>12722</td>
<td>13810</td>
<td>14716</td>
<td>15622</td>
</tr>
<tr>
<td>Winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>load %</td>
<td>59.2</td>
<td>58.2</td>
<td>57.5</td>
<td>57.2</td>
<td>58.3</td>
<td>60.9</td>
<td>69.8</td>
<td>77.2</td>
<td>77.1</td>
<td>79.0</td>
<td>83.1</td>
<td>79.6</td>
</tr>
<tr>
<td>MW</td>
<td>9120</td>
<td>8966</td>
<td>8858</td>
<td>8812</td>
<td>8981</td>
<td>9382</td>
<td>10753</td>
<td>11893</td>
<td>11877</td>
<td>12170</td>
<td>12802</td>
<td>12262</td>
</tr>
</tbody>
</table>

6.1.3 Brief Introduction to Wan’an Key Water Project & Taihe Key Water Project
The Shihutang Project is the third cascade control project in the middle reach of River Kan. The Wan’an Project (completed) and the Taihe Project (to be constructed) are both located in the upper reaches of the Shihutang Project, to produce certain impact upon the Shihutang Project.

6.1.3.1 Operation & Dispatching Model in Wan’an Project
(1) Operation & Management Principles
The Wan'an Project, as the largest hydropower station in Jiangxi Province, has such major functions as power generation, flood control, shipping and irrigation. It plays the role of peak load modulation, frequency modulation and emergency duty. The Project is under operation and management in such principles as: under the premise of safety operation, the Project shall play a full role in power generation, flood control, navigation and irrigation efficiency. To ensure the safe operation of the project, the Project shall give priority to safe flood discharge; in case of conflicts between flood discharge and other benefits, the project hub safety shall be placed at the first place.

(2) Authority of Operation & Dispatching

When the in-flow or out-flow is less than 4000 m³/s and the water level in the reservoir does not exceeded the operation water level, the project will be run in the mode of power generation and navigation, with the sluice gates under operation by the power plant; in case the in-flow or out-flow is more than 4000 m³/s the Project is under direct dispatching by the provincial flood control department, or if necessary, all the authority concerning operation of the said Project will be completely transferred to the said flood control department.

(3) Rule for Dispatching

In case the in-flow or out-flow is less than 4000 m³/s, the said Project will be run in the mode of power generation and navigation; in case the said flow exceeds 4000 m³/s, the said Project will be run in the mode of flood control.

1) Power generation & navigation operation mode

The Power generation mode in the Wan’an Project shall be performed in line with the Wan’an Key Project Scheduling Drawing (Figure 6.1.1 is for the final scale operation scheduling diagram and Figure 6.1.2 for the initial operation scheduling). From April to June the reservoir will have the highest water level at 88.11 m (final scale operation), or at 83.11 ~ 86.11 m (initial operation, determined by the provinces’ flood control department), to control the power plant to operate at natural in-coming flow. In case the in-coming flow exceeds the project’s maximum discharge capacity, the excess water will be discharged from the spillway. By the end of June the Project will work at the firm capacity to have full reservoir filling. When the reservoir filing reaches 98.11 m (final scale operation), or 94.11 m (early operation) the project will work under the natural flow. In case the in-coming flow is less than regulated flow, the project works under the firm capacity mode and the inadequate flow is under supply from the reservoir, until the reservoir falls to the dead water level by March. When the water level at the restriction is lower than the restricted water line, the project works under 80% of firm capacity. To meet the shipping requirements in the downstream, the project will arrange two units of 25 MW in the power plant for shipping load so that discharge shipping flow will total 130 m³/s.

2) Flood control model in early stage

In accordance with "Report of Flood Control Dispatching in Wan’an Hydraulic Power Plant in Early Stage" and with "Demonstration of Wan’an Reservoir Operation Mode", during the initial operation of the reservoir flood the control program is recommended as follows: during the flood season from April to June the normal operation water level shall be 86.11 m (to be determined by the provincial flood control department) and the flood control level shall be 91.71 m (under cascade control against 50-year-recurrence flood) by way of pre-discharge and despiking. In case of flood over 50-year-recurrence, the project will be run in the mode of dam protection, as follows:
A. Pre-discharge Mode
In case flow in Ji’an is less than 5000 m$^3$/s, the discharge shall be equal to in-flow, so that the project will work under normal water level at 86.11m.
In case flow in Ji’an exceeds or is equal to 5000 m$^3$/s, while the flood tends to rise higher, the reservoir undertakes pre-discharge at 1730 m$^3$/s (the added value after deduction of discharge flow from in-flow), to last a day, until the water level falls to 83.11m.
B. Impounding & Flood Peak Despiking
In case in-flow in Wan’an is more than or equal to 8800 m$^3$/s, the impounding will commence at a discharge of 8800 m$^3$/s.
In case in-flow in Wan’an is over 9550 m$^3$/s but less than 12000 m$^3$/s, the discharge will total 750 m$^3$/s.
In case in-flow in Wan’an is more than 12000 m$^3$/s, the discharge will reach 4000 m$^3$/s.
When the impounding water level reaches 91.71 m in Wan’an, the reservoir shall open all sluice gates for discharge; in case the in-flow is less than 8800 m$^3$/s, discharge shall total 8800 m$^3$/s until the storage water level drops to 86.11 m for normal operation.

C. Dam Protection Flood Control Mode
In case of over 50-year-recurrence flood (the storage water level reaches higher than design flood level and keeps rising), the reservoir shall be under full discharge for dam protection.

Final Scale Flood Control Mode
Up to now the Wan’an Project can not run under final scale, hence there is no study concerning its operation under the final scale. Such an operation shall proceed in line with the designed flood control drawings, which are drafted in accordance with the flood rising rate and the in-flow as basis to determine the storage in Wan’an. According to the flood control scheduling, in case of instantaneous storage, higher level of storage will be undertaken; in case of instantaneous discharge, lower discharge rate will be performed. In case of choice between storage and discharge, storage will be undertaken. When the storage level reaches the designed flood control level, scheduling shall be in line with the principle of dam safety operation (that is, flood control model).

The normal operation water level in Wan'an for early stage operation may be modified to 88.11 m, and the designed flood control water level to 98.11 m, so that the final scale control model will be undertaken in line with the despiking scheduling and dam protection scheduling.

6.1.3.2 Operation & Scheduling Mode in Taihe Project (to be constructed)
Taihe Project is mainly for power generation, to be complemented by navigation and irrigation, and other functions. The scheduling mode in Taihe Project in the design phase in accordance with the project properties is determined as follows:

As a daily regulation hydropower station, in addition to meet the need for shipping base flow, Taihe will be running to its own advantages. As a daily regulation hydropower station, Taihe will be under impact from the upstream cascade hydropower station Wan’an Project (a seasonal regulation hydropower station) in modes of operation. In one day, the aggregate water for Taihe is equal to discharged column from Wan’an Project plus the runoff in the reach. Under this project development tasks, Taihe will function for peak load modulation, frequency modulation and emergency service for Jiangxi Province power system.

Taihe Reservoir has neither flood control nor storage capacity, unable to control flood in the downstream. Flood control scheduling in Wan’an will be achieved at 20-year-recurrence flood to prevent flood from submerge of Wan’an, when the reservoir will be under operation of flood discharge capacity. In order to reduce losses from reservoir inundation and from reservoir resettlement, in case of 5-year-recurrence flood, pre-discharge will be undertaken, so that discharge will reach 10000 m$^3$/s before the in-flow flood reaches 10000 m$^3$/s, until the storage level drops to 67.0m. Taihe Project will function as an equalizing reservoir to satisfy the need
of base flow for navigation in the downstream (at 135 m$^3$/s, and corresponding output reaches 14 MW).

6.1.4 Water Regime in Shihutang
In the mainstream of the middle reaches of River Kan there will be four cascade development projects, of which Wan’an was completed in 1993 in line with the final scale and commenced operation in the very year. At present Wan’an is under operation of early stage storage level, while the three projects—Taihe, Shihutang and Xiajiang are currently in the early stage of preparation, to be built in the near future and scheduled to be completed by 2020. Under current conditions water regime for Shihutang Project takes the early stage operation level in Wan’an Project when the other three cascade projects have not yet been completed.

6.1.4.1 Current Flow

(1) Discharge process in normal years for Wan’an Project
In accordance with Wan’an operation and scheduling plan, with power generation and shipping scheduling methods, the mean seasonal discharge in Wan’an in typical years are listed in Table 6.1-7.

(2) Typical daily discharge process in Wan’an Project
Wan’an is of seasonal regulation (partial regulation), of limited regulatory capacity. Based on survey and from Table 6.1-7, it is known that Wan’an Project generally has three units for peak load modulation. Now the change in daily discharge in summer and winter in Wan’an is described on the basis of three or four generation sets under full load. The unit discharge capacity in Wan’an reaches 556 m$^3$/s, and hence the maximum discharge capacity for three and four generating units totals 1668 m$^3$/s and 2224 m$^3$/s respectively. Based on the typical daily load curve in 2015 in Jiangxi Power System, at 8-hour peak load modulation in Wan’an, when all the generating units concerned will work under full load at the maximum discharge. In case of no peak load modulation, there will be one unit under operation whose discharge base flow reaches 130 m$^3$/s. For detail of discharge process in Wan’an during summer and winter operation, see Table 6.1.8. From the table it is obvious that the minimum discharge in Wan’an in case of peak load modulation reaches 130 m$^3$/s and the maximum discharge totals 1668 m$^3$/s when the three units are involved in peak load modulation, when the flow variation reaches 1538 m$^3$/s; in case of peak load modulation from four units the maximum discharge totals 2224 m$^3$/s when the flow variation reaches 2094 m$^3$/s.
Table 6.1.7 Average In-flow & Discharge in Wan’an in Designed Normal Years

<table>
<thead>
<tr>
<th>Items</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early</td>
<td>Middle</td>
<td>Late</td>
<td>Early</td>
</tr>
<tr>
<td>In-flow (m³/s)</td>
<td>1420</td>
<td>522</td>
<td>603</td>
<td>2492</td>
</tr>
<tr>
<td>Discharge (m³/s)</td>
<td>848</td>
<td>848</td>
<td>848</td>
<td>2492</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Early</td>
<td>Middle</td>
<td>Late</td>
<td>Early</td>
</tr>
<tr>
<td>In-flow (m³/s)</td>
<td>1434</td>
<td>521</td>
<td>360</td>
<td>2021</td>
</tr>
<tr>
<td>Discharge (m³/s)</td>
<td>772</td>
<td>772</td>
<td>772</td>
<td>1098</td>
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<table>
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<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Early</td>
<td>Middle</td>
<td>Late</td>
<td>Early</td>
</tr>
<tr>
<td>In-flow (m³/s)</td>
<td>533</td>
<td>631</td>
<td>470</td>
<td>375</td>
</tr>
<tr>
<td>Discharge (m³/s)</td>
<td>583</td>
<td>583</td>
<td>497</td>
<td>497</td>
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</table>

Note: The table shows the calculation results of early stage operation under normal storage at 96m.

Table 6.1—8 Flow during Peak Load Modulation in Wan’an Project

<table>
<thead>
<tr>
<th>Time</th>
<th>1 am</th>
<th>2 am</th>
<th>3 am</th>
<th>4 am</th>
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<th>9 am</th>
<th>10 am</th>
<th>11 am</th>
<th>12 am</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>3 units</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
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<td>130</td>
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<td>130</td>
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<td>4 units</td>
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<td>130</td>
<td>130</td>
<td>130</td>
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<td>2224</td>
</tr>
<tr>
<td>Winter</td>
<td>3 units</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>1668</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>4 units</td>
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<td>130</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>2224</td>
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<table>
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<th>20 pm</th>
<th>21 pm</th>
<th>22 pm</th>
<th>23 pm</th>
<th>24 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>3 units</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>1668</td>
<td>1668</td>
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<td>1668</td>
<td>1668</td>
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<tr>
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<td>4 units</td>
<td>130</td>
<td>130</td>
<td>130</td>
<td>2224</td>
<td>2224</td>
<td>130</td>
<td>2224</td>
<td>2224</td>
<td>2224</td>
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<tr>
<td>Winter</td>
<td>3 units</td>
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<td>130</td>
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<td>1668</td>
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<tr>
<td></td>
<td>4 units</td>
<td>130</td>
<td>130</td>
<td>130</td>
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<td>2224</td>
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<td>2224</td>
<td>2224</td>
<td>130</td>
</tr>
</tbody>
</table>

Note: in the table the unit is m³/s.

(3) Runoff in design representative years at Shihutang dam site under current conditions
Wan’an Project was completed in 1993, with a certain storage capacity to control 84.3% of the
catchment area up to the Shihutang dam site; hence the runoff at Shihutang is subject to storage
in Wan’an reservoir. Under the current conditions the representative annual runoff at Shihutang
dam site is the runoff subject to impact from early stage operation in Wan’an reservoir. The
said runoff in Shihutang dam site will be the result of out-flow in Wan’an reservoir after
regulation therein plus the runoff from Wan’an to Shihutang. Runoff regulation is Wan’an is
calculated in seasons. For detail see Table 6.1.—9.
Table 6.1.—9 Annual runoff distribution at Shihutang dam site in design representative years

<table>
<thead>
<tr>
<th>Items</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Whole year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992-93 (P=10%)</td>
<td>4211</td>
<td>3335</td>
<td>3041</td>
<td>2743</td>
<td>2384</td>
<td>902</td>
<td>820</td>
<td>458</td>
<td>435</td>
<td>428</td>
<td>459</td>
<td>397</td>
<td>1640</td>
</tr>
<tr>
<td>1982-83 (P=25%)</td>
<td>1341</td>
<td>1343</td>
<td>2365</td>
<td>2778</td>
<td>977</td>
<td>854</td>
<td>787</td>
<td>736</td>
<td>807</td>
<td>868</td>
<td>1203</td>
<td>2029</td>
<td></td>
</tr>
<tr>
<td>1990-91 (P=50%)</td>
<td>1019</td>
<td>2658</td>
<td>1378</td>
<td>1866</td>
<td>940</td>
<td>1188</td>
<td>1389</td>
<td>713</td>
<td>668</td>
<td>561</td>
<td>582</td>
<td>569</td>
<td>1130</td>
</tr>
<tr>
<td>1966-67 (P=75%)</td>
<td>584</td>
<td>1423</td>
<td>1180</td>
<td>3400</td>
<td>1015</td>
<td>544</td>
<td>420</td>
<td>403</td>
<td>361</td>
<td>368</td>
<td>371</td>
<td>630</td>
<td>877</td>
</tr>
<tr>
<td>1986-87 (P=90%)</td>
<td>1027</td>
<td>1623</td>
<td>1178</td>
<td>2034</td>
<td>828</td>
<td>503</td>
<td>392</td>
<td>307</td>
<td>355</td>
<td>304</td>
<td>272</td>
<td>276</td>
<td>758</td>
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<tr>
<td>Mean flow</td>
<td>1611</td>
<td>2076</td>
<td>1828</td>
<td>2564</td>
<td>1229</td>
<td>798</td>
<td>761</td>
<td>523</td>
<td>525</td>
<td>506</td>
<td>577</td>
<td>780</td>
<td>1147</td>
</tr>
<tr>
<td>Max daily mean flow</td>
<td>13791</td>
<td>10122</td>
<td>5962</td>
<td>9032</td>
<td>10720</td>
<td>3392</td>
<td>5346</td>
<td>1463</td>
<td>2525</td>
<td>1967</td>
<td>2946</td>
<td>6181</td>
<td>13791</td>
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In years

<table>
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<th>Low year</th>
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<th>Wet year</th>
<th>Wet year</th>
<th>Wet year</th>
<th>Wet year</th>
<th>High year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min daily mean flow</td>
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<td>532</td>
<td>360</td>
<td>755</td>
<td>287</td>
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In years

<table>
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<th>Low year</th>
<th>Low year</th>
<th>Low year</th>
<th>Normal year</th>
<th>Normal year</th>
<th>Normal year</th>
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<th>Low year</th>
<th>Wet year</th>
<th>High year</th>
<th>Wet year</th>
</tr>
</thead>
</table>

Note: in the table the unit is m$^3$/s.

From Table 6.1-9 it is clear that under current conditions the annual mean flow at Shihutang dam site in the five representative design years reaches 1150 m$^3$/s, with the maximum monthly mean flow at 4211 m$^3$/s to occur in the wet years in March, identical to flow under the natural state. Minimum monthly average flow totals 272 m$^3$/s, to occur in dry years in January, an increase by 117 m$^3$/s if compared with the minimum monthly flow under natural state (at 155 m$^3$/s). Of the five design representative years, the maximum daily average flow reaches 13,791 m$^3$/s, to occur in wet years on March 28, identical to flow under the natural state. The minimum daily mean flow totals 208 m$^3$/s, to occur in the wet years in January 4, an increase by 84 m$^3$/s if compared with the minimum monthly flow under natural state (at 124 m$^3$/s). Owing to impact from early operation in Wan’an during storage, flow in dry seasons at Shihutang dam site increases a little than under natural state.

(4) Typical daily flow at Shihutang dam site under current conditions

The catchment area from Wan’an dam site to Shihutang dam site totals 6870 km$^2$. Analysis indicates that the annual mean runoff from Wan’an to Shihutang dam site reaches 198 m$^3$/s, and at the assurance rate of 90% the sectional flow is only 31.5 m$^3$/s, or 53.9 m$^3$/s at the assurance rate of 75%. Under the current conditions the typical daily flow at Shihutang dam site is of the discharge from the Wan’an Project plus the flow between the reach. In summer and winter Wan’an Project is of seasonal peak load modulation power plant. Analysis shows that there is limited flow in Wan’an during peak load modulation, to be exact; the flow reaches 53.9 m$^3$/s in summer at an assurance rate of 75%, and 31.5 m$^3$/s in winter at a assurance rate of 90%. During non-flood season in Wan’an with three or four generating units in operation the representative mean daily flow at Shihutang dam site is listed in Table 6.1—10.
Table 6.1—10 Representative mean daily flow at Shihutang dam site

<table>
<thead>
<tr>
<th>Time</th>
<th>1 am</th>
<th>2 am</th>
<th>3 am</th>
<th>4 am</th>
<th>5 am</th>
<th>6 am</th>
<th>7 am</th>
<th>8 am</th>
<th>9 am</th>
<th>10 am</th>
<th>11 am</th>
<th>12 am</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>184</td>
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</tbody>
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<table>
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<th>15 pm</th>
<th>16 pm</th>
<th>17 pm</th>
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<th>21 pm</th>
<th>22 pm</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>184</td>
<td>184</td>
<td>184</td>
<td>184</td>
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</tr>
<tr>
<td>Winter</td>
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<td>2256</td>
<td>2256</td>
<td>2256</td>
<td>162</td>
</tr>
</tbody>
</table>

Note: in the table the unit is m³/s.

6.1.4.2 Water level at Shihutang dam site

(1) Annual level for design representative years at Shihutang dam site
From Table 6.1-9 on the basis of the representative years’ average monthly flow and the maximum and the minimum mean daily flow in the five design years, the water level—flow curve can be obtained, hence the representative years’ average monthly flow, the maximum and the minimum mean daily flow in the five design years are listed in Table 6.1-11.

From Table 6.1-11 it is obvious that annual mean water level at Shihutang dam site reaches 48.90 m, with the highest monthly mean level at 52.04 m in March of the wet years, identical to the condition under natural state. The minimum monthly mean water level is 47.09 m, to occur in January, an increase by 0.44m if compared with the level under natural condition. The water level difference between the highest level and the lowest reaches 4.95m, a drop by 0.44m if compared with the level under natural condition. The highest mean daily water level reaches 57.19 m to occur in wet years on March 28, identical to the condition under natural state. The lowest mean daily level is 46.87 m to occur on August 9 of design normal years and on January 4 of wet years, an increase by 0.37m if compared with the lowest water level (46.50m) under
natural state. Water level variation between the highest mean daily level and the lowest amounts to 10.69 m, narrowed by 0.37 m.
6.0 Environment Impact Assessment

Table 6.1-11 Summary of annual water level at Shihutang dam site

<table>
<thead>
<tr>
<th>Items</th>
<th align="right">Mar</th>
<th align="right">Apr</th>
<th align="right">May</th>
<th align="right">June</th>
<th align="right">July</th>
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<th align="right">Oct</th>
<th align="right">Nov</th>
<th align="right">Dec</th>
<th align="right">Jan</th>
<th align="right">Feb</th>
<th>Whole year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992:93 (P=10%)</td>
<td align="right">52.04</td>
<td align="right">51.32</td>
<td align="right">51.05</td>
<td align="right">50.77</td>
<td align="right">50.42</td>
<td align="right">48.50</td>
<td align="right">48.36</td>
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<td align="right">47.53</td>
<td align="right">47.61</td>
<td align="right">47.45</td>
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</tr>
<tr>
<td>1982:83 (P=25%)</td>
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<td align="right">49.18</td>
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<td align="right">50.81</td>
<td align="right">48.63</td>
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<td align="right">48.98</td>
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</tr>
<tr>
<td>1990:91 (P=50%)</td>
<td align="right">48.70</td>
<td align="right">50.69</td>
<td align="right">49.23</td>
<td align="right">49.85</td>
<td align="right">48.57</td>
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<td align="right">47.90</td>
<td align="right">47.87</td>
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</tr>
<tr>
<td>1966:67 (P=75%)</td>
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<td align="right">48.95</td>
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<td align="right">48.69</td>
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<td align="right">47.38</td>
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</tr>
<tr>
<td>1986:87 (P=90%)</td>
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<th>High year</th>
<th>High year</th>
<th>Low year</th>
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<th>Wet year</th>
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<th>Low year</th>
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<th>Low year</th>
<th>Wet year</th>
<th>High year</th>
<th>Wet year</th>
</tr>
</thead>
</table>

Note: the figures are based on Yellow Sea base level.

(2) Daily water level process at Shihutang dam site

Table 6.1-10 indicates that under current conditions the typical daily flow is based upon the water level—flow curve at Shihutang dam site, to conclude that in summer and winter when the Wan’an Hydropower Station has 3 and 4 units under operation for peak load modulation for Jiangxi Power System under full load, the daily water level at Shihutang dam site in summer and winter is listed in Table 6.1-12.

From Table 6.1-12 of the typical daily water level at Shihutang dam site it is known that in summer when Wan’an Hydropower Station uses three units for peak load modulation, the highest daily level reaches 49.67 m and the lowest level amounts to 46.77 m, at a daily variation of 2.90 m. In summer when four units are in operation in Wan’an the highest water level totals 50.31 m and the lowest level amounts to 46.77 m, at a variation of 3.54 m. In winter when Wan’an Hydropower Station has three units for peak load modulation, the highest daily level reaches 49.65 m and the lowest level amounts to 46.68 m, at a daily variation of 2.97 m. In case of four units under operation for peak load modulation, the highest level reaches 50.25 m and the lowest level is 46.68 m, at a variation of 3.60 m.
### Table 6.1—12 Typical daily water level at Shihutang dam site under current condition

<table>
<thead>
<tr>
<th>Time</th>
<th>1 am</th>
<th>2 am</th>
<th>3 am</th>
<th>4 am</th>
<th>5 am</th>
<th>6 am</th>
<th>7 am</th>
<th>8 am</th>
<th>9 am</th>
<th>10 am</th>
<th>11 am</th>
<th>12 am</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
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<tr>
<td></td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>46.77</td>
<td>50.31</td>
<td>50.31</td>
<td>50.31</td>
</tr>
<tr>
<td></td>
<td>46.68</td>
<td>46.68</td>
<td>46.68</td>
<td>46.68</td>
<td>46.68</td>
<td>46.68</td>
<td>46.68</td>
<td>46.68</td>
<td>46.68</td>
<td>49.65</td>
<td>49.65</td>
<td>49.65</td>
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<tr>
<td></td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
<td>49.67</td>
</tr>
</tbody>
</table>

#### 6.1.5 Water regime in upper stream & downstream after completion of the Project

#### 6.1.5.1 Project operation & scheduling at Shihutang Project

(1) Operation & dispatching principles

Shihutang Project is a comprehensive hub mainly for shipping, to be complemented from power generation. After the hub completion, in dry seasons the water level in the upper stream will be elevated due to the dam, thus to deepen the water level in the upper stream and improve navigation conditions. During non-flood seasons the stream fall will be utilized for power generation, to narrow the gap between power supply and power demand in Jiangxi Province. During the flood season greatest attention will be paid to the dam safety and to reduction of inundation losses, to try to minimize elevation of water level in the upper stream. Hence the principle for Shihutang Project operation is that under the premise of safety for the dam and for flood control in the upper stream and satisfaction to navigation, as much power will be generated as possible, in which case dispatching will ensure that water level remains at a high level to make full use of water resources to obtain the highest benefits.
(2) Dispatching mode
Flood control scheduling in Shihutang will take in-flow as indicator for flood control, namely flood control will be based upon in-flow to decide the open/close state of discharge sluices and irrigation gates. In case the in-flow is over or equal to the critical flow at the sluice gates, flood control mode will commence, otherwise the Project will run in power generation mode. Specific scheduling for the operating mode is that when flow at Dongbei Station is over or equal to the critical flow (4330 m$^3$/s, corresponding to 4700 m$^3$/s at Shihutang dam site) and the floods are still rising while the irrigation water flow at Guanyuan is less than the critical flow (70.0 m$^3$/s), the regulating lock at Guanyuan will be closed (meanwhile the divergence and drainage locks will be opened). Shihutang will open all the sluice gates for full discharge to lower water level in front of the dam. When the flow at Dongbei Station and Guanyuan is greater than or equal to the critical flow and the flood is still rising, or when flow at Dongbei Station is less than the critical flow but the flow at Guanyuan is more than the critical flow and the flood keeps rising, all the discharge gates in Shihutang and in Guanyuan will be opened (meanwhile the divergence and drainage locks in Guanyuan will be closed), to minimize elevation of water level in the upper stream and to reduce inundation losses. In case the flow at Dongbei and Guanyuan is less than the critical flow, the discharge sluice in Guanyuan will be closed (meanwhile the divergence and drainage locks will be opened), and the Shihutang discharge locks will be closed or partially opened, so that water level in front of the dam will maintain between normal storage (56.5m) and dead level (56.2m), to deepen navigation channels in the upper stream and improve navigation conditions. Power will be generated by use of the stream fall to relieve the tense condition of power supply in Jiangxi Province. During the low seasons power generation in River Kan Shihutang will be synchronous with Wan’an Hydropower Station to make full use of water resources.

Considering downstream shipping, this hub base flow for navigation will reach 187 m$^3$/s; corresponding output will total 15 MW. In engineering design six turbine generating units will be employed, each with an installed capacity of 19.5 kW and rated flow capacity at 420 m$^3$/s. The said units can work under 30% of rated flow (126 m$^3$/s).

6.1.5.2 Water regime in the upper stream of Shihutang dam site
(1) Annual runoff & typical daily flow in the upper reach
In the upper stream of Shihutang dam site and downstream of Taihe Project there are three tributaries into the reservoir area, of which River Guanyuan has a catchment area of 3084 km$^2$ with annual mean flow at about 89.4 m$^3$/s; River Yunting has a catchment area of 763 km$^2$ with annual mean flow at about 22.1 m$^3$/s; River Shu has a catchment area totaling 1305 km$^2$ with average annual flow at about 37.8 m$^3$/s. the annual mean in-flow from the three tributaries amounts to 76.1 m$^3$/s. navigation base flow in Wan’an reaches about 130 m$^3$/s, in Taihe about 135 m$^3$/s. Completion of the Shihutang Project will not change the water regime in the upper stream, hence the annual mean runoff and daily mean flow at Shihutang dam site remains the same after operation of the project. See Table 6.1—9 and Table 6.1—10.

(2) Annual water level & daily water level at Shihutang dam site
In line with operation scheduling in Shihutang Project, during the flood seasons the reservoir will be under natural operation (flow at the dam site exceeds 4700 m$^3$/s), hence in the upstream there is limited elevation of water level. But during non-flood seasons(flow at the dam site is less than 4700 m$^3$/s), the sluice gates shall be closed which will elevate water level in the upper stream and will canalize fairways in the upper stream and thus to improve navigation conditions. Meanwhile the elevated water level will be utilized for power generation, to relieve power shortage in Jiangxi Province. In accordance with the Shihutang scheduling mode, on the
basis of five representative year’s runoff, the typical water level in Shihutang is listed in Table 6.1-13. In summer and winter when the Wan’an Hydropower Station has three or four generating units for peak load modulation and Shihutang Project has four or five units for synchronous peak load modulation, the typical water level in upper stream of Shihutang, on the basis of representative daily runoff, is shown in Table 6.1—14.

Table 6.1—13 Summary of design representative years’ water level in upper stream after completion of Shihutang Project

<table>
<thead>
<tr>
<th>Items</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Whole year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992:93 (P=10%)</td>
<td>56.06</td>
<td>56.06</td>
<td>55.85</td>
<td>55.97</td>
<td>55.68</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>56.17</td>
<td></td>
</tr>
<tr>
<td>1992:83 (P=25%)</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>55.36</td>
<td>56.12</td>
<td>56.12</td>
<td>56.35</td>
<td>56.35</td>
<td>56.10</td>
<td>56.35</td>
<td>56.35</td>
<td>55.96</td>
<td>56.20</td>
</tr>
<tr>
<td>1990:91 (P=50%)</td>
<td>56.14</td>
<td>55.85</td>
<td>56.35</td>
<td>56.13</td>
<td>55.95</td>
<td>55.90</td>
<td>56.03</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>56.17</td>
<td></td>
</tr>
<tr>
<td>1996:67 (P=75%)</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>55.81</td>
<td>56.16</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>56.35</td>
<td>56.29</td>
<td></td>
</tr>
<tr>
<td>1996:87 (P=90%)</td>
<td>56.23</td>
<td>56.23</td>
<td>56.35</td>
<td>55.94</td>
<td>55.34</td>
<td>56.35</td>
<td>56.35</td>
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<td>56.35</td>
<td>56.35</td>
<td>56.21</td>
<td></td>
</tr>
<tr>
<td>Mean level</td>
<td>56.23</td>
<td>56.17</td>
<td>56.25</td>
<td>55.84</td>
<td>55.90</td>
<td>56.21</td>
<td>56.29</td>
<td>56.35</td>
<td>56.30</td>
<td>56.35</td>
<td>56.35</td>
<td>56.27</td>
<td>56.21</td>
</tr>
<tr>
<td>Max daily level</td>
<td>57.31</td>
<td>56.50</td>
<td>56.50</td>
<td>56.50</td>
<td>56.50</td>
<td>56.50</td>
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<td>56.50</td>
<td>56.50</td>
<td>56.50</td>
<td>57.31</td>
</tr>
<tr>
<td>in years</td>
<td>high year</td>
<td>Every year</td>
<td>Every year</td>
<td>Every year</td>
<td>Every year</td>
<td>Every year</td>
<td>Every year</td>
<td>Every year</td>
<td>Every year</td>
<td>Every year</td>
<td>Every year</td>
<td>high year</td>
<td></td>
</tr>
<tr>
<td>Min daily level</td>
<td>49.71</td>
<td>50.67</td>
<td>51.27</td>
<td>49.78</td>
<td>48.39</td>
<td>48.48</td>
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<td>56.20</td>
<td>51.25</td>
<td>48.39</td>
</tr>
<tr>
<td>in years</td>
<td>Normal year</td>
<td>Normal high year</td>
<td>Normal Low year</td>
<td>Normal Low year</td>
<td>Normal Normal year</td>
<td>Normal Wet year</td>
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<td>Normal Wet year</td>
<td>Normal Wet year</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: the figures are in meters.
Table 6.1—14 Representative daily water level in upper stream after completion of Shihutang Project

<table>
<thead>
<tr>
<th>Time</th>
<th>1 am</th>
<th>2 am</th>
<th>3 am</th>
<th>4 am</th>
<th>5 am</th>
<th>6 am</th>
<th>7 am</th>
<th>8 am</th>
<th>9 am</th>
<th>10 am</th>
<th>11 am</th>
<th>12 am</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 units in Wan’an &amp; 4 in Shihutang for peak load modulation</td>
<td>56.50</td>
<td>56.50</td>
<td>56.49</td>
<td>56.49</td>
<td>56.49</td>
<td>56.49</td>
<td>56.48</td>
<td>56.48</td>
<td>56.48</td>
<td>56.47</td>
<td>56.47</td>
<td>56.48</td>
</tr>
<tr>
<td>4 units in Wan’an &amp; 5 in Shihutang for peak load modulation</td>
<td>56.50</td>
<td>56.49</td>
<td>56.48</td>
<td>56.46</td>
<td>56.45</td>
<td>56.44</td>
<td>56.43</td>
<td>56.42</td>
<td>56.41</td>
<td>56.39</td>
<td>56.38</td>
<td>56.40</td>
</tr>
<tr>
<td>Winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 units in Wan’an &amp; 4 in Shihutang for peak load modulation</td>
<td>56.50</td>
<td>56.50</td>
<td>56.49</td>
<td>56.49</td>
<td>56.49</td>
<td>56.48</td>
<td>56.48</td>
<td>56.48</td>
<td>56.47</td>
<td>56.47</td>
<td>56.47</td>
<td>56.47</td>
</tr>
<tr>
<td>4 units in Wan’an &amp; 5 in Shihutang for peak load modulation</td>
<td>56.50</td>
<td>56.49</td>
<td>56.48</td>
<td>56.46</td>
<td>56.45</td>
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<td>56.40</td>
<td>56.39</td>
<td>56.38</td>
<td>56.40</td>
</tr>
</tbody>
</table>

Note: the water level is based on Yellow Sea base level.

From Table 6.1-13 it is known that in Shihutang Project in the upstream in the five design representative years the annual average water level is 56.21 m and the highest monthly average water level reaches 56.35 m, while the lowest monthly mean level is 55.84 m, so the level variation (the highest mean monthly level minus the lowest mean monthly level) is 0.51 m. Of the five design representative years the highest mean daily water level is 57.31 m in wet years on 28 while the lowest mean daily level is 48.39 m to occur in dry years on July 3, hence the variation (the highest mean daily level minus the lowest mean daily level) reaches 8.92 m. The highest and the lowest mean daily level occur in Shihutang when the project is under full open sluice gates for sand flushing.

From Table 6.1-14 it is clear that in summer in case of three units in Wan’an and four units in Shihutang in synchronous operation for peak load modulation for Jiangxi Power System,
6.0 Environment Impact Assessment

during the typical non-flood period on the upper stream the highest level goes to 56.50 m and
the lowest level is 56.47 m, at a daily variation of only 0.03 m; in summer in case of four units
in Wan’an and five units in Shihutang in synchronous operation for peak load modulation for
Jiangxi Power System, during the typical non-flood period on the upper stream the highest
level reaches 56.50 m, and the lowest water level is 56.36 m, at a daily variation of only 0.14
m. In winter in case of three units in Wan’an and four units in Shihutang in synchronous
operation for peak load modulation for Jiangxi Power System, during the typical non-flood
period on the upper stream the highest level goes to 56.50 m and the lowest level is 56.46 m, at
a daily variation of only 0.04 m; in winter in case of four units in Wan’an and five units in
Shihutang in synchronous operation for peak load modulation for Jiangxi Power System,
during the typical non-flood period on the upper stream the highest level reaches 56.50 m, and
the lowest water level is 56.36 m, at a daily variation of only 0.14 m.

6.1.5.3 Water regime in downstream of Shihutang dam site

Design representative years’ runoff & water level at Shihutang dam site

Between Shihutang dam site downstream and Ji’an City there are two tributaries flowing into
the reservoir area, of which River He has a catchment area 9058 km², with mean annual flow at
about 262 m³/s; River Gu has a catchment area of 3084 km² with mean annual flow at 89.4
m³/s. the two tributaries contribute mean annual flow to River Kan at about 351.4 m³/s. The
Shihutang Project has a base navigation flow at 187 m³/s. As this project is runoff
development, there is limited effective storage, to produce almost no regulation upon the
runoff. Analysis shows that it will take about 2 hours for the discharge from Wan’an to reach
Shihutang dam, thus there will be no peak load modulation for Jiangxi Power System unless
Wan’an is operated synchronously with Shihutang Project. In other words, Shihutang generates
electricity on the basis of the discharged flow from Wan’an plus runoff between the two
projects. To ensure that in Shihutang Project the discharged base flow for navigation is
equivalent to 187 m³/s, the balance shall be achieved by water from the Shihutang reservoir
(76.1 m³/s) when flow from Wan’an (130 m³/s) is not enough to meet the need for base
navigation flow. Therefore, at Shihutang downstream the design representative years’ mean
annual flow and mean monthly flow and mean annual/monthly water level is identical to the
annual runoff and water level under current conditions. See Table 6.1-9 and Table 6.1-11.

(2) Typical daily flow & water level at Shihutang dam site downstream

Shihutang Project is different from Wan’an in base shipping flow and installed generating
units, therefore in case of peak load modulation and guarantee of downstream shipping
requirements, Shihutang differs from Wan’an in daily distribution of power generation.
Through analysis of operation in summer and winter in case of three units for peak load
modulation in Wan’an and four units in Shihutang under full load, or four units in Wan’an and
five units in Shihutang concerning typical daily runoff, the results is shown in Table 6.1-15 and
Table 6.1-16 concerning daily runoff and water level in downstream Shihutang dam.
### Table 6.1—15 Typical daily flow at downstream Shihutang dam site after completion of the project

<table>
<thead>
<tr>
<th>Time</th>
<th>1 am</th>
<th>2 am</th>
<th>3 am</th>
<th>4 am</th>
<th>5 am</th>
<th>6 am</th>
<th>7 am</th>
<th>8 am</th>
<th>9 am</th>
<th>10 am</th>
<th>11 am</th>
<th>12 am</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer</strong></td>
<td>206</td>
<td>206</td>
<td>206</td>
<td>206</td>
<td>206</td>
<td>206</td>
<td>206</td>
<td>206</td>
<td>206</td>
<td>206</td>
<td>206</td>
<td>1680</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
<td>279</td>
<td>279</td>
<td>279</td>
<td>279</td>
<td>279</td>
<td>279</td>
<td>279</td>
<td>279</td>
<td>279</td>
<td>279</td>
<td>279</td>
<td>2100</td>
</tr>
</tbody>
</table>

3 units in Wan’an & 4 in Shihutang for peak load modulation  
4 units in Wan’an & 5 in Shihutang for peak load modulation

<table>
<thead>
<tr>
<th>Time</th>
<th>13 pm</th>
<th>14 pm</th>
<th>15 pm</th>
<th>16 pm</th>
<th>17 pm</th>
<th>18 pm</th>
<th>19 pm</th>
<th>20 pm</th>
<th>21 pm</th>
<th>22 pm</th>
<th>23 pm</th>
<th>24 pm</th>
</tr>
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<tbody>
<tr>
<td><strong>Summer</strong></td>
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<td>206</td>
<td>206</td>
<td>3680</td>
<td>3680</td>
<td>206</td>
<td>3680</td>
<td>3680</td>
<td>3680</td>
<td>3680</td>
<td>3680</td>
<td>3680</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
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<td>279</td>
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<td>2100</td>
<td>2100</td>
<td>2100</td>
<td>2100</td>
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<td>2100</td>
</tr>
</tbody>
</table>

3 units in Wan’an & 4 in Shihutang for peak load modulation  
4 units in Wan’an & 5 in Shihutang for peak load modulation

<table>
<thead>
<tr>
<th>Time</th>
<th>13 pm</th>
<th>14 pm</th>
<th>15 pm</th>
<th>16 pm</th>
<th>17 pm</th>
<th>18 pm</th>
<th>19 pm</th>
<th>20 pm</th>
<th>21 pm</th>
<th>22 pm</th>
<th>23 pm</th>
<th>24 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer</strong></td>
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<td>187</td>
<td>187</td>
<td>1658</td>
<td>1658</td>
<td>1658</td>
<td>1658</td>
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<td>1658</td>
<td>1658</td>
<td>1658</td>
<td>187</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
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<td>257</td>
<td>257</td>
<td>257</td>
<td>257</td>
<td>257</td>
<td>257</td>
<td>257</td>
<td>257</td>
<td>257</td>
<td>257</td>
<td>257</td>
</tr>
</tbody>
</table>

3 units in Wan’an & 4 in Shihutang for peak load modulation  
4 units in Wan’an & 5 in Shihutang for peak load modulation

Note: the unit is m³/s.
<table>
<thead>
<tr>
<th>Time</th>
<th>1 am</th>
<th>2 am</th>
<th>3 am</th>
<th>4 am</th>
<th>5 am</th>
<th>6 am</th>
<th>7 am</th>
<th>8 am</th>
<th>9 am</th>
<th>10 am</th>
<th>11 am</th>
<th>12 am</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer</strong></td>
<td>46.86</td>
<td>46.86</td>
<td>46.86</td>
<td>46.86</td>
<td>46.86</td>
<td>46.86</td>
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<td>46.86</td>
<td>47.11</td>
<td>47.11</td>
<td>47.11</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
<td>47.11</td>
<td>47.11</td>
<td>47.11</td>
<td>47.11</td>
<td>47.11</td>
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</tr>
<tr>
<td><strong>Summer</strong></td>
<td>46.78</td>
<td>46.78</td>
<td>46.78</td>
<td>46.78</td>
<td>46.78</td>
<td>46.78</td>
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<td>46.78</td>
<td>47.04</td>
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<td>47.04</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
<td>47.04</td>
<td>47.04</td>
<td>47.04</td>
<td>47.04</td>
<td>47.04</td>
<td>47.04</td>
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<td>47.04</td>
<td>47.04</td>
<td>47.04</td>
<td>50.11</td>
<td>47.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>14 pm</th>
<th>15 pm</th>
<th>16 pm</th>
<th>17 pm</th>
<th>18 pm</th>
<th>19 pm</th>
<th>20 pm</th>
<th>21 pm</th>
<th>22 pm</th>
<th>23 pm</th>
<th>24 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer</strong></td>
<td>46.86</td>
<td>46.86</td>
<td>46.86</td>
<td>46.86</td>
<td>49.62</td>
<td>49.62</td>
<td>46.86</td>
<td>49.62</td>
<td>49.62</td>
<td>49.62</td>
<td>49.62</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
<td>47.11</td>
<td>47.11</td>
<td>47.11</td>
<td>50.11</td>
<td>50.11</td>
<td>47.11</td>
<td>50.11</td>
<td>50.11</td>
<td>50.11</td>
<td>50.11</td>
<td>50.11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>14 pm</th>
<th>15 pm</th>
<th>16 pm</th>
<th>17 pm</th>
<th>18 pm</th>
<th>19 pm</th>
<th>20 pm</th>
<th>21 pm</th>
<th>22 pm</th>
<th>23 pm</th>
<th>24 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer</strong></td>
<td>46.78</td>
<td>46.78</td>
<td>49.59</td>
<td>49.59</td>
<td>49.59</td>
<td>49.59</td>
<td>49.59</td>
<td>46.78</td>
<td>46.78</td>
<td>46.78</td>
<td>46.78</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
<td>47.04</td>
<td>47.04</td>
<td>50.11</td>
<td>50.11</td>
<td>50.11</td>
<td>50.11</td>
<td>50.11</td>
<td>47.04</td>
<td>47.04</td>
<td>47.04</td>
<td>47.04</td>
</tr>
</tbody>
</table>

**Note:** The water level is based on Yellow Sea base level.

From Table 6.1-15 it is known that in summer in case there are three units in Wan’an for peak load modulation and four units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical maximum daily flow reaches 1680 m³/s, and the minimum flow is 206 m³/s; in summer in case there are four units in Wan’an for peak load modulation and five units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical maximum daily flow downstream reaches 2100 m³/s, and the minimum flow is 279 m³/s. In winter in case there are three units in Wan’an for peak load modulation and four units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical maximum daily flow in downstream reaches 1658 m³/s, and the minimum flow is 187 m³/s; In winter in case there are four units in Wan’an for peak load modulation and five units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical maximum daily flow in downstream reaches 2100 m³/s, and the minimum flow is 257 m³/s.
From Table 6.1-16 it is known that in summer in case there are three units in Wan’an for peak load modulation and four units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical highest daily water level reaches 49.62m, and the lowest level is 46.86; in summer in case there are four units in Wan’an for peak load modulation and five units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical highest water level reaches 50.11m, and the lowest level is 47.11m. In winter in case there are three units in Wan’an for peak load modulation and four units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical highest daily water level reaches 49.59m, and the lowest level is 46.78; in winter in case there are four units in Wan’an for peak load modulation and five units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical highest water level reaches 50.11m, and the lowest level is 47.04m.

6.1.6 Change in water regime after completion of the project

6.1.6.1 Change in water regime in upper stream after completion of the project

(1) Change in upper stream flow after completion of the project
Any water-control project can not change the upper stream runoff allocation, so is the Shihutang Project, which, when completed, will have the same upstream runoff as it is at present. In other words, there is no change in the upper stream flow after completion of the project.

(2) Change in upper stream water level after completion of the project
As the Shihutang Project will construct in the main stream of River Kan a river dam for storage during non-flood seasons for effective storage, thus the water level will be under elevation after completion of the Shihutang project.

Change in upper stream water level during flood seasons
During the flood seasons the banked-up water level at Shihutang dam site before completion of the project is listed in Table 6.1-17; Table 6.1—18 shows the change in banked-up water level after completion of the project.

Table 6.1—17 Banked-up water level before completion of Shihutang Project during flood seasons
<table>
<thead>
<tr>
<th>Items</th>
<th>Unit</th>
<th>P=0.33%</th>
<th>P=0.5%</th>
<th>P=1%</th>
<th>P=2%</th>
<th>P=3.3%</th>
<th>P=5%</th>
<th>P=10%</th>
<th>P=20%</th>
<th>P=50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design peak discharge</td>
<td>m³/s</td>
<td>23620</td>
<td>22670</td>
<td>20890</td>
<td>19240</td>
<td>18400</td>
<td>16990</td>
<td>14750</td>
<td>11420</td>
<td>8720</td>
</tr>
<tr>
<td>Water level downstream</td>
<td>m</td>
<td>60.54</td>
<td>60.25</td>
<td>59.70</td>
<td>59.16</td>
<td>58.88</td>
<td>58.39</td>
<td>57.56</td>
<td>56.19</td>
<td>54.89</td>
</tr>
<tr>
<td>Dam water level</td>
<td>m</td>
<td>60.65</td>
<td>60.39</td>
<td>59.82</td>
<td>59.34</td>
<td>59.04</td>
<td>58.53</td>
<td>57.64</td>
<td>56.27</td>
<td>54.96</td>
</tr>
<tr>
<td>Max. discharge</td>
<td>m³/s</td>
<td>23120</td>
<td>22300</td>
<td>20560</td>
<td>19140</td>
<td>18300</td>
<td>16870</td>
<td>14550</td>
<td>11330</td>
<td>8680</td>
</tr>
<tr>
<td>Corresponding downstream level</td>
<td>m</td>
<td>60.39</td>
<td>60.14</td>
<td>59.59</td>
<td>59.13</td>
<td>58.84</td>
<td>58.34</td>
<td>57.48</td>
<td>56.15</td>
<td>54.87</td>
</tr>
<tr>
<td>Water head between upper stream &amp; downstream</td>
<td>m</td>
<td>0.26</td>
<td>0.24</td>
<td>0.23</td>
<td>0.21</td>
<td>0.20</td>
<td>0.19</td>
<td>0.16</td>
<td>0.12</td>
<td>0.09</td>
</tr>
<tr>
<td>Banked-up level</td>
<td>m</td>
<td>0.11</td>
<td>0.13</td>
<td>0.12</td>
<td>0.18</td>
<td>0.16</td>
<td>0.14</td>
<td>0.08</td>
<td>0.08</td>
<td>0.07</td>
</tr>
<tr>
<td>Notes</td>
<td></td>
<td>Gradual consideration of protected zones</td>
<td>No consideration of protected zones</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table is based on storage impact from Wan’an Project during its early operation and in line with the 1968 design flood process in Shihutang dam site after flood routing.

Table 6.1—18 Results of water surface line in River Kan during flood seasons in Shihutang Project

<table>
<thead>
<tr>
<th>Section No.</th>
<th>Location</th>
<th>Distance from dam site (km)</th>
<th>Design water level (Yellow Sea base level)/m</th>
<th>Water surface line now</th>
<th>Water surface line after project completion (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P=5%</td>
<td>P=10%</td>
</tr>
<tr>
<td>Upper dam</td>
<td>Jiangjiaou</td>
<td>0.00</td>
<td>58.39</td>
<td>57.56</td>
<td>54.89</td>
</tr>
<tr>
<td></td>
<td>Shigan</td>
<td>2.04</td>
<td>58.69</td>
<td>57.86</td>
<td>55.22</td>
</tr>
</tbody>
</table>
In accordance with Shihutang operation and scheduling rules, in the flood period (the upstream in-flow is greater than or equivalent to critical flow), Shihutang will have all the flood gates opened for flushing and discharge, to try to avoid banked-up water level in the upper stream, thus there is limited elevation of water level during flood seasons. Flood routing shows that during flood seasons after completion of Shihutang Project in case of $P = 50\%$ or $P = 0.33\%$, banked-up water level before the Shihutang dam is only 0.07m to 0.18 m, very limited. After comparison of the water surface line before the Shihutang Project and after completion of the Project, there is not much change in elevation of water level.

From Table 6.1-18 it is known that in case of flood $P = 50\%$ to $P = 5\%$ the elevated water level ranges from 0.05m to 0.24 m.

□ Change in water level in upper stream in Shihutang dam site during non-flood seasons
For detail of elevated water level in the upper stream after completion of the project see Table 6.1—19.

<table>
<thead>
<tr>
<th>Item</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Whole</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992/1993 (P=10%)</td>
<td>4.02</td>
<td>4.74</td>
<td>4.80</td>
<td>5.20</td>
<td>5.26</td>
<td>7.85</td>
<td>7.99</td>
<td>8.74</td>
<td>8.80</td>
<td>8.82</td>
<td>8.74</td>
<td>8.90</td>
<td>6.60</td>
</tr>
<tr>
<td>1982/1983 (P=25%)</td>
<td>7.17</td>
<td>7.17</td>
<td>5.95</td>
<td>4.55</td>
<td>7.72</td>
<td>7.70</td>
<td>8.05</td>
<td>8.14</td>
<td>7.76</td>
<td>7.90</td>
<td>7.37</td>
<td>5.93</td>
<td>7.04</td>
</tr>
</tbody>
</table>
From Table 6.1—13 Summary of design representative years’ water level in upper stream after completion of Shihutang Project and from Table 6.1—11 Summary of annual water level at Shihutang dam site it is known that of the five representative years the mean monthly water level is raised from 48.90m to 56.21m, by 7.31m; the highest monthly water level is elevated from 52.04m to 56.35m, by 4.31m; the lowest mean monthly level is raised from 47.09m to 55.34m, by 8.25m. Of the five representative years the highest daily water level rises from 57.19m to 57.31m, by only 0.12m; the lowest mean daily level is raised from 46.87m to 48.39m, by 1.52m. The monthly variation in water level between the highest and the lowest monthly mean water level under current conditions reaches 4.95m, while after completion of Shihutang Project the monthly level variation will be reduced to 1.01m, by 3.94m. The daily water level variation between the highest and the lowest daily mean water level under current conditions reaches 10.32m, while after completion of Shihutang Project the daily mean level variation will be reduced to 8.92m, by 1.40m.

For detail of variation in water level at different time of a day before and after construction of Shihutang Project see Table 6.1—20.
Table 6.1—20 Compared elevation value in upper stream water level against current conditions in Shihutang Project

<table>
<thead>
<tr>
<th>Time</th>
<th>1 am</th>
<th>2 am</th>
<th>3 am</th>
<th>4 am</th>
<th>5 am</th>
<th>6 am</th>
<th>7 am</th>
<th>8 am</th>
<th>9 am</th>
<th>10 am</th>
<th>11 am</th>
<th>12 am</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>14 pm</td>
<td>15 pm</td>
<td>16 pm</td>
<td>17 pm</td>
<td>18 pm</td>
<td>19 pm</td>
<td>20 pm</td>
<td>21 pm</td>
<td>22 pm</td>
<td>23 pm</td>
<td>24 pm</td>
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</tr>
<tr>
<td>Summer</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 units in Wan’an &amp; 4 in Shihutang for peak load modulation</td>
<td>9.70</td>
<td>9.70</td>
<td>9.70</td>
<td>9.70</td>
<td>6.80</td>
<td>6.81</td>
<td>6.81</td>
<td>6.81</td>
<td>6.82</td>
<td>6.82</td>
<td>6.83</td>
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<tr>
<td>Winter</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Unit: meter

From Table 6.1—14 *Representative daily water level in upper stream after completion of Shihutang Project* and Table 6.1—12 *Typical daily water level at Shihutang dam site under current condition*, it is known that in summer in case there are three units in Wan’an for peak load modulation and four units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical highest daily water level reaches 56.50m, an elevation by 6.83m from current 49.67m; and the corresponding lowest level is 56.47m, an increase by 9.70m compared with the lowest level under current conditions. In summer in case there are four units in Wan’an for peak load modulation and five units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical highest daily water level reaches 56.50m, an elevation by 6.19m compared with the highest level (50.31m) under current conditions; and the lowest daily level is 56.36m, an increase by 9.59m against the lowest daily level (46.77m). In winter in case there are three units in Wan’an for peak load modulation and four units in Wan’an and Shihutang
under synchronous operation for peak load modulation, during non-flood seasons the typical highest daily water level reaches 56.50m, rising by 6.85m against the current highest level at 49.65m; and the lowest level is 56.46m, an elevation by 9.78m against the current lowest level at 46.68m. In winter in case there are four units in Wan’an for peak load modulation and five units in Wan’an and Shihutang under synchronous operation for peak load modulation, during non-flood seasons the typical highest daily water level reaches 56.50m, an elevation by 6.22m against the current highest level at 50.28m; and the lowest daily level reaches 56.36m, a rise by 9.58m against current lowest level at 46.78m. Under current conditions the level variation between the highest and the lowest level ranges from 2.9m to 3.6m, which will change to 0.0m to 0.14m after completion of the Shihutang Project. During non-flood seasons when there are three or four units in Wan’an for peak load modulation and four or five units in Wan’an and Shihutang under synchronous operation for peak load modulation, analysis based on current water curve line indicates that due to banked-up water level for sand flushing and irrigation, there will be considerable increase in water level elevation. For detail see Table 6.1—21 and Figure 6.1—3.

![Water line change in upper stream in Shihutang before/after the project](image-url)
Table 6.1—21 Design water line in main stream in River Kan during non-flood period in Shihutang Project

<table>
<thead>
<tr>
<th>Section No</th>
<th>Location</th>
<th>Distance from the dam site (km)</th>
<th>Present Water line</th>
<th>Elevated water line after project completion(m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sluice closed</td>
<td>Sluice opened</td>
</tr>
<tr>
<td>Upper dam site</td>
<td>Jiangjiazhou</td>
<td>0.00</td>
<td>52.40</td>
<td>52.46</td>
</tr>
<tr>
<td>ShiganCS4</td>
<td>Yinxiajiang</td>
<td>2.04</td>
<td>52.75</td>
<td>52.80</td>
</tr>
<tr>
<td>ShiganCS5</td>
<td>Gaozhang</td>
<td>4.00</td>
<td>53.04</td>
<td>53.08</td>
</tr>
<tr>
<td>ShiganCS+1</td>
<td>Zhangjia</td>
<td>5.00</td>
<td>53.23</td>
<td>53.27</td>
</tr>
<tr>
<td>ShiganCS6</td>
<td>Sunjia</td>
<td>6.13</td>
<td>53.43</td>
<td>53.46</td>
</tr>
<tr>
<td>ShiganCS+2</td>
<td>Xinzou</td>
<td>7.53</td>
<td>53.72</td>
<td>53.75</td>
</tr>
<tr>
<td>ShiganCS7</td>
<td>Zushan</td>
<td>9.16</td>
<td>54.05</td>
<td>54.07</td>
</tr>
<tr>
<td>ShiganCS8</td>
<td>Huangken</td>
<td>11.11</td>
<td>54.46</td>
<td>54.48</td>
</tr>
<tr>
<td>ShiganCS9</td>
<td>Xinju</td>
<td>13.87</td>
<td>55.13</td>
<td>55.15</td>
</tr>
<tr>
<td>ShiganCS+3</td>
<td>Yanxidu</td>
<td>15.32</td>
<td>55.44</td>
<td>55.45</td>
</tr>
<tr>
<td>ShiganCS10</td>
<td>Kangjiahu</td>
<td>16.32</td>
<td>55.66</td>
<td>55.67</td>
</tr>
<tr>
<td>ShiganCS11</td>
<td>Pengxia</td>
<td>18.86</td>
<td>56.00</td>
<td>56.01</td>
</tr>
<tr>
<td>ShiganCS12</td>
<td>Xiaozou</td>
<td>21.56</td>
<td>56.63</td>
<td>56.64</td>
</tr>
<tr>
<td>ShiganCS13</td>
<td>Yongchang</td>
<td>24.24</td>
<td>57.28</td>
<td>57.29</td>
</tr>
<tr>
<td>ShiganCS14</td>
<td>Gaocheng</td>
<td>27.54</td>
<td>57.88</td>
<td>57.88</td>
</tr>
<tr>
<td>ShiganCS15</td>
<td>Zhoulou</td>
<td>30.44</td>
<td>58.31</td>
<td>58.31</td>
</tr>
<tr>
<td>ShiganCS16</td>
<td>Sukouzou</td>
<td>33.34</td>
<td>58.91</td>
<td>58.91</td>
</tr>
<tr>
<td>ShiganCS17</td>
<td>Pengzili</td>
<td>35.84</td>
<td>59.63</td>
<td>59.63</td>
</tr>
<tr>
<td>ShiganCS18</td>
<td>Guoqia</td>
<td>38.19</td>
<td>60.27</td>
<td>60.27</td>
</tr>
<tr>
<td>ShiganCS19</td>
<td>Chengzou</td>
<td>40.84</td>
<td>60.95</td>
<td>61.08</td>
</tr>
</tbody>
</table>

Note: the water level in the table refers to the level in each location in the upper stream at the critical flow of 4700m³/s for sluice lock.

(3) Change in flow rate in the upper stream after completion of the Shihutang Project
Such four sections as follows will serve as representative sections for calculation of flow rate in Shihutang Projects, as shown in Table 6.1—22 and 6.1—23:

(a) Shigan CS4 (located in the main stream of River Ken, about 2.04km in upstream, closest to the dam site). This section will suffer from the highest elevated level after completion of Shihutang Project;
(b) Shigan CS8: located in the main stream of River Kan, about 11.11km in the upstream, the section to suffer from the largest change in discharge section before and after the completion of the Shihutang project;

(c) Shigan CS11: located in the main stream of River Kan, about 18.86km in upper stream from the dam site. This section will suffer from the largest change in elevated water level before and after completion of Shihutang project;

(d) Shigan CS14: located in the main stream of River Kan, about 27.54km in the upstream. This section suffers from almost no change in elevated water level after completion of Shihutang project.
### Table 6.1—22 Change in flow rate before/after construction of Shihutang Project in representative sections in upper stream

<table>
<thead>
<tr>
<th>Section Names</th>
<th>Section Location</th>
<th>Design Frequency (%)</th>
<th>Design level (m)</th>
<th>Design Flow (m³/s)</th>
<th>Discharge area (m²)</th>
<th>Mean flow rate in section (m³/s)</th>
<th>Increase in flow rate by percentage</th>
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</thead>
<tbody>
<tr>
<td>Shigan CS4</td>
<td>Shihutang Upper stream from dam site 2.04km</td>
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<td>18400</td>
<td>59.25</td>
<td>59.40</td>
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Remarks: Shigan CS4 is closest to the dam site. This cross section in elevated water level will be closest to water level before construction of Shihutang and after completion of the project.

Shigan CS8: this cross section will see greatest change in discharge section after completion of Shihutang Project.

Shigan CS11: this cross section will witness highest elevated water level after completion of Shihutang Project.

Shigan CS14: there will be almost no change in elevated water level after completion of Shihutang Project and completion of flood bank.
### Table 6.1—23 Comparison of mean flow rate in Upper stream representative cross sections

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<tr>
<th>Section Names</th>
<th>Section Location</th>
<th>Design frequency (%)</th>
<th>Design level (m)</th>
<th>Discharge area (m²)</th>
<th>Mean flow rate in section (m/s)</th>
<th>Increase in flow rate by percentage</th>
<th>Remarks</th>
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<td>54.38</td>
<td>56.67</td>
<td>1227</td>
<td>2728</td>
</tr>
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</table>

Remarks: Shigan CS4 is closest to the dam site. This cross section in elevated water level will be closest to water level before construction of Shihutang and after completion of the project.

Shigan CS8: this cross section will see greatest change in discharge section after completion of Shihutang Project.

Shigan CS11: this cross section will witness highest elevated water level after completion of Shihutang Project.

Shigan CS14: there will be almost no change in elevated water level after completion of Shihutang Project and completion of flood bank.
From Table 6.1-22 and Table 6.1-23 based on such four representative cross sections as Shigan CS4, Shigan CS8, Shigan CS11 and Shigan CS14, in terms of change in design frequency and flow rate before and after the project is completed, it is known that during the flood period (P = 50 % ~ P = 3.3%) in Shihutang Project after completion of the project and of the flood bank the flow rate will increase only by -1.38% ~ -0.11%; comparison of the Shihutang Project before construction and after completion indicates that except for Shigan CS8 which will suffer from relatively much decrease in discharge sections and whose flow rate change will be about 8.62% to 21.64%, the change in the other three representative cross sections in terms of flow rate will range from only -3.80% to 3.21%; even during the flood period the flow rate before the construction of Shihutang Project remains 98.6% to 99.9% of the flow rate after completion of the project. In section Shigan CS8 after completion of Shihutang Project the flow rate will be 108.6% to 121.6% of the current rate, while in the other three representative cross sections the flow rate after completion of the project will be 96.2% to 103.2% of the current rate. In case of low or normal water years (in case of critical flow at 4700 m³/s or mean annual flow at 1150 m³/s), since the Shihutang Project will close the sluice gates for storage for power generation, there will be great elevation in the reservoir water level, and the flow rate will vary in percentage from -73.2% to -13.8%. But at this moment the mean flow rate at this section will be very limited, even in case of critical flow or mean annual flow, flow rate in the said four sections will be 26.8% to 86.2% of the rate before construction of Shihutang project.

### 6.1.6.2 Change in water regime in downstream after completion of Shihutang Project

As Shihutang Project has poor regulation capacity in runoff, therefore, for Shihutang Project the representative years’ mean annual/monthly/daily flow and water level will remain unchanged if compared with the same parameters before and after construction of the project. In other words, after completion and operation of Shihutang project, the mean annual/monthly/daily flow downstream suffers from basically no change. But to ensure discharge from Shihutang Project is more than the base navigation flow at 187 m³/s, there will be reasonable adjustment in daily in-flow. From Table 6.1-10 *Representative mean daily flow at Shihutang dam site* and Table 6.1-15 *Typical daily flow at downstream Shihutang dam site after completion of the project* by comparison it is known that after completion and operation of Shihutang Project, in case when Wan’an has three/four generating units under peak load modulation and Shihutang has four/five units under synchronous peak load modulation, during non-flood periods the maximum flow downstream will change from current 2278 m³/s to 2100 m³/s, and the minimum flow downstream will increase from 162 m³/s to 187 m³/s. This shows that completion of Shihutang Project in operation will reduce high flow downstream and make compensation for low flow, so that the variation in flow will change from 2116 m³/s to 1913 m³/s. For detail of increase in different time in a day concerning daily flow in Shihutang Project, see Table 6.1-24.

<table>
<thead>
<tr>
<th>Table 6.1—24 Comparison of daily flow in project operation downstream against current conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
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<tr>
<td>3 units in Wan’an &amp; 4 in Shihutang for peak load modulation</td>
</tr>
</tbody>
</table>
(2) Change in water level downstream after completion & operation of Shihutang Project

From Table 6.1-12 *Typical daily water level at Shihutang dam site under current condition* and Table 6.1-16 *Typical daily water flow at downstream Shihutang dam site after completion of the project* by comparison it is known that after completion and operation of Shihutang Project, in case when Wan’an has three/four generating units under peak load modulation and Shihutang has four/five units under synchronous peak load modulation, during non-flood period the maximum water level downstream will drop from current 50.31m to 50.11m, and the lowest water level will increase from 46.68m to 46.78m. This shows that completion of Shihutang Project in operation will elevate the lowest water level during non-flood period and reduce the heist level downstream, so that the variation in water level changes from 3.63m to 3.33m. For detail of compared elevation in water level downstream after completion of the project, see Table 6.1-25.
### Table 6.1—25 Comparison of daily water level change downstream in operation period

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<th>4 am</th>
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<th>6 am</th>
<th>7 am</th>
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<td>23 pm</td>
<td>24 pm</td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 units in Wan’an &amp; 4 in Shihutang peak load modulation</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td>-0.05</td>
<td>-0.05</td>
<td>0.09</td>
<td>-0.05</td>
<td>-0.05</td>
<td>-0.05</td>
<td>-0.05</td>
<td>-0.05</td>
<td></td>
</tr>
<tr>
<td>4 units in Wan’an &amp; 5 in Shihutang peak load modulation</td>
<td>0.34</td>
<td>0.34</td>
<td>0.34</td>
<td>-0.20</td>
<td>-0.20</td>
<td>0.34</td>
<td>-0.20</td>
<td>-0.20</td>
<td>-0.20</td>
<td>-0.20</td>
<td>-0.20</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 units in Wan’an &amp; 4 in Shihutang peak load modulation</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>-0.06</td>
<td>-0.06</td>
<td>-0.06</td>
<td>-0.06</td>
<td>-0.06</td>
<td>0.10</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 units in Wan’an &amp; 5 in Shihutang peak load modulation</td>
<td>0.36</td>
<td>0.36</td>
<td>0.36</td>
<td>-0.17</td>
<td>-0.17</td>
<td>-0.17</td>
<td>-0.17</td>
<td>-0.17</td>
<td>0.36</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Unit: meter

(3) Change in flow rate downstream after completion of Shihutang Project
Shihutang Project is limited in adjustment of runoff, to produce very limited adjustment on daily runoff. Since Shihutang project is located in the natural river, when the flow increases, the water level also rises to lead to increase in cross section, therefore Shihutang Project will see little change in flow rate downstream after completion of the project.

### 6.1.7 Sediment discharge at Shihutang dam site & impact from sediment after completion of Shihutang Project

#### 6.1.7.1 Sediment discharge at Shihutang dam site
Sand and mud in River Kan and its tributaries comes mainly from flood’s top soil erosion. Due to desirable vegetation in the basin, soil erosion is not serious; therefore, the river suffers from limited sediment impact. According to the various test stations in River Kan concerning sediment, the suspended sediment annual change occurs at the same time as the basic runoff, to mean that high flow will carry abundant sediment and low flow will convey limited sediment. Sediment is concentrated mainly during the flood seasons from April to June, to account for
63.8% ~ 67.2% of total in a year. Shihutang dam site is located between the Wan’an reservoir dam site and Ji’an Hydrometric Station, in the upstream about 83km from Wan’an and downstream about 30km from the Ji’an Hydrometric Station. Based on 50 years’ sediment data as collected in Ji’an Station, it is estimated that annual sediment in suspension at Shihutang dam site totals $372 \times 10^4$ t, and tractional load totals $55.8 \times 10^4$ t, and annual total sediment discharge amounts to $428 \times 10^4$ t.

### 6.1.7.2 Analysis of impact from sediment accumulation after completion of Shihutang Project

The discharge sluice bottom elevation in Shihutang Project is 47.0m, almost the same in height as the river bed, thus advantageous for sand flushing. Moreover, the project will be operated with the in-flow as indicator for openness of the sluice gates: when at the dam site the in-flow is over $4700$ m$^3$/s, all the flood gates will be opened for sand flushing; when at the dam site the in-flow ranges from 2520 to 4700 m$^3$/s, the spillway gates will be partially opened for sand flushing. Only when the in-flow is less than 2,520 m$^3$/s, all the flood gates will be closed for storage to meet the need for shipping and power generation in this case there will be limited sediment concentration and sediment grains are very small.

In terms of general layout and project dispatching mode, there is limited change in Shihutang project in flow if compared with that under natural state, especially during flood periods in case of high water. Since the sluice gates are sufficient for sand flushing and when all are opened the sluice gates will produce no change in flow and hydraulic elements and the sand grains are too small to create silting in the reservoir and majority of sediment from the upper stream will be removed in flood discharge. But due to long reaches of backup water, the suspension sediment is difficult to carry to the dam site, and the sediment before the dam site will be easily flushed downstream due to low elevation at the bottom sluice. It is estimated that sediment in Shihutang project will develop into small-scaled delta in the reservoir and there will be very limited sediment at the terminal of the reservoir and in front of the dam. In a word, there will be limited impact from sediment against the water line and project operation.

### 6.2 Water Environment

#### 6.2.1 Water Impact Analysis during the construction period

1. During the construction period, the waste water includes the waste water from washing the gravel, the waste water from mixing the concrete and the pit’s waste water, etc. The pollutants are mainly of SS, the wastewater mainly comes from gravel washing. The drained gravel-washing water is 5760m$^3$/d, the drained suspension concentration is 50000mg/L; the average wastewater from concrete pouring is 593.83m$^3$/d, the suspension concentration is 5000mg/L, the PH value is 11.9.

The wastewater for flushing the gravel contains relatively high concentration of SS, the water’s SS concentration within 1000m in the low reaches will be raised during normal water level period or in dry season if it is not treated and drained. Thus, the wastewater should be treated (SS should reach 70mg/L after treatment); the treated wastewater for flushing the gravel has less impact on the water environment.

2. During the construction peak of Shihutang Project, there are 2900 men/day, water consumption is 150L/man per day, and sewage discharge is computed at 80 percent of water consumption. The maximum domestic sewage drainage is 348 m$^3$/day. In the sewage, the main
pollutant factors are COD and BOD5, whose concentrations are respectively 300mg/L and 200mg/L, the production of COD and BOD5 is respectively 104.4kg/day and 69.6kg/day. The domestic sewage in Shihutang area will be under treatment to reach the standard before disposal, it will have relatively little effect on the recipient.

(3) The oil sewage at the tank bottom of the construction ship

The average oil concentration of the oil sewage at the tank bottom is 5000mg/L. If the oil sewage is directly drained without treatment, it will do great harm to the water environment; the drained concentration after treatment will not be over 15mg/L.

According to some related regulations, the oil sewage from the ship tank should be treated by the oil-water separator and shall not be disposed until reaching the standard (the drain concentration is 15mg/L). As for the small ships or boats without oil-water separator, the oil sewage from the ship tank should be stored in its own container, and then is sent to the oil sewage accepting boat or the oil sewage accepting unit to be treated. If the oil sewage from construction ships (mainly slurry-digging ships and material haul ships) is drained according to the standards, it will have limited impact on the water environment.

(4) During the construction period the production sewage and domestic sewage will be under discharge somewhat far from the drinking intake and water source protection zones (over 500m). After adoption of effective measures in construction against pollution there will be no impact upon water intake and water source protection zones downstream.

6.2.2 Prediction of impact upon water environment during the construction period

The reservoir itself will produce no pollutants, but the reservoir performance will create impact the water regime in the reservoir and downstream reaches, upon pollutant dilution, degradation and spread process. Impact from the reservoir upon the river quality in the reservoir area occurs mainly due to elevated water level, increase in the cross section and in the water depth, sedimentation, decrease in flow rate, etc. impact upon downstream reaches occurs mainly due to the difference in discharged flow and water quality if compared with the parameters under the natural conditions. Prediction is made after consideration of such factors as the water temperature, pollution sources, the overall water quality in the reservoir area, the water quality in the inshore, eutrophication, water environmental capacity and discharged water quality and wastewater quality during construction period, so that water quality will be guaranteed to minimize impact from the project construction upon the water environment.

The major protection objectives under this project consist of Chengjiang Intake and its water source protection zone; Nanmenzou Intake and its water source protection zone. Meanwhile, in the planning Shangtian Intake and its source protection zone is also under consideration. 33km down the dam site (upper stream of Ji’an City) under protection will be such intakes as intake for the first and second stage of the Jinggangshan Power Plant, intake for Wuyue Water Plant proposed for construction in near future and its water source protection areas; intake for Ji’an City No 2 Water Plant and its water source protection areas; intake for Ji’an City No 1 Water Plant and its water source protection areas; intake for the Pharmaceutical Factory and its water source protection areas; intake for Ji’an City Dongchang Water Plant and its water source protection areas.

6.2.2.1 Water Temperature
The water temperature is predicted according to the methods in common use at home or abroad:

\[ a = \frac{\text{flow} \cdot S_{\text{mean value}}}{\text{reservoir's volume}} = \frac{115}{0.98} \approx 165 \]

When \( a \) value is greater than 20, the reservoir water temperature structure is mixed; when \( a \) value is less than 10, it is sliced; while 10 < \( a < 20 \), it is transitional. The reservoir’s \( a \) is far greater than 20, thus, the reservoir’s water temperature is mixed. The water in the reservoir is relatively shallow, the incoming water amount is relatively great, the water objects exchanges very frequently, thus, there will be no sliced water temperature phenomenon in the reservoir, the water temperature in the reservoir is almost the same as in the natural conditions, it will have no effect on the industry, agriculture and living water consumption and aquatic creature.

**6.2.2.2 Potential pollutant sources**

Within the reservoir there are three drain outlets, namely (a) Taihe County Outlet; (b) Industrial Park Outlet and (c) Yanxi Outlet for the Sewage Treatment Plant. Taihe Outlet is of typical domestic sewage discharge, and for the latter two outlets they are mainly of industrial wastewater. The proposed Chengjiang Sewage Treatment Plant (whose outlet is located in the existing County Outlet) and Wentian Sewage Treatment Plant (whose outlet is located 200m downstream down the outlet of the Industrial Park Outlet) will respectively handle the county domestic sewage and Industrial Park’s industrial wastewater. The water intake and outlet location is seen in Figure 6.2-1.

(1) COD discharge prediction in the near future (in 2012)
On the basis of General Layout Planning Report in Taihe County, the urban sewage discharge in 2012 will be 2718.07×10^4 t/a, of which the domestic sewage contributes 762.52×10^4 t/a and the industrial sewage 1955.5×10^4 t/a. It is planned to set up Chengjiang sewage plant in the east side of Jinggangshan Avenue and in the south side of the first line ditches. The purpose is to treat the domestic sewage in Chengjiang area. Wentian sewage plant is set up in the east side of Beijing-Kowloon railway to treat the living and industrial sewage in Wentian area. The design treatment capacity of Chengjiang and W entian sewage plant is respectively 1.5×10^4 t, 3×10^4 t, the treatment ratio is respectively 46.5% and 60.0%. In 2012 Yanxi Sewage Plant will dispose sewage totaling 965.5×10^4 t of industrial waste. Yanxi Sewage Plant has a capacity of 2.1JJ×10^4 t/d, at a treatment ratio of 100%. The rank of the two sewage plants is secondary treatment, and after treatment the sewage is discharged into Kan River.

On the basis of Pollutant Discharge Standards for Urban Sewage Plant (GB18918-2002), the COD drainage concentration in Chengjiang sewage plant of Taihe County is not greater than 60mg/L, the COD drainage concentration in W entian sewage plant isn’t greater than 100mg/L. Thus, we can know the pollutant drainage conditions in the reservoir area in 2012. If the domestic sewage isn’t treated, its COD drainage concentration is 300mg/L, 341.4mg/L for industrial sewage. According to the above forecast, the drained wastewater through the secondary treatment is 1642.5t/a, the drained wastewater without treatment is 1489.5t/a. For details, see Tab. 6.2-1 and Tab. 6.2-2.

Table 6.2-1 Waste Water Discharge Unit □×10^4 t/a

<table>
<thead>
<tr>
<th>Item</th>
<th>Chengjiang Sewage Outlet</th>
<th>Industrial Park Outlet</th>
<th>Yanxi Outlet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction of criteria</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Waste water amount</td>
<td>547.5</td>
<td>215.0</td>
<td>1095.0</td>
</tr>
<tr>
<td>Total</td>
<td>762.52</td>
<td>1955.5</td>
<td>965.5</td>
</tr>
</tbody>
</table>

Table 6.2—2 Pollutant discharge Unit: t/a

<table>
<thead>
<tr>
<th>Item</th>
<th>Chengjiang Sewage Outlet</th>
<th>Industrial Park Outlet</th>
<th>Yanxi Outlet</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH3-N</td>
<td>43.8</td>
<td>94.07</td>
<td></td>
</tr>
<tr>
<td>BOD5</td>
<td>109.5</td>
<td>322.53</td>
<td></td>
</tr>
<tr>
<td>COD</td>
<td>328.5</td>
<td>645.1</td>
<td>1095.0</td>
</tr>
</tbody>
</table>

Such prediction shows that waste water flowing into Kan River under secondary treatment will total 2608.0t/a while waste water under no treatment will aggregate 1075.6t/a. Amount of NH3-N, BOD5 and COD under disposal from Chengjiang Sewage Outlet will total 137.87t/a 432.03t/a and 5585.7t/a respectively.

(2) Long-term COD discharge forecast (in 2020)

On the basis of General Layout Planning Report in Taihe County, the Chengjiang and W entian Sewage Plant will undertake 100% interception of urban sewage; Yanxi Sewage Plant will intercept all sewage from the Industrial Park, for secondary treatment to the sewage plant. Completion of the project will reduce discharge of sewage to relieve pressure in Kan River. By 2020 discharge in the county city will amount to 4380×10^4 t; the long-term design treatment
capacity for Chengjiang and Wentian Sewage Plant is respectively $5 \times 10^4$ t/d and $7 \times 10^4$ t/d, at a treatment ratio of 100%. The rank of the sewage plant is secondary treatment and after treatment the sewage is drained into Kan River.

In line with Discharge Standards of Sewage Treatment in Cities & Towns (GB18918—2002), in Taihe county the Chengjiang Sewage Treatment Plant has NH3-N emissions concentrations $\leq 8$ mg/L, BOD5 emission concentrations $\leq 20$ mg/L, COD emission concentrations $\leq 60$ mg/L, text fields sewage treatment plant emissions COD concentrations $\leq 100$ mg/L, respectively. Yanxi Sewage Treatment Plant has emissions COD concentrations $\leq 60$ mg/L.

The pollutant discharge conditions in the reservoir area in 2020 can be worked out. In 2020, the urban sewage discharge amounts to $5730 \times 10^4$ t, of which, $1825 \times 10^4$ t comes from Chengjiang Sewage Outlet, and $2555 \times 10^4$ t from Wentian Sewage Outlet. After treatment the total NH3-N discharged will be 146.0t/a and BOD$_5$ 165.0t/a. COD discharge totals 4460t drained into Kan River.

(3) Forecast of the phosphorus into the reservoir

The NH3-N and phosphorus in the reservoir area mainly come from domestic sewage of the residents and livestock along the two banks of the river. According to the actual conditions in the reservoir area, the analyzed objects mainly include three parts: domestic sewage, soil erosion, pesticide and chemical fertilizer.

The concentrated residential area in the reservoir area is mainly Chengjiang Town in Taihe County. In 2012, 49.8t is drained into the river; in 2020 69.6t is drained into the river. The phosphorus with soil erosion into the water is 0.96t/a, the phosphorus with farm chemical into the water is 4.70t/a.

The phosphorus into the reservoir area thanks to the residential area, soil erosion and chemical fertilizer is 55.41t in 2012 and 75.23t in 2020.

### 6.2.2.3 Water Quality in the Reservoir

(1) Forecast conditions

Forecast level year: regard 2012 in the near future and 2020 in the long term as the forecast level year.

Forecast factor: use the permanganate index fro prediction.

Pollution sources:

The current wastewater in the urban sewage outlet is treated by Chengjiang Plant, its discharge $Q=0.173 m^3/s$, of which NH3-N concentration reaches $C_p=8mg/L$, BOD$_5$ concentration $C_p=20mg/L$, COD concentration $C_p=60 mg/L$, and the untreated waste water discharge $Q_p=0.200068 m^3/s$, COD discharge concentration $C_p=300mg/L$. In Yanxi Outlet NH3-N concentration reaches $C_p=43.75 mg/L$, BOD$_5$ discharge concentration $C_p=150mg/L$, COD discharge concentration $C_p=300mg/L$. In Wentai Plant, its discharge $Q=0.347 m^3/s$, COD discharge concentration $C=60mg/L$; the untreated wastewaster discharge rate reaches $Q=0.273 m^3/s$, when COD discharge concentration $C=341.4mg/L$. In Yanxi Sewage Plant after secondary treatment the waste discharge quantity totals $Q_p=0.23 m^3/s$, and COD discharge concentration $C_p=60 mg/L$.

The long term waste water from Chengjiang Sewage Outlet is treated in Chengjiang Plant, its
discharge Q=0.579 m³/s, where NH₃-N concentration reaches Cᵢ=8mg/L, BOD₅ concentration Cᵢ=20mg/L and COD discharge concentration C=60mg/L; the long term waste water from Wentian Sewage Outlet is treated in Chengjiang Plant, its discharge Q=0.8105/s, COD discharge concentration C=100mg/L. In Yanxi Sewage Plant after secondary treatment the waste discharge quantity totals Qᵢ=0.23 m³/s, and COD discharge concentration Cᵢ=60 mg/L.

Design flow: design flow is based on 90% or 95% assurance rate of monthly average flow in the driest season in the river section of Shihutang pivot.

Forecast plan: adopt Shihutang pivot on Kan River to forecast the water quality in the reservoir area.

Position of waste outlet: the urban sewage outlet and the sewage outlet in planned Chengjiang Sewage Plant are 22.3km away from the dam site. Wentian Sewage Outlet is 18.74km and Yanxi Sewage Outlet is 16.36km away from the dam site.

The hydrological parameters near the waste outlet at 90% or 95% assurance rate of monthly average driest flow are shown in Table 6.2-3 and Table 6.2-4.

### Table 6.2-3 Hydrological Parameters near waste outlets at 90% of Assurance Rate at Monthly Average Driest Flow

<table>
<thead>
<tr>
<th>Parameter section</th>
<th>flow (m³/s)</th>
<th>Mean flow rate (m³/s)</th>
<th>Mean water depth (m)</th>
<th>Hydraulic slope (‰)</th>
<th>Mean river width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban waste outlet</td>
<td>163</td>
<td>0.217</td>
<td>2.5</td>
<td>0.26‰</td>
<td>300</td>
</tr>
<tr>
<td>Yanxi Waste Outlet</td>
<td>163</td>
<td>0.217</td>
<td>2.5</td>
<td>0.26‰</td>
<td>300</td>
</tr>
<tr>
<td>Chengjiang Plant</td>
<td>163</td>
<td>0.217</td>
<td>2.5</td>
<td>0.26‰</td>
<td>300</td>
</tr>
<tr>
<td>Wentian Plant</td>
<td>163</td>
<td>0.217</td>
<td>2.5</td>
<td>0.26‰</td>
<td>300</td>
</tr>
</tbody>
</table>

### Table 6.2-4 Hydrological Parameters near waste outlets at 95% of Assurance Rate at Monthly Average Driest Flow

<table>
<thead>
<tr>
<th>Parameter Section</th>
<th>flow (m³/s)</th>
<th>Mean flow rate (m³/s)</th>
<th>Mean water depth (m)</th>
<th>Hydraulic slope (‰)</th>
<th>Mean river width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chengjiang Sewage Treatment Plant 90%</td>
<td>163</td>
<td>0.0385</td>
<td>6</td>
<td>0.0037‰</td>
<td>705</td>
</tr>
<tr>
<td>Wentian Sewage Treatment Plant 90%</td>
<td>163</td>
<td>0.0385</td>
<td>6</td>
<td>0.0037‰</td>
<td>705</td>
</tr>
<tr>
<td>Yanxi Sewage</td>
<td>163</td>
<td>0.0385</td>
<td>6</td>
<td>0.0037‰</td>
<td>705</td>
</tr>
</tbody>
</table>
(2) Forecast model

Shihutang Reservoir belongs to a stream way reservoir. Its water is detained for a short period of time, the water depth is relatively shallow, its water temperate has no obvious slices, and the water quality in the reservoir area is forecast by means of one-dimensional water quality model.

\[ C_x = C_0 \exp\left(-\frac{K}{u} X\right) \]

In this formula:
- \( x \) — pollutant’s concentration after flowing \( X \) distance, mg/L
- \( o \) — pollutant’s concentration at the starting section \((X=0)\), mg/L
- \( U \) — river’s mean flow rate, m/s
- \( X \) — longitudinal distance m
- \( K \) — pollutant’s overall disintegration coefficient, s\(^{-1}\).

Determination of \( K \) value: the pollutant’s overall disintegration coefficient shows that the degradation rate of organic pollutant is related with the river’s hydrological conditions, such as: flow, flow rate, river width, water depth and silt content. Before building the dam, \( K \) value is 0.2(1/d). After building the dam, considering about the hydrological change, \( K \) value is 0.06(1/d).

Determination of \( o \) value

\[ o = \frac{p \cdot h + p}{p \cdot h + p} \]

In the formula:
- \( p \) — sewage’s discharge flow (m\(^3\)/s) and concentration (mg/L)
- \( h \) — flow, m\(^3\)/s
- \( h \) — average COD concentration from upper reaches h=5.16mg/L

In the near future: \( p = 0.99386 \) m\(^3\)/s \( p=79.8200.0 \) mg/L in long-term \( p=1.38962 \) m\(^3\)/s \( p=33.3380.04 \) mg/L

\( Q \) is 90% assurance rate of monthly average driest flow, \( Q=163 \) m\(^3\)/s

The pollutant’s forecast results are permanganate index, the conversion factor of COD and permanganate index is 2.5.

(3) Forecast results

The forecast results show that under the hydrological conditions of 90% assurance rate of monthly average driest flow, before construction of the dam, the current permanganate index COD concentration is 5.12 mg/L, or 4.88 mg/L in the long term; after building the dam, the current permanganate index concentration will be 4.49 mg/L, or 4.28 mg/L in the long term. Thus, after building the dam, there is not much change in total water quality yin the reservoir. See Tab. 6.2-5.

<table>
<thead>
<tr>
<th>Treatment Plant</th>
<th>90%</th>
<th>4.88</th>
<th>705</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chengjiang Sewage Treatment Plant</td>
<td>95%</td>
<td>5.12</td>
<td>705</td>
</tr>
</tbody>
</table>

Table 6.2-5 COD Concentration Forecast Results for Reservoir Water Quality

Unit (mg/l)
6.0 Environment Impact Assessment

<table>
<thead>
<tr>
<th>Longitudinal distance (m)</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
<th>300</th>
<th>3461</th>
<th>17860</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term before construction of the dam</td>
<td>5.896</td>
<td>5.893</td>
<td>5.890</td>
<td>5.887</td>
<td>5.884</td>
<td>5.881</td>
<td>5.686</td>
<td>4.877</td>
</tr>
<tr>
<td>Long-term after construction of the dam</td>
<td>5.894</td>
<td>5.889</td>
<td>5.883</td>
<td>5.878</td>
<td>5.873</td>
<td>5.868</td>
<td>5.543</td>
<td>4.276</td>
</tr>
</tbody>
</table>

6.2.2.4 Water Quality in Nearshore Towns & Cities

Shangtian Intake and its water source protection areas and Nanmen Intake and its water outfall protected areas are located in the upper reaches; Chengjiang Intake and her water source protection areas are 3461m from the upstream County Sewage Outlet (i.e. proposed Chengjiang Sewage Outlet) 3461 m. In terms of the relationship between the intake and outlet location, in order to guarantee the safety of drinking water sources, impact upon the Chengjiang Intake and its water source protection zones will be analyzed from various prediction factors.

Prediction factors: for Chengjiang Outlet NH3-N, BOD5 and COD will be taken as prediction factors; for Wentian and Yanxi Outlet COD as prediction factor.

Prediction Program: under 95% and 90% of assurance rate in Shihutang project during low months, under near future and far future and emergency emissions, prediction will be made concerning Chengjiang Outlet - Chengjiang Intake in terms of reservoir water quality. Prediction will also be made under 90% of assurance rate during low months, under near future and far future and emergency emissions concerning total water quality in the reservoir.

Prediction model

Water quality variation is under prediction on the basis of two-dimensional convection and diffusion model, with no consideration to tenuation since it is short-term prediction. The model may be simplified as follows:

\[
C(x, z) = C_h + \frac{2C_p Q_p}{H \sqrt{4 \pi E_x u}} e^{-\frac{u}{4E_x x}} x \left(u \frac{e^{-\frac{2z}{4E_x x}}}{4E_x x}\right)
\]

Of which:
- \(C(x, z), C(h)\) mean concentration of point pollutants \(\text{mg/L}\)
- \(C_h\) concentration of pollutants in the upper reach \(\text{mg/L}\)
- \(H\) mean depth calculated from the section of pollution zone \(\text{m}\)
- \(U\) — longitudinal flow velocity \(\text{m/s}\)
- \(C_p\) pollutant discharge concentration \(\text{mg/L}\)
- \(Q_p\) discharge of waste water \(\text{m}^3/\text{s}\)
- \(E_x\) Lateral diffusion coefficient \(\text{m}^2/\text{s}\)
- \(x\) longitudinal distance from the computed point to the drain outlet \(\text{m}\)
- \(z\) Lateral distance from the computed point to the drain outlet \(\text{m}\)
Lateral diffusion coefficient $E_z$ may be computed by such empirical formula:

$$E_z = a_z \cdot H \cdot U^*$$

$$U^* = \sqrt{gHI}$$

Of which $a_z$ — zero dimension diffusion coefficient; regular reach: $0.15$.

$H$ — mean depth in a section.

$U^*$ — friction flow velocity.

$g$ — acceleration of gravity $9.8m/s^2$.

$I$ — hydraulic gradient $‰$.

$E_z = 0.01327m^2/s$

**Prediction Result**

No consideration is given to attenuation.

**Short-term Prediction**

At 95% of assurance rate in the driest season, prediction is made concerning nearshore waters close to county town drain outlets (discharged to Kan River) concerning NH3-N, see Table 6.2—6 for detail; for prediction of BOD5, see Table 6.2—7; for COD, see table 6.2—8.

The Table shows that under the hydrological condition of monthly average flow of the driest month at 95% of assurance rate, after completion of the dam, in scope of the nearshore waters lasting 2050m long and 23m wide close to Chengjiang Sewage Outlet in the near future, the pollutant concentration goes beyond Grade II of water quality standard; at 2461m downstream the outlet (1000m in the upstream, 5m to the bank) NH3-N concentration $0.5mg/L$, BOD5 $3mg/L$ and COD $15mg/L$. Still, water meets the requirement of water intaking of the Chengjiang Water Plant, 3461m downstream.

**Table 6.2—6 Short-term NH3-N Prediction in Chengjiang Outlet in Downstream**

<table>
<thead>
<tr>
<th>Longitudinal Horizontal (m)</th>
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<th>500</th>
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At 90% of assurance rate in the driest season, prediction is made concerning Chengtian Outlet nearshore waters NH3-N concentration, see Table 6.2—9; concerning BOD5, see Table 6.2—10; concerning COD concentration see Table 6.2—11; at 90% of assurance rate in the driest season, after completion of the dam, in Wentian Outlet in the nearshore waters Prediction is made concerning COD, see Table 6.2—12; concerning COD concentration in Yanxi Outlet, see Table 6.2—13.
Table 6.2—9 Short-term NH3-N Prediction in Chengjiang Outlet in Downstream Nearshore Waters

<table>
<thead>
<tr>
<th>Longitudinal Horizontal (m)</th>
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<th>1000</th>
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Note: the table shows NH3-N prediction under 90% assurance rate in Chengjiang Outlet in near future.

Table 6.2—10 Short-term BOD₅ Prediction in Chengjiang Outlet in Downstream Nearshore Waters

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</table>

Note: the table shows BOD₅ prediction under 90% assurance rate in Chengjiang Outlet in near future.
Table 6.2—11 Short-term COD Prediction in Chengjiang Outlet in Downstream Nearshore Waters

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Note: the table shows COD prediction under 90% assurance rate in Chengjiang Outlet in near future.

Table 6.2—12 Short-term COD Prediction in Wentian Outlet in Downstream Nearshore Waters

<table>
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<th>Longitudinal Horizontal (m)</th>
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Note: the table shows COD prediction under 90% assurance rate in Wentian Outlet in near future.
Table 6.2—13 Short-term COD Prediction in Yanxi Outlet in Downstream Nearshore

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<th>Longitudinal Horizontal (m)</th>
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Note: The table shows COD prediction under 90% assurance rate in Yanxi Outlet in near future.

Prediction shows that at 90% of assurance rate in the driest season, after completion of the dam, in the nearshore waters lasting 2000m long and 22m wide close to Chengjiang Sewage Outlet, the permanganate index concentration goes beyond Grade II; in the long run in the nearshore waters will be under pollution. Still, water meets the criteria for water intake to the Chengjiang Water Plant, which is 3461m downstream from the dam site.

Long-term Prediction

At 95% of assurance rate in the driest season, long-term prediction is made concerning NH3-N concentration in Chengjiang Outlet. For detail of predicted NH3-N concentration see Table 6.2—14; for detail of prediction of BOD5 concentration see Table 6.2—15 and for COD concentration see Table 6.2—16.

Prediction shows that under the hydrological condition of monthly average flow of the driest month at 95% of assurance rate, after completion of the dam, in scope of the nearshore waters lasting 2350m long and 15m wide close to Chengjiang Sewage Outlet in the far future, the pollutant concentration goes beyond Grade II of water quality standard; at 2461m downstream the outlet (1000m in the upstream, 5m to the bank) NH3-N concentration <0.5 mg/L, BOD5 <3 mg/L and COD <15 mg/L. Still, water meets the requirement of water intaking of the Chengjiang Water Plant, 3461m downstream.
### Table 6.2—14 Long-term NH3-N Prediction in Chengjiang Outlet in Downstream Nearshore Waters

<table>
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Note: the table shows NH3-N prediction under 95% assurance rate in Chengjiang Outlet in near future.

### Table 6.2—15 Long-term BOD$_5$ Prediction in Chengjiang Outlet in Downstream Nearshore Waters

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</table>

Note: the table shows BOD$_5$ prediction under 95% assurance rate in Chengjiang Outlet in near future.

At 90% of assurance rate in the driest season, long-term prediction is made concerning NH3-N concentration in the nearshore waters close to Chengjiang Sewage Outlet, see Table 6.2—17; for prediction of BOD$_5$, see Table 6.2—18 and for COD see Table 6.2—19. At 90% of assurance rate in the driest season, the same long-term prediction is made concerning COD concentration near Wentian Outlet, see Table 6.2—20; for prediction of COD concentration...
near Yanxi Outlet, see Table 6.2—21.

Prediction shows that after completion of the dam, in the nearshore waters in Chengjiang Sewage Outlet that last 2250m long and 15m wide, in the far future the permanganate index concentration goes beyond Grade II; in the nearshore waters in Chengjiang Sewage Outlet lasting 700m long and 16m wide, the permanganate index concentration goes beyond Grade III. In the long run in the nearshore waters close to the two drain outlets will be under pollution. Still, water meets the criteria for water intake to the Chengjiang Water Plant 3461m downstream. In Yanxi Outlet the nearwaters lasting 700m long and 12m wide goes beyond Grade II in terms of COD concentration.

Table 6.2—16 Long-term COD Prediction in Chengjiang Outlet in Downstream

<table>
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Note: the table shows COD prediction under 95% assurance rate in Chengjiang Outlet in near future.

Table 6.2—17 Long-term NH3-N Prediction in Chengjiang Outlet in Downstream

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Note: the table shows NH3-N prediction under 90% assurance rate in Chengjiang Outlet in near future.

**Table 6.2—18 Long-term BOD$_5$ Prediction in Chengjiang Outlet in Downstream Nearshore Waters**

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Note: the table shows BOD$_5$ prediction under 90% assurance rate in Chengjiang Outlet in near future.

**Table 6.2—19 Long-term COD Prediction in Chengjiang Outlet in Downstream Nearshore Waters**

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Note: the table shows COD prediction under 90% assurance rate in Chengjiang Outlet in near future.
Table 6.2—20 Long-term COD Prediction in Wentian Outlet in Downstream Nearshore Waters

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<th>Longitudinal Horizontal (m)</th>
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Note: the table shows COD prediction under 90% assurance rate in Wentian Outlet in near future.

Table 6.2—21 Long-term COD Prediction in Yanxi Outlet in Downstream Nearshore Waters

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Note: the table shows COD prediction under 90% assurance rate in Yanxi Outlet in near future.

6.2.2.5 Prediction of Water Pollution from Sewage Treatment Works in Emergency discharge

At 95% of assurance rate in the driest season, prediction is made concerning NH3-N concentration in downstream nearshore waters during emergency discharge in Chengjiang Outlet, see Table 6.2—22; concerning BOD5 see Table 6.2—23; concerning COD see Table 6.2—24. At 95% of assurance rate in the driest season, prediction is made concerning NH3-N concentration in nearshore waters close to emergency discharge in Chengjiang Omelet in far
future, see Table 6.2—25; concerning BOD$_5$ concentration see Table 6.2—26; concerning COD concentration see Table 6.2—27.

Table 6.2—22 Estimate of Emergency Discharge from Chengjiang Outlet (Near future) (mg/l)

<table>
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<th>400</th>
<th>500</th>
<th>1000</th>
<th>3461</th>
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Note: the table shows NH$_3$-N prediction under 95% assurance rate in Chengjiang Outlet in near future in case of emergency discharge.

Table 6.2—23 Estimate of Accident BOD$_5$ Discharge from Chengjiang Outlet (Near future) (mg/l)

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Note: the table shows BOD$_5$ prediction under 95% assurance rate in Chengjiang Outlet in near future in case of emergency discharge.
Table 6.2—24 Estimate of COD Emergency Discharge from Chengjiang Outlet (Near future) (mg/l)

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<td>5.207</td>
<td>5.451</td>
<td>6.363</td>
<td>8.585</td>
</tr>
<tr>
<td>70</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.168</td>
<td>5.227</td>
<td>5.646</td>
<td>7.526</td>
</tr>
<tr>
<td>80</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.175</td>
<td>5.332</td>
<td>6.704</td>
</tr>
<tr>
<td>90</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.165</td>
<td>5.215</td>
<td>6.113</td>
</tr>
<tr>
<td>100</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.177</td>
<td>5.716</td>
</tr>
</tbody>
</table>

Note: the table shows NH3-N prediction under 95% assurance rate in Chengjiang Outlet in near future in case of emergency discharge.

Table 6.2—25 Estimate of NH3-N Emergency Discharge from Chengjiang Outlet (Far future) (mg/l)

<table>
<thead>
<tr>
<th>Lateral (m)</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
<th>1000</th>
<th>3461</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>9.083</td>
<td>7.033</td>
<td>5.928</td>
<td>5.221</td>
<td>4.342</td>
<td>3.424</td>
<td>2.240</td>
</tr>
<tr>
<td>10</td>
<td>5.408</td>
<td>5.429</td>
<td>4.990</td>
<td>4.590</td>
<td>3.986</td>
<td>3.254</td>
<td>2.194</td>
</tr>
<tr>
<td>20</td>
<td>0.745</td>
<td>1.959</td>
<td>2.524</td>
<td>2.752</td>
<td>2.836</td>
<td>2.655</td>
<td>2.023</td>
</tr>
<tr>
<td>30</td>
<td>0.116</td>
<td>0.419</td>
<td>0.851</td>
<td>1.202</td>
<td>1.624</td>
<td>1.898</td>
<td>1.767</td>
</tr>
<tr>
<td>40</td>
<td>0.097</td>
<td>0.124</td>
<td>0.243</td>
<td>0.421</td>
<td>0.770</td>
<td>1.199</td>
<td>1.465</td>
</tr>
<tr>
<td>50</td>
<td>0.097</td>
<td>0.098</td>
<td>0.114</td>
<td>0.163</td>
<td>0.332</td>
<td>0.683</td>
<td>1.155</td>
</tr>
<tr>
<td>60</td>
<td>0.097</td>
<td>0.097</td>
<td>0.098</td>
<td>0.106</td>
<td>0.162</td>
<td>0.368</td>
<td>0.870</td>
</tr>
<tr>
<td>70</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.111</td>
<td>0.206</td>
<td>0.631</td>
</tr>
<tr>
<td>80</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.135</td>
<td>0.445</td>
</tr>
<tr>
<td>90</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.108</td>
<td>0.311</td>
</tr>
<tr>
<td>100</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.097</td>
<td>0.100</td>
<td>0.221</td>
</tr>
</tbody>
</table>

Note: the table shows NH3-N prediction under 95% assurance rate in Chengjiang Outlet in far future in case of emergency discharge.
Table 6.2—26 Estimate of BOD\textsubscript{5} Emergency Discharge from Chengjiang Outlet (Far future) (mg/l)

<table>
<thead>
<tr>
<th>Longitudinal(m)</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
<th>1000</th>
<th>3461</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral(m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>1000</td>
<td>3461</td>
</tr>
<tr>
<td>50</td>
<td>1.484</td>
<td>1.578</td>
<td>1.987</td>
<td>2.594</td>
<td>3.225</td>
<td>5.264</td>
<td>6.175</td>
</tr>
<tr>
<td>60</td>
<td>1.483</td>
<td>1.487</td>
<td>1.545</td>
<td>1.713</td>
<td>1.976</td>
<td>3.495</td>
<td>5.114</td>
</tr>
<tr>
<td>70</td>
<td>1.483</td>
<td>1.483</td>
<td>1.488</td>
<td>1.517</td>
<td>1.589</td>
<td>2.413</td>
<td>4.137</td>
</tr>
<tr>
<td>80</td>
<td>1.483</td>
<td>1.483</td>
<td>1.484</td>
<td>1.487</td>
<td>1.500</td>
<td>1.857</td>
<td>3.315</td>
</tr>
<tr>
<td>90</td>
<td>1.483</td>
<td>1.483</td>
<td>1.483</td>
<td>1.484</td>
<td>1.485</td>
<td>1.614</td>
<td>2.678</td>
</tr>
<tr>
<td>100</td>
<td>1.483</td>
<td>1.483</td>
<td>1.483</td>
<td>1.483</td>
<td>1.484</td>
<td>1.523</td>
<td>2.219</td>
</tr>
</tbody>
</table>

Note: the table shows BOD\textsubscript{5} prediction under 95% assurance rate in Chengjiang Outlet in near future in case of emergency discharge.

Table 6.2—27 Estimate of COD Emergency Discharge from Chengjiang Outlet (Far future) (mg/l)

<table>
<thead>
<tr>
<th>Longitudinal(m)</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
<th>1000</th>
<th>3461</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral(m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>66.786</td>
<td>52.729</td>
<td>45.152</td>
<td>40.304</td>
<td>34.278</td>
<td>27.981</td>
<td>19.861</td>
</tr>
<tr>
<td>10</td>
<td>41.584</td>
<td>41.731</td>
<td>38.722</td>
<td>35.975</td>
<td>31.835</td>
<td>26.812</td>
<td>19.550</td>
</tr>
<tr>
<td>60</td>
<td>5.164</td>
<td>5.164</td>
<td>5.173</td>
<td>5.230</td>
<td>5.610</td>
<td>7.024</td>
<td>10.471</td>
</tr>
<tr>
<td>70</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.171</td>
<td>5.261</td>
<td>5.911</td>
<td>8.828</td>
</tr>
<tr>
<td>80</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.181</td>
<td>5.425</td>
<td>7.554</td>
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<tr>
<td>90</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.243</td>
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<tr>
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<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.164</td>
<td>5.185</td>
<td>6.021</td>
</tr>
</tbody>
</table>

Note: the table shows COD prediction under 95% assurance rate in Chengjiang Outlet in near future in case of emergency discharge.

The prediction shows that in the near future 3461m downstream in Chengjiang Outlet (1000m in the upper stream of the intake) emission of NH\textsubscript{3}-N, BOD\textsubscript{5} and COD averages > 0.5mg/L, > 3mg/L and < 15 mg/L respectively; in the long run the same index will average > 0.5mg/L, > 3mg/L and > 15 mg/L respectively, all beyond the water quality standard.
6.2.2.6 Estimate of Eutrophication in Reservoir

(1) Model Prediction

Phosphorous concentration in the reservoir is under estimate from Vollenweidwer Model and Dylon Model.

□ Annual mean concentration of NH3-N and phosphor is estimated according to Vollenweidwer Model:

\[
C = \frac{C_i}{1 + \sqrt{H / q_s}}
\]

\[q_s = Q_{inflow} / A\]

of which: \(C\) —Annual mean concentration of NH3-N and phosphor, mg/L;

\(C_i\) —Annual mean concentration of NH3-N and phosphor by flow weighted mean, mg/L;

\(H\) —reservoir mean water depth, m;

\(q_s\) —Annual mean load in unit area, m\(^3\)/(m\(^2\)·a);

\(Q_{inflow}\) —inflow, m\(^3\);

\(A\) —Water area, m\(^2\)

\(C_i\) in Vollenweidwer Model is determined in line with the mean concentration of NH3-N and phosphor coming from the upper stream.

□ Dylon Model:

\[
C = \frac{L (1 - R )}{\rho \cdot H}
\]

Of which: \(L\) —annual NH3-N or phosphor accumulated in certain area of a reservoir, g/(m\(^2\)·a);

\(R\) —NH3-N or phosphor retardance coefficient, 1/a;

\(R = 0.426\exp(-0.271q_s) + 0.547\exp(-0.00949q_s)\)

\[q_s = Q_{inflow} / A\]

\(\rho\) —hydraulic erosion coefficient, 1/a, and \(\rho = \frac{Q_{inflow}}{V}\)

\(Q_{inflow}\) —inflow, m\(^3\)/a

\(V\) —volume of reservoir, m\(^3\)

According to Vollenweidwer Model and Dylon Model it is estimated that in 2012 NH3-Nous and phosphorous concentration will reach 0.0145mg/L and 0.0132mg/L respectively; while in 2020 they will average 0.0150mg/L and 0.0137mg/L respectively. For detail of the major
parameters see Table 6.2—28.

Table 6.2—28 Estimate of NH3-Nous & Phosphorous Concentration

<table>
<thead>
<tr>
<th>Item</th>
<th>Gross contaminant t/a</th>
<th>unit area loading g/m².a</th>
<th>Estimated Concentration(mg/ L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vollenweidwer Model</td>
</tr>
<tr>
<td>Total phosphorus in 2012</td>
<td>High water</td>
<td>55.41</td>
<td>19.30</td>
</tr>
<tr>
<td></td>
<td>Low water</td>
<td>55.41</td>
<td>6.50</td>
</tr>
<tr>
<td>Total phosphorus in 2020</td>
<td>High water</td>
<td>75.23</td>
<td>19.98</td>
</tr>
<tr>
<td></td>
<td>Low water</td>
<td>75.23</td>
<td>7.18</td>
</tr>
</tbody>
</table>

Estimate analysis and computation shows that in Shihutang Reservoir mean phosphorus nutritive element is <0.015 mg/l. With reference to assessment criteria (See Table 6.2—29) of reservoir eutrophication, it is known that the phosphorus concentration is at the lower limit of the mesotrophic level, therefore there will be no eutrophication in Shihutang Reservoir.

(2) Analogy

Eutrophication is usually under analysis by way of such indexes as NH3-N, phosphorous and chlorophyl. Wan'an reservoir in the upper stream is similar to Shihutang Project in the natural conditions and geographic location, and can be used as analogy works. According to data collected in Wan'an Reservoir in 2002 (see Table 6.2-30), the total phosphorus concentration averages 0.02 to 0.026 mg / L, total NH3-N concentration 0.66 to 0.8 mg / L, thus it can be seen that the reservoir is of medium nutrition level. For Shihutang reservoir in the unit area the NH3-N and phosphorus concentration is similar to the indexes in Wan’an. In addition, Shihutang is of daily regulation reservoir with numerous water replacement in a year, so it is clear that the Shihutang reservoir will be free from eutrophication on the whole.

Table 6.2—29 Criteria of Eutrophication of Phosphorus Concentration

<table>
<thead>
<tr>
<th>Nutritional status</th>
<th>Index</th>
<th>TP</th>
<th>TN</th>
<th>Chlorophyll</th>
<th>Permanganate index</th>
<th>Transparency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oligotrophic</td>
<td>10</td>
<td>0.001</td>
<td>0.02</td>
<td>0.0050</td>
<td>0.15</td>
<td>10.00</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.004</td>
<td>0.05</td>
<td>0.0010</td>
<td>0.40</td>
<td>5.00</td>
</tr>
<tr>
<td>mesotrophic</td>
<td>30</td>
<td>0.010</td>
<td>0.10</td>
<td>0.0020</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>0.025</td>
<td>0.30</td>
<td>0.0040</td>
<td>2.00</td>
<td>1.50</td>
</tr>
<tr>
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<td>50</td>
<td>0.050</td>
<td>0.50</td>
<td>0.0100</td>
<td>4.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Eutrophication</td>
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<td>0.0260</td>
<td>8.00</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>0.200</td>
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<td>0.0640</td>
<td>10.00</td>
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</tr>
<tr>
<td></td>
<td>80</td>
<td>0.600</td>
<td>6.00</td>
<td>0.1600</td>
<td>25.00</td>
<td>0.30</td>
</tr>
<tr>
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<td>9.00</td>
<td>0.4000</td>
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<td>0.20</td>
</tr>
<tr>
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<td>16.00</td>
<td>1.0000</td>
<td>60.00</td>
<td>0.12</td>
</tr>
</tbody>
</table>
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**Table 6.2—30 Water Grade & Eutrophication in Wan’an Reservoir**

<table>
<thead>
<tr>
<th>Seasons</th>
<th>Grade</th>
<th>Status of Eutrophication</th>
<th>TP</th>
<th>TN</th>
<th>Chlorophyll</th>
<th>Transparency</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Permanganate index</td>
<td>Concentration</td>
<td>Score</td>
<td>Concentration</td>
<td>Score</td>
<td>Concentration</td>
</tr>
<tr>
<td>Whole year</td>
<td>□</td>
<td>2.4</td>
<td>42</td>
<td>0.023</td>
<td>39</td>
<td>0.73</td>
<td>55</td>
</tr>
<tr>
<td>Flood seasons</td>
<td>□</td>
<td>2.6</td>
<td>43</td>
<td>0.026</td>
<td>40</td>
<td>0.8</td>
<td>56</td>
</tr>
<tr>
<td>Non-flood periods</td>
<td>□</td>
<td>2.1</td>
<td>41</td>
<td>0.02</td>
<td>37</td>
<td>0.66</td>
<td>53</td>
</tr>
</tbody>
</table>

In the reservoir area it is about 38 km from Taihe dam site to Shihutang dam site, where there are two tributaries: Shu River (with catchment area of 1305 km²) and Yunting River (with catchment area of 763 km²) (Guanyuan River is under diversion by Wanhe Diversion & Drainage Canal to flow downstream the dam site). In the upper stream of the two tributaries there are no large-scale industrial and mining enterprises, but under impact from the submerged vegetation and other organisms in the reservoir, the organic remnants will dissolve in the water and it is likely that in 2 to 3 years there may be eutrophication in the branch of the reservoir where flow is relatively slow flow.

### 6.2.2.7 Prediction of Surface Water Capacity & Pollutant Control

Two-dimensional convection-diffusion model is applied for prediction of reservoir water pollutant carrying capacity as follows:

\[
m = \left( \frac{C_s - C_0 \exp \left( -k \frac{x}{u} \right)}{\exp \left( -k \frac{x}{u} \right)} \right) \cdot H \cdot \sqrt{\pi E_z \cdot \frac{x}{u}}
\]

where:
- \(m\)—environmental capacity t/a
- \(C_s\)—average pollutant concentration at the section of the control point mg/L
- \(C_0\)—average pollutant concentration at the section of the drain outlet mg/L
- \(H\)—average water depth at the initial section m
- \(U\)—longitudinal flow velocity m/s
- \(k\)—self-purification coefficient l/d for NH3-N; 0.22 l/d for BOD₅ and 0.06 l/d for COD
- \(E_z\)—lateral diffusion coefficient m²/s
- \(x\)—distance from initial calculation point to the drain outlet m

Lateral diffusion coefficient \(E_z\) may be obtained in such empirical formula as follows.
where \( a_z \) — zero dimensional diffusion coefficient at 0.15, 

\[ H \] — average water depth at the section, 

\[ U^* \] — friction flow velocity, 

\[ g \] — gravitational acceleration, 9.8 m/s², 

\[ I \] — hydraulic slope, 9.8 m/s². 

After completion of the dam, \( E_z = 0.01327 m^2/s \) 

Prediction shows that in case of the design flow at 157.5 m³/s for the Shihutang Project at 90% assurance rate in the dry season, water environmental capacity for NH₃-N at Chengjiang Outlet reaches 155.9 t/a, for BOD₅ 695.2 t/a and for COD 3506.6 t/a. 

Annual emission in the near future Chengjiang Outlet of NH₃-N is estimated to total 137.87 t/a, of BOD₅ 432.03 t/a, and of COD 973.6 t/a. In the far future annual emission of NH₃-N therein is expected to amount to 146.0 t/a, of BOD₅ to 365.0 t/a, and of COD to 1095.0 t/a, all of which is less than local evaluated environmental capacity. See Table 6.2.31. 

### Table 6.2.31 Environmental capacity from Chengjiang Sewage Outlet to 100m up in the Upper Stream from Intake of Chengjiang Water Plant

<table>
<thead>
<tr>
<th>Time</th>
<th>Items</th>
<th>Environmental capacity t/a</th>
<th>Pollutant discharge t/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near future</td>
<td>NH₃-N</td>
<td>155.9</td>
<td>137.87</td>
</tr>
<tr>
<td></td>
<td>BOD₅</td>
<td>695.2</td>
<td>432.03</td>
</tr>
<tr>
<td></td>
<td>COD</td>
<td>3506.6</td>
<td>973.6</td>
</tr>
<tr>
<td>Long run</td>
<td>NH₃-N</td>
<td>155.9</td>
<td>146.00</td>
</tr>
<tr>
<td></td>
<td>BOD₅</td>
<td>695.2</td>
<td>365.00</td>
</tr>
<tr>
<td></td>
<td>COD</td>
<td>3506.6</td>
<td>1095.00</td>
</tr>
</tbody>
</table>

#### 6.2.2.8 Estimate of Discharged Water Quality

In case of the hydropower station under normal operation, in the near future in front of the dam, COD in the reservoir is estimated to reach 4.49 mg/l, and in the far future COD will total 4.28 mg/l. Discharge of such water will accelerate flow velocity and improve reoxygenation capacity so that water quality will change for the better. As a result, there is not much change in water quality downstream if compared with the quality before construction of the project. 

#### 6.2.2.9 Analysis of Sewage from Ships in the Reservoir

Vessel sewage discharge in the reservoir will total 1079.1 t/a in 2020 and 1333.1 t/a in 2030 respectively. Comparison and analysis on the basis of acquired data shows that corresponding concentration of COD and BOD₅ will total 300 mg/l and 200 mg/l respectively. Without direct
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treatment the vessel sewage will be discharged into the channel, only to produce pollution to water environment in the reservoir. Hence arises the necessity to forbid discharge of vessel sewage. Vessel sewage shall be under collection from gathering units in the vessel to transfer to sewage receiving vessels or to shore receiving units for treatment until to meet the Grade I criteria as described in Standard for Sewage Discharge (GB8978-1996) (concentration of COD and BOD₅ will reach 100mg/l and 20mg/l respectively). To be exact, discharge of COD in 2020 and 2030 shall be less than 323.7kg/a and 399.9kg/a and OD₅ shall be less than 215.8kg/a and 266.6kg/a respectively.

6.2.2.10 Bilge Water

Mean oil concentration in bilge water averages 5000mg/l, so that in 2020 and 2030 bilge water will total 393.4t/a and 611t/a respectively. If without treatment, direct discharge of bilge water would create desirable pollution to water body. So there will be no direct discharge of bilge water, which shall be under collection from gathering units in the vessel to transfer to sewage receiving vessels or to shore receiving units for treatment until to meet the Grade I criteria as described in Standard for Sewage Discharge (GB8978-1996) (5mg/l). To be exact, discharge of bilge water in 2020 and 2030 shall be less than 2.0kg/a and 3.1kg/a.

6.2.2.11 Domestic Sewage out of Personnel from Shihutang Management Bureau

There will be about 129 staff in Shihutang Project Management Bureau, who will discharge 7062.75t/a of domestic sewage. Such sewage contains mainly COD and BOD₅, whose concentration may reach 300mg/L and 200mg/L respectively, so annual discharge will total 2118.83kg and 1412.55kg respectively. Such sewage shall be under treatment to meet the Grade I standard so that discharge concentration of COD and BOD₅ will average 100mg/L and 20mg/L respectively or to total 706.28kg/a and 141.26kg/a. After treatment such domestic sewage will produce little impact upon water quality in Kan River.

6.2.3 Comprehensive Evaluation of Environmental Impact upon Surface Water

- Water body in the reservoir is of mixed pattern, thus there is little difference in water temperature in the discharged water and natural water, to produce no impact upon downstream eco-environment.

- Under the hydrological condition of monthly average flow of the driest month at 95% of assurance rate, after completion of the dam, in scope of the nearshore waters lasting 2050m long and 23m wide close to Chengjiang Sewage Outlet in the near future, the pollutant concentration goes beyond Grade II of water quality standard; at 2461m downstream the outlet (1000m in the upstream, 5m to the bank) NH₃-N concentration □0.5 mg/L, BOD₃ 3 mg/L and COD□15 mg/L. Still, water meets the requirement of water intaking of the Chengjiang Water Plant, 3461m downstream.

Under the hydrological condition of monthly average flow of the driest month at 95% of assurance rate, after completion of the dam, in scope of the nearshore waters lasting 2350m long and 15m wide close to Chengjiang Sewage Outlet in the far future, the pollutant concentration goes beyond Grade II of water quality standard; at 2461m downstream the outlet (1000m in the upstream, 5m to the bank) NH₃-N concentration □0.5 mg/L, BOD₃ 3 mg/L and COD□15 mg/L. Still, water meets the requirement of water intaking of the Chengjiang Water...
Plant, 3461m downstream.

In case of the sewage treatment plants under normal discharge, under the conditions with and without the Shihutang Project and of short-term and long-term impacts, the quality of water at 1000m upstream of the water intake can satisfy Grade II of water quality standard; if under emergency discharge, the quality of water can not satisfy Grade II.

Under the hydrological condition of monthly average flow of the driest month at 90% of assurance rate, after completion of the dam, within the scope of 2000m long and 22m wide nearshore waters downstream of Chengjiang Wastewater Outlet, the quality of water will exceed Grade II in the near future; within the scope of 4480m long and 31m wide nearshore waters from Wentian Wastewater Outlet to Yanxi Wastewater Outlet, the pollutant concentration will exceed the Grade II of the water quality standard.

Under the hydrological condition of monthly average flow of the driest month at 90% of assurance rate, after completion of the dam, within the scope of 2250m long and 15m wide nearshore waters downstream of Chengjiang Wastewater Outlet, the pollutant concentration will exceed Grade II in the far future; within the scope of 1800m long and 31m wide nearshore waters downstream of Wentian Wastewater Outlet, the COD concentration will exceed the Grade II of the water quality standard in the far future; within the scope of 700m long and 12m wide nearshore waters downstream of Yanxi Wastewater Outlet, the COD concentration will exceed the Grade II of the water quality standard in the far future.

Annual mean phosphorus nutritive element in Shihutang reservoir will be 0.015mg/l, to mean that phosphorus concentration is at the lower limit of mesotrophic level, therefore there will be no eutrophication in the reservoir.

Water environmental capacity of NH3-N at Chengjiang Wastewater Outlet is 155.9t/a; BOD$_5$ 695.2t/a, and COD 3506.6t/a.

In the near future annual NH3-N discharge at Chengjiang Wastewater Outlet is expected to be 137.87 t/a, BOD$_5$ 432.03 t/a, and COD 973.6 t/a; in the long run annual NH3-N discharge at Chengjiang Wastewater Outlet will reach 146.0 t/a, BOD$_5$ 365.0 t/a and COD 1095.0 t/a, all are below the environmental capacity of the river section.

Under normal operation, in the reservoir area upstream of the dam in the near future, COD concentration is expected to be 4.49 mg/l, and in the long run 4.28 mg/l; After water is discharged, the water flow rate will increase so that reoxygenation capacity will be improved and water quality will get better, thus the quality of water downstream of the dam site will not have a big change compared with that before construction of the dam.

[6] During the operation period, collection and disposal of vessel sewage, bilge water and domestic sewage from Shihutang Project Management Dept. will meet the Grade I criteria as described in Standard of Waste Discharge (GB8978-1996). As a result there will be limited impact upon water body to produce no change in surface water function.

6.2.4 Analysis of Impact upon Underground Water

6.2.4.1 Geohydrologic Characteristics of Underground Water
Unconsolidated rock pore water is distributed along the bank of Kan River and her tributaries, with the water-bearing rock made up of alluvial deposit. Such alluvial deposit is the major water bearing strata. Water supply is mainly in form of rainfall by way of gravel and sand seepage and river lateral seepage. During the flood periods the nearshores are under feeding from the river flow, while during normal seasons and low water periods the shores supply water to the river. The first bottom and the second terrace are of inter-slanted, of identical underground level, to discharge toward the river. the other part of the terrace is of base terrace, where underground will discharge into the river by way of wells in the front of the terrace or in where there are deep-cut low-lying areas.

Bedrock fracture water is mainly of red clasolite of Cretaceous System, where the sand gravel is moderately weathered, rich in water; in comparison, siltite are filled with pelyte in the fracture, thus the zone of weathering bears little water, and the underground water exists mainly in fracture and pore or weathered submergence under tectonization and mechanical weathering. The fracture is under feeding from rainfall, to discharge into the fracture underground layers, not so abundant in water reserve.

### 6.2.4.2 Relationship between Underground Water & Kan River

Kan River is related to underground water that exists surrounding the second bottom and the second terrace close to Kan River. When water level in Kan River is higher than that of underground water, underground water receives feeding from Kan River; otherwise underground water will discharge into Kan River. Kan River produces long-term impact upon the underground water in that there is more impact upon underground water if Kan River is closer to underground water location, and vice versa.

### 6.2.4.3 Underground Water Reserve & Utilization Status

Underground water is classified into unconsolidated rock pore water and bedrock fracture water, with pore water richest in reserve. Generally individual well water inflow amounts to 5815.12~3614.55t/d, or maximum to 6778.01t/d. Pore water is mainly distributed in the overflow land and second bottom, while fracture water mainly in hilly land.

Underground water is under exploitation for drinking or irrigation.

### 6.2.4.4 Analysis of Environmental Impact upon Underground Water

After reservoir filling to normal water level at 56.5m, water will be raised to different degree in different sections of the river. The normal water level is higher than natural water level by 9.43m (Minimum flow as observed on Feb. to Oct. 2006 reached 274m³/s, with corresponding water level in the upper reach of the dam averaged 47.07m), and water level for 10-year and 20-year recurrence flood was raised by 0.08m and 0.14m respectively. Now water feeding to the underground water in the second bottom and second terrace will be resumed in this case until dynamic equality of underground water is established. Lowering of the underground water will be under effective control, so that underground water reserve will remain stable and steady, to provide sufficient water sources for development of daily water and industrial consumption in Taihe County Town.

Meanwhile, due to gradual rising of underground water, drought in the second bottom will be relieved effectively, so that some of the deserted farmland may become suitable for
reclamation. The lakes and wetland at the edge of the second bottom and the second terrace will be enlarged with the gradual rising of the underground water, to perfect its eco-function.

After reservoir filling to normal water level at 56.5m, water filling will be undertaken only in non-flood season, so there will little impact upon the downstream reach of Kan River or upon development of underground water.

But with reservoir filling and operation of Shihutang Project, a huge narrow artificial lake will develop in the reach of Taihe County, when Kan River will transform from a natural river into relatively static lake and natural purification will be greatly weakened. If more wastewater were discharged into Kan River and such wastewater failed to be under proper treatment, Kan River would be polluted with worse water quality. Since the underground water in the second bottom and second terrace is closely related to Kan River in terms of hydraulic connection and complementary action, underground water in the second bottom and the second terrace will be contaminated to result in worse water quality and negative impact upon daily life and production. In a word, during construction and the operation period of the project there must be as limited pollutants as possible to be discharged to Kan River so as to protect surface and underground water resources.

To sum up, by way of decease in discharge into Kan River of pollutants and sewage, the Shihutang Project meets the environmental need concerning underground water, only to create positive impact upon eco-benefit and economic benefit in areas close to Kan River.

6.3 Ecological Environment

6.3.1 Evaluation Methodology

Based on analysis and evaluation of the status quo, 3S technology will be fully utilized to collect as much information as possible. Then on the basis of ecological system, such methodology as ecological mechanism analysis and landscape ecology will be adopted to make prediction concerning direct or indirect impact from construction and operation of the Shihutang Project.

6.3.2 Analysis of Ecological Environment during the Construction Period

This project has a construction period of 51 months, to cover such works as main works, protection embankment and diversion canal, etc. Such construction works as housing for construction, embankment construction, and highway development will produce change to original land layout. Such main works as cofferdam, bank regulation, and sand and gravel acquisition will greatly increase suspended solid in the reach of Kan River, which is the major cause of impact out of the Project upon ecological environment.

6.3.2.1 Impact upon Terrestrial Plants

- Impact upon vegetation

Direct impact from the Project upon vegetation is mainly in form of (a) permanent acquisition of land for pivotal projects; (b) permanent acquisition of land for protection embankment; (c) damage to vegetation during bank regulation; (d) acquisition of stones and sand, and excavation waste dump; and (e) acquisition of land for temporary roads, etc. The major species of vegetation include Form Pinus massoniana, Form Pinus elliottii, shrub and meadow and artificial gardens (For detail see Table 6.3-1). There is no broad-leaved forest or native
vegetation. Except for permanent acquisition of land, there is no re-vegetation for other kinds of land use. Except for limited historical trees, there is no rare plant community, all of which is local dispersed species.
### Table 6.3—1 Directory of Land for the Project

<table>
<thead>
<tr>
<th>Works</th>
<th>Sum</th>
<th>Paddy fields</th>
<th>Dry land</th>
<th>Garden</th>
<th>Forest</th>
<th>Uneven ground</th>
<th>Resident land</th>
<th>Unexploited</th>
<th>Waters</th>
<th>Land for communications</th>
<th>alluvial land</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>For pivotal works</td>
<td>424.95</td>
<td>34.5</td>
<td>112.95</td>
<td>0</td>
<td>72.0</td>
<td>202.05</td>
<td>0</td>
<td>0</td>
<td>3.45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For Project management</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>49.95</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For embankment</td>
<td>3877.95</td>
<td>402.6</td>
<td>973.65</td>
<td>76.35</td>
<td>1237.15</td>
<td>1017.0</td>
<td>10.2</td>
<td>56.4</td>
<td>104.6</td>
<td></td>
<td></td>
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<tr>
<td>For inundation</td>
<td>38172.15</td>
<td>299.25</td>
<td>1154.25</td>
<td>28.05</td>
<td>2159.25</td>
<td>1500.9</td>
<td>106.2</td>
<td>415.05</td>
<td>32484</td>
<td>25.5</td>
<td></td>
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<tr>
<td>Sum</td>
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<td>736.35</td>
<td>2240.9</td>
<td>104.4</td>
<td>3468.4</td>
<td>2769.9</td>
<td>116.4</td>
<td>471.45</td>
<td>32592.1</td>
<td>25.5</td>
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<tr>
<td>Broadening roads</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>48.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resettlement</td>
<td>78.15</td>
<td>39.0</td>
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<td></td>
<td></td>
<td></td>
<td>39.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifting field</td>
<td>1237.05</td>
<td>1237.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction site &amp; living quarters</td>
<td>963.15</td>
<td>37.2</td>
<td>493.95</td>
<td>0</td>
<td>227.7</td>
<td>49.95</td>
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<td></td>
<td>154.35</td>
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<tr>
<td>construction detour</td>
<td>412.95</td>
<td>3.75</td>
<td>188.25</td>
<td>0</td>
<td>108.15</td>
<td>97.5</td>
<td></td>
<td></td>
<td></td>
<td>15.3</td>
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<td></td>
</tr>
<tr>
<td>Borrow earth pits</td>
<td>517.95</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>Sand gravel yard</td>
<td>1873.95</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>1873.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excavation waste dump</td>
<td>1764.45</td>
<td>13.95</td>
<td>451.8</td>
<td>0</td>
<td>508.05</td>
<td>732.6</td>
<td></td>
<td></td>
<td></td>
<td>58.05</td>
<td></td>
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<tr>
<td>Total</td>
<td>6895.65</td>
<td>1330.95</td>
<td>1417.65</td>
<td>0</td>
<td>1000.8</td>
<td>957.45</td>
<td>39.15</td>
<td>48.0</td>
<td>2101.65</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Impact upon biodiversity & plant resources

Impact upon plant resources during the construction period includes destruction of some red pines, slash pines and sapling of Form Populus lasiocarpa which have been planted in the course of returning farming land to forestry; impact also includes reduction of hay crop resources in the alluvial flat. In addition, acquisition will create some impact upon farmland and gardens. All the impact is partial and local, with nonnegative influence upon species reproduction and preservation. Construction of the Project will produce no destructive impact upon biodiversity or to the overall agriculture or forestry. There is no rare species of trees under impact, except for some historical trees.

Impact upon historical trees

During the construction period, impact upon historical trees is a sensitive point in such aspects as (a) direct influence to historical trees; (b) construction of the project will create negative impact upon growth of the historical trees (especially out of embankment protection works); (c) after reservoir filling the surrounding underground water will be raised to bring negative impact upon historical trees of low elevation (upon their root respiration); (d) damage of the construction to historical trees, upon their leaves, root, and stems. For detail see Chapter Seven concerning evaluation of impact upon historical trees.

Impact upon province-level protection trees

There are 11 species of plants under province-level protection, including podocarpus macrophyllus, Osmanthus fragrans, camellia, mastic tree, Chinese holly, Ilex rotunda, Bischofia tyifiata, Gentiana scabra Bunge, Planchonella spp., Sapindus mukorossi Gaerth and Asnaragus cochinchenisic. These species are mainly distributed in the herbage of shrub and underwood and in the broad-leaved forest close to villages. There is no such mentioned species in the project site, except for Gentiana scabra Bunge, Planchonella spp., Chinese holly, Asnaragus cochinchenisic occasionally in borrow earth pits. Anyway they are limited in number, with no large trees or historical trees, all of which are dispersed species. The project will in no way threaten their survival or reproduction, and its impacts are slight.

6.3.2.2 Impact upon Terrestrial Animals

With broadening of the access roads, with construction machinery and constructors moving to the site, noise from the stockyard and from construction operation will change the habitat environment of the wild animals, to produce negative impact upon the habitat, life habit and residence thereof. Such influence is decided by various causes.

Construction will produce little impact upon terrestrial animals. Due to limited quantities of wild animals, which are mostly distributed in artificial forests and shrubs somewhat distant from the dam site in Yanxi, Chengjiang and Tongjianzhuang. They may be frightened from their original habitat, but they will return once the project is completed, thus such impact is temporary and will be finished with the completion of the project.

Amphibians undertake reproduction and ingestion in the underwood and the scrub forest. After reservoir filling, these places in the Shihutang Reservoir will be under inundation, to force these amphibians to move to shallow river bend or forks in the upper reach. Rhacophoridae is terricolous. The dam once completed will reduce its habitat and reduce its community. But to Bufo B.gargarizans Cantor that lives on farmland, gulch or villages, reservoir filling will enlarge its habitat, favorable for its development.

Bufo B.gargarizans Cantor and Zaocys dhumnades mainly inhabit close to moist and dark
shrub, farmland, gulch or villages, by feeding on insects. Serpentry mostly live on low-relief terrain and hills in broad-leaved deciduous forest, mixed broadleaf-conifer forest or dark and moist brushwood, or farmland, to feed upon insects, Batrachia, birds or rats. During construction, the construction materials and waste slag will change the river turbidness and other physicochemical properties, to bring damage to the life habitat to these amphibians and reptiles. But they will move to non-construction areas or to non-inundation regions, thus there will be no threat to their survival. Numerous constructors working in the site may kill some wild animals, to damage these amphibians and reptiles resources. There shall be countermeasures to prevent such occurrence.

Ardeidae is the dominant bird in this area, which mainly inhibits in water surface and forests to feed upon fishes. Of beasts the dominant is Lepus capensis. These dominant species will be under influence from construction to be forced to desert their original habitat. Adjacent beasts and birds will also be frightened to move away. But such impact is limited and will not last long. Re-vegetation of temporary acquisition of land will make them return to initial habitat.

Muridae (like Rattus norvegicus Berkenhout) overlaps a lot with human activities, which may inhibit at human houses or in outdoors and change with the seasons. In winter then food is rare outdoors, they will move to human houses. While in spring when it gets warm and there is plenty of food outdoors they will move outside. They are the source of natural focal infection. During construction their density will increase, therefore close observation shall be made to prevent any occurrence of natural focal infection.

### 6.3.2.3 Impact upon Aquatic Organism

- **Impact upon benthonic organism**

During the construction period, sand machinery will stir the bed silt and fine sand into moving upward to create a pinniform cloudy belt, to create negative impact upon aquatic organism, especially upon benthonic organism. Secondary settlement of sand from sand stirring will bury the benthonic organism nearby, to deteriorate their life habitat and make it impossible to survive, except for some species of strong adaptability, like mussel.

The construction will have benthonic organism in the reach suffer from complete destruction. Based on investigation in Shihutang concerning benthonic organism status, mean bio-mass of benthonic organism amounts to 76.4g/m², if calculated at affected area of 104mu, estimated loss of benthonic organism totals about 5.24t.

- **Impact upon fish stocks**

For detail see Chapter Eigt concerning fishes and spawning grounds.

### 6.3.3 Impact upon Ecological Environment

#### 6.3.3.1 Impact upon Terrestrial Plants

- **Impact upon vegetation**

Direct impact from the Project upon vegetation is mainly in form of (a) permanent acquisition of land for pivotal projects; (b) permanent acquisition of land for protection embankment; (c) damage to vegetation during bank regulation; (d) acquisition of stones and sand, and excavation waste dump; and (e) acquisition of land for temporary roads, etc. The major species of vegetation include Form Pinus massoniana, Form Pinus elliottii, shrub and
meadow and artificial gardens (For detail see Table 6.2—1). There is no broad-leaved forest or native vegetation. Except for permanent acquisition of land, there is no re-vegetation for other kinds of land use. Except for limited historical trees, there is no rare plant community, all of which is local dispersed species.

- Impact upon biodiversity & plant resources

Impact upon plant resources during the construction period includes destruction of some red pines, slash pines and sapling of Form Populus lasiocarpa which have been planted in the course of returning farming land to forestry; impact also includes reduction of hay crop resources in the alluvial flat. In addition, acquisition will create some impact upon farmland and gardens. All the impact is partial and local, with nonnegative influence upon species reproduction and preservation. Construction of the Project will produce no destructive impact upon biodiversity or to the overall agriculture or forestry. There is no rare species of trees under impact, except for some historical trees.

- Impact upon historical trees

During the construction period, impact upon historical trees is a sensitive point in such aspects as (a) direct influence to historical trees; (b) construction of the project will create negative impact upon growth of the historical trees (especially out of embankment protection works); (c) after reservoir filling the surrounding underground water will be raised to bring negative impact upon historical trees of low elevation (upon their root respiration); (d) damage of the construction to historical trees, upon their leaves, root, and stems. For detail see Chapter Seven concerning evaluation of impact upon historical trees.

6.3.3.2 Impact of habitat upon animals

- Loss of Habitat

After reservoir filling, the existing habitat for wild animals will be under flood inundation, which will reduce their habitat. For animals located in lower altitudes, such as reptiles and small beasts and serpentry, damage of initial habitat will force them to resettle upward. For birds and beasts initially inhabiting in lower altitudes shrub, meadows, their habitat will be partially damaged. But they are of resettlement capacity, with multiple sources of food, thus the project will not produce much influence upon them. After reservoir filling their prowl will decrease, but they will not be threatened.

- Impact of changed riverside landscape upon wetland animals

Completion of the project will lift the water surface and enlarge waters, to create ideal habitat for static hydrocole amphibians like bufo gargarizans. Prowl and habitat for the waterfowl will vanish, thus original eco-function will be destroyed.

After reservoir filling, forest cover will create desirable conditions for such water birds as aigrette and grey heron, good for their reproduction.

6.3.3.3 Impact upon Plankton

Completion of the project will transform the river into lacustrine facies, so that nutritive materials will keep releasing during flood inundation and more nutritive materials will flow into the reservoir with the runoff, favorable for development of phytoplankton. After reservoir
filling there will be numerous embayment where water is relatively static with limited concentration of nutritive salts, to create necessary conditions for survival and reproduction of plankton. Diatom, which was dominant, will be gradually replaced by chlorella. Moreover, in spring and autumn due to water convection, nutritive materials rich in subjacent waters will move to the surface water, desirable for phytoplankton, which lives and reproduces in sunshine layers. In spring, green algae will quickly multiply in species and quantity, followed by other species of algae. It may be safely estimated that on the reservoir the quantity and biomass of phytoplankton will reach peak in spring. In autumn when the air and water temperature is low, there will be no peak of phytoplankton.

In the river there is limited species and quantity of Cladocera and copepoda, which will increase in quantity and species, so will rotifer and protozoans. In spring there will be peak of plankton in quantity and biomass.

### 6.3.3.4 Impact upon Benthonic Organism

Completion of Shihutang Project will broaden the river, which will have no more torrents, not to create much impact upon benthonic organism. Numerous freshwater snails originally attached to nearshore rocks or stones will disappear due to increased water level, but formation of broader river channels will create better condition for freshwater snails. Where there is no torrent and water depth is over 10m, the freshwater snails will vanish, but waters of various hydraulic properties will create habitat for migratory fishes and non-migratory fishes, favorable for parasitic larva. In a word, completion of Shihutang Project produces little impact upon benthonic organism in species and quantity.

### 6.3.3.5 Impact upon Fish Stocks

Completion of Shihutang Project will produce change in some of the natural reach of Gan River close to Taihe County, to create some impact to aquatic organism, so that original eco-balance is broken to establish fresh balance by way of fish regulation. For detail see Chapter Eight.

### 6.3.4 Impact upon Arable Land & Agricultural Activities during Operation Period

- Acquisition of arable land

Permanent and temporary acquisition of land will total 5725.9 mu, of which permanent acquisition of land reaches 2977.3 mu (including 198.27 mu of basic farmland), temporary acquisition of land totals 2748.6 mu, which will create some influence to agricultural activities. Permanent acquisition of land will involve only 1.18% of gross arable land (251295 mu), thus very limited in impact. By way of lifting the field and re-vegetation of temporary acquisition of land, crop loss may be compensated to some degree. Of the permanent acquisition of land, 198.27 mu is of basic farmland, which shall be under acquisition in line with Laws of Protection of Basic Farmland. For such acquisition see Table 6.3-2.
Table 6.3—2 Percentage of Permanent Acquisition of Land in Gross Arable Land

<table>
<thead>
<tr>
<th>Towns</th>
<th>Gross affected arable land (mu)</th>
<th>Permanent acquisition (mu)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wanhe</td>
<td>71850</td>
<td>873.88</td>
<td>1.22%</td>
</tr>
<tr>
<td>Yanxi</td>
<td>35670</td>
<td>1007.78</td>
<td>2.83%</td>
</tr>
<tr>
<td>Tangzhou</td>
<td>50175</td>
<td>818.10</td>
<td>1.63%</td>
</tr>
<tr>
<td>Chengjiang</td>
<td>31905</td>
<td>180.10</td>
<td>0.56%</td>
</tr>
<tr>
<td>Mashi</td>
<td>60105</td>
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</tr>
<tr>
<td>Wuxi</td>
<td>1590</td>
<td>55.31</td>
<td>3.48%</td>
</tr>
<tr>
<td>Sum</td>
<td>251295</td>
<td>2977.3</td>
<td>1.18%</td>
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</tbody>
</table>

The permanent acquisition of land for Shihutang Project will total 198.27 mu. In line with Regulations of Protection of Primary Farmland and relevant laws and rules, the owner shall obtain permits from state land planning department for approval of the said acquisition of primary farmland. The owner shall make compensation for the occupied farmland in the principle of reclamation of the same amount of primary farmland. In case of impossibility to reclaim the same amount of farmland of identical quality, the owner shall pay fees to the province in line with relevant regulations concerning reclamation of farmland. The owner in this case shall recover the surface soil of the occupied arable land for improvement of the newly reclaimed land or poor arable land. At present the owner has entrusted the departments concerned with compilation of Amended Overall Planning of Land Utilization in Taihe County for Construction of Shihutang Project, and are undergoing relevant procedures and permits from the state land management department. The permanent acquisition of land (especially of arable land totaling 2977.3 mu and of primary land totaling 198.27 mu) has been listed in the said Amended Overall Planning, so that the project will achieve balance between acquisition of land and reclamation of farmland.

Impact upon Grain Output

Impact upon Grain Output in paddy fields: in accordance with statistics of 2005 yearbook the average early rice output in Taihe County was 301 kg/mu, late rice 306 kg/mu, so annual rice output totals 607 kg/mu.

Annual loss in paddy fields from permanent acquisition of land: $607 \times 775.4 = 470.7 \text{ (t)}$

Annual loss in paddy fields from temporary acquisition of land in the first three years: $607 \times 58.65 \times 3 = 106.8 \text{ (t)}$

Annual loss in paddy fields prior to lifting the field: $607 \times 1237.1 = 751 \text{ (t)}$

Grain output will be reduced after restoration of farming even after termination of the temporary acquisition of land and after lifting the field.

Impact upon grain output in dry fields: investigation shows that in the project area there are mainly such dry crops as legume, tuber crops, oil-bearing crops and vegetable. Basic loss is calculated as follows:

Legume $68 \text{ kg/mu} \times 3673.2 \text{ mu} = 249.8 \text{ (t/a)}$

Tuber crops $264.9 \text{ kg/mu} \times 3673.2 \text{ mu} = 973.0 \text{ (t/a)}$

Oil-bearing crops $62.9 \text{ kg/mu} \times 3673.2 \text{ mu} = 231.1 \text{ (t/a)}$
Vegetable: 1849 kg/μ×3673.2 μ×6791.8 (t/a)

At present, some of the existing farmland is frequently subject to impact from inundation, thus with lower yields. Shihutang Project will develop five protection zones in Taihe county city, Wanhe, Yongchang, Yanxi and Zhangtang, in order to improve the current flood standard from 2 to 5 year-recurrence to 10 to 20-year-recurrence. As result, the Project will have a total area of 74.8 km² and 650 million mu of cultivated land and 53000 residents under protection. By way of elevated fields on the left bank the tributary Yunting River and in Mawei city at the tail of the reservoir, a total area of 0.12 million mu of cultivated land will be brought under protection. This is very favorable for agricultural activities.

Such temporary measures as elevation of farmland will compensate to some degree for agricultural losses.

6.3.5 Impact upon Productivity of Land

6.3.5.1 Biological Productivity

Biological productivity refers to the gross organic yield in unit area and unit time (t/hm²·a). this index reflects the productivity of green plants.

\[
P_q = P_n + R \\
P_n = B_q + L + G
\]

Of which
- \( P_q \) —— gross mass growth
- \( P_n \) —— net mass growth
- \( R \) —— quantity of consumption in respiration
- \( B_q \) —— mass growth
- \( L \) —— loss of dead branches and fallen leaves
- \( G \) —— loss from animals ingestion

Coefficient of growth

\[
P_a = B_q / B_{mo}
\]

Of which
- \( B_{mo} \) —— rated biomass

6.3.5.2 Biomass

Biomass refers to the weight of living organisms in unit area that exist during unit time, calculated at t/hm².

Relative biomass

\[
P_b = B_m / B_{mo}
\]

Of which
- \( B_m \) —— rated biomass

6.3.5.3 Species Quantity

Species quantity refers to the amount of certain species in unit area in a community.

Relative species quantity
\[ P_s = \frac{B_s}{B_{so}} \]

Of which $B_s$ —— species quantity

$B_{so}$ —— standardized species quantity

### 6.3.5.4 Composite Index of Productivity Assessment

\[
p = \sum P_j = P_a + P_b + P_s + P_m + P_w
\]

\[
= \frac{B_s}{B_{so}} + \frac{B_m}{B_{mo}} + \frac{B_s}{S_{so}} + \frac{S_m}{S_{wo}}
\]

### 6.3.5.5 Prediction of Change in Production Capacity of Natural System

Completion of the project will result in change in vegetation area and in biomass. See table 6.3 for detail.

From the table it is known that completion of the project gross biomass loss will reach 12232.62t, and gross biological productivity loss will total 3402.29t/a, to make 1.2% and 1.07% in the area respectively. This will create negative impact upon the area, but not much.

**Table 6.3—3 Change in Biomass in Shihutang Area**

<table>
<thead>
<tr>
<th>Types</th>
<th>Area</th>
<th>Biomass (t/hm²)</th>
<th>Biomass loss (t)</th>
<th>Productivity (t/hm²·a)</th>
<th>Productivity loss (t/a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coniferous forest</td>
<td>-353.34</td>
<td>26.34</td>
<td>-9306.98</td>
<td>9.2</td>
<td>-3250.73</td>
</tr>
<tr>
<td>broad-leaved forest</td>
<td>-7.87</td>
<td>90.47</td>
<td>-712.00</td>
<td>11.26</td>
<td>-88.6162</td>
</tr>
<tr>
<td>Shrub &amp; underbrush</td>
<td>-143.45</td>
<td>10.56</td>
<td>-1514.83</td>
<td>6.34</td>
<td>-909.473</td>
</tr>
<tr>
<td>Bamboo grove</td>
<td>-3.45</td>
<td>75</td>
<td>-258.75</td>
<td>18.29</td>
<td>-63.1005</td>
</tr>
<tr>
<td>Meadow</td>
<td>-130.33</td>
<td>3.13</td>
<td>-407.93</td>
<td>2.45</td>
<td>-319.309</td>
</tr>
<tr>
<td>Dry land</td>
<td>-315.83</td>
<td>6</td>
<td>-1894.98</td>
<td>6</td>
<td>-1894.98</td>
</tr>
<tr>
<td>Paddy fields</td>
<td>-141.48</td>
<td>5.26</td>
<td>-744.18</td>
<td>5.26</td>
<td>-744.185</td>
</tr>
<tr>
<td>Waters</td>
<td>2172.53</td>
<td>1.2</td>
<td>2607.04</td>
<td>1.78</td>
<td>3867.103</td>
</tr>
<tr>
<td>Total</td>
<td>1076.78</td>
<td>-12232.62</td>
<td>-3403.29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: mean biomass is based on *Biomass & Net Productivity in Chinese Forestry*, by Fang Jinyun, 1996.

### 6.3.5.6 Assessment of ecosystem stability

Ecosystem stability depends upon two factors, namely resilience and impedance. Resilience stability is related to such factors as quantities and production capacity of meta-stable elements (like vegetation), while impedance stability is closely related to landscape heterogeneity.

Completion of the project will produce change in land type, for example, there will be decrease in arable land and forest, increase in waters, limited impact upon landscape and area or percentage of vegetation forms. Decrease in forest, arable land and ecosystem will result in
decrease of biomass by 12232.62t and loss of productivity by 3402.29t/a. the project on the whole will cause limited interference, to produce not much change in ecosystem stability.

In Shihutang area the dominant vegetation is of artificial or semi-artificial coniferous forest (Form Pinus massoniana and Slash Pine). Such community is monotonous in composition, unable to develop into bio-diversity, poor in timbre thus open to attack from insects, poor in self-adjustability, and imperfect in function. Study shows that artificial forest is inferior to natural forest in saturated soil water content and soil fertility, while suffers more from soil erosion, to play limited role in relief of ecological environment. Completion of the project will enlarge the waters to increase from 18.81km² to 43.47km²(to account for 53.99% of local area). In a word, the project will produce much impact upon landscape heterogeneity and impedance.

6.3.5.7 Assessment of Comprehensive Prediction of Landscape Eco-system

A comparison is made of the amounts and area of the patch type. See Table 6.3—4. Superiority of the patch type after completion of the project is listed in Table 6.3—5.

From the two tables it is known that after completion of the project there is change in land use patterns, of which the waters patch will play a bigger role due to construction of navigation and hydropower generation works, to improve its dominance index from 16.94%(before the completion of the project) to 37.04%, and the degree of dominance of land for building improves too, while there is decrease in dominance index of other patches. The dominance index of waters increases by 20.10%, very high above normal. In a word, the project will create much impact upon landscape.

Table 6.3—4 Comparison of Amounts & Area of Patch Types before & after

<table>
<thead>
<tr>
<th>Patch type</th>
<th>Before completion</th>
<th>After completion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patches</td>
<td>Area  km²</td>
</tr>
<tr>
<td>Forest land</td>
<td>338</td>
<td>323.88</td>
</tr>
<tr>
<td>Shrub grassland</td>
<td>40</td>
<td>109.35</td>
</tr>
<tr>
<td>waters</td>
<td>40</td>
<td>43.93</td>
</tr>
<tr>
<td>Land for urban/rural construction and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mining</td>
<td>57</td>
<td>9.83</td>
</tr>
<tr>
<td>Paddy fields</td>
<td>97</td>
<td>182.69</td>
</tr>
<tr>
<td>Dry land</td>
<td>115</td>
<td>146.95</td>
</tr>
<tr>
<td>Unused land</td>
<td>33</td>
<td>78.54</td>
</tr>
</tbody>
</table>
Table 6.3—5 Dominance Index of Major Patch Types before & after Completion of Shihutang Project

<table>
<thead>
<tr>
<th>Patch types</th>
<th>Rd</th>
<th>Rf</th>
<th>Lp</th>
<th>Do</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest land</td>
<td>46.94</td>
<td>46.97</td>
<td>48.81</td>
<td>48.81</td>
</tr>
<tr>
<td>Shrub grassland</td>
<td>5.56</td>
<td>6.05</td>
<td>72.31</td>
<td>72.31</td>
</tr>
<tr>
<td>Waters</td>
<td>5.56</td>
<td>5.33</td>
<td>7.16</td>
<td>7.16</td>
</tr>
<tr>
<td>Land for residents/enterprises/mines</td>
<td>7.92</td>
<td>8.21</td>
<td>35.29</td>
<td>35.29</td>
</tr>
<tr>
<td>Paddy fields</td>
<td>13.47</td>
<td>12.54</td>
<td>49.71</td>
<td>49.71</td>
</tr>
<tr>
<td>Dry land</td>
<td>15.97</td>
<td>17.00</td>
<td>56.23</td>
<td>56.23</td>
</tr>
<tr>
<td>Unused land</td>
<td>4.58</td>
<td>3.89</td>
<td>9.24</td>
<td>9.24</td>
</tr>
</tbody>
</table>

As above-mentioned, completion of the Project will change existing land use patterns to produce impact upon natural system. The project will involve self-adjustability of the ecosystem, landscape engineering and resilience of vegetation, the character and function of natural system will be restored. Moreover, attention shall be paid to preservation of the ecosystem so that the affected natural productiveness of the ecosystem will be restored as soon as possible. Anyway, the project produces limited impact upon ecosystem stability or upon landscape heterogeneity. Such impact is acceptable to regional natural system.

Cascade development of Kan River will artificially cut the river into 9 or 11 reaches, of which 8 or 10 will be of river-type reservoir, which will totally change the natural landscape, to produce damage to some degree in terms of integrity and continuity of natural landscape.

6.3.6 Ecological Water Consumption Downstream

There are numerous methods to calculate base ecological flow within the basin, each focusing upon different aspects. According to the characteristics in this basin, base ecological flow is udder calculation by "the average monthly base" and "Tennant", in addition to comparative analysis.

(1) Mean monthly flow in the driest season

On the basis of data in terms of monthly runoff collected in Dong back Hydrometric Station and Linken Hydrometric Station from 1957 to 2005, the mean monthly flow can be obtained from section year the flow; the smallest sampling method shows that the mean monthly flow at Shihutang dam site is 163m3/s in the driest month at 90% of assurance rate.

(2) Tenant Method

On the basis of the average monthly flow at Shihutang dam site, it is known that annual mean flow therein is 1150 m³/s; by Tenant method, namely at 10% of annual mean flow, the ecological base flow for this basis is 115 m³/s.
Shihutang Project is mainly for shipping, to be complemented from power generation, flood control and other comprehensive utilization purposes. To meet the need for navigable channel is the most important objective during construction period, when the discharge shall be kept at 187 m³/s. Furthermore, in the near future the flow at the ship lock will be 11.24 m³/s and 15.31 m³/s in the long run. The minimum guaranteed flow is 198.24 m³/s in the near future and 202.31 m³/s in the long run m³/s. This shows that during the period of operation of the project the discharge flow meets the base flow for downstream ecological water consumption, to produce no significant impact upon downstream ecological environment.

In initial storage the base flow shall remain at 187 m³/s to satisfy the need for water consumption for downstream ecology and water consumption units.

Base flow from Wan’an Power Plant is about 130 m³/s (135 m³/s after the completion of Taihe Hydropower Station). Between the 38km-long reach from Shihutang to Taihe there are three tributaries, of which Yunting River has a catchment area of 763 km² with annual mean flow at about 22.1 m³/s; Shu River has a catchment area of 1305 km² with mean annual flow at about 37.8 m³/s; mean annual flow form the two tributaries amount to about 59.9 m³/s (Guanyuan River has a catchment area of 558 km² with annual mean flow at about 16.2 m³/s; its inflow is under diversion by Wanhe Diversion & Drainage Canal to downstream). Evidently, at Shihutang dam site the base flow (187 m³/s) is guaranteed.

Base flow at 187m³/s is equivalent to base output of 15 MW. Shihutang will have 6 turbine generating units, each having an installed capacity of 19.5 kW at rated flow of 420 m³/. The said unit can generate power at 30% of the lowest rated flow 30% (126 m³/s).

### 6.3.7 Water & Soil Conservation

#### 6.3.7.1 Prediction of Water & Soil Erosion during Constructing Period

- **Area of perturbed topography and damaged land and vegetation**

Permanent acquisition of land includes acquisition of land for the pivotal project, for embankment protection, for projects for stagnant water drainage, for reservoir inundation and for resettlement of affected residents, etc. Permanent acquisition of land totals 2843.41 hm², of which paddy fields amount to 51.69 hm², dry land 150.39 hm², gardens 6.96 hm², forest land 231.22 hm², uneven ground 184.66 hm², building lot for residents 7.76 hm², unused land 36.24 hm² and waters total 2172.8 hm². Temporary acquisition of land consists of land for living quarters, for auxiliary enterprises, for construction road, for borrow pit, for sand stocking yard and spoil areas, to amount to 451.26 hm² in all, including paddy fields of 86.13 hm², dry land of 94.49 hm², forest land of 66.72 hm², uneven ground of 63.83 hm², and alluvial land of 140.11 hm².

Perturbed topography aggregates 3294.67 hm², damaged acreage 624.93 hm², and damaged vegetation 302.44 hm².

- **Area of damaged water and soil conservation facilities**

Damage to facilities concerning water and soil conservation lies in damage and acquisition of water and soil conservation facilities so that their function is deprived of. But such acquisition of water and soil conservation facilities does not destroy the facilities concerned. Damage to water and soil conservation facilities amounts to 302.44 hm² in area (excluding forest or meadow area of flood inundation). For detail see Table 6.3—6.
Table 6.3—6 Index In Kind of Damaged or Appropriated Water & Soil Conservation Facilities

<table>
<thead>
<tr>
<th>Item</th>
<th>Sum</th>
<th>Forest land</th>
<th>Uneven ground</th>
<th>Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nodal region</td>
<td>18.27</td>
<td>4.80</td>
<td>13.47</td>
<td>Permanent</td>
</tr>
<tr>
<td>Embankment protection</td>
<td>3.33</td>
<td>3.33</td>
<td>18.51</td>
<td>Permanent</td>
</tr>
<tr>
<td>Construction site</td>
<td>150.29</td>
<td>82.49</td>
<td>67.80</td>
<td>Permanent</td>
</tr>
<tr>
<td>Construction detour</td>
<td>18.51</td>
<td>15.18</td>
<td>3.33</td>
<td>Temporary</td>
</tr>
<tr>
<td>Borrow earth pits</td>
<td>13.71</td>
<td>7.21</td>
<td>6.50</td>
<td>Temporary</td>
</tr>
<tr>
<td>Excavation waste dump</td>
<td>15.62</td>
<td>10.46</td>
<td>5.16</td>
<td>Temporary</td>
</tr>
<tr>
<td>Total</td>
<td>82.71</td>
<td>33.87</td>
<td>48.84</td>
<td>Temporary</td>
</tr>
</tbody>
</table>

- Prediction of construction spoil
- Construction spoil out of excavation

During the construction period, excavation spoil will total $314.10 \times 10^4 m^3$.

- Construction spoil out of stockyard mining

In the trunk channel of the project all together 13 borrow earth pits will be developed to total $34.53 hm^2$ in area out of arable land, forest land and wasteland. Mined soil will aggregate $48.47 \times 10^4 m^3$, to this end surface soil about $0.2 \sim 0.3 m$ will be stripped (such top soil will total $10.36 \times 10^4 m^3$, such stripped top soil is of temporary spoil, to be piled together for backfilling after completed mining of the stockyards.

- Construction spoil in host area

Resettlement of affected residents is in form of rural resettlement, all in form of local integration. There will be 744 immigrants for resettlement for acquisition of land totaling $5.21 hm^2$. Immigrants amount to 197 households in need of building new houses, if calculated at $17 m^3$ of construction spoil, total construction spoil in housing will amount to $3349 m^3$. Such spoil will be disposed of to the low-lying areas around the villages.

Construction spoil will total $324.8 \times 10^4 m^3$.

6.3.7.2 Prediction of new coming water and soil erosion area

- Prediction method parameters

Water and soil erosion produced during the construction period comes mainly from two parts: (a) perturbed and damaged topography, damaged and appropriated land and vegetation, which will disfunction water and soil conservation and aggravate soil corrosion; (b) construction spoil in construction of the project will add to water and soil erosion due to unreasonable placing.

Soil loss amount is calculated as follows:
6.0 Environment Impact Assessment

- Gross amount of water and soil erosion: \( W_{\text{gross}} = F_i \times M_{ri} \times T_i \)
- Added amount of water and soil erosion: \( W_{\text{fresh}} = F_i \times (M_{ri} - M_0) \times T_i \)

Of which: \( W_{\text{gross}} \) — gross amount of water and soil erosion (t);
\( W_{\text{fresh}} \) — added amount of water and soil erosion (t);
\( F_i \) — perturbed area in each district (hm\(^2\));
\( M_{ri} \) — soil corrosion modulus after perturbation (t/km\(^2\).a);
\( M_0 \) — soil corrosion modulus before perturbation (t/km\(^2\).a);
\( T_i \) — perdition duration (a).

- Prediction of soil corrosion modulus

Predicted value of soil corrosion modulus is listed in Table 6.3—7.
### Table 6.3—7 Predicted Value of Soil Corrosion Modulus

<table>
<thead>
<tr>
<th>Prediction duration</th>
<th>Segment unit</th>
<th>Soil corrosion modulus(\text{t/km}^2\cdot\text{a})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction &amp; living quarters</td>
<td>Nodal region</td>
<td>8826</td>
</tr>
<tr>
<td>Construction road</td>
<td>Nodal region</td>
<td>9793</td>
</tr>
<tr>
<td>Pivotal project</td>
<td></td>
<td>15000</td>
</tr>
<tr>
<td>Embankment protection</td>
<td>Embankment protection</td>
<td>15900</td>
</tr>
<tr>
<td></td>
<td>Projects for stagnant water drainage</td>
<td>14950</td>
</tr>
<tr>
<td>Project management site</td>
<td></td>
<td>11200</td>
</tr>
<tr>
<td>Stockyard</td>
<td></td>
<td>15600</td>
</tr>
<tr>
<td>Construction spoil</td>
<td></td>
<td>22200</td>
</tr>
<tr>
<td>Construction &amp; living quarters</td>
<td></td>
<td>8826</td>
</tr>
<tr>
<td>Construction road</td>
<td></td>
<td>9793</td>
</tr>
<tr>
<td>Host area</td>
<td>Resettlement of affected residents</td>
<td>11200</td>
</tr>
<tr>
<td></td>
<td>Lifting the field</td>
<td>22200</td>
</tr>
<tr>
<td>Tree-grass recovery period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pivotal project</td>
<td></td>
<td>562</td>
</tr>
<tr>
<td>Embankment protection</td>
<td>Embankment protection</td>
<td>562</td>
</tr>
<tr>
<td></td>
<td>Diversion canal</td>
<td>562</td>
</tr>
<tr>
<td>Project management site</td>
<td></td>
<td>766</td>
</tr>
<tr>
<td>Stockyard</td>
<td>Borrow pits</td>
<td>1380</td>
</tr>
<tr>
<td>Construction spoil</td>
<td></td>
<td>1672</td>
</tr>
<tr>
<td>Construction &amp; living quarters</td>
<td></td>
<td>719</td>
</tr>
<tr>
<td>Construction road</td>
<td></td>
<td>719</td>
</tr>
<tr>
<td>Host area</td>
<td>Resettlement of affected residents</td>
<td>766</td>
</tr>
<tr>
<td></td>
<td>Lifting the field</td>
<td>500</td>
</tr>
</tbody>
</table>

□ Amount of water and soil erosion during the construction period

On the basis of prediction segment units, area of water and soil erosion, topography and soil corrosion modulus, calculated amount of water and soil erosion during the construction period will be 24.93\(\times10^4\)\(\text{t}\), of which newly increased water and soil erosion amounts to (without engineering blockage measure) 22.84\(\times10^4\)\(\text{t}\). For detail see Table 6.3—8.

#### 6.3.7.3 Forecast of damage from water and soil erosion

Damage from water and soil erosion is most often potential and underlying. If measures were
adopted to control water and soil erosion after such damage occurred, land resources would be
damaged and productivity of land would be lowered and there would be more channel
sedimentation. And such control works would be costly, challenging and unfruitful. If
without full consideration to control of water and soil erosion in engineering design and
construction, there would be such damage as follows:

☐ Damage to the works itself

Earth excavation and earth-rock fill will severely threaten the stability of soil stratum, only to
aggravate water and soil erosion. Especially in areas potential to such damage as landsliding
and bank sloughing and debris flow, works construction may result in flourishing of such
geologic hazards. If without timely control measures, occurrence of such mentioned hazards
will create severe impact upon the smooth progress of the project.

☐ Damage to ecological environment

During the construction period, original topography will be under severe perturbation, with
topsoil and vegetation under serious damage, which will greatly reduces soil resistance to
corrosion. The project will involve such areas as residents’ settlement, land for farming and
rivers and streams. Any neglect of temporary control of water and soil erosion will result in
desirable increase in runoff sedimentation in rainy seasons, which will deposit to block the
dam or channel to produce negative impact upon flooding or water transmission. In dry
season such neglect will produce a lot of dust to be unfavorable to people’s production or
living, unfavorable to vegetation growth only to worsen ecological environment.

☐ Damage to downstream and surrounding areas

In such measures as concerning construction management and construction spoil control
failed to be undertaken, there would be a lot of construction spoil under discharge to produce
damage to downstream production and living.

☐ Such discharge of construction spoil will lower productivity of land and crop output.

Perturbed topography will aggravate water and soil erosion, lessen soil thickness, reduce soil
fertility, and therefore lower the productivity of land; part of the water and soil erosion
flows along the gulch and slopes into arable land to create sedimentation there or even to
cover the crops to affect crop output.
Table 6.3—8  Prediction of amount of water and soil erosion

<table>
<thead>
<tr>
<th>Period</th>
<th>Works</th>
<th>F/hm²</th>
<th>Mₚ/t/km²·a</th>
<th>Mₚ/t/km²·a</th>
<th>T·Year</th>
<th>Wₚ gross/t</th>
<th>Wₚ fresh/t</th>
</tr>
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<td>1284</td>
<td>8826</td>
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<td>8826</td>
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<td>753</td>
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<td>1014</td>
<td>22200</td>
<td>3.7</td>
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<td>406</td>
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<td>Period</td>
<td>Works</td>
<td>Prediction of amount of water and soil erosion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>---------------</td>
<td>----------------------------------------</td>
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<td></td>
<td>$F_{\text{hm}^2}$</td>
<td>$M_{\text{g}}\text{t/\text{km}^2\cdot\text{a}}$</td>
<td>$M_{\text{r}}\text{t/\text{km}^2\cdot\text{a}}$</td>
<td>$T_{\text{y}}\text{Year}$</td>
<td>$W_{\text{gross}}\text{t}$</td>
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<td>1114</td>
<td>9793</td>
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<td>2403</td>
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<tr>
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<td>Host area</td>
<td>Resettlement of affected residents</td>
<td>5.21</td>
<td>1752</td>
<td>11200</td>
<td>1.0</td>
<td>584</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lifting the field</td>
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<td>1752</td>
<td>22200</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tree-grass</td>
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<td>562</td>
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<td>753</td>
<td>562</td>
<td>1.0</td>
<td>647.87</td>
<td>-220.18</td>
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<td>753</td>
<td>562</td>
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<td>805.07</td>
<td>-273.61</td>
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<td>1.0</td>
<td>25.51</td>
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<td>1672</td>
<td>1.0</td>
<td>1966.27</td>
<td>773.81</td>
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<td>64.20</td>
<td>1284</td>
<td>719</td>
<td>1.0</td>
<td>461.60</td>
<td>-362.73</td>
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<td></td>
<td>30.73</td>
<td>1114</td>
<td>719</td>
<td>1.0</td>
<td>220.95</td>
<td>-121.38</td>
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<td>Host area</td>
<td>Resettlement of affected residents</td>
<td>5.21</td>
<td>1752</td>
<td>766</td>
<td>1.0</td>
<td>39.91</td>
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<td>Lifting the field</td>
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<td>500</td>
<td>500</td>
<td>1.0</td>
<td>412.35</td>
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<tr>
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<td>Sum of tree-grass recovery period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5265</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>249296</td>
</tr>
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</table>
6.3.8 Analysis of Environmental Reasonableness of Permanent Acquisition of Land

Permanent acquisition of land totals 42525.15 mu, of which the pivotal project will cover an area of 424.95 mu, the inundation an area of 38172.15 mu, embankment protection 3877.95 mu, and project management an area of 49.95 mu. Such acquisition of land consists of (a) dry land, floodland meadow, unused land, partial paddy fields and forest land for the pivotal project; (b) dry land, forest land, unused land, shrub grassland and meadow for embankment protection; floodland meadow, sand spit, nearshore shrub grassland, limited arable land and forest land for flood inundation, etc. Engineering works will cover such land as for gardens (mainly of tea and orange), to plan for building lot for residents. On the whole, permanent acquisition of land does not produce much negative impact upon local social or economic development. Use of land is convenient to restore eco-system, thus reasonable from the eye of environment.

6.3.9 Analysis of environmental reasonableness of temporary acquisition of land & construction sites

6.3.9.1 Suitability of workyard with environmental sensitive objects

Field investigation shows that located on the right bank of the dam are such environmental sensitive objects as Shihutang Village (about 400m downstream of the recommended dam site), Sangfu Primary School (about 500m downstream of the recommended dam site) and Jiangjia Village (450m upstream of the recommended dam site, about 150m from the ship lock). There are rural houses between the Sangfu Primary School and workyard, long in distance between, to suffer limited impact from works construction. In concrete layout of the works, such noisy and dusty structure as spoils, concrete batching plants, compressed air stations, sand and stone processing plants and oil tankage have been under layout near the shore, far away from the mentioned objects, to minimize the negative impact upon them. In a word, there is reasonableness in layout of the construction plane on the right bank.

Located on the left bank of the dam are such environmental sensitive objects as Lingbei Village, Xiayinxia Village (about 500m on the upper stream of the dam site, on the left bank). In concrete layout of the works, such noisy and dusty structure as spoils, concrete batching plants, compressed air stations, sand and stone processing plants and oil tankage have been under layout near the shore, far away from the mentioned objects, to minimize the negative impact upon them. In a word, there is reasonableness in layout of the construction plane on the right bank.

In a word, the layout of workyard is reasonable from the point of environmental protection.

6.3.9.2 Analysis of Environmental Reasonableness of Temporary Acquisition of Land

In line with the topography of the site, the workyard is under layout on the left and right bank. To be exact, on the left bank workyard are located such temporary facilities as sand and stone processing plants, concrete mixing plants, steel and timbre processing plants, mechanical repair and replacement system, parking lots and carshops, warehouses of various facilities and equipment, houses for management and welfare, etc. While in contrast, on the right bank workyard are located such temporary facilities as sand and stone processing plants, concrete mixing plants, steel and timbre processing plants, mechanical repair and replacement system,
parking lots and carshops, warehouses of various facilities and equipment, houses for management and welfare, etc. Temporary acquisition of land for construction encampment and auxiliary enterprises amounts to 963.15mu, including 37.2mu of paddy fields, 493.95mu of dry land, and 227.7mu of forest land. Temporary acquisition of land in pivotal works for construction encampment and auxiliary enterprises totals 532.05mu, consisting of paddy fields (37.2mu), dry land (218.1mu), and forest land (122.4 mu). See Table 6.3—9.

Table 6.3—9 Temporary Acquisition of Land for Construction Encampment & Auxiliary Enterprises

<table>
<thead>
<tr>
<th>Items</th>
<th>Unit</th>
<th>Area</th>
<th>Paddy fields</th>
<th>Dry land</th>
<th>Garden</th>
<th>Forest land</th>
<th>Uneven</th>
<th>Alluvial land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pivotal project</td>
<td>mu</td>
<td>532.05</td>
<td>37.2</td>
<td>218.1</td>
<td>0</td>
<td>122.4</td>
<td>0</td>
<td>154.35</td>
</tr>
<tr>
<td>Embankment protection</td>
<td>mu</td>
<td>400.95</td>
<td>0</td>
<td>269.85</td>
<td>0</td>
<td>96.3</td>
<td>34.95</td>
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</tr>
<tr>
<td>Projects for stagnant water drainage</td>
<td>mu</td>
<td>30.0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>9</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>mu</td>
<td>963.15</td>
<td>37.2</td>
<td>493.95</td>
<td>0</td>
<td>227.7</td>
<td>49.95</td>
<td>154.35</td>
</tr>
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</table>

In terms of layout of the nodal region workyard, a temporary acquisition of 532.05 mu for construction encampment and auxiliary enterprises is reasonable. For the sake of protection arable land, especially of paddy fields, there shall be proper adjustment of workyard on the left bank, to try to avoid temporary acquisition of 37.2 mu of paddy fields.

In terms of layout of the embankment protection workyard, a temporary acquisition of 400.95 mu for construction encampment and auxiliary enterprises is reasonable. For the sake of protection arable land, there shall be proper adjustment of workyard to try to avoid temporary acquisition of dry field.

In a word, after undertaking of all necessary measures concerning water and soil conservation, there is reasonableness for temporary acquisition of land for construction encampment and auxiliary enterprises.

6.3.10 Analysis of Environmental Reasonableness of Temporary Acquisition of Land for Stockyards

The project plans to have 17 stockyards, to cover an area of 2391.9 mu, of which dry land totals 283.65mu, forest land 156.9mu, uneven ground 77.4mu, and alluvial land 1873.95mu. For detail of the stockyards see Table 6.3—10.

In terms of road distribution, transport distance, stockyard and surrounding environment and acquisition of farmland, layout of stockyards take into consideration both the convenience of transport and impact upon surrounding environment. Stockyards shall be located in the alluvial land, is possible, to minimize acquisition of farmland. In line with the principle of concentrated location of stockyards, it is recommended that the Huangken Stockyard and Zouken will be combined into one, to cancel the Zouken Stockyard; that Futang Stockyard be cancelled to include in Lianhuatang Stockyard; that Wanheti Stockyard be cancelled to include in Lianhuatang Stockyard; that Wanheti Stockyard be cancelled to
include in Chenjia Stockyard; that Bailiangang Stockyard and Lijia Stockyard and Tianhong Stockyard be cancelled to include in Shiihutang Stockyard. After such adjustment there will be only 11 stockyards, to decrease acquisition of land by 77.4 mu (5.16 hm²).

In a word, selection of borrow pits in this project follows the principles of minimum impact upon environment and principles of best solution of conflicts of borrow and acquisition of land. Meanwhile there are measures of reclamation or vegetation restoration concerning the stockyard in line with land utilization planning and concrete situations, so that temporary acquisition of land will be basically under reclamation or vegetation restoration. Adoption of proposals in this Statement and undertaking of various engineering measures concerning water and soil conservation, layout of stockyards is reasonable in terms of environmental protection.
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Huangkeng Borrow Pits  Zoukeng Borrow Pits

Xigang Borrow Pits  Lianghuatang Borrow Pits

Futang Borrow Pits  Sixth farm Borrow Pits

Xiejia Borrow Pits  Lianxi Stockyard
6.0 Environment Impact Assessment
<table>
<thead>
<tr>
<th>No</th>
<th>Names</th>
<th>Environmental introduction</th>
<th>Reserve ($10^4 m^2$)</th>
<th>Area (hm²)</th>
<th>Analysis &amp; Suggestion</th>
</tr>
</thead>
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<td>Hub Stockyard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>gravel stones</td>
<td>On the alluvial land on the right bank, mainly under submarine mining</td>
<td>200</td>
<td>50</td>
<td>Reasonable in terms of road distribution, transport distance and spoil ground status</td>
</tr>
<tr>
<td></td>
<td>Gravel</td>
<td>Procurement will total 2.99 * 10^7 m³</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Shihutang Stockyard</td>
<td>On the second bottom on the right bank, mainly of pine wood, with partial waste land</td>
<td>36</td>
<td>2</td>
<td>Reasonable in terms of road distribution, transport distance and spoil ground status</td>
</tr>
<tr>
<td>4</td>
<td>Xiejia</td>
<td>On the left bank second bottom, mainly of dry land, with partial pine wood</td>
<td>96</td>
<td>3</td>
<td>Reasonable in terms of road distribution, transport distance and spoil ground status</td>
</tr>
<tr>
<td></td>
<td>Drainage works stockyard</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>Bainigang Earth Stockyard</td>
<td>Of low hills, mainly of pine wood with partial dry land</td>
<td>80</td>
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<td>Cancelled to include in Shihutang Stockyard</td>
</tr>
<tr>
<td>2</td>
<td>Lijia</td>
<td>Of low hills, mainly of pine wood with partial dry land</td>
<td>80</td>
<td>2.00</td>
<td>Cancelled to include in Shihutang Stockyard</td>
</tr>
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<td>Tianhong</td>
<td>Of low hills, mainly of pine wood with partial dry land</td>
<td>30</td>
<td>2.67</td>
<td>Cancelled to include in Shihutang Stockyard</td>
</tr>
<tr>
<td>4</td>
<td>Sand and gravel stockyard</td>
<td>For procurement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Xigang</td>
<td>Of dry land for pine</td>
<td>96</td>
<td>5.80</td>
<td>Reasonable in terms of road distribution, transport distance and spoil ground status</td>
</tr>
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<td>Hunagken</td>
<td>Of low hills, high in EL, mainly of pine wood</td>
<td>100</td>
<td>4.20</td>
<td>Reasonable in terms of road distribution, transport distance and spoil ground status</td>
</tr>
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### 6.0 Environment Impact Assessment

<table>
<thead>
<tr>
<th>No</th>
<th>Names</th>
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<td>Zouken</td>
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</tr>
<tr>
<td>2</td>
<td>Nangong Reserve</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Laodongtang</td>
<td>Of low hills, high in EL, mainly of pine wood</td>
<td>30</td>
<td>5.13</td>
<td>Reasonable in terms of road distribution, transport distance and spoil ground environment status quo</td>
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<td>4</td>
<td>No 6 Farmland</td>
<td>Of low hills, now serving as earth stockyard</td>
<td>140</td>
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<td>Reasonable in terms of road distribution, transport distance and spoil ground environment status quo</td>
</tr>
<tr>
<td>5</td>
<td>Futang</td>
<td>Of low hills, high in EL, with partial pine wood</td>
<td>240</td>
<td>1.20</td>
<td>Cancelled to include in Lianhuatang Stockyard</td>
</tr>
<tr>
<td>6</td>
<td>Lianhuatang</td>
<td>Of low hills, now serving as earth stockyard</td>
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<td>1.07</td>
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<tr>
<td>7</td>
<td>Wanheti</td>
<td>In belt form along the embankment line, basically of dry land</td>
<td>30</td>
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</tr>
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<td>8</td>
<td>Chenjia</td>
<td>Of low hills, high in EL, mainly of pine wood</td>
<td>30</td>
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<td>9</td>
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<td>Alluvial land</td>
<td></td>
<td>159.46</td>
<td>Reasonable in terms of road distribution, transport distance and spoil ground environment status quo</td>
</tr>
</tbody>
</table>
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6.3.11 Analysis of Environmental Reasonableness of Excavation Waste Dump

There will be 38 construction spoil grounds in this Project, with the spoil to total $314.1 \times 10^4 m^3$ to cover an area of 117.61hm$^2$. There will be 4 such spoil grounds on the left and right bank, which is flat as a pancake so that the spoil grounds are located in the bowl-shaped depression, to appropriate a part of dry land. Due to the lengthy works of embankment protection and projects for stagnant water drainage, spoil will be under local placing in flat areas, depression, slight grade, and valley or gully (mostly in flat foot of slope and depression). Most of such acquisition is of waste land, forest land and arable land. For detail of construction spoil, see Table 6.3-11; for layout of construction spoil grounds, see Attached Drawing No 20～22; for detail of construction spoil grounds in quantity and types, see Table 6.3-12.

![Wanhe Construction Spoil Ground](image1) ![Yanxi Construction Spoil Ground](image2)

### Table 6.3-11 Amount/Types of Temporary Acquisition of Land for Construction Spoil Grounds

<table>
<thead>
<tr>
<th>Items</th>
<th>Unit</th>
<th>Area</th>
<th>Paddy fields</th>
<th>Dry land</th>
<th>Garden</th>
<th>Forest land</th>
<th>Uneven ground</th>
<th>Alluvial land</th>
</tr>
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<tbody>
<tr>
<td>Pivotal project</td>
<td>mu</td>
<td>199.95</td>
<td>13.95</td>
<td>82.05</td>
<td>□</td>
<td>46.05</td>
<td>□</td>
<td>58.05</td>
</tr>
<tr>
<td>Embankment protection</td>
<td>mu</td>
<td>120.3</td>
<td>□</td>
<td>81</td>
<td>□</td>
<td>28.8</td>
<td>10.5</td>
<td>□</td>
</tr>
<tr>
<td>Projects for stagnant water</td>
<td>mu</td>
<td>1444.05</td>
<td>□</td>
<td>288.75</td>
<td>□</td>
<td>433.2</td>
<td>722.1</td>
<td>□</td>
</tr>
<tr>
<td>drainage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>mu</td>
<td>1764.3</td>
<td>13.95</td>
<td>451.8</td>
<td>□</td>
<td>508.05</td>
<td>732.6</td>
<td>58.05</td>
</tr>
</tbody>
</table>

Analysis indicates there is reasonableness for layout of construction spoil grounds in the nodal region (Temporary acquisition of land amounts to 199.95 mu). For protection of arable land, especially of paddy fields, there shall be adjustment of No 1 spoil ground on the left bank of the nodal region, to try to avoid the paddy fields of 13.95mu.

There is reasonableness for temporary acquisition of 1564.35mu of land for construction spoil grounds in embankment protection works and Projects for stagnant water drainage.
Construction spoil grounds to this end will occupy an area of 369.75mu of dry land, which is capable of restoration to dry land or paddy fields after completion of the project.

In terms of environmental protection, layout of construction spoil grounds shall take into consideration both traffic convenience and avoidance of impact upon environment. Such construction spoil grounds shall make full use of flat depression, gully or valley, and unused alluvial land. Water and soil conservation programs shall involve construction of slag trap walls and drain ditch. For any spoil grounds capable of reclamation, stripped top soil shall be returned, otherwise there shall be engineering protection measures or vegetation cover measures. In a word, layout and acquisition of land for this Project is reasonable from the point of environmental protection.
### Table 6.3—12 Reasonableness Analysis of Construction Spoil Grounds

<table>
<thead>
<tr>
<th>Location</th>
<th>Spoil ground</th>
<th>Area (hm²)</th>
<th>Qty (10⁴m³)</th>
<th>Mean height (m)</th>
<th>Topography</th>
<th>Type of land(hm²)</th>
<th>Suitability analysis &amp; comment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Land</td>
<td>Wood</td>
</tr>
<tr>
<td>In hub</td>
<td></td>
<td>13.33</td>
<td>112.12</td>
<td>6.40</td>
<td>3.07</td>
<td>□</td>
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<tr>
<td>Left bank</td>
<td></td>
<td>5.00</td>
<td>35.77</td>
<td>7.14</td>
<td>Flat low land</td>
<td>2.40</td>
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</tr>
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<td></td>
<td></td>
<td>3.73</td>
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<td>2.47</td>
<td>24.99</td>
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<td>22.85</td>
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<td>1.93</td>
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<td>4.75</td>
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<td>5.00</td>
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### Environment Impact Assessment

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<th>Mean height (m)</th>
<th>Topography</th>
<th>Type of land (hm²)</th>
<th>Suitability analysis &amp; comment</th>
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</thead>
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<td></td>
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<td>19.25</td>
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</tr>
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### 6.0 Environment Impact Assessment

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<tr>
<th>Location</th>
<th>Name</th>
<th>Area (hm²)</th>
<th>Qty ($10^4$m³)</th>
<th>Mean height (m)</th>
<th>Topography</th>
<th>Type of land (hm²)</th>
<th>Type of land (hm²)</th>
<th>Type of land (hm²)</th>
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### Yanxi

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<th>Type of land (hm²)</th>
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<td>0.00</td>
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</tr>
<tr>
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<td>0.20</td>
<td>0.20</td>
<td>This stockyard is suitable considering existing roads, transport distance and ecological condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>----</td>
<td>------</td>
<td>------</td>
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<tr>
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<td>This stockyard is suitable considering existing roads, transport distance and ecological condition</td>
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</tbody>
</table>
6.3.12 Analysis of environmental reasonableness of acquisition of land for construction road

Shihutang Project is located in the trunk channel of Kan River, in Taihe County of Ji’an City. It is 26km from the Ganjiang Bridge in Taihe County, which is an important city in Jiangxi Province, to connect Nanchang by railway and highways, to connect with the Yangtze River by waterways. Highways and roads close to the project radiate in all directions, very convenient to connect with the outside world.

Existing roads and highways on the right and left bank will be connected to each construction area and working face. In the dam site there is internal road network consisting of approach road and special road to the spoil grounds.

Newly constructed roads for this Project lasts 40km and extended roads 46km (including 6km-long newly constructed and 4km-long extended road in the nodal region). For detail of internal traffic, see Table 2.11. For detail of internal and outside traffic, see Table 2.11—2.

Most of traffic for the Project will be of existing roads and highways, to avoid acquisition of land. Newly constructed and extended roads will match traffic construction programs in local villages, with grass along the roadside to alleviate water and soil erosion. In a word, layout and acquisition of land for this Project is reasonable from the point of environmental protection.

6.3.13 Analysis of Environmental Reasonableness & Fruitfulness of Water & Soil Conservation

☐ Completeness of water and soil conservation programmed

Water and soil conservation programme covers the pivotal project, the embankment protection, the project management site, the construction area and living quarters, the stockyards, the construction spoil grounds, roads and highways and the host area. Such a coverage is complete for completion of the Project.

☐ Effect analysis of water and soil conservation programme

Based on the requirement of “three simultaneity”, the measures for water and soil conservation must be practically positioned before the trial operation of the project. Therefore, during the period of Complex operation, the surface earth of the permanent land occupation of the project have been hardened and afforested; slopes have been cut for protection; temporary land has been leveled and afforested; drainage system for roads have been perfected; ecologic environment of the project area has been recovered and improved. In this case, if soil erosion occurs, the volume would be limited. By that time, the measures for conservation of water and soil in the migrant resettlement area have exerted their protective functions, and the soil erosion can be ignored.

Through the implementation of the measures for conservation of water and soil where engineering measures and planting measures are adequately integrated, the project has formed
a complete system for protection and treatment of soil erosion. Such has not only prevented
great quantity of earth from entering the reservoir that results in reduction of reservoir storing
capacity, but also ensured the safety of the building structures and the smooth progress of the
project construction. It will also beautify the environment, improve the ecologic environment
of the reservoir area, increase the comprehensive benefits and prolong the life of the reservoir.

Above all, through a series of measures for conservation of water and soil, construction of the
project will fully make use of the natural water resources, improve regional environment of
the reservoir area and promote the working of water conservation.

Environmental feasibility of water and soil conservation programme

Water and soil conservation programme is made out of combined engineering measures and
biological control measures, thus to avoid any conflict between construction of the project
with the nature.

Water and soil conservation programme will effectively reduce rain drop erosion and thus
greatly relieve water and soil erosion during the construction period, to play a positive role in
water and soil conservation. During embankment protection works at the same time or earlier
there will be construction of soil trap wall. There will be considerable increase in water and
soil erosion during the early period of construction. At the late period most of the
embankment protection works will be finished and the vegetation will be under restoration, so
water and soil erosion will be under control.

Based on comprehensive analysis of engineering re—vegetation, if measures concerning
embankment protection and re—vegetation are undertaken, then water and soil erosion will be
under effective control during the construction period, and all facilities concerning water and
soil conservation will be restored to original level, or even be better.

In terms of construction spoil grounds layout, most of the grounds are located in such areas as
mild low-lying ground, gulch or valley, unused alluvial land, to meet the need for
environmental protection. There might be environmental challenges from partial water and
soil erosion and vegetation damage and acquisition of limited arable land. In engineering
reclamation measures consideration is given to reclamation, re—vegetation, masonry dam and
drainage facility, all to alleviate impact from water and soil erosion.

In a word, engineering measures and biological control measures in the course of water and
soil conservation programme is feasible from the point of environmental protection.
6.0 Environment Impact Assessment

6.4 Ambient Air

6.4.1 Impact upon Ambient Air during Construction Period

6.4.1.1 Atmospheric Pollution during Construction Period

The characteristics of the project will mean that the major discharge of air contaminant includes bug dust, followed by limited fuel exhaust from the construction machinery and haulage vehicles, mainly out of such works as follows:

- machining operation like bulldozer, excavating machine, shoveling machine, lift trucks and mixing plant or stirring mill
- dust from the sand stocking yards due to aerodynamic
- dusting and secondary dusting in the course of earthrocks haulage and of construction of sand stocking yards due to vibration or natural wind
- bug dust pollution from automatic unloading and from unpacking of cement.
- there will be limited discharge of fuel exhaust from the main engines of the workboats, the haulage vehicle and other kinds of construction machinery, mainly in form of SO₂, NOₓ and hydrocarbon.

The above-mentioned pollution occurs mostly on the left and right bank of pivotal project area, on the newly constructed pumping stations for the sake of embankment protection; on the spoil grounds and borrow pits; on the area of lifting the field; on resettlement host areas; and on existing roads for temporary approaches and construction purpose.

6.4.1.2 Impact upon ambient air during the construction period

Atmospheric pollution during the construction period all comes from disorderly discharge, scattered in spatial-temporal location, thus analysis is made as follows based on analogy investigation:

- on the basis of site survey data of similar works, TSP concentration 50m leeward from the concrete mixing plant reaches 8.90mg/m³; 100m leeward 1.65mg/m³; 150m leeward TSP concentration satisfies Grade III as described in Quality Standard of Ambient Air (GB3095-1996)(daily mean value is 0.30mg/m³).

- based on data out of analogy investigation, for soil haulage vehicles, TSP concentration 50m leeward averages 11.62mg/m³, 100m leeward 9.69mg/m³; 150m leeward 5.09mg/m³ and 160m leeward such concentration meets the lower limit value in Comprehensive Discharge Standard of Air Contaminant (GB16297-1996).

- In other works such as site grading, matter transport and placing there may be dusting pollution which is capable of being brought under control within a range of 50~100m, which is in line with Grade II in Quality Standard of Ambient Air (GB3095-1996).

- Impact upon ambient air in this Project is under analysis on the basis of site observed data in Baise Pivotal Project in Guangxi Autonomous Region. Observation was made in the mentioned Baise Project in summer, autumn and winter during the construction period, with the result listed in Table 6.4-1.

<p>| Table 6.4-1 Observed Results in Baise Project during Construction Period |</p>
<table>
<thead>
<tr>
<th>Item</th>
<th>Points</th>
<th>Monitoring Period</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Summer</td>
<td>Autumn</td>
</tr>
<tr>
<td>NO₂</td>
<td>1</td>
<td>0.022</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.027</td>
<td>0.021</td>
</tr>
<tr>
<td>TSP</td>
<td>1</td>
<td>0.23</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.23</td>
<td>0.06</td>
</tr>
</tbody>
</table>

From Table 6.4-1 it is known that about 100m from the construction site, such index as TSP and NO₂ concentration in three seasons all goes beyond Grace II if judged by *Quality Standard of Ambient Air*. Therefore it is estimated that 100m from the construction site the ambient air basically meets the criteria.

Air contaminant produced out of construction machinery (such as crowd shovel, pullshovel, bulldozer, autodumper, workboats) for consumption of diesel and petrol is mainly in form of SO₂, NOₓ, CO and hydrocarbon. During the construction period gross contaminant from the construction machinery amounts to 22.233t (SO₂), 323.547t (NOₓ), 331.844t (CO) and 59.088t (CnHm). For detail see Table 3.1-1.

Since all the major operation occurs in the shore or on the surface of water, and such operation is of mobility and intermittence, noxious gas discharged from the construction machinery, workboats and the haulage vehicle will swiftly spread to the surroundings as to produce little impact upon environment.

### 6.4.1.3 Impact upon Protected Objects during Construction Period

For detail of impact from contraction operation upon protection objectives adjacent, see Table 6.4-1. For detail of impact from construction concerning operation of protection embankment, drainage canal and temporary roads, see Table 6.4-3.

Bug dust created during the construction period will produce pollution to the protection embankment, diversion canal, temporary approaches and existing roads and roadside residents who live within a range of 150m. Bug dust created during the construction period will produce pollution to the borrow pits, the spoil grounds, the lifting the field, the host area and the roadside residents who live within a range of 150m. Impact upon ambient air will not last long. Completion of the Project will mean an end to such pollution. Still, during the construction period, necessary measures shall be adopted.

### 6.4.2 Impact upon Ambient Air during Operation Period

Hydropower is a process to make use of hydraulic resources, to produce almost no pollution to the ambient air during the operation period.

Ships in the channel will produce limited exhaust to the ambient air. Such exhaust consists of NO₂ (to total 11.0t in 2020 and 13.92t in 2030), SO₂ (15.29t in 2020 and 19.34t in 2030). Such exhaust is mainly of unsystematic emission source, of short-distance pollution, thus to produce pollution to surrounding the ambient air. But such impact is limited to 50m of the emission source, not to produce much pollution to protected objects in terms of ambient air.
## Table 6.4—2 Impact upon Ambient Air during Operation Period

<table>
<thead>
<tr>
<th>No.</th>
<th>Protection objectives</th>
<th>Location/distance</th>
<th>Scale/features</th>
<th>Impact analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shihutang Village</td>
<td>About 400m downstream on the right bank of the recommended dam site</td>
<td>About 100 households and 350 residents</td>
<td>The construction site is about 50m from the nearest point in the village, and there may be construction dust pollution.</td>
</tr>
<tr>
<td>2</td>
<td>Sangyuan Primary School</td>
<td>About 500m downstream on the right bank of the recommended dam site</td>
<td>About 200 pupils and 1 teachers</td>
<td>The construction site is about 50m from the nearest point in the village, and there may be limited impact from construction dust.</td>
</tr>
<tr>
<td>3</td>
<td>Jiangjiazhou Village</td>
<td>About 450m in the upper stream on the right bank of the recommended dam site; about 150m from the ship lock</td>
<td>About 110 households and 385 residents</td>
<td>The construction site is about 50m from the nearest point in the village, and there may be construction dust pollution.</td>
</tr>
<tr>
<td>4</td>
<td>Lingbei Village</td>
<td>About 500m on the left bank from the recommended dam site</td>
<td>About 50 households and 175 residents</td>
<td>The construction site is about 50m from the nearest point in the village, and there may be construction dust pollution.</td>
</tr>
<tr>
<td>5</td>
<td>Xiayinxia Village</td>
<td>About 500m downstream on the left bank of the recommended dam site</td>
<td>About 40 households and 155 residents</td>
<td>The construction site is about 50m from the nearest point in the village, and there may be construction dust pollution.</td>
</tr>
</tbody>
</table>
### Table 6.4—3 Impact upon Ambient Air against Protection Objectives during Operation Period from Construction of protection Embankment, Drainage Canals & Temporary Roads

<table>
<thead>
<tr>
<th>No</th>
<th>Objective</th>
<th>Location and distance</th>
<th>Features</th>
<th>Impact analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sangyuan Village</td>
<td>~100m to the road to be used for construction</td>
<td>~20 households: 80 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>2</td>
<td>Duxia Village</td>
<td>~50m to the road to be used for construction</td>
<td>~15 households: 60 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>3</td>
<td>Kou'an Village</td>
<td>60m to the road to be used for construction</td>
<td>~20 households: 80 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>4</td>
<td>Xiehouling</td>
<td>100m to the road to be used for construction</td>
<td>~20 households: 80 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>5</td>
<td>Xiabian Village</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households: 160 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>6</td>
<td>Yinxiajiang</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households: 160 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>7</td>
<td>Maqian Village</td>
<td>~80m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households: 60 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>8</td>
<td>Pingshan Village</td>
<td>~20m to the fending groyne line &amp; road to be used for construction</td>
<td>~50 households: 200 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>9</td>
<td>Gaozhang Village</td>
<td>~50m to the fending groyne line &amp; road to be used for construction</td>
<td>~10 households: 40 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>10</td>
<td>Dunshang Village</td>
<td>~70m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households: 60 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>11</td>
<td>Zhang Jia</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households: 160 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>12</td>
<td>Huwei</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households: 80 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>13</td>
<td>Zengjia</td>
<td>~70m to the fending groyne line &amp; road to be used for construction</td>
<td>~25 households: 100 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>14</td>
<td>Zhushan</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~50 households: 200 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>15</td>
<td>Mazhou city</td>
<td>~160m to the fending groyne line &amp; road to be used for construction</td>
<td>~60 households: 240 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>16</td>
<td>Maozhou</td>
<td>~80m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households: 60 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>17</td>
<td>Jingouan</td>
<td>~60m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households: 80 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>18</td>
<td>Yaoxi</td>
<td>~40m to the fending groyne line &amp; road to be used for construction</td>
<td>~10 households: 40 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>19</td>
<td>Xiamu</td>
<td>~80m to the fending groyne line &amp; road to be used for construction</td>
<td>~25 households: 100 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>20</td>
<td>Fenglin Village</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households: 60 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>21</td>
<td>Dengjia</td>
<td>~120m to the fending groyne line &amp; road to be used for construction</td>
<td>~50 households: 200 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>No</td>
<td>Objective</td>
<td>Location and distance</td>
<td>Features</td>
<td>Impact analysis</td>
</tr>
<tr>
<td>----</td>
<td>----------------</td>
<td>-----------------------</td>
<td>---------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>22</td>
<td>Shangyinxia</td>
<td>~50m to the fending groyne line &amp; road to be used for construction</td>
<td>~30 households x 120 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>23</td>
<td>Tongluobei</td>
<td>~40m to the fending groyne line &amp; road to be used for construction</td>
<td>~50 households x 200 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>24</td>
<td>Heshupeng</td>
<td>~180m to the fending groyne line &amp; road to be used for construction</td>
<td>~60 households x 240 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>25</td>
<td>Heshuxia</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households x 160 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>26</td>
<td>Caoping</td>
<td>~30m to the fending groyne line &amp; road to be used for construction</td>
<td>~80 households x 320 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>27</td>
<td>Guibang</td>
<td>~60m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households x 80 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>28</td>
<td>Huangkengpengxia</td>
<td>~50m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households x 60 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>29</td>
<td>Xiaojia</td>
<td>~50m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households x 80 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>30</td>
<td>Xinju</td>
<td>~30m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households x 160 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>31</td>
<td>Kangjia Lake</td>
<td>~40m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households x 80 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>32</td>
<td>Jiangqian Village</td>
<td>~80m to the fending groyne line &amp; road to be used for construction</td>
<td>~30 households x 120 people</td>
<td>Certain pollution from construction dust</td>
</tr>
<tr>
<td>33</td>
<td>Shanjia</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households x 60 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>34</td>
<td>Zengjiapengxia</td>
<td>~60m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households x 160 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>35</td>
<td>Nanmenzhou</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~30 households x 120 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>36</td>
<td>Duwu Village</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~20 households x 80 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>37</td>
<td>Yutai Village</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~15 households x 60 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>38</td>
<td>Zhouwei</td>
<td>~100m to the fending groyne line &amp; road to be used for construction</td>
<td>~40 households x 160 people</td>
<td>Limited impact from construction dust</td>
</tr>
<tr>
<td>39</td>
<td>Nanshanxia</td>
<td>~150m to the fending groyne line &amp; road to be used for construction</td>
<td>~50 households x 200 people</td>
<td>Limited impact from construction dust</td>
</tr>
</tbody>
</table>
6.5 Acoustical Environment

6.5.1 Noise Effect during Construction Period

Noise during the construction period comes mainly from construction machinery and traffic, with limited noise from blasting.

6.5.1.1 Noise effect from construction machinery

Prediction is made on such simplified formula as follows:

\[ L_i = L_0 - 20 \log\left(\frac{r_i}{r_0}\right) - L \]

Of which \( L_i \) —— sound level at a distance from sound source \( r_i \) dB(A)

\( L_0 \) —— sound level at a distance from sound source \( r_0 \) dB(A)

\( L \) —— noise attenuation caused by other factors dB(A)

Taken into consideration the maximum value of sound level \( r_0 \) from various construction machineries, then predicted value of noise from the construction machinery at different period of construction is listed in Table 6.5-1.

Table 6.5-1 Predicted Value of Noise at Stationary Noise Sources  Unit: dB(A)

<table>
<thead>
<tr>
<th>Types</th>
<th>15m</th>
<th>50m</th>
<th>100m</th>
<th>200m</th>
<th>300m</th>
<th>400m</th>
<th>500m</th>
<th>600m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stirring mill, concrete mixing station</td>
<td>70.5</td>
<td>60.0</td>
<td>54.0</td>
<td>48.0</td>
<td>44.5</td>
<td>42.0</td>
<td>40.0</td>
<td>38.5</td>
</tr>
<tr>
<td>Crushing machine, sieving machine</td>
<td>82.5</td>
<td>72.0</td>
<td>66.0</td>
<td>60.0</td>
<td>56.5</td>
<td>54.0</td>
<td>52.0</td>
<td>50.5</td>
</tr>
<tr>
<td>Winding engine, crane</td>
<td>72.5</td>
<td>62.0</td>
<td>56.0</td>
<td>50.0</td>
<td>46.5</td>
<td>44.0</td>
<td>42.0</td>
<td>40.5</td>
</tr>
<tr>
<td>Excavating machine</td>
<td>60.5</td>
<td>50.0</td>
<td>44.0</td>
<td>38.0</td>
<td>34.5</td>
<td>32.0</td>
<td>30.0</td>
<td>28.5</td>
</tr>
<tr>
<td>Drilling machine</td>
<td>63.5</td>
<td>53.0</td>
<td>47.0</td>
<td>41.0</td>
<td>37.5</td>
<td>35.0</td>
<td>33.0</td>
<td>31.5</td>
</tr>
<tr>
<td>Air compressor</td>
<td>74.5</td>
<td>64.0</td>
<td>58.0</td>
<td>52.0</td>
<td>48.5</td>
<td>46.0</td>
<td>44.0</td>
<td>42.5</td>
</tr>
</tbody>
</table>

The result shows that within 15m of noise source, noise rating number (NRN) for such machinery as crushing machine and sieving machine are both over 75dB(A); beyond 50m NRN for all machinery is below 75dB(A); beyond 200m machinery noise (except for crushing machine and sieving machine) will all reduce below 55dB(A). This indicates that beyond 50m of construction site, the daytime noise meets the criteria as described in Noise Limits in Construction Site [75dB(A)]; and beyond 200m from the construction machinery, the noise basically satisfies the night noise meets the criteria as described in Noise Limits in Construction Site [55dB(A)].

Impact from construction upon the protection objectives surrounding the construction sites is listed in Table 6.5—2.

The results show that at daytime there is no noise impact beyond the standard upon
surrounding protection embankment, diversion and drainage canals, borrow pits and spoil grounds, and elevated fields and residents (15m adjacent), nor impact to 100m surrounding the construction sites at night. Such construction noise is temporary, to end with the completion of the project. Still, there shall be necessary measures against noise pollution.
Table 6.5—2 Impact of Dam Construction upon Surrounding Protection

<table>
<thead>
<tr>
<th>No</th>
<th>Objectives</th>
<th>Location/Distance</th>
<th>Scales/features</th>
<th>Impact analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shihutang Village</td>
<td>About 400m downstream on the left bank of the</td>
<td>About 100 households</td>
<td>The construction site is about 50m from the nearest point in the village. At daytime there is basically no noise pollution beyond the required standard, despite certain adverse impact at night.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>recommended dam site</td>
<td>350 persons</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Sangyuan Primary</td>
<td>About 500m downstream on the left bank of the</td>
<td>200 pupils and 10</td>
<td>The construction site is about 150m from the nearest point in the village. At daytime and night there is basically no noise pollution beyond the required standard (There is no class at night).</td>
</tr>
<tr>
<td></td>
<td>School</td>
<td>recommended dam site</td>
<td>teachers</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Jiangjiazhou</td>
<td>About 450m downstream on the left bank of the</td>
<td>About 110 households</td>
<td>The construction site is about 50m from the nearest point in the village. At daytime there is basically no noise pollution beyond the required standard, despite certain adverse impact at night.</td>
</tr>
<tr>
<td></td>
<td>Village</td>
<td>recommended dam site; 150m from the ship lock</td>
<td>385 persons</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Lingbei Village</td>
<td>About 500m on the left bank of the recommended dam site</td>
<td>About 50 households</td>
<td>The construction site is about 50m from the nearest point in the village. At daytime there is basically no noise pollution beyond the required standard, despite certain adverse impact at night.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>175 persons</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Xiayingxia Village</td>
<td>About 500m downstream on the left bank of the</td>
<td>About 40 households</td>
<td>The construction site is about 50m from the nearest point in the village. At daytime there is basically no noise pollution beyond the required standard, despite certain adverse impact at night.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>recommended dam site</td>
<td>155 persons</td>
<td></td>
</tr>
</tbody>
</table>
Noise created at daytime during the construction period will produce no noise pollution to protection embankment, to diversion channel, to borrow pits, to the spoil grounds, to the lifting the field and to host area (within 15m), and nor noise to a range of 100m at night. Such mentioned sporadic residential areas will suffer from limited noise at daytime, and from noise pollution to different degree at night.

6.5.1.2 Effects of traffic noise

Prediction model of traffic noise

On the basis of Guide Rules to Environmental Impact Assessment—Acoustical Environment (HJ/T2.4—1995) which recommends the prediction model by Federal Highway Administration concerning highway noise (FHWA), traffic noise is under prediction during the construction period in the construction roads. Since the construction vehicles are mainly of oversize vehicle, the construction roads may be deemed to be boundless in length, so the prediction model is simplified as follows:

\[
(LA_{eq}) = L_w + 10 \log \left( \frac{N \pi D_0}{V T} \right) + 10 \log \left( \frac{D_0}{D} \right)^{1+a} + \Delta S - 30
\]

Of which: 

- (LA_{eq})——equivalent noise level, dB(A);
- L_w——mean radiation sound level of oversize vehicle in reference energy, dB(A);
- N ——the ith type of traffic flow at designated time T(1h);
- D_0——reference range from measurement of vehicle radiated noise level, D_0=15m;
- D ——vertical distance from center lane to the predicted position, m;
- V ——mean velocity of oversize vehicle, km/h;
- T ——computing time of equivalent sound level, 1h;
- a ——surface coverage coefficient, depending on site conditions, a=0 or a=0.5;

Since the construction vehicles are mainly of oversize vehicles, therefore the mean radiated noise level is calculated in such formula as follows:

oversize vehicle: \[L_w=24.6 \log(V)+38.5\]

Of which: \(V\) refers to the mean running speed, estimated to 40km/h at daytime and 20km/h at night.

The predicted value of traffic noise level during the construction period is listed in Table 6.5-3.
Noises within 10m of the temporary roads and existing roads basically has no standard-exceeding impacts and fall within Grade IV at daytime, with no standard-exceeding impact upon objects 30m away from the roadside at night. In a word, during the construction period noise standard-exceeding pollution impacts on scattered residential areas by roadside of the temporary roads and existing roads is limited.

This Project will produce temporary noise effect upon local regions in acoustical environment. With completion of the Project, such impact will be terminated. Still, during the construction period there shall be necessary countermeasures.

### 6.5.1.3 Noise of Blasting

This project involves no submarine blasting, though blasting occurs mainly in the foundation bedrock leveling. Noise impact is under analysis on the basis of analogy of similar works, where observed results are listed in Table 6.5-4.

#### Table 6.5-4  Predicted Value of Noise of Blasting

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>5</th>
<th>20</th>
<th>50</th>
<th>100</th>
<th>200</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise rating number: dB(A)</td>
<td>100</td>
<td>96</td>
<td>97</td>
<td>82</td>
<td>75</td>
<td>67</td>
</tr>
</tbody>
</table>

Noise of blasting is of temporary noise, whose maximum value, in line with relevant standard, shall be 15dB(A) less than designated value. Table 6.3-3 shows that 100m from the shotpoint the noise level satisfies the criteria (15dB(A) less than designated value); 400m from the shotpoint the noise level satisfies the criteria too. All the environmental protective objects involved in this Project are 400m away, thus impact from blasting is very limited and minor.

### 6.5.2 Noise Effect during Operation Period

Noise pollution sources during the operation period come mainly from generating sets and from traffic (ships and boats passing by).

- Noise from the generating sets is limited to the nodal region, which is over 400m away from the nearest settlement, who thus will not suffer from such noise effect.
- Ship tonnage is estimated to be 500t and 800t for the year of 2020 and 2030, and observed water traffic flow totals 16860 ships/times/a (or 47 ships/times/d) and 16663 ships/times/a.
Exposed sound level for 500t-ship at 15m is about 71dB(A), which takes about 15m to attenuate to 70dB(A) and about 95m to attenuate to 55dB(A). The noise level for 800t-ship at 15m is about 73dB(A), which takes about 21m to attenuate to 70dB(A) and about 119m to attenuate to 55dB(A).

All the settlement involved in this Project is at least 150m away from the pivotal project area (ship lock) and more than 150m from the thalweg. In fact most of the settlement is 400m off the ship lock and the thalweg, therefore during the operation period noise from the ships basically creates no noise effect upon residents.

6.6 Resettlement of Affected Residents
6.6.1.1 Plan of Land Acquisition & Relocation

Plan of Relocation & Resettlement

Persons affected in arable land but not in housing will be under resettlement in the very affected village or in ant village adjacent. At present there will be 2175 persons in need of resettlement and it is estimated that 2271 persons will be in need of production resettlement in 2010.

Such resettlement will involve people who live below the reservoir flooded line; people affected in arable land but not in housing; people who can not be satisfied by relocation backward in terms of arable land thus need to be resettled in other areas; people involved in acquisition of land for the embankment protection works. Such resettlement will involve 711 persons at present or 744 by 2010.

Plan of Settlement

Most of the resettlement is in form of backward relocation in the same village, the same township or town, to make sure that every household is satisfied with production conditions, housing conditions and fundamental facilities in supply of water, electricity and roads. There will be 3 centralized settlements according to the plan, to meet the need for 269 immigrants.

Resettlement of Enterprises or Institutions

The Project will involve 8 enterprises or institutions concerning relocated housing to total 4373.71m², most of which consists of warehouses, processing factories and some enterprises, which are located within the protection embankment works or within the reservoir flooded line, thus the living area and facilities are affected. There is no unit in need of complete
relocation, all of the enterprises or institutions are just partially affected.

- **Relocation of Urban Residents**

There will be no urban residents in resettlement after completion of the embankment protection works.

- **Reconstruction Plan of Special Items**

The resettlement involves 2.21km of 4th-grade highway and 10.71km of tractor road, 18 ferries and docks, 82.47hm$^2$ of lifting the field. All such affected land will be under compensation to restore original function in scale and standard.

### 6.6.2 Analysis of Environmental Capacity & Suitability in Host Area

- **Impact upon Arable Land Resources**

In accordance with statistics in Taihe County, involved in the resettlement there will be 77674 persons, 110538 mu of arable land (1.42 mu per capita) and net income per capita is 4842 Yuan.

In Wanhe Township the inundation will involve 43215mu of arable land, 29213 persons, (1.48 mu per capita), to involve resettlement of 756 persons and 873.88 mu of land). In Tangzhou Town the inundation will involve 27887mu of arable land, and 17188 persons (1.62 mu per capita), to concern resettlement of 631 persons and 818.1 mu of arable land). In Yanxi Town the inundation will involve 22513 mu of arable land, 13030 persons, (1.73 mu per capita), to involve resettlement of 575 persons and 1007.78 mu of land). In Chengjiang Town the inundation will involve 12766 mu of arable land and 15057 persons, (0.85 mu per capita), to involve resettlement of 255 persons and 180.1 mu of land). In Mashi Town the inundation will involve 2567 mu of arable land and 3186 persons, (0.81 mu per capita), to involve resettlement of 54 persons and 42.13 mu of land). There is a high percentage of inundated arable land (4.5% of gross land) in Yanxi Town, so that after the inundation arable land per capita is reduced by 0.08 mu. For detail of environmental capacity, see Table 6.6-1.

After completion of the embankment protection works and works concerning lifting the field, there will be land acquisition in form of belt, so that arable land per capita will reduce by 2.7%, from 1.42mu per capita to 1.38mu. There is little impact from such land acquisition to local residents. Meanwhile resettlement is distributed in 44 villages, so they will benefit from low-yield land improvement.

- **Impact upon resettlement living standards**

Permanent acquisition of land for reservoir inundation and embankment protection will amount to 2829.8 mu, which accounts for only 2.7% of gross resources in affected villages, so that rural residents will reduce arable land by 0.04mu per capita. Social and economic survey shows that at present net income per capita reaches about 4842Yuan per capita. Based on the statistics in Taihe County, rural residents’ income from the primary industry rises by about 8.8% annually, by 19.2% from other industries. This means that in the plan period their income from the primary industry will total Yuan per capita and 6132 Yuan per capita from other industries. For this plan period the income target is set at 9623 Yuan per capita.

After relocation, despite decrease in arable land, improvement in embankment and newly constructed dykes will improve flood control standard. In addition, in the plan period,
agricultural hydraulic engineering has been improved and plant production optimized and such industries as horticulture, livestock breeding, township-run enterprises, catering industry and trade have been in small-scaled commercial activities, therefore rural residents’ income is steady in rise. In a word, if proper measures are adopted to solve any problems concerning production or living for the resettlement, their living standards will be better. This shows that plan for resettlement of affected residents is basically reasonable.

- Impact upon resettlement habits and customs

In order to minimize the impact upon immigrants in habits and customs, to minimize any damage to their social network, to avoid enlarging their farming radius, resettlement will be mainly in form of local relocation, with focus on development of plant production and livestock breeding. By way of perfection of rural infrastructure, regulation of industrial structure and improved varieties will sustainable development be guaranteed. Moreover, more immigrants will be encouraged to participate in project construction to earn more money.

Since the immigrants are under local relocation, their customs and habits will suffer little from cultural shock, thus plan for the resettlement of affected residents is basically reasonable.

- Impact upon immigrants’ infrastructure

- Impact upon traffic

Construction of this Project is of limited impact upon local traffic facilities and during the construction all affected traffic facilities are expected to restore their function Prior to reservoir filling. Moreover, completion of the Project will greatly improve local waterways to accelerate logistics in the reservoir surroundings and in south of Jiangxi Province, thus to promote local economic development. Meanwhile, with implementation of the resettlement of affected residents, immigrants will enjoy improved living and traffic conditions.
### Table 6.6—1 Environmental Capacity

<table>
<thead>
<tr>
<th>Affected townships /towns</th>
<th>Village</th>
<th>Rural (men)</th>
<th>Arable land (mu)</th>
<th>Arable land per capita</th>
<th>Arable land under inundation &amp; acquisition (mu)</th>
<th>% of arable land</th>
<th>Residual arable land (mu)</th>
<th>Arable land per capita after completion of project (mu)</th>
<th>Reduced arable land per capita (mu)</th>
<th>Increase in capacity (person)</th>
<th>Production relocation</th>
<th>Planned production relocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wanhe Town</td>
<td>16</td>
<td>29213</td>
<td>43215</td>
<td>1.48</td>
<td>873.88</td>
<td>2</td>
<td>42341</td>
<td>1.45</td>
<td>0.03</td>
<td>2431</td>
<td>(men)</td>
<td>(men)</td>
</tr>
<tr>
<td>Tangzhou Town</td>
<td>10</td>
<td>17188</td>
<td>27887</td>
<td>1.62</td>
<td>818.1</td>
<td>2.9</td>
<td>27069</td>
<td>1.57</td>
<td>0.05</td>
<td>1253</td>
<td>724</td>
<td>756</td>
</tr>
<tr>
<td>Yanxi Town</td>
<td>8</td>
<td>13030</td>
<td>22513</td>
<td>1.73</td>
<td>1007.78</td>
<td>4.5</td>
<td>21505</td>
<td>1.65</td>
<td>0.08</td>
<td>962</td>
<td>604</td>
<td>631</td>
</tr>
<tr>
<td>Chengjiang Town</td>
<td>9</td>
<td>15057</td>
<td>12766</td>
<td>0.85</td>
<td>180.1</td>
<td>1.4</td>
<td>12586</td>
<td>0.84</td>
<td>0.01</td>
<td>1399</td>
<td>551</td>
<td>575</td>
</tr>
<tr>
<td>Mashi Town</td>
<td>1</td>
<td>3186</td>
<td>2567</td>
<td>0.81</td>
<td>42.13</td>
<td>1.6</td>
<td>2524</td>
<td>0.79</td>
<td>0.01</td>
<td>295</td>
<td>244</td>
<td>255</td>
</tr>
<tr>
<td>Washman Reclamation Farm</td>
<td>1</td>
<td>1590</td>
<td>55.31</td>
<td>3.5</td>
<td>1535</td>
<td></td>
<td>160</td>
<td>52</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>77674</td>
<td>110538</td>
<td>1.42</td>
<td>2977.3</td>
<td>2.7</td>
<td>107560</td>
<td>1.38</td>
<td>0.04</td>
<td>6500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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□ Water

The project will affect areas located in the valley, which is abundant in surface water and underground water (which is high in water level, thus convenient for welling or construction of tap water). In a word the project will constitute no impact upon drinking water to local residents. On the contrary, rise in reservoir water level is more convenient for irrigation to local production and daily water consumption. To sum up, local residents’ water consumption will not reduce in terms of convenience and comfort.

□ Electricity

Power transmission and sub-transformation facilities will be restored, thus affected residents will fell no impact. Instead, completion of the Project will transmit $4.8 \times 10^8$ kW.h of power to Ji’an Power Network, to improve power assurance rate.

□ Medical, Cultural & Educational Conditions

The Project will not create direct impact upon medical, educational facilities, thus there will be no negative effect upon local medical service or schooling.

□ Fuel Supply

Affected residents depend upon such fuel as liquidized gas, coal and firewood, while acquisition of land produces minute impact upon local residents.

6.6.3 Environmental Impact upon Host Area

Resettlement of affected residents is on the basis of making full use of existing resources and tapping potential of land resources. Such resettlement is active in relocation to gradually improve their living standards to former level, with much room for development so that the resettlement enjoys long-term development.

Land in Shihutang area is under high use, thus there is limited room for development of arable land in waste hills or unused land. As a result, the Project will adopt measures for protection of arable land below the flooded line. Due to scattered relocation of immigrants, each host area will not suffer from pressure due to limited resettlement. According to the plan, resettlement will be achieved in the very same village or in villages nearby. In a word, limited resettlement creates not much negative impact upon environments, as analyzed as follows:

□ Advantage of water resources will be fully utilized to promote industry adjustment

At present economy does not major in plant production, which accounts for about 38% of local GDP. Within Wanhe and Yanxi Embankment Protection Zone, some arable land frequently suffers from flood to produce low output. Developmental resettlement will mean decrease in arable land per capita, but by way of newly constructed or improved embankment to improve flood control standard, by perfection of agricultural hydraulic engineering to improve medium-or-low output farmland to high output land, by optimization of plant production and commercial development of such industry as horticulture, livestock breeding, village-run enterprises, catering industry and supermarkets, immigrants will earn more money due to improved output per unit.

□ To promote the capacity to resist natural calamities in the resettlement areas.
Large input of funds, materials, information and technologies during the migrant resettlement will improve the electric supply, transportation and telecommunication facilities in the resettlement areas. Irrigative conditions for farmland will be radically improved, thus strengthen the capacity of the migrants to resist the natural calamities.

☐ To improve the living standards of migrants

The objects of migrant resettlement of the project are some rural households. The resettlement has provided new opportunities for the improvement of the living conditions of the migrants. Newly constructed houses have taken good consideration of the infrastructure. The quality of the houses will be also improved.

☐ To increase the land productivity through reasonable development of land resources.

The normal water storage level of the project is 56.5m. A certain amount of surplus labors for re-employment. These people will loss the productive foundation that they live on. According to the RAP, improvement of low-yield farmland and dry land and greenhouse vegetable planting and aquiculture in the reservoir area will be used for re-employment. Such land development projects help to comprehensively utilize the land resources in the resettlement areas, hence increase the land productivity.

☐ The impacts of resettlement on the land resources

The reserved farmland in the reservoir area is limited. There are very few farmlands that are suitable for agricultural purposes in the reservoir area. Due to the inundation and migrating resettlement that will occupy some quantity of land, the contradiction between farmland resources and population tend to be more intensive. Productive resettlement of migrants will end with local adjustment of the remained farmland after inundation of the reservoir, which shall be done by local people’s government according to the overall planning. After adjustment, the average farmland per capita will be less than that before reservoir construction. This has affected agricultural activities to some extent. However, through the economic income from the project construction and economic compensation for the migrants that will be used to improve the land productivity, the population-land contradiction will be mitigated effectively.

☐ The analysis of the impacts of resettlement on the environment

The productive resettlement of the project mainly includes improvement of low-yield farmland and dry land and greenhouse vegetable planting and aquiculture in the reservoir area. This means that resettlement will not occupy new land. The impacts of productive resettlement on the environment are in the following aspects:

The impacts on water quality: Productive resettlement will cause water erosion, mainly of SS. It is because that there are many places being scattered in a vast area. So the impacts are on big range but of little degree. On the other hand, the impacts of mesh-cage fishery cultivation on the environment are mainly of organic pollution caused by the feeds thrown into the water. However, most feeds will be consumed by the aquatic life and the impacts of the remains on the environment will be very limited.

Water erosion caused by productive resettlement will come into being in construction. The
main impacts of water erosion are on the quality of the water in the ditches nearby the agricultural development areas, causing mud accumulation. The cultivatable layer in the agricultural production areas will become thinner due to water erosion, thus affecting agricultural production. Therefore, it is required to enhance the works of conservation of water and soil during the process of development.

The impacts of migrating resettlement on social environment

The issues of migrating resettlement of project construction are somewhat sensitive. For the sake of project construction, some people have to give up the existing quiet life and reestablish their livelihood; some people have to newly engage in land development for agricultural production. The issues of migrating resettlement will cause some negative impacts on the social environment if not properly resolved. Therefore, it is required to thoroughly carry out the plans for migrating resettlement and do well the works, such as settle the problems of water supply in the migrating areas and the accommodation for the migrants during the transition period. Such will help to accelerate the project construction.

**6.6.4 Environmental Reasonableness of Plan for Resettlement of Affected Residents**

Environmental capacity is under full consideration in planning of resettlement of affected residents. By way of embankment protection and lifting the field, arable land per capita in the area reduces only by 2.7%, from 1.42mu to 1.38mu. Acquisition of land for the Project produces limited impact upon local residents. Meanwhile, the immigrants will be under relocation in 44 villages. By way of improvement of low-yield farmland in nearby villages, resettlement of affected residents will be under proper solution so that their living standard will even be better than at present.

Resettlement plan covers plan of relocation, plan of settlement, plan of relocation of enterprises or institutions, plan of reconstruction of special items, plan of environmental protection and plan of water and soil conservation. Amount them environmental protection plan consists of plan to handle such issues as rural domestic sewage treatment, solid waste disposal, environmental protection measures concerning immigrants infrastructure, feasible measures for promotion of people's health. Water and soil conservation measures in the plan will cover such measures as concerning water and soil conservation works in the host area and measures for lifting the field. Implementation of these measures will effectively prevent water and soil erosion in the host area, will alleviate environmental loads to avoid any potential negative impact, thus favorable for regional environmental balance.

To sum up, the plan concerning resettlement of affected residents is somewhat reasonable from the point of environmental protection.

**6.7 Antiquities Preservation**

In accordance with *Cultural Relics Investigation Report of Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River* as compiled from Jiangxi Provincial Institute of Cultural Relics and Archaeology, also based upon site investigation, in the inundation and surrounding area of Shihutang there are such 5 relics as (a) site of ancient Baikou City (State-level unit of cultural relics protection), (b) Gouzi Tower (county-level unit of cultural relics protection), (c) Ouyang Ancestral Hall (under application for province-level cultural relics protection), (d) Huangkeng Ancient Ferry, and (e) site of ancient city.

For detail of location of the five relics' protection see Attached Drawing 03. For detail of a
profile of the 5 relics and impact thereupon from the planned Shihutang Project, see Table 6.7—1.

From Table 6.7—1 it is clear that of the 5 relics only 2 are under protection (one under state-level protection and one under county-level), with one under application for province-level protection. The project and inundation will produce no impact upon the two relics, which are under protection, and the one under application for province-level protection. The project will create impact upon the 2 relics, which are under no protection.

Huangkeng Ancient Ferry is located within the project inundation. Prior to the construction of the project, if there are no measures for protection of the said ferry, cultural relics there will be under adverse impact. In accordance with Cultural Relics Investigation Report of Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River as compiled by Jiangxi Provincial Institute of Cultural Relics and Archaeology, there is a pledge therein to the extent that the Jiangxi Provincial Institute of Cultural Relics and Archaeology will adopt measures, before the construction of the Shihutang Project, for protection of the ferry to obtain relevant historical information so that after the cultural relics protection work is completed, there will be no impact from the Project upon the ferry.

The ancient city site is located 40m from the south bank of the Kan River, where generally it is over 60.80m in EL, higher than the design flood level (58.65m), to suffer from no impact of water level rise in the Kan River. But the north wall of the ancient city, due to channel rerouting of the Zhulin River, has an EL of only 56.7m, about 0.20m higher than the normal storage level (56.5m), but lower than the design flood level (58.65m). If there are no protection measures before the project is implemented, the ancient city will suffer from adverse impact. In accordance with Cultural Relics Investigation Report of Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River as compiled from Jiangxi Provincial Institute of Cultural Relics and Archaeology, there is a pledge therein to the extent that the Jiangxi Provincial Institute of Cultural Relics and Archaeology will adopt measures, before the construction of the Shihutang Project, for protection of the ancient city to obtain relevant historical information so that after this measure there will be no impact from the Project upon the ancient city.

### 6.8 Inundation of Mineral Resources

In accordance with Evaluation Report of Mineral Resources under Inundation from Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River, the stratum here is simple in structure in the permanent acquisition of land by the Project, mainly composed of cretaceous Maodian Group (k2m), Zhoutian Group (k2z) and Hongningang Group (K2hg) of red clasolite; of gravel and vermiform reticulate laterite of Jinxian Group of Pleistocene series of quaternary system; of alluvial gravel, sandy loam and clay soil of Holocene. There is no metallic mineral resource or non-metallic resource, except for such non-vital minerals as building sand, rocks and clay soil, etc.

In the permanent acquisition of land from Shihutang Hydropower & Navigation Project in the inundation area, there are no mineral resources under inundation; there is therefore no need for avoidance.
<table>
<thead>
<tr>
<th>No</th>
<th>Names</th>
<th>Site</th>
<th>Era</th>
<th>Level</th>
<th>Impact from project construction and inundation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Baikou ancient city</td>
<td>Zhoutou Village of Tangzhou Town, 3 km southeast of Taihe County Town, south bank of Kan River.</td>
<td>West Han to Sui Dynasty</td>
<td>state-level key protection</td>
<td>The site is located 25 km south of Kan River bank, where EL is usually over 59.3m, higher than design flood level (58.65m). Yongchang Embankment Protection will be constructed at least 5 km from the site. There will be no impact upon the site from Shihutang Hydropower &amp; Navigation Project construction and inundation.</td>
</tr>
<tr>
<td>2</td>
<td>Gouzi Tower</td>
<td>About 20km upper reach of recommended dam site, at the top of shore hill</td>
<td>Qing Dynasty</td>
<td>County-level protection</td>
<td>The tower is about 60m to the shore of Kan River, whose foundation is higher than design flood level, to suffer from no impact from Shihutang Hydropower &amp; Navigation Project construction and inundation.</td>
</tr>
<tr>
<td>3</td>
<td>Ouyang Ancestral Hall</td>
<td>About 35km upper reach of recommended dam site, at Shujiang Village of Mashi Town; 1.5 km to the shore of Kan River</td>
<td>Qing Dynasty</td>
<td>Under application for province-level protection</td>
<td>Far away from the inundation area, to suffer from no impact from Shihutang Hydropower &amp; Navigation Project construction and inundation.</td>
</tr>
<tr>
<td>4</td>
<td>Huangkeng Ancient Ferry</td>
<td>west of Huangken Village, 2 km southwest of Zhangtang, Zhangtang Township, Taihe County</td>
<td>Qing Dynasty</td>
<td>Under no protection</td>
<td>Within the inundation area. Jiangxi Provincial Institute of Cultural Relics and Archaeology will undertake protection to obtain relevant historical data. There will be no impact upon the site from Shihutang Hydropower &amp; Navigation Project construction and inundation.</td>
</tr>
<tr>
<td>5</td>
<td>Site of Ancient City</td>
<td>At Xiamu Village, Hejiang Village Committee, 2km to the north of Yongchang City, Taihe County</td>
<td>South Dynasty</td>
<td>Under no protection</td>
<td>The site is located 40m south of Kan River bank, where EL is usually over 60.68m, higher than design flood level (58.65m), to suffer from no impact out of water rise in Kan River. But due to river diversion from Zhujiang, the north</td>
</tr>
</tbody>
</table>
6.9 Social Environment

6.9.1 Impact upon Social Environment during The construction period

- The project will need newly constructed roads lasting 40km long and expanded roads 4 km long. During the construction period, the engineering vehicles and material carrier vehicles will use existing roads and village roads. Partial jamming may occur to produce negative impact upon local traffic.

- The construction will adversely affect navigation. In line with the construction diversion program, on the first stage, operation will commence first on the cofferdam and the 11-hole flushing locks on the left bank and also on the ship lock and grooves on the right bank, ith only the central channel for navigation. After narrowing of the river the flow velocity will increase, which is unfavorable for navigation during the flood period, while during the dry season the deepened upstream is favorable for navigation. River navigation parameters are:
  When at the river section the average velocity is less than 2.0 m/s, ships will sail at will; when the average flow ranges from 2.0 to 3.0 m/s, they shall move from the help of tugboats.

  During the second stage, the right bank ship lock will have been completed for shipping. At the same time, the left bank will have 11-hole flushing sluices available for flow control to meet the need for upper stream and downstream navigation. In the second phase during cofferdam construction there will be about two months for suspension of navigation. In order to resolve this challenge, if necessary, there shall be public notice for such suspension in cooperation with local marine and navigation departments for shipping security.

[3] About 500m downstream on the right bank of the recommended dam site stands Sangyuan Primary School whose 200 students go to and from by a road in front of the school. During the construction period this road will be used for transport of materials, thus there will be high peak in traffic. As a result, good management of this road will be vital to students’ study and safety.

[4] The project will have about 4 years as the construction period, to have about 3900 personnel per day in peak, which will create desirable demand of meat and vegetables from
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local markets. If at 200 Yuan per day per capita, in peak time the local benefit will increase by 78000 Yuan per month. Construction units in operation will promote development of local catering industry, service industry and entertainment, in addition to supply of jobs to local residents. All of these factors will promote local economy, improve people’s living standards and promote development of local social environment.

6.9.2 Impact upon Social Environment during the operation period

- Kan River one of the major channels in China listed by the Ministry of Communications. In accordance with Planning of Inland Channel and Terminals Layout in PR China, Grade III channel available for 1000-t ships is considered as “major channel”, channel for 500-t as “complementary channel” (Grade IV). Such major channels and Yangtze River channel network together with Pearl River channel network will make up 2 horizontal--one vertical--two networks--16 major channel layout (called “2-1-2-16”), of which Kan River is part from Ganzhou to Hukou (606km). After completion of Shihutang Project, Grade III channelized waterway in Kan River will be extended in the upper stream by 38 km to finally realize the planned goal.

- Water transport is the traditional traffic in Jiangxi Province, at steady development at present. But in terms of overall transport system, water transport is far backward from railway or highway transport. Completion of Shihutang Project will promote development of the major channel in Kan River, development of modernization of harbor installation and of auxiliary support and safeguards system, and development of containers and special ship transport. Meanwhile the Project will accelerate modernization, upsizing and standardization of bulk carriers, to help water transport in Kan River develop in virtuous cycle.

- Upsizing and standardization of inland craft is the sole way to improve efficiency and adapt to market competition. Faced with market propeller and competition, water transport in Jiangxi Province is under self-adjustment. With gradual recovery of water transport market, especially due to flourishing as never before in transport of building materials and of mineral resources, water craft is harvesting better and better reward. Owing to the exemplary role of 1000-t and above carriers’ investment from individuals, more and more individuals realize that construction of heavy-tonnage vessels proves more efficient than light-tonnage ones. Jiangxi Province is rich in mineral resources and building materials, while the Yangtze River, Kan River and Xing River connects the middle and lower reaches of the Yangtze River and the Yangtze delta, where there is a huge demand for such materials and resources. Completion of Shihutang Project will greatly improve channel conditions so that bulk vessels may reach any places directly to reduce cost and improve economic benefits.

- With the fast economic development in Jiangxi Province, there will be greater demand for power. Shihutang Hydropower Station, a medium-scaled one, is close to the load center of Jiangxi Province, will become the backbone hydropower station. After completion the station
together with Wan’an Hydropower Station is capable of peak modulation, to play a vital role in relief of power shortage in Jiangxi Province.

Jiangxi Province as a power-shortage province has limited coal reserve, except for some hydropower. At present she depends upon thermal power and hydropower for energy. She has very limited coal reserve, after exploitation for some time, the resource will soon be exhausted. Her energy structure is far from rational, with coal to play too big a role. In 2004 all the power generated amounted to $327.77 \times 10^8$ kW·h, of which thermal power contributed $297.64 \times 10^8$ kW·h, or 90.8% of the total; while hydropower generated only $30.13 \times 10^8$ kW·h, or 9.2%, less than one tenth. Shihutang Hydropower Station is one of the medium-scaled stations under planning. Once it is put into operation, it will raise the percentage of hydropower over the whole Jiangxi power grid and help to improve energy structure of Jiangxi Province.

In terms of the history of urban development in Jiangxi Province, most of the towns and cities thrive close to rivers or lakes, therefore water transport plays a decisive role in formation and development of towns and cities. Development of water transport promotes fast development of towns and cities along the shores of such rivers as Kan River, Fu River, Xing River, Rao River and Xiu River. Depending upon water transport of Kan River, such big cities as Nanchang, such medium-sized cities as Ganzhou and Ji’an, such small cities and towns as Zhangshu, Fengcheng and Taihe came into being. In accordance with *Urban System Plan in Jiangxi Province*, by 2020, there will be such three super-metropolitan cities as Nanchang, Jiujiang and Ganzhou, one large city – Ji’an, and such four medium-sized cities as Fengcheng, Zhangshu, Ruijing, and Taihe. Modernization of cities demands development of swift, efficient, safe and comfortable traffic, thus water transport will offer quality service for economic connection between all cities and towns, large or small.

Jingang Mountain is one of the most famous revolutionary regions where people once made greatest contribution to foundation of PR China. Due to various reasons economy is still far behind the times, thus there is need for more investment to promote local economic development by exploitation of regional resources. Shihutang Project is located in the hinterland of Jingang Mountain, close to Jingang Mountain Scenic Spot, with numerous counties nearby, therefore the completion of the project will greatly promote regional economic development.

Once into operation, Shihutang Project will not only create direct financial benefit to Taihe County, but also necessary conditions for development of tourism by contribution to traffic and energy, thus to provide fresh chance for sustainable development of economy in Taihe County.

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At present in Wan’he and Yanxi some farmlands often suffer from flood inundation in Kan River, with poor annual yield. Completion of Shihutang Project will bring such five areas under protection as Taihe County Town, Wan’he, Yongchang, Yanxi, and Zhangshu, so as to improve the current flood prevention standard from 2-to-5-year-recurrence to 10-to-20-year recurrence. As a result, there will be 74.8 km² of area under protection, among which farmland totals 65000 mu and population 53000 persons. By improvement of embankment in left-bank inundation area of Kan River’s tributary Yunting River and of dyke in Mashi Town (tail of reservoir), there will be 1200 mu of farmland under protection. All of these will be beneficial for perfection of municipal infrastructure in Taihe, for protection of people’s lives and wealth and for improvement of farmland yield.

Within Taihe County there are only highway bridges to connect the Kan River. Wanhe Town on the left bank and Yanxi Town on the right bank is somewhat far away from Taihe County Town, while there are about 43000 people in Wanhe, about 19000 in Yanxi. Both towns are backward in economy, where people depend upon boats or ships for traffic, to suffer from threat during flood seasons. Shihutang Project will build a highway bridge over the dam (10m in width and 1637m in length, with a pavement of 2×1.5m). Such a bridge will greatly relieve traffic bottleneck and remove any threat from flood to people or to water traffic, thus to play a great role in promotion of regional economic development.

Completion of Shihutang Project will bring a lot of convenience to Taihe Water Plant and to intake of scattered pumping irrigation stations.

6.9.3 Impact upon Downstream Water Supply during Operation Period

In the 33km-long reach from Shihutang dam site downstream to Ji’an City there are such major water consumption units as Jinggangshan Power Plant Water Works, Hedong Water Plant of Ji’an City, No 1 and No 2 Water Plant, Water Works of the Pharmaceutical Plant, Wuyueguan Waterworks, to have a total designed daily supply capacity of 208.7×10⁴t/d, equivalent to the flow of 24.1 m³/s. See Table 1.7-3.

The base navigation flow at Shihutang dam site is 187 m³/s; the ship lock has a flow of 11.24 m³/s in the near future and 15.31 m³/s in the long run. The project minimum assurance flow averages 198.24 m³/s in the near future and 202.31 m³/s in the far future.

At Shihutang dam site in the upper stream there is one tributary Guanyuan River (with a catchment area of 558 km² and mean annual flow at about 16.2 m³/s), whose inflow is under diversion by the Wanhe Diversion and Drainage Canal downstream.

Downstream from the Shihutang dam site to Ji’an there are two tributaries, of which Heshui River has a catchment area of 9058 km² with mean annual flow at about 262 m³/s; Gu River has a catchment area of 3084 km² with annual mean flow at about 89.4 m³/s; mean annual flow from the two tributaries total about 351.4 m³/s.
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Since Shihutang Project is of runoff development, there is limited effective storage, with almost no regulation control over the runoff. It serves as peak load modulation with Wan’an Hydropower Station for Jiangxi Power Network. To satisfy the base navigation flow at least equivalent to 187m³/s, the discharged base navigation flow from Wan’an (130m³/s) shall be under compensation from Shihutang reservoir (inflow at Shihutang reservoir totals 76.1m³/s). Therefore the mean annual, monthly and daily flow and water level downstream at Shihutang dam site is the same as the index at present (See Table 6.1—9 and Table 6.1—11).

To sum up, the water consumption from Shihutang dam site to Ji’an is equivalent to a water flow of 24.1m³/s, while the aggregate inflow between the two regions reaches 565.84m³/s; meanwhile the mean annual, monthly and daily flow and water level downstream at Shihutang dam site is the same as the index at present, to show that operation of Shihutang project will create no impact upon normal water consumption downstream.

6.10 Regional Climate

6.10.1 Profile of Regional Climate

Kan River basin falls within sub-tropical wet climate, of east-Asian monsoon region, abundant in rainfall. Annual mean rainfall totals 1300~1800mm in the basin, severely uneven in distribution between months. In accordance with record in meteorological stations in Kan River, most rainfall, about 41%~51% of rain in a year, drops from April to June. Annual mean evaporation amounts to 1294~1765mm; annual mean temperature ranges from 17.2 to 19.3℃, while extreme temperature reached 41.6℃ (observed in Yichun Meteorological Station on 16 Aug, 1953), and extreme low -14.3℃ (observed in Fengcheng Meteorological Station on 29, 1991); annual mean humidity is 76%~82%, with relative minimum humidity at 6% (observed in Xiajiang Meteorological Station on Nov, 28,1978); annual mean wind velocity ranges from 1.1 to 2.9m/s, while most severe wind reached 30m/s (observed in Taihe Meteorological Station on Apr. 24, 1977), of west wind (W). Annual mean sunshine averages 1628~1875h, and annual frost-free period lasts 252~288days. Taihe Meteorological Station, closest to the Project, records annual mean wind velocity at 1.8m/s, while maximum mean wind speed reaches 13.4m/s.

6.10.2 Analysis of Impacts on Local Climate

River water impounding has changed the quality of the original underlying surface in that the energy budget has changed, which will affect the local climate. The impacts of water on the climate are classified into two types. The first one is direct influence, i.e. the air denaturalization above water body, where air will expand in all directions to land through stratospheric action. Such will change the air quality above the neighboring land but being of little impacts mainly on the air layer by the underlying surface. The other one is indirect impact. Due to the change of meteorological elements above the water body, the function of thermodynamic circulation is formed, which enables rising or descending of the air in large
scale. In the air rising area, rainfall is easily formed. Increase of clouds in the daytime will reduce the sunshine hours, which will consequently lower the temperature, and vice versa in the nighttime.

6.10.2.1 Impacts on atmospheric temperature
The impacts of the reservoir water body on temperature are divided into direct and indirect impacts. As for direct impact, due to the different thermodynamic features of land surface and water surface, when the air parcel moves on land surface and water surface, under the vertical exchange and horizontal exchange, different denaturalization will occur. In the daytime, the land is hotter than the water surface, while in the nighttime; such will be on the contrary. When the air parcel moves from land to water surface, cold denaturalization will occur, which is closely related to the moving time on the new underlying surface and the strength of turbulent exchanges. After completion of the reservoir, the water surface will be enlarged. The time for air parcel moving above water surface becomes longer, so such degree will be stronger than the previous one. As for indirect impacts, due to lower surface temperature of water than the land, in the daytime, there exists relatively strong down draft above the water body, while at the same time there exists rising current on the land nearby the banks of water body. After completion of the reservoir, the volume of clouds above water body in the daytime will reduce, while the volume of clouds above the lands by the banks will increase. According to monitoring data, every additional one hour of sunshine will enable additional rise of temperature of 0.43\degree; each additional of 10% of cloud volume, the daily average temperature will varieties 0.8-1.0\degree. The range impacted by water body on temperature is related to the areas of water surface. According to the survey of Hongshuihe River conducted by concerned departments, the maximum temperature difference between water surface temperature and land surface temperature is 2.0\degree. Such impacts shall cover the range of about 2km or less when the landforms are undulating. The water surface will be 250-550 m broader than the one before construction. The water surface after reservoir construction still shapes river type at 250-550m widths, showing little difference between before and after reservoir construction. Based on the temperature analysis of similar river-type reservoir project, the impact caused by change of water body on the temperatures in different seasons shall be about 0.1\degree covering the range of about 2km. It can be seen that the impacts after construction of the Project on temperatures of both banks are very limited.

6.10.2.2 Impacts on rainfall
The elements that affect the rainfall in reservoir district are relatively complicated, which are mainly due to the variations of water vapor content in the atmosphere above the reservoir and the changes of wind-fields caused by the changes of heating power. In daytime, due to the down current above water body, rainfall reduces; in nighttime, due to rising current above water body, rainfall increases. As for the land on neighboring area, such shall be on the contrary. The bigger water surface, the more obvious of such case is. After construction of the reservoir, it still belongs to river-channel type reservoir. The widened area of water surface will not be much, which will not bring much impact on the rainfall. The spatiotemporal distribution will remain the same, and the variation of rainfall will not be obvious. The
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Gravitational field caused by the changes of heat power is relatively complicated. The prediction herewith only aims at the variation of rainfall caused by the changes of water vapor contents.

The prediction formula is:

\[
\frac{R'}{R} = \frac{1}{K} + \frac{E'}{E} \left(1 - \frac{1}{K}\right)
\]

In the formula:

- \(R'\)—— rainfall after heading up, mm
- \(R\)—— rainfall before heading up, mm
- \(E'\)—— evaporation quantity after and before heading-up, mm
- \(E\)—— evaporation quantity after and before heading-up, mm
- \(K\)—— moisture circulation coefficient;
- \(K=1.002659+0.00005084L\)
- \(L\)—— featured length of backwater area. m.

Analogical analysis of similar project, \((E'/E) = 1.0029\), computation results \((R'/R) = 1.002\). The annual average rainfall of the Project area is 1300~1800mm. The rainfall after heading up only increases 2.6~3.6mm than that before the heading up. It can be seen that the water impounding will basically have no impacts on rainfall.

6.10.2.3 Impacts on wind

When air current enters from the underlying surface of one property to another, wind speed will change due to the different degrees of roughness. When wind blows from land surface to water surface, due less roughness of water surface, the wind speed will increase. Variation of wind speed is related to the length of wind zone. The longer the wind zone, the bigger variation of the wind speed is. The addition of wind speed will be rapid at the beginning and gradually slow down till stable after passing certain distance. According to the monitoring data for similar projects, when the additional width is at 200-500m range, the wind speed will be 1.07~1.16 times of the previous speeds. The width of water surface after reservoir impounding will not change much, only 50~250m wider than the previous width. Therefore, the wind speed after reservoir impounding will not have obvious changes.

6.10.2.4 Impacts on foggy days

Variation of foggy days is related to the changes of local humidity and temperature. It can be seen from the paragraph of temperature impacts, the variation of temperature is little after water retaining. In addition, due to the little changes of the wideness of water surface after water retaining, plus humid location of the project, the impacts of water body on air humidity will be little, from which, it can be inferred that the dammed water will not have serious
impacts on foggy days.

6.10.2.5 Impacts on frost days
The number of frost days is closely related to the average lowest temperature. According to the similar project survey, the reservoir after being completed will reduce 2-3 days of the frost period for the land nearby the water body than that of the land far away from the water body, i.e. prolonging the frost-free period for 2-3 days. According to the prediction of temperature variation, after the completion of the reservoir, the lowest temperature on the banks in winter will be 1.0°C higher. The analogy analysis shows that the frost period in winter will be about 3 days less.

6.10.2.6 Impacts on humidity
According to the survey, the absolute humidity in summer above the water body shall be lower than that above the land, while in winter, it will be higher than that of land. The district for assessment belongs to low latitude humid area; the impacts of water body on air humidity will be less than that in dry areas. Based on the survey results of like projects before and after project construction, the absolute humidity in wet season after reservoir construction will be 1hpa lower than that before reservoir construction, while in dry season, the figure will be about 1hpa higher. Therefore, it can be inferred that the absolute humidity will not undergo obvious variation after water impounding of the reservoir.

6.11 Geological Environment
6.11.1 Analysis of Impact upon Embankment Stability
The reservoir created out of Shihutang Project is of river channel, with the embankment mainly of second bottom and second terrace. There is no discovery of such unfavorable geological conditions as collapse or landslide or bank failure, except for small-scaled embankment collapse or bank failure in the front of the terrace, therefore the embankment of the reservoir is basically stable and steady. Preliminary analysis indicates that after reservoir filling the soil embankment under long-term influence of wave impact will suffer from embankment collapse to some extent, despite not much negative impact upon the works’ construction.

In accordance with engineering surveying, the embankment out of second bottom suffering from torrential impact is poor in stability, mainly including the reach (a) from Jiangjiezhou to Huwei within Wanhe Embankment Protection Zone, from Jiangbei to Huangken within Zhangtang Embankment Protection Zone, from Yanxi Town to Xiajia Village within Yanxi Embankment Protection Zone, from Tangxuan to Shantian Terminal within Taihe Embankment Protection Zone, and the reach (b) on the left bank of Shui River and the reach (c) covering most of the cave bank of Yunting River, to last about 29 km in length. Here the slope is of dualistic structure, the upper made of clay soil, loam, sand soil or fine sand to serve as the major soil of the slope; the bottom usually of gravel. The slope is most often 5~7m above normal water level at a grading angle of 60~75°, upright at partial reach. Estimate by
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Descriptive geometry solution shows that after reservoir filling the above-mentioned embankment will suffer from bank failure by 15 to 21 m in width.

Although most of the rest of reservoir banks is made up of unconsolidated sediment of quaternary system, they are located on accretion beach with slow slope, under weak fluvial erosion, thus the embankment is desirably steady and stable. There will be little bank failure after reservoir filling. The embankment on the left bank of Dahe Tower and the reach on the right bank of Jiangbei and the reach close to Taihe Highway Bridge is made up of low hills of cretaceous red stratus, usually 30 to 40 m in height at an angle of 15°, almost horizontal. Here the embankment, about 2 km in length, is basically stable, to suffer from no collapse or bank failure after reservoir filling.

6.11.2 Analysis of Potential Surface Collapse

The bed rock in Shihutang Project is all of dark purple thick stratified mudstone, of pelitic siltstone, of poststone and of packsand, etc, over 582.0m in thickness, of non-dissoluble rock. Without artificial underground caves, therefore there is no possibility of surface collapse from karst or from goaf.

The stratum is simple in structure in the permanent acquisition of land by the Project, mainly composed of Maodian Group (k2m), (k2z) and Hongningang Group K2hg) of red clasolite; of gravel and vermiform reticulate laterite of Jinxian Group of; of alluvial gravel, sandy loam and clay soil of Holocene. There is no metallic mineral resource or non-metallic resource, except for such non-vital minerals as building sand, rocks and clay soil, etc.

6.11.3 Analysis of Dam Deformation & Stability against Sliding

In the dam site the bare stratum is of red clasolite of cretaceous Zhoutian Group, and of alluvium of Pleistocene series and holocene of quaternary system weathered or lightly weathered red clasolite classified into C□—B□1, with four developed faults (F1, F2, F3 and F4), of which F1 runs 40—45°, at a slope angle of 60—75°S—E, of extensional fault and of medium permeable stratum; F3 is of unidentified structure, of medium permeable stratum; F2 and F4 are estimated to be of compression fault, of weak permeable stratum. There are four groups of crevice, of which the N—E joints and plane fracture are relatively developed, with clay gouged intercalation. The two sides of the dam are of earth and rockfill dam, with silty clay and loam as supporting course to the dam foundation. There shall be anti-seepage treatment to the bottom of sand and gravel layer. On the left bank on the second terrace the surface has an elevation of 60 to 66 m, while the right bank is usually 56 to 66 m high in EL. In the bedrock the concrete dam has a foundation of weak weathered rock formation, there will be necessity of deep excavation in case of encounter with fault or dense joints.

The overburden soil at the dam site is of medium—compressibility, allowable bearing pressure and shearing resistance at the dam foundation generally meets the need for load of the earth and rockfill dam, which will suffer from no stability against sliding. At the concrete dam the bedrock is of silty mudstone, muddy siltite and interbedding of the two, out of
cretaceous Zhoutian Group. Here the allowable bearing pressure and deformation behavior of
the bedrock satisfies the need for concrete dam design. Here clay gouged intercalation of
podiform is buried 10 to 20m below the bedrock, to create not much impact upon stability
against sliding.

6.11.4 Analysis of Seepage Impact

6.11.4.1 Reservoir Seepage
The reservoir bank is of second bottom and second terrace, with partial low topography, lower
than normal water level, and partial low hills of slow slopes, which are higher than normal
water level, free from low pass or structure fracture zone, thus desirable in seal. Investigation
indicates the well and reservoirs constructed along the low hills enjoy an elevation higher than
normal water level. There is challenge from seepage just on the right bank of the dam site
where there is underground sand and sandy gravel, for vertical anti-seepage engineering. After
reservoir filling there is little chance of seepage.

6.11.4.2 Seepage through Dam Foundation

□ Earth & Rockfill Dam
The second bottom and the second terrace are covered with clay soil or loam, with a
permeability coefficient of $1.29 \times 10^{-7} - 9.26 \times 10^{-9}$ cm/s, thus of weak permeability. On the
bottom of the and the terrace are sand and gravel, with a permeability coefficient of $3.0 \times 10^{-3} - 1.0 \times 10^{-1}$ cm/s, of medium permeability, in need of anti-seepage engineering. Of the earth
and rockfill dam if the permeability coefficient is less than 10Lu, it is considered relative
water insulation. Boring packer permeability test indicates that the bed rock permeability
coefficient is less than 10Lu, t satisfy the need for bed rock anti-seepage. But there are F1 and
F3 fault of medium permeability, in need of anti-seepage engineering.

□ Concrete Dam
The bed rock at the dam site is of low permeability, desirable in permeability, except for dam
foundation near boring ZK203 and ZK206, where permeability coefficient ranges from 10 to
100Lu, of medium permeability, in need of anti-seepage engineering.

6.11.4.3 Seepage through Dam Abutment
The earth and rockfill dam connects with the second terrace on the left bank and with massif
on the right bank. Boring (ZK1) on the left bank and (ZK10) on the right bank indicates the
stable underground water table reaches 57.56m and 58.77m respectively, both of which are
higher than normal water level (56.50m). There will be no seepage through dam abutment if
the cut-off wall extends until the two sites.
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6.11.5 Analysis of Impact from Reservoir Silting
Sand and mud in Kan River comes mainly from flood’s top soil erosion, which is not so severe in the basin. It is not a silt-laden river. At the dam site the total annual discharge of sediment reaches $428 \times 10^4$ t, mostly of fine silt ($0.054 \text{mm}$). Due to low elevation of the sluice flour slab, which is favorable for discharge of sediment, all the discharge sluices are open to discharge of sediment in flood seasons, so that most of sediment from the upper reach will be discharged out of the reservoir. Sediment accumulation in the reservoir is estimated to develop into a small-scaled delta, with little sediment accumulation in the reservoir head and in front of the dam, which will produce little impact upon works operation.

6.11.6 Analysis of Reservoir-induced Earthquake
In the reservoir the earthquake peak acceleration is less than 0.05g, corresponding to VI in earthquake intensity. In recent years there has been no active fault, with no background to induce strong earthquake, falling into relatively stable area. The reservoir is located in the central-to-south part of Jitai Basin, whose stratum is mainly of cretaceous redbed, weak in permeability. Fracture tectonics is mainly of cretaceous syn-sedimentary fault and small-scaled fault. There is no passage for the reservoir to seepage deeper. After operation the reservoir will not raise water head by much, which will produces little change in terrestrial stress, therefore there is little possibility to induce earthquake.

6.12 Analysis of Impact from Reservoir Inundation

6.12.1 Inundation Survey
Within the reservoir some hydrologic(al) geology impregnation sections are arranged to determine the standard of reservoir inundation in accordance with groundwater mound, to make prediction concerning possible inundated areas.

Taihe County Embankment Protection Zone

The Protection Zone is located on the second bottom of the left bank, where the elevation ranges from 58.3m to 60.2m (upper reach to downstream), where the top clay is usually 5~6m in thickness. Except for the southern side of the protection zone, all the rest are for paddy fields. After reservoir filling, the crest elevation of the cohesive soil water-bearing zone reaches 56.5~58.9m, and bury of underground reaches 0~0.9m.inundation will produce negative impact upon the areas south of Xinning, north of Gaoyin, east of Guanxi and west of Hunagjiaba, because there areas have an EL of 59.5m. the surface elevation on the south of the county town usually goes to 59.5~61m, and after reservoir filling the crest elevation of the cohesive soil water-bearing zone reaches 57~58.6m where bury of underground is 0.90~3.3m, therefore negative impact from reservoir inundation will be produced upon buildings of two to four floors whose foundation depth ranges 1.5~2.2m.

Wanhe Embankment Protection Zone

Wanhe Embankment Protection Zone is located on the second bottom and second terrace of
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the right bank of Kan River, to feed on paddy fields. The second bottom is usually 54～56m in EL, and part of depression and bayou is only 52～54m EL. In the Protection Zone there is sparse terrace whose EL reaches 56～58m, for cash cropping at present. The top clay on the second terrace goes to 3.6～6m in thickness. Most of the Protection Zone is lower than normal water level (56.50m), falling into inundation area. After reservoir filling due to ground water mound the groundwater table will reach 56.40～58.62m, all these areas lower than 56.5m will be under waterlogging, and these areas higher than 56.5m will be marsh under waterlogging, except for sporadic islands which will be free from impact out of inundation.

Jintan Embankment Protection Zone

This Protection Zone is located on the second bottom of the right bank of Kan River, to feed on paddy fields, with limited second terrace on parts of Laodongtang — Maowubei. The second bottom elevation takes 1～1’ inundation section as boundary: east of Laojintan has an EL of 56～58m and west of Laojintan 58～60m, with parts of terrace reaching 61～63m EL. After reservoir filling to 56.5m the backwater surface will reach about 56.8～57.2m EL.

The top clay on terrace from Laojintan to Xinzhou is generally 4.5～10m in thickness, with part of marginal terrace lost. After reservoir filling the underground water has an elevation of 54.95～56.83m, with a bury depth of 0～3.06m, and these areas located at 57.4m EL (Mazhou, Jinhu and Jujia Village) will be under waterlogging or become marsh under waterlogging.

The top clay on terrace from Laojintan to west of Xinzhou is generally 4～7.2m in thickness, with part of marginal terrace lost in Kan River and Yunting River. After reservoir filling the underground water has an elevation of 57.11～57.95m, with a bury depth of 1.22～2.75m. there will be no impact upon most areas with EL over 58～60m. But after reservoir filling the normal level of Yunting River remains at 57.2m, almost the same as that in Kan River, thus the terrace located between Yunting River and Kan River and the coast along Yunting River which is lower than 58.0m will suffer from inundation.

Yanxi Embankment Protection Zone

This Protection Zone is located on the second bottom of the left bank of Kan River, to feed on paddy fields, with limited second terrace (dry land) for cash crops.

The second bottom is usually at 54.5～56.5m, with only part of Caoping in the upper reach reaches 56.5～57.3m EL, basically under inundation. The top clay on terrace is generally 2～5m in thickness, with part of marginal terrace lost. After reservoir filling the underground water has an elevation of 55.86～57.15m, a bury depth of 0～0.75m, basically to be under waterlogging or to become marsh under waterlogging.

The second terrace has an elevation of 60～62m, whose margin borders the second bottom where develops a NE gulch. From Xiaojia Village to Zhangjiapeng to Kan River, the margin due to erosion reaches 58～60m EL. The top clay is usually 4～7m in thickness, with the bottom made up of gravel. After reservoir filling, underground table in the terrace reaches 56.37～60.25m, with a bury depth of 0.85～2.75m. Since the dry land and the villages are
located in high places, there is no impact from inundation after reservoir filling.

**Zhangtang Embankment Protection Zone**

This Protection Zone is located on the right bank of Kan River, to feed on paddy fields. This Zone is mainly situated on the second bottom of Guanshui River and its tributaries, with an elevation of 58~54m. The second bottom on the right bank of Kan River goes usually to 56~57m EL. Embankment protection will be constructed along Kan River, with the dyke foundation under vertical anti-seepage treatment. Wanhe Canal head will extend to Guanyuan River, and at the converge of Guanyuan River to Kan River there will be a large sluice (Zhangtang Regulating Sluice) and a smaller one (Wanhe Regulating Sluice). By way of pivotal sluice and the two regulating sluices, Guanyuan River will remain what it naturally was. After vertical anti-seepage treatment the underground water will mainly connect with Guanyuan River. Since the works will not change the natural state of Guanyuan River, there is little chance of impact from inundation.

**Reservoir Head Zhoutou & Mashi**

In case of normal water level (56.5m) and under full-load flow (2400m$^3$/s) for Taihe Hydropower Station, the backwater elevation will reach 57.5~57.9m, about 0.8~1.1m higher than water surface curve of the same flow in natural state. Investigation shows that Zhoutou and Mashi has an elevation of 61~62m, while top clay of the terrace usually reaches 4~6m in thickness. When the reservoir filling reaches 56.5m, the ground water mound will reach 58~59m, with a bury depth of 3m or so, therefore basically there is no impact from inundation.

Based on uplifted bury depth due to ground water mound (except for Mashi inundation area which will be under treatment), all areas under potential inundation are under protection from embankment.

In protection design for each embankment protection zone, the embankment has been raised, consolidated or newly constructed, to develop into sealed protection ring. Vertical anti-seepage treatment has been undertaken; drain system has been completed in regulation and dredging, with drain pumping stations completed in outlet of inland inundation and waterlogging control; hillsides within the area have been under diversion. As a result, all problems facing inundation have been solved.

### 6.12.2 Inundation Analysis

Field survey and data provided by local agriculture department and urban construction department indicate that in the reservoir area the major crops are composed of rice, rapeseed, tea, cotton, sugar cane and Penny’s potato, etc. Buildings in the area are divided into three categories: Category No 1 includes the one to three story rural housing, mostly of strip foundation with embedded depth of foundation ranging from 0.5m to 0.6 m; The second category includes 2~4 story urban buildings, mostly of strip foundation with embedded depth of foundation ranging from 1.5m to 2.2 m; Category No 3 consists of 3 to 5 story or high
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urban buildings, mainly of pile foundation with the supporting course located in the gravel or bedrock below the underground water.

Due to dual structure in terrace stratigraphy in the reservoir area, the underground water is mainly of confined underground water. Calculation of elevated underground water level is based on hydrodynamic theory to obtain the crest slab depth of water-bearing zone in the clay.

Capillary rise height for clay in the reservoir is calculated at 1.0m to 1.50 m. According to the "Farmland Drainage Engineering Technical Norms" (SL/T4-1999) and distribution features of local crops and buildings, immersion standards are recommended. On the basis of underground water level due to elevation from reservoir filling and the corresponding immersion standards, except for the inundated area, it is known that all areas likely to inundation impact are all located within the protection zones.

To prevent possible impact from inundation, the project will develop such five protection zones Wanhe, Yanxi, Zhangtang, Yongchang and Taihe County City. The protective embankment line lasts 38.38 km long, of which the embankment in Taihe lasts 3.36 km long, in Wanhe 8.12 km, in Zhangtang 0.80 km, in Yongchang15.79 km, in Yanxi 10.32 km. The Daotuo Canal lasts 61.33 km, of which restored canal of the original section after dredge lasts 17.18 km long; Yongchang canal lasts 14.45 km (improved in line with original standard); newly constructed canal from Wanhe to Yanxi lasts 29.70 km long; improved diversion channels last 11.85 km long; there will be 6 newly constructed pumping stations with a total installed capacity of 5456 kW; there will two new regulation locks. The Works will lift fields by 1237.05 acres.

Works grading and flood control standards: Grave IV for rural protective zones, III for Taihe County City; design of flood recurrence year ranges from 10 to 20 and 20 to 50 years respectively for rural and urban areas.

The drainage design criteria is as follows: for the protection zones with villages and towns, the flood prevention standard will be five-year-recurrence of a rainstorm for 3 days until drainage is achieved to the depth of submerge-resistance; for Taihe County City the drainage standards shall be "Preliminary Design Report of Taihe County Flood Control" (as compiled by Ji’an City Water Conservancy and Hydropower Planning and Design Institute) concerning the 10-year-recurrence rainstorm for one day without inundation to the main buildings; for the drainage canals within thee protective zones corresponding drainage standards will be practical.

From the said information it is known that in the reservoir area to prevent possible immersion, in the protective zones the protection engineering design shall take such measures as reinforced heightening of the protective embankment to basically form a closed protection ring; vertical impermeable treatment shall be adopted against the dual foundation of the protective embankment; the gutter shall be under renovation and dredge and there shall be drainage pumping stations where there is frequent waterlogging; the hillside runoff shall be
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under diversion and drainage; some regions have adopted elevated fields measures. Engineering design shall fully take into account the immersion problems. The inundation has now been basically resolved.

This evaluation recommends that in the next design phase of the project, according to the elevated water levels and inundation standards in protection zones there will be detailed survey concerning inundation with corresponding counter-measures.

6.13 River Regime & Flood Discharge

On the basis of Flood Prevention Report of Shihutang Project, in Kan River of Jiangxi Province, analysis is made concerning impact from the project upon the river regime and flood discharge.

- Shihutang Project dam will narrow the original discharge flow cross section, to raise water level in the upper reach of Kan River and enlarge the flow cross section for flood discharge in the upper reach, thus to slow down the flow rate. But the Project after completion will achieve limited rising of water and very limited flow speed-down. In case of flood P=50%~P=3.3%, flow is accelerated by 3.80%~3.21%. After completion the Shihutang Project during non-flood seasons will achieve reservoir filling to raise water level in the upper reach, to deepen the water and reduce flow rate, there will be little change in sediment accumulation because at this period there is little sediment concentration in the river, and there is little impact from flushing downstream. Sediment accumulation produces little impact upon water surface curve and works operation. In engineering design there will be works concerning protection of downstream embankment open to erosion or collapse. In a word after completion the Shihutang Project will not change basic stability of the existing plane form of the Kan River within the affected area or the situation of slow riverbed silting. The Shihutang Project produces little negative impact upon the stability of the river regime.

- Shihutang Project will construct a barrage in the major channel in the middle reach of Kan River, with little change in clear width in terms of sand sluicing gates, and its bottom slab is almost of the same elevation as that of the original river bed, thus favorable for flood discharge and sediment discharge. In construction and operation the Shihutang Project will raise the water level in the upper reach, but not much. Although the Project narrows the flow cross section, but the raised water head will accelerate flow rate so that the flood still flows smoothly. In a word, the Project produces little impact upon flood discharge.

- After completion the Shihutang Project raises the water level in the upper reach, but not by much. Thus the Project will create little impact upon existing embankment projects or bridges.

- During construction all sand and gravel for the works will be obtained from nearby river channels, with block stones from nearby quarries. Despite the sporadic distribution of embankment projects, all stones for the works will be locally obtained. Despite heavy traffic during the construction period, during flood season there will be no use of flood control vehicles and after completion of the project there will be no damage to highways or traffic conditions. In a word, the Project produces no negative impact upon emergency flood fighting.

- In engineering design, the permanent water retaining structure, outlet structure and energy
dissipation works in Shihutang Project are all proper and desirable for proper flood control, in line with the flood control standard in each of the embankment protection zone.

- after completion the Shihutang Project creates more convenience for Taihe Water Plant and pumping irrigation stations.
- Shihutang Project will raise water level in non-flood seasons to meet the need for irrigation and enlarge the scope of inundation in the upper reach, which will create much impact upon drain for the farmland. In addition, during operation Shihutang Project will create flushing downstream, to produce possible collapse or bank failure. All these have been under proper engineering treatment in design in line with technical descriptions, standards or criteria.

### 6.14 Navigation

Impact upon navigation is under analysis in line with Verification Report of Navigation in Kan River in Jiangxi Province concerning Shihutang Project.

- The major purpose of Shihutang Project is to improve the channels, complimented from power generation and flood control. The Project will achieve canalized waterway totaling 38km (Grade III), to play a desirable role in improvement of existing channel, which is difficult for navigation.
- After completion the Project produces little change in runoff or flood in the main channel. Discharge at 187m³/s will create no impact upon all kinds of function of downstream pivotal hydraulic works. Instead, the Project will play some role in navigation during low water periods. Meanwhile such a discharge will create prerequisite for the downstream channel to meet Grade III.
- The balancing storage of this Project is not large, but it still is capable of daily adjustment to guarantee basic navigation to some degree.
- During construction of the cofferdam in the second stage, with development of the berm, original channel will no longer be too narrow to be available for navigation, while the permanent structure will not function until the water is raised to certain level, thus there will be a period not open to navigation. To solve the problem, it is recommended that cooperation with the maritime and navigation departments concerned be established to apply for temporary blockage with necessary notice in advance, for the sake of safety.
- Construction of the Project will make the original leading light fail to function, which will create negative impact upon navigation. Therefore there shall be cooperation with the maritime and navigation departments concerned to establish temporary light for the sake of safe navigation.

### 6.15 Public health

The analysis of the impacts of hydropower projects aims to predict the possible occurrence, spreading and development of some diseases caused by the environmental changes due to project construction and operation. The predictive analysis herewith covers the diseases of
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natural focal disease, endemic disease, water-borne infection and insect-borne infectious disease etc. The methods for assessment mainly is analogical predictive analysis.

6.15.1 Analysis of impacts of the Project on public health during construction

The project construction lasts four years to involve 3900 employees per day during construction peak. During the construction period, frequent floating working staff will increase the chances for spreading of various diseases, which will bring some epidemic diseases that the construction sites do not previously have, or extend some diseases of the areas to outside places. Sanitary garbage, ordure and wastewater, if not properly treated, will cause pollution to river and water sources. Local people and the workers who drink the water may suffer from intestinal epidemic disease such as hepatitis and bacillary dysentery, which, if not properly controlled, will lead to mass epidemic diseases. On the other hand, earthwork and stonework after excavation will easily form plashes where may become the places for breeding of mosquitoes, thus may lead to the occurrence and spreading of insect-borne infectious diseases including malaria. Dust, NO₂, SO₂ produced by construction will have adverse impacts on the air of the construction site, which will add to the patients who suffer from respiratory diseases. Noise pollution may harm the auditory system and public health. Meanwhile, strong labor intensity of the workers may worsen the physique and weaken the resistance against disease, and labors may easily suffer from disease. It can be seen that project construction will bring adverse influences on the working personnel and neighboring residents. According to the statistical data of 1987 of Yantang Hydropower Station of Hongshuihe River, in the construction site, there were over 200 people suffering from diarrhea, more than 300 people from malaria. The incidences of these two diseases in local countryside are relatively higher during construction period than that before construction, indicating obvious rising.

6.15.2.2 Analysis of impacts of the Project on public health during operation

People’s health is closely related to the natural conditions, living habits, living idea, living standard and sanitary conditions. However the impacts on the health by these factors are complicate which shall be difficult to present quantitative description. Therefore, the prediction herewith adopts analogical method. The similar project is Dahua Hydropower Station that has the same natural river channel.

From the collected materials, it can be seen that:
(1) No epidemic diseases are found due to environmental changes after 10 years of water retaining in Dahua Hydropower Station;
(2) No schistosomiasis patients or oncomelania are found before and after reservoir construction.
(3) The incidences of diarrhea and viral hepatitis of water-borne infection are high during construction period and reduced after one year.
(4) The incidence of malaria is high during construction period, and tends to reduce after water retaining. No fulminate epidemic is found.
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(5) The encephalitis B does not have obvious changes.

From the analogical data, it can be predicted that, after water retaining of the reservoir, the project will not have adverse impacts on the people’s health. On the other hand, operation of the project will promote the local economy and living standard. The cultural information exchanges will be also enhanced. People’s living ideas will also undergo changes, which will make them attach to the good living habits. Therefore, the bad factors that affect people’s health will disappear gradually and the occurrence of various epidemic diseases will be controlled.

6.16 Solid Waste

Solid waste produced during construction consists mainly of builders’ rubbish and domestic garbage. Peak yield of solid waste will total 3900Kg/d during the construction period, and the gross solid waste from the project will reach 200 to 300 tons. If there were no effective measures to treat the waste, constructors’ health would be under threat, and surroundings and landscape will be polluted.
7.0 SPECIAL ASSESSMENT OF IMPACTS ON LARGE AND OLD TREES

According to Special Appraisal on Impact to Old and Famous Trees and Key Wild Plants of the Shihutang Project of Jiangxi Province compiled by Forestry Institute of Jiangxi Agricultural University, as well as impact of project construction period and operating period of field investigation result appraisal of this appraisal to the old and famous trees and key wild plants, nature protection area distributed within the appraisal range, and put forward corresponding protective measures.

According to the field evaluation of experts of Forestation Commission of Jiangxi Province Forestry Department, all old trees within the appraisal range of the project belong to Class III old trees (See Appendix V for details); Forestation Commission of Jiangxi Province made an official reply of Special Appraisal on Impact to Old and Famous Trees and Key Wild Plants of Navigation and Power Junction of Kan River Shihutang of Jiangxi Province with the title of Reply of Special Protection of Old Trees of Navigation and Power Junction of Kan River Shihutang of Jiangxi Province GanLuBanHan [2007] No.1 (See Appendix III for details).

7.1 Investigation of current status of old and large trees
7.1.1 Determination of old trees, big trees
Consult with the file information of old trees of Taihe County, we found that most old trees in the project area have not established files, which should be confirmed during the field investigation. Most old trees in the project area are Cinnamomum camphora, according to natural growth rhythm of Cinnamomum camphora in Taihe County and evaluation method of Taihe County Forestation Commission on old Cinnamomum camphora, for Cinnamomum camphora that has no exact age record, determine diameter at the breast height $\geq 100$cm belong to old tree. Considering that other places usually take diameter at the breast height $\geq 80$cm as old Cinnamomum camphora, hence, big Cinnamomum camphora ——“potential old trees ” (big tree) with a breast diameter $80 \sim 100$cm should also be as object of detailed investigation.

Tree species that have no exact age record should be determined according to local habitat conditions with analogy method.

7.1.2 Field of investigation
Field of investigation is the entire project area of Shihutang navigation and power junction project, including inundation area, junction area, protection area, construction area, resettlement area and etc.

7.1.3 Investigation contents

□ Investigation of old and famous trees
Carry out investigation and inspection on species of old and famous trees, diameter at the breast height, tree height, crown diameter, age, growth status, site condition, as well as accurate measurement and positioning of azimuth and elevation of old trees and big trees.

Investigation of key protected wild plants
Carry out investigation and inspection on species of key protected wild plants within investigation area, diameter at the breast height, tree height, crown diameter, growth status, site condition, as well as accurate measurement and positioning of azimuth and elevation of them.

Investigation of old and famous trees and key protected wild plants habitat
Carry out investigation on habitat condition of old and famous trees and key protected wild plants, especially detailed investigation on composition of habitat and tree species of old tree groups.

Investigation of root system of affected tree species
According to the investigation and data processing of the aforesaid contents, find out tree species affected by the project. And further carry out investigation on the root system situation, distribution features and growth soil of these tree species in the investigation area, and provide scientific basis for the impact assessment of these tree species and protective measures.

Investigation of water tolerant situation of affected tree species
investigate tree species distribution and growth status affected by the project of habitat similar with the project area after retaining water on the bank of reservoir, pond, river close to the water level, so as to make analogy analysis evaluation on the impact of these tree species.

7.1.4 Investigation method

Investigation of old and famous trees and protected plants: carry out detailed investigation and every-tree inspection on various investigation contents, hang tag and numbering, photo, and control measurement with total station, and carry out level and elevation positioning on each investigating object.

Habitat investigation: investigate the composition of tree species of old and famous trees and protected plants community, especially old trees community, and select typical sector, excavate soil profile (combining with root system investigation) to carry out soil investigation.

Root system investigation: excavate a soil profile on the investigated trees in south-north direction, carry out investigation on growth situation of the entire root system, mainly investigate the morphological characteristics and level and vertical distribution situation of main root and Grade I, II and III of lateral roots.

7.1.5 Current investigation result
Taihe County is situated in the central subtropical zone, belong to east moist forest region in the China vegetated area with characters of subtropical zone evergreen broad-leaved forest
belt, advantageous natural environment and abundant hydrothermal condition; however, the original vegetation is destroyed seriously due to the requirements of local production and life, less native and semi-native vegetation, evergreen broad-leaved forest is reserved better only under special habitat condition of tiny minority mountainous area and creek area, the rest mostly are secondary forests, artificial forest and scrub and grass clump or fell grass clump.

According to this investigation, vegetations in the project inundation area and around the reservoir are mainly secondary forest and artificial forest, such as protective forest of protection embankment, village amenity forest and poplar young growth of returning land for farming to forestry and etc. plants in inundation area are mostly common species distributed at low elevation.

Famous trees and wild national key protected wild plants have not been discovered in the project area.

7.1.5.1 Distribution status of old trees

After field investigation, there are altogether 215 old trees in the project area (according to the filed appraisal of experts of Forestation Commission of Jiangxi Province Forestry Department, all old trees belong to Class III protective old trees), including 211 Cinnamomum camphora, 2 Cupressus funebris, 1 Sabina chinensis and 1 Castanopsis sclerophylla. The old trees are mainly distributed in old forest of Jintan, Huanghangpengxia, Xinzhou, Shihutang, Jiangjiazhou, Xiabian Village, Yinxiajiang, Taipan, Zhangjia, Laohukeng and etc. Old trees form an old trees community in nature protection area of Jintan, and others are irregular stocking in the village or beside the village sporadically. Moreover, there are some sporadic distributions of old trees in Tongluobei, Lingbei Village and Xiayinxia Village. Since the terrain is higher with farther distance, according to the arrangement of the project scheme, the project construction has basically no impact to them; hence, it is not involved in this investigation. See Figure 04 for detailed distribution of old trees in the project area, and see Figure 29-Figure 38 for detailed positioning of each old tree; See figure collection for photo of each old tree.

- Old trees distributed on the protection embankment

There are 6 old trees on the planned construction protection embankment of the project, see Table 11 for details.

- Old trees distributed in the protection embankment

Considering the construction of protection embankment may have some impact to old trees, so investigation has been made on old trees within the range about 50m in the internal side of the embankment. There are 14 old trees in this area after the investigation, see Table 12 for details.

- Old trees distributed in other project land

There are 7 old trees beside the highway of Shihutang Village on the edge of junction project area after the investigation, see Table 13 for details.

- Old trees outside the protection embankment
The protection embankment is designed on both banks of the reservoir area, which is located outside the protection embankment and 7 old trees are distributed in the inundation area (the range of inundation area will be determined on the basis of corresponding water level elevation of switch off critic flow 4700m³/s), see Table 14 for details; 181 old trees are distributed in the non-inundation area, and see Table 15 for details, altogether 188 old trees. Most of these old trees are in Jintan.

7.1.5.2 Distribution status of big trees

Key national protected wild plants have not been discovered in the project area through the investigation. Although Cinnamomum camphora in the project area not belongs to wild plants, however, as a protective species, it has important economic use and ornamental value. Furthermore, diameters at the breast height of many Cinnamomum camphora are between 80~100cm, which belong to “potential old trees”, hence, project impact to these old trees should be controlled to the minimum as well. Therefore, detailed investigation has also made on Cinnamomum camphora with diameter at the breast height 80~100cm. after investigation, there are 74 Cinnamomum camphora with diameter at the breast height 80~100cm in the project area, including 9 trees in the inundation area, 4 on the embankment, 60 outside the embankment and 1 inside the embankment. See Table 16 for details.

In summary, there are 215 old trees distributed in the project area after the field investigation, including 6 old trees in the planned protection embankment, 14 old trees within protection embankment, 7 beside the road of Shihutang Village on the edge of the junction project area, 7 old trees in the inundation area outside the protection embankment, 181 old trees in the non-inundation area outside the protection embankment (most of them is located in the Jintan Nature Protection Area at County Level). Moreover, there are 74 Cinnamomum camphora (potential old trees) with breast diameter of 80~100cm in the project area, including 9 in the inundation area, 4 on the embankment, 60 outside the embankment and 1 inside the embankment.

7.2 Investigation on growth situation of root system of Cinnamomum camphora in the project area

In order to know impact to the growth of old trees and big trees of Cinnamomum camphora reserved in the project area for Shihutang Hydropower Project after it fills water according to the design water level, investigators have made deep field investigation into Huangkengpengxia, Zhoushanzhou and Jintan of the project area where distribution of old Cinnamomum camphora and big Cinnamomum camphora are concentrated, and then select representative sectors to carry out investigation and analysis on growth situation both on the ground and underground of old trees and big trees of Cinnamomum camphora.

Investigation content include: distribution rules and growth characteristics of innamomum camphora Class lateral roots (main root system of fixed Cinnamomum camphora);

- Root system distribution of Cinnamomum camphora and correlativity of crown diameter
Distribution status of main absorption root system and growth correlativity of Cinnamomum camphora.

We investigate 3 old trees of Cinnamomum camphora this time (Jintan No.47, No.35, No.20); 5 big trees (2 in Huangkengpengxia, 3 in Zhoushanzhou). Among them, we investigate root system distribution and growth situation of 4 old trees by digging soil along the basal of trunk; since outside soil of old Cinnamomum camphora at Kan River side of Jintan collapse, we investigate root system distribution and growth situation of 2 old trees; Main root system of old trees were exposed due to erosion by large water for many years in Zhoushanzhou, in cooperation with manual oil excavation this time, we investigate root system distribution and growth situation of 2 old trees. For the purpose of not affect the normal growth of the trees, excavate usually at most 2 direction during the investigation, after the investigation, the soil will be returned back to the original location. Through careful investigation and analysis, master basically the old trees and big trees root system distribution and growth situation of Cinnamomum camphora. The detailed investigation result is as follows:

8 old trees and big trees of Cinnamomum camphora in this investigation, Class lateral roots usually is prominent at basal of trunk, judge accurately on the basis of prominent situation the number of Class lateral roots growing from the basal of trunk. Class lateral roots of 8 Cinnamomum camphora in this investigation are 3-4, Class lateral roots enter into the soil 40-60cm depth in slant or vertical direction from crown of root, and then extend outwards in the soil layer of 40-60cm depth, during the slant or horizontal extension process of Class lateral roots, branches grow every interval 20-50cm, Class lateral roots will grow gradually during the growth process of Class lateral roots. Usually Class lateral roots grew from the basal of trunk are bulky board shape or round shape big root, most diameter of Class lateral roots is equivalent to 2/3 ground diameter at the connection point with the trunk. For example, the trunk ground diameter of No.3 big Cinnamomum camphora in Zhoushanzhou is 40cm, while diameters of 4 Class lateral roots reaches to 28cm. since each old tree of Cinnamomum camphora has 3-4 large Class lateral roots extending into the soil and generate a lot of Class — Class lateral roots, which form a Class — Class lateral roots network, enable the tree roots firmly in the soil and not afraid wind blow and snow pressure.
7.0 Special Assessment of Impacts on Large & Old Trees

Huangkengpengxia

Jintan

Zhoushanzhou
7.0 Special Assessment of Impacts on Large & Old Trees

The root system of cross growth distribution zone of 4 old trees and big trees investigated in this soil excavation all exceed the projection of tree crown. Tree crown east-west direction of No. 62 large Cinnamomum camphora in Huangkengpengxia is 13.1m; root system east-west direction excavation reaches 14.5m, which exceeds projection of tree crown 1.4m. Tree crown north-south direction of No. 47 old Cinnamomum camphora in Jintan is 12m, root system north-south direction excavation reaches 13.3m, which exceeds projection of tree crown 1.3m. Most root system distributed around tree crown is Class lateral roots or rootlets and fibrous root. Most of them is distributed in the 5-30cm soil layer, root system both inside and outside the tree crown forms an immense absorption water and nutrient network, which provide continuously water and nutrition to the tree and promote the fast growth of the tree.

Investigation result shows that depth of Class lateral roots of Cinnamomum camphora distributed in the soil mostly is 40-70cm, most Class lateral roots grew from Class lateral roots and Class lateral roots grew from Class lateral roots is distributed in 30-40cm soil layer. Rootlet (diameter is less than 0.5cm) and fibrous root are distributed mostly in 5-30cm soil layer, rootlet and fibrous root are main root system to absorb water and nutrition (it is called absorption root system) for Cinnamomum camphora. It must have fine water and air permeability in the distribution scope of the absorption root system, thus, it can promote the metabolism of root system and sprout new roots, and the root system keeps strong vigor. According to biological characteristics and growth characters of Cinnamomum camphora, Cinnamomum camphora has certain water resistance, however, its absorption root system cannot be submerged in the water for a long time, Otherwise, the root system will rot due to poor ventilation condition, and finally cause poor growth of the trees or even death. The investigation result shows that water level in distribution area of Cinnamomum camphora lower than 1.0m will not have apparent impact to the growth of trees.

7.3 Impact appraisal of old and large trees

According to requirements of Regulations for the Protection of Old and Famous Trees of Jiangxi Province (2004.11.26): old tree refers to tree with ages more than 100 years; Famous tree refers to rare, precious trees or trees that have important historical, culture, scientific research value and memorial meaning. Old trees implement grading protection method. Old trees with age above 500 years will be the first grade protection; old
trees with age above 300 year and less than 500 years the second grade protection, and age above 100 years and less than 300 years the third grade protection. Famous trees implement the first grade protection. Old and famous trees that should be transplanted due to the construction of important engineering project must apply to the forestry, city greening competent administrative department according to the following regulations: transplant first, second grade protection old trees and famous trees, apply to the forestry, city greening competent administrative department of district government; Transplant third grade protection old trees; apply to the forestry, city greening competent administrative department of county level government.

After evaluation of expert of Forestation Commission of Jiangxi Province Forestry Department, all old trees distributed within the appraisal range belong to the third protection old trees (See Appendix V for details).

The representatives of the Owner, engineering designer, environment assessment personnel, ecological and old trees protective researcher form a joint working group, taking design recommendation (embankment line) scheme of engineering design as the basis, carry out field investigation on impact of the engineering design scheme to old trees, in case design recommendation (embankment line) scheme has impact on the old trees, consider firstly to adjust the embankment line direction; When the designers confirm that the embankment line direction cannot be adjusted after considering various factors comprehensively, then the environment assessment personnel, ecological and old trees protective researchers should consider protective scheme and measures.

According to the design recommendation (embankment line) scheme based on full protection of old trees confirmed jointly by the engineering design contractor and environment assessment personnel, ecological and old trees protective researchers, after field investigation and actual measurement, old trees distribute within the range of project area: 14 old trees are inside the protection embankment, 6 on the protection embankment, 188 outside protection embankment and 7 in the vicinity of junction area construction area. According to azimuth and elevation of old trees, during the project construction and after junction project storing water, it will generates different impact to old trees, through biological characteristics and ecology characteristics analysis on old Cinnamomum camphora, as well as root system investigation of typical old trees, old Cinnamomum camphora in the project area has certain adaptability of water resistant due to discontinuous immersion for a long time, in addition, Cinnamomum camphora itself has stronger water resistant characteristics. The project will generate the following impact to old trees on the basis of positioning analysis on old trees one by one:

7.3.1 Old trees inside the protection embankment

When the water level doesn’t exceed the protection embankment, it will not be affected by the river in principle. Its impact factors are: old trees near the dyke during the construction of the project, take soil to build the dyke, build bunkhouse, root system of old trees, and trunk or tree crown may be damaged directly by machine during the implementation of mechanical operation.

7.3.2 Old trees on the protection embankment
When dyke construction and earth filling at upper part of root crown of old trees and lower than 1.2m, it will not generate serious impact to the growth of old trees; if new dyke earth filling exceeding above 1.2m, it may generate bad impact to the respiration of root system of old trees and new root system will not be easy to generate in the root crown of old trees and trunk earth filling section.

7.3.3 Old trees outside the protection embankment

Elevation of root crown of 183 old trees is larger than 1.0m above elevation of design level, it will not generate bad impact in common hydrological years; elevation of root crown of 5 old trees is larger than that of design level 0.5~1.0m, the river water will generate certain impact to the respiration of root system, and cause week growth and even death; Design level of old tree at root crown and below will be affected seriously, and finally lose the plant.

Xinzhou has 9 old trees. Since Xinzhou will not build protection embankment, and elevation of old trees has smaller elevation difference with design level (0.27~0.66m), these old trees will be affected seriously.

There are 161 old trees in Jintan old forest, since Jintan old forest has been eroded seriously along the bank, after the junction project is completed, the water level will be advanced, the soil of slope of river bank below the design level is immersed in the water for a long time, which may cause collapse, some root system of old trees far from the bank may be eroded to be exposed, and affect seriously the normal growth of old trees.

7.4 Impacts on Zhujia Village Nature Reserve and Environment Protection Alternative Scheme

7.4.1 Zhujia Village County Level Small Natural Reserve (Jintan Old Woods) of Tangzhou Township

Zhujia Village County Level Small Natural Reserve (Jintan Old Woods) of Tangzhou Township is located at Jintan Village of Tangzhou Township with an area of 330mu, including core area 225mu, buffer zone 105mu. In July 2002, Reply on Agreeing to List Cinnamomum Camphora Forest of Zhujia Village of Tangzhou Township as Small Natural Reserve (TaiFuBanZi[2002]No.106) issued by Taihe County Government to set up the small natural reserve. See DRAWING NO. 05 for details of the natural reserve plan.
The Jintan Old Woods has beautiful outlook with fine vegetation and abundant tree species. Old trees community in the upper layer of arbor layer are mainly Cinnamomum camphora, Liquidambar formosana Hance, Ilex rotunda Thunb, Sapindus mukorossi, Dalbergia balansae, Celtis sinensis, Ulmus parvifolia, Diospyros oleifera and etc, composition of tree species of secondary layer are mainly Lindera communis, Ligustrum sinense, Photinia davidsoniae, Elaeocarpus sylvestris, Symlocos sumuntia, Osmanthus fragrans, Citrus grandis, Xylosma racemosum, Ligustrum lucidum and etc., tree species at the edge of the forest and riverside are mainly Sapium sebiferum, Pterocarya stenoptera, Morus alba, Salix glandulosa, Celtis sinensis, Ulmus parvifolia and etc.; plants species below the forest and herb layer are less, which are mainly Symlocos sumuntia, Clerodendrum cyrtophyllum, Phyllanthus glaucus, Vitex negundo var. cannabifolia, Wikstroemia indica, Ardisia japonica, Lycoris radiata, Viola verecunda, Cynodon dactylon, Eleusine indica, Centella asiatica, Liriope spicata and so on.

According to Special Report on Impact of Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River on Old and Famous Trees and Key Wild Plants prepared by Forestry Institute of Jiangxi Agricultural University, 161 old trees are more than 100 years old among Jintan Old Woods (identified as Grade 3 old trees by experts organized by Greening Commission of Jiangxi Provincial Forestry Bureau), the breast diameter of the largest Cinnamomum camphora reaches 230cm with a tree height 34m. In addition, there are 39 Cinnamomum camphora with breast diameter 80-100cm, these old trees or big trees are located in the non-inundation area outside the embankment. Embankment line direction of
Yongchang Protection Area of the project in the engineering design will pass through the core area and buffer zone of this reserve.

7.4.2 Analysis of impacts of the Project on county-grade small nature reserve of Zhujia Village, Tangzhou Township -- Jintan Old Woods

Camphor root system growth survey results of the project area show that the distribution area of camphor trees with water table below 1.0m has no obvious impacts on the growth of camphor trees. It is calculated as per corresponding maximum design level at gate-opening critical flow 4700m³/s that water tables of distribution points of all the old trees and follow-up old trees of Jintan Old Woods are all below 1.0m, which indicates that growth of all the old trees and follow-up old trees in the Jintan Old Woods will not be distinctively affected under the condition of corresponding maximum design level at gate-opening critical flow 4700m³/s after the Project is impounded.

Currently Jintan Old Woods has been eroded seriously along the bank of the Kan River, after the Project is impounded, the water level will be raised, the soil of slope of river bank below the design level is immersed in water for a long time, which may cause collapse, some root systems of old trees at the bank may be eroded to be exposed, which will affect seriously the normal growth of old trees.

Embarkment line direction of Protection Embankment Subproject of Yongchang Protection Area will pass through the core area and buffer zone of this reserve, the arrangement plan of embankment line put forward by the engineering design contractor doesn’t comply with relative laws, rules and regulations of Regulation on Nature Reserves of the People’s Republic of China (Decree No.167 of the State Council, October 9, 1994).

There are many old trees distributed in core area and buffer zone of protection embankment line, new earth filling will exceed 1.2m, it may generate bad impact on the respiration of root system of old trees and new root system is not easy to grow in earthing filling section of the root crown of old trees and trunks.

7.4.3 Environment protection alternative scheme of the designed fending groyne line direction of Jintan fending groyne of Yongchang Protection Area

Designed fending groyne line direction

The designed fending groyne line direction of Jintan fending groyne of Yongchang Protection Area will pass through the core area and buffer zone (see DRAWING NO.03 for details) of county-grade small nature reserve of Zhujia Village, Tangzhou Township -- Jintan Old Woods, this EIA deems this scheme infeasible from the angle of environment protection. To meet the regulations of Regulation on Nature Reserves of the People’s Republic of China (Decree No.167 of the State Council, October 9, 1994), this EIA puts forward two environment protection alternative schemes for comparison and selection from the angle of environment protection (See DRAWING NO.05 for details).

Environment protection alternative schemes

Environment protection alternative scheme I (Inner line scheme) (Recommended
7.0 Special Assessment of Impacts on Large & Old Trees

scheme\): Whereas growth of all the old trees and follow-up old trees in the Jintan Old Woods will not be distinctly affected under the condition of corresponding maximum design level at gate-opening critical flow 4700m3/s after the Project is impounded, the fending groyne line will pass through the inner side (facing the Kan River is outer side) beyond the boundary of county-grade small nature reserve of Zhujia Village, Tangzhou Township -- Jintan Old Woods, (the fending groyne line is about 20~50m away from the boundary of the reserve); In addition, the bank of the Kan River which the core area of the reserve is facing will be protected with 1040m long cement laid stone revetment (the revetment is at the boundary of the reserve), to prevent from bank collapse to be caused by river water scouring after the Project is impounded.

Environment protection alternative scheme II (Outer line scheme) (Alternative scheme)\): the fending groyne line will pass through the outer side (the side facing the Kan River) beyond the boundary of county-grade small nature reserve of Zhujia Village, Tangzhou Township -- Jintan Old Woods, (the fending groyne line is at the boundary of the reserve); In addition, drainage canal will be arranged within the reserve to prevent the reserve from waterclogging.

Comprehensive comparison and selection of the two environment protection alternative schemes are given in Table 7.4—1. Fending groyne line directions of the two environment protection alternative schemes are shown in DRAWING NO.05.

Table 7.4—1 Comprehensive comparison and selection of the two environment protection alternative schemes

<table>
<thead>
<tr>
<th>Item</th>
<th>Scheme I (Inner line scheme)</th>
<th>Scheme II (Outer line scheme)</th>
<th>Comparison result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of works</td>
<td>12.5m wide concrete diaphragm wall 1860m²; 1040m long cement laid stone revetment.</td>
<td>12.5m wide concrete diaphragm wall 1520m²; 1730m long drainage canal.</td>
<td>Scheme II is better than Scheme I.</td>
</tr>
<tr>
<td>Cost</td>
<td>Concrete diaphragm wall: 8.37 million yuan (incl. in project investment); Cement laid stone revetment: 2.9068 million yuan (incl. in EA investment). Total: 11.2768 million yuan.</td>
<td>Concrete diaphragm wall: 6.84 million yuan (incl. in project investment); Drainage canal: 519,000 yuan (incl. in EA investment). Total: 7.359 million yuan.</td>
<td>Scheme I is better than Scheme II.</td>
</tr>
<tr>
<td>Ambient air</td>
<td>Construction activities within the reserve are distinctly less than Scheme II. Impact on the ambient air within the reserve is lighter than Scheme II.</td>
<td>Construction activities within the reserve are distinctly more than Scheme I. Impact on the ambient air within the reserve is bigger than Scheme I.</td>
<td></td>
</tr>
<tr>
<td>Ecological environment</td>
<td>Construction activities are mainly at outside of the reserve. The main construction activities within the reserve are transport of a small amount of materials (mainly by water) and trimming and cement laid stone of dome facing the Kan River, the existing earth road within the reserve can be applied for transport of construction materials. Basically the vegetation within the reserve will not be damaged. Because there are less construction activities within the reserve, the concrete diaphragm wall (dyke) requires to permanently occupy 19000m² land within the reserve and will cause greater vegetation loss to the reserve. In addition, drainage canal will also damage a certain amount of vegetation. Construction activities are mainly at inside of the reserve. It is required to build construction access road within the reserve which will cause a certain loss of vegetation. Because there are more construction activities within the reserve, the</td>
<td></td>
<td>Scheme I is obviously better than Scheme II.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Protection effect</th>
<th>Environment management during construction within the reserve is easier. Probability of constructors’ artificial damage to old trees is smaller than Scheme II.</th>
<th>Environment management during construction within the reserve is difficult.</th>
<th>Scheme II is better than Scheme I.</th>
</tr>
</thead>
</table>

Both Scheme I and Scheme II are feasible. Through comprehensive comparison and selection, Scheme I is better than Scheme II.

<table>
<thead>
<tr>
<th>Comment</th>
<th>Recommended</th>
<th>Not recommended</th>
</tr>
</thead>
</table>

Through comprehensive comparison and selection, Scheme I (Inner line scheme) is recommended.

After communicated with the Owner and the engineering design contractor, they have agreed at Scheme I in principle. Because the river bank revetment work is at the boundary of the reserve (within the scope of the reserve), Taihe County People’s Government agreed to implement the river bank revetment work at the boundary of the reserve put forward in this EIA in a document titled *Reply on Adjustment of Core Area and Buffer Zone of Zhujia Village Cinnamomum Camphora Forest County Level Nature Reserve, Tangzhou Township, Taihe County*.

7.5 Protective measures for old trees and big trees

7.5.1 Old trees and big trees to be protected

After the project storing water, it will generate certain impact to trees in the project area. According to analysis, old trees that are affected and should be protected are: old trees located in embankment line of protection embankment with dyke construction and earth filling over 1.2m; old trees located in design ship lock; old trees with differences between elevation and design level of root crown (the corresponding maximum design level of switch off critic flow 4700m³/s) less than 1m outside protection embankment.

According to the investigation, 21 old trees should be protected, including 20 Cinnamomum camphora trees, 1 Cupressus funebris. The distribution are: 2 inside the ship lock, 1 on the dyke, 18 outside the dyke, see table 7.5—1 and 7.5—2 for details.

27 big trees should be protected with diameter at the breast height 80cm~100m, including 26 Cinnamomum camphora trees, 1 Castanopsis sclerophylla, see table 7.5—3 for details.
### Table 7.5—1 Protective measures for protected old trees

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>No.</th>
<th>Tree species</th>
<th>Diameter at the breast height (cm)</th>
<th>Location</th>
<th>Elevation (m)</th>
<th>Water level difference (m)</th>
<th>Location protective measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Huang 8</td>
<td><em>Cinnamomum camphora</em></td>
<td>105.0</td>
<td>Huangkeng pengxia</td>
<td>57.30</td>
<td>0.61</td>
<td>Outside dyke Masonry breast wall</td>
</tr>
<tr>
<td>2</td>
<td>Huang 9</td>
<td><em>Cinnamomum camphora</em></td>
<td>106.5</td>
<td>Huangkeng pengxia</td>
<td>57.30</td>
<td>0.61</td>
<td>Outside dyke Masonry breast wall</td>
</tr>
<tr>
<td>3</td>
<td>Jiang 2</td>
<td><em>Cinnamomum camphora</em></td>
<td>128.0</td>
<td>Jiangjiazhou</td>
<td>54.46</td>
<td>-2.04</td>
<td>In ship lock Transplant</td>
</tr>
<tr>
<td>4</td>
<td>Jiang 3</td>
<td><em>Cupressus funebris</em></td>
<td>85.6</td>
<td>Jiangjiazhou</td>
<td>54.51</td>
<td>-1.99</td>
<td>In ship lock Transplant</td>
</tr>
<tr>
<td>5</td>
<td>Tai 8</td>
<td><em>Cinnamomum camphora</em></td>
<td>110.8</td>
<td>Taipan</td>
<td>55.83</td>
<td>-0.69</td>
<td>Outside dyke Concrete diaphragm wall</td>
</tr>
<tr>
<td>6</td>
<td>Xia 6</td>
<td><em>Cinnamomum camphora</em></td>
<td>122.5</td>
<td>Xiabian Village</td>
<td>55.03</td>
<td>-1.49</td>
<td>Outside dyke Transplant</td>
</tr>
<tr>
<td>7</td>
<td>Yin 1</td>
<td><em>Cinnamomum camphora</em></td>
<td>229.8</td>
<td>Yinxiajiang</td>
<td>57.46</td>
<td>0.94</td>
<td>Outside dyke Masonry breast wall</td>
</tr>
<tr>
<td>8</td>
<td>Yin 2</td>
<td><em>Cinnamomum camphora</em></td>
<td>145.8</td>
<td>Yinxiajiang</td>
<td>55.94</td>
<td>-0.58</td>
<td>Outside dyke Concrete diaphragm wall</td>
</tr>
<tr>
<td>9</td>
<td>Yin 4</td>
<td><em>Cupressus funebris</em></td>
<td>156.6</td>
<td>Yinxiajiang</td>
<td>56.23</td>
<td>-0.29</td>
<td>Outside dyke Concrete diaphragm wall</td>
</tr>
<tr>
<td>10</td>
<td>Xin 2</td>
<td><em>Cupressus funebris</em></td>
<td>145.0</td>
<td>Xinzhou shangpeng</td>
<td>57.28</td>
<td>0.67</td>
<td>Outside dyke Masonry breast wall</td>
</tr>
<tr>
<td>11</td>
<td>Xia 5</td>
<td><em>Cupressus funebris</em></td>
<td>139.4</td>
<td>Xiabian Village</td>
<td>55.04</td>
<td>-1.48</td>
<td>Adjust embankment line outward 16m</td>
</tr>
<tr>
<td>12</td>
<td>Xin 2</td>
<td><em>Cupressus funebris</em></td>
<td>145</td>
<td>Xinzhou shangpeng</td>
<td>57.28</td>
<td>0.67</td>
<td>Outside dyke Masonry breast wall</td>
</tr>
<tr>
<td>13</td>
<td>Xin 3</td>
<td><em>Cupressus funebris</em></td>
<td>162</td>
<td>Xinzhou shangpeng</td>
<td>56.85</td>
<td>0.24</td>
<td>Outside dyke Concrete diaphragm wall</td>
</tr>
<tr>
<td>14</td>
<td>Xin 5</td>
<td><em>Cupressus funebris</em></td>
<td>101</td>
<td>Xinzhou shangpeng</td>
<td>56.96</td>
<td>0.35</td>
<td>Outside dyke Concrete diaphragm wall</td>
</tr>
<tr>
<td>15</td>
<td>Xin 8</td>
<td><em>Cupressus funebris</em></td>
<td>103</td>
<td>Xinzhou shangpeng</td>
<td>57.17</td>
<td>0.56</td>
<td>Outside dyke Masonry breast wall</td>
</tr>
<tr>
<td>16</td>
<td>Xin 9</td>
<td><em>Cupressus funebris</em></td>
<td>106</td>
<td>Xinzhou shangpeng</td>
<td>56.85</td>
<td>0.24</td>
<td>Outside dyke Concrete diaphragm wall</td>
</tr>
<tr>
<td>17</td>
<td>Xin 15</td>
<td><em>Cupressus funebris</em></td>
<td>105</td>
<td>Xinzhou shangpeng</td>
<td>56.93</td>
<td>0.32</td>
<td>Outside dyke Concrete diaphragm wall</td>
</tr>
<tr>
<td>18</td>
<td>Xin 19</td>
<td><em>Cupressus funebris</em></td>
<td>114</td>
<td>Xinzhou xiapeng</td>
<td>56.87</td>
<td>0.26</td>
<td>Outside dyke Concrete diaphragm wall</td>
</tr>
<tr>
<td>19</td>
<td>Xin 21</td>
<td><em>Cupressus funebris</em></td>
<td>130.5</td>
<td>Xinzhou xiapeng</td>
<td>56.24</td>
<td>-0.37</td>
<td>Outside dyke Concrete diaphragm wall</td>
</tr>
<tr>
<td>20</td>
<td>Huang 7</td>
<td><em>Castanopsis sclerophylla</em></td>
<td>91.8</td>
<td>Huangkeng pengxia</td>
<td>57.60</td>
<td>0.91</td>
<td>Outside dyke Masonry breast wall</td>
</tr>
</tbody>
</table>
Table 7.5—2  Protective measures for old trees located in new dyke with dyke construction and earth filling over 1.2m

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>No.</th>
<th>Tree species</th>
<th>Location</th>
<th>Tree elevation (m)</th>
<th>Design dyke height (m)</th>
<th>Height of dyke construction and earth filling (m)</th>
<th>Protective measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Xia 5</td>
<td>Cinnamomum camphora</td>
<td>Xiabian Village</td>
<td>55.04</td>
<td>58.75-60.27</td>
<td>3.71-5.23</td>
<td>Adjust embankment line outward 16m</td>
</tr>
</tbody>
</table>
### Table 7.5—3  Protective measures for protected big trees

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>No.</th>
<th>Tree species</th>
<th>Diameter at the breast height (cm)</th>
<th>Location</th>
<th>Elevation (m)</th>
<th>Design Water level (m)</th>
<th>Elevation difference (m)</th>
<th>Location</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Huang1</td>
<td>Cinnamomum camphora</td>
<td>84.0</td>
<td>Huangkeng pengxia</td>
<td>57.60</td>
<td>56.69</td>
<td>0.91</td>
<td>Outside dyke</td>
<td>Masonry breast wall</td>
</tr>
<tr>
<td>2</td>
<td>Huang2</td>
<td>Cinnamomum camphora</td>
<td>92.5</td>
<td>Huangkeng pengxia</td>
<td>57.60</td>
<td>56.69</td>
<td>0.91</td>
<td>Outside dyke</td>
<td>Masonry breast wall</td>
</tr>
<tr>
<td>3</td>
<td>Huang4</td>
<td>Cinnamomum camphora</td>
<td>97.3</td>
<td>Huangkeng pengxia</td>
<td>57.45</td>
<td>56.69</td>
<td>0.76</td>
<td>Outside dyke</td>
<td>Masonry breast wall</td>
</tr>
<tr>
<td>4</td>
<td>Huang7</td>
<td>Castanopsis sclerophylla</td>
<td>91.8</td>
<td>Huangkeng pengxia</td>
<td>57.60</td>
<td>56.69</td>
<td>0.91</td>
<td>Outside dyke</td>
<td>Masonry breast wall</td>
</tr>
<tr>
<td>5</td>
<td>Jiang 1</td>
<td>Cinnamomum camphora</td>
<td>92.3</td>
<td>Jiangjiashou</td>
<td>54.05</td>
<td>56.50</td>
<td>-2.45</td>
<td>Inside the ship lock</td>
<td>Transplantation</td>
</tr>
<tr>
<td>6</td>
<td>Tai 4</td>
<td>Cinnamomum camphora</td>
<td>98.7</td>
<td>Taipan</td>
<td>56.49</td>
<td>56.52</td>
<td>-0.03</td>
<td>Outside dyke</td>
<td>Concrete diaphragm wall</td>
</tr>
<tr>
<td>7</td>
<td>Tai 9</td>
<td>Cinnamomum camphora</td>
<td>84.0</td>
<td>Taipan</td>
<td>56.01</td>
<td>56.52</td>
<td>-0.51</td>
<td>Outside dyke</td>
<td>Concrete diaphragm wall</td>
</tr>
<tr>
<td>8</td>
<td>Xia7</td>
<td>Cinnamomum camphora</td>
<td>88.5</td>
<td>Xiabian Village</td>
<td>55.04</td>
<td>56.52</td>
<td>-1.48</td>
<td>Outside dyke</td>
<td>Transplantation</td>
</tr>
<tr>
<td>9</td>
<td>Xia8</td>
<td>Cinnamomum camphora</td>
<td>95.5</td>
<td>Xiabian Village</td>
<td>55.31</td>
<td>56.52</td>
<td>-1.21</td>
<td>Outside dyke</td>
<td>Transplantation</td>
</tr>
<tr>
<td>10</td>
<td>Xia9</td>
<td>Cinnamomum camphora</td>
<td>92.3</td>
<td>Xiabian Village</td>
<td>56.63</td>
<td>56.52</td>
<td>0.11</td>
<td>Outside dyke</td>
<td>Concrete diaphragm wall</td>
</tr>
<tr>
<td>11</td>
<td>Xin 10</td>
<td>Cinnamomum camphora</td>
<td>85.0</td>
<td>Xinzhou shangpeng</td>
<td>57.07</td>
<td>56.61</td>
<td>0.46</td>
<td>Outside dyke</td>
<td>Ditto</td>
</tr>
<tr>
<td>12</td>
<td>Zhang 5</td>
<td>Cinnamomum camphora</td>
<td>86.9</td>
<td>Zhangjia</td>
<td>56.93</td>
<td>56.56</td>
<td>0.37</td>
<td>Outside dyke</td>
<td>Ditto</td>
</tr>
<tr>
<td>13</td>
<td>Zhang 11</td>
<td>Cinnamomum camphora</td>
<td>91.0</td>
<td>Zhangjia</td>
<td>57.44</td>
<td>56.56</td>
<td>0.88</td>
<td>Outside dyke</td>
<td>Masonry breast wall</td>
</tr>
<tr>
<td>14</td>
<td>Zhang 13</td>
<td>Cinnamomum camphora</td>
<td>88.5</td>
<td>Zhangjia</td>
<td>56.44</td>
<td>56.56</td>
<td>-0.12</td>
<td>Outside dyke</td>
<td>Concrete diaphragm wall</td>
</tr>
<tr>
<td>15</td>
<td>Xin 1</td>
<td>Cinnamomum camphora</td>
<td>83</td>
<td>Xinzhou shangpeng</td>
<td>57.41</td>
<td>56.61</td>
<td>0.80</td>
<td>Outside dyke</td>
<td>Masonry breast wall</td>
</tr>
<tr>
<td>16</td>
<td>Xin 4</td>
<td>Cinnamomum camphora</td>
<td>98.5</td>
<td>Xinzhou shangpeng</td>
<td>56.88</td>
<td>56.61</td>
<td>0.27</td>
<td>Outside dyke</td>
<td>Concrete diaphragm wall</td>
</tr>
<tr>
<td>17</td>
<td>Xin 6</td>
<td>Cinnamomum camphora</td>
<td>81.5</td>
<td>Xinzhou shangpeng</td>
<td>57.07</td>
<td>56.61</td>
<td>0.46</td>
<td>Outside dyke</td>
<td>Masonry breast wall</td>
</tr>
<tr>
<td>18</td>
<td>Xin 10</td>
<td>Cinnamomum camphora</td>
<td>85</td>
<td>Xinzhou shangpeng</td>
<td>57.07</td>
<td>56.61</td>
<td>0.46</td>
<td>Outside dyke</td>
<td>Ditto</td>
</tr>
<tr>
<td>19</td>
<td>Xin 11</td>
<td>Cinnamomum camphora</td>
<td>80.5</td>
<td>Xinzhou shangpeng</td>
<td>56.95</td>
<td>56.61</td>
<td>0.34</td>
<td>Outside dyke</td>
<td>Concrete diaphragm wall</td>
</tr>
<tr>
<td>20</td>
<td>Xin 12</td>
<td>Cinnamomum camphora</td>
<td>97</td>
<td>Xinzhou shangpeng</td>
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</table>
7.5.2 Protective measures for old trees and big trees

Aiming at elevation, location, growth status of old trees in the project area, according to relative results of Special Report on Impact of Jiangxi Shihutang Shipping and Hydropower Pivotal Project at the Kan River on Old and Famous Trees and Key Wild Plants, this assessment puts forward the following protective countermeasures and measures.

口 If any old trees in the new planned construction or adjusted levee, and the elevation of root crown less than 58.8m (namely dyke construction and earth filling over 1.2m), adopt avoiding protective measures in principle, move the embankment line inward or outward, so as to let the central line of the dyke keep more than 12m from old trees.

口 Raise the height of protection embankment of the planned construction project on the original dyke basis, old trees on the top of the dyke or slope under conditions of earth building not over 0.8m will not adopt special treatment in principle, while protective measures of trees binding should be adopted during the constructions in order to prevent direct damage to the trees; for instance, increase height to 1~1.2m, protective measures should be adopted, as well as suggest to construct by 2 times layer by layer with an interval of 1~2 years between the 2 times, and arrange vertical aeration pope.

口 old trees in the vicinity of protection embankment, river and underground water has smaller impact to the trees due to the protection embankment functions, special protective measures will not be considered in principle, mainly to prevent direct or indirect impact to the trees during the constructions dyke body, such as borrow soil from the tree side, stack material, soil rolling, damage by construction machines and transport vehicles and etc., original soil environment should be kept usually 5m from tree crown.

口 Old trees outside dyke should be treated combining with the design level, growth trend and root system exposure situation and etc. usually old trees with elevation difference higher than 1m or above will not be transplanted, however, rejuvenation measures may be adopted for old trees according its growth status, decide whether to adopt earth backing and earth-retaining works (breast wall) according to root system exposure status and terrain and soil collapse situation 6m around trunk; old trees with elevation difference 0.5~1m should all adopt in situ conservation measures, such as slurry masonry breast wall for protection, and cooperate with technologies of excised roots, prune, earth backing, fertilization and etc. (Technical proposal for in situ conservation scheme □); old trees with elevation difference -0.7~0.5m, cast-in-place concrete diaphragm wall 6m or so from the trunk, and at the same time cooperate with technologies of excised roots, prune, earth backing, fertilization and etc. (Technical proposal for in situ conservation scheme □); old trees with elevation difference less than -0.7m, implement transplanting and adopt rational comprehensive supporting transplant technology to advance the transplant survival rate (technical proposal for transplant conservation).

口 7 old trees distributed in Shihutang are located around the construction area of the dam, tree body binding measures should be adopted during the construction, and set protective measures, such as enclosure and etc.
The project will adopt protective measures for 21 old trees and 27 big trees, including transplanting protective measures for 3 old trees and 3 big trees; adopting concrete diaphragm wall protective measures for 9 old trees and 13 big trees; masonry breast wall protective measures for 7 old trees and 11 big trees; Embankment line avoiding protective measures for 2 old trees and no big trees.

- The recommended transplanting place of the three old trees and three big trees is Jintan Old Woods for centralized management.

- Old trees and three big trees that will be in situ conservation, especially key protective trees on the dyke or outside the dyke should be strengthened for caring and management work during the project construction and operating period.

- Cement laid stone masonry slope protection will be adopted for river bank of Xinzhou (30m long) in order to prevent river erosion.

- It is recommended that environment protection protection department under the owner appoint special persons for protection work of old and large trees. During implementation of the project, the owner shall handle related formalities of old and large trees transplanting and local conservation from the forestry authority. College of Forestry of Jiangxi Agricultural University and qualified unit shall be entrusted as technical consultation organ of old and large trees protection during construction and operation (5 years); qualified nursery stock company or specialized maintenance team shall be entrusted to carefully do the protection work of old and large trees as per the SPECIAL REPORT ON IMPACTS OF THE SHIHUTANG PROJECT ON OLD AND FAMOUS TREES AND KEY WILD PLANTS, this EIA, the engineering design of next stage and the specific protection schemes to be put forward by the technical consultation organ of large and old trees protection and the regulations and requirements of forestry authority.

### 7.6 Technical proposal for in situ conservation for old trees and big trees

#### 7.6.1 Class I Technical proposal for in situ conservation for old trees and big trees

- **Applicable object**
  - Old trees and big trees outside protection embankment with difference between elevation of root crown and design level larger than 1m;
  - Old trees and big trees (diameter at the breast height above 80cm) on levee with dyke construction and earth filling not over 1.2m.

- **Protective measures**
  - Normal water storage line should be over 6m from trees with flat ground, tree crown with wild lawn grass under the tree may not adopt any protective measures, for those that have conditions may fertilize in low water season or winter time in every 2 years in order to promote or keep the growth trend of the tree, and take it as the forest against wave wash of river way.
7.0 Special Assessment of Impacts on Large & Old Trees

- Normal water storage line should be over 6m from the trees, however, the terrain under tree crown is steep and even soil collapse or soil drawn out, side of some root system is collapsed, make a masonry breast wall in collapse azimuth or 3~6m around from the trees (according to size of trees and collapse distance). If upper part of root system of the tree is exposed, adopt earth backing 30~50cm and fertilize properly. The height of breast wall should be higher than 20cm after the earth backing.

For trees community with smaller spacing and row spacing, and certain quantity and area, soil retaining wall of single tree can be changed to larger planting bed wall.

For trees with poor growth situation, check the cause and adopt relative rejuvenation technology.

- When normal water storage line is less than 6m from the trunk, ground should be finished in order to smooth the landform and plant centipede grass, or make masonry breast wall.

- Old trees or big trees on the levee with dyke construction and earth filling not higher than 1.2m can adopt healthcare measures, such as scarification, fertilization, moth proof and etc., half or one year before the construction in order to promote the normal growth of the trees, and once earth filling not over 80cm. protective measures, such as trunk binding, ramification higher and bough shortcut and etc., should be adopted in order to prevent damage of the tree body during the construction.

7.6.2 Class II old trees and big trees technical proposal for in situ conservation

- Applicable object

Old trees and big trees outside protection embankment with difference between elevation of root crown and elevation of design level is -0.7~1m.

- Protective measures

- Old trees with elevation difference 0.5~1m, adopt protective Scheme □.

- Old trees with elevation difference -0.7~0.5m, adopt protective Scheme □.

7.6.2.1 Technical proposal for in situ conservation Scheme □ for old trees and big trees

- Purpose: through implementing protective project, make the trees to grow healthy, surface root system retracting and raise distribution position of main root system, coordinate upper ground part and underground part of trees and adapt to the rising of certain degree underground water level.

- Main construction procedure and requirements:

- First year, promote the tree’s growth or rejuvenation of big trees: main contents include:

  A Fertilization: combining methods of surface application, furrow application, foliage application;

  B Trunk injection with active materials of “tree impetus” or “plants mineral elements” and etc., so as to promote the growth of trees;

  C Prevent diseases and insect pests
7.0 Special Assessment of Impacts on Large & Old Trees

- Second year, excised roots treatment: make 2 times circular arc furrow excised roots by section in spring, autumn seasons at 5m or so from the trunk, furrow depth 80cm with smooth cut, big root over 5cm should not be sawed down but make round skin at the inner section of the furrow, and irrigate ABT root promoting powder after earth back fill.

- Third year, make masonry breast wall and prune: take trunk as the center; make a round masonry breast wall 1m outward from inner section of excised roots furrow. Breast wall should be 0.6～0.8m higher than the original ground (raise the height accordingly if the root system of tree exposes seriously), PVC drainage pipes should be distributed at different height around the breast wall, and then fill in 0.4～0.6m planting soil in the breast wall, and arrange evenly 4～5 vertical aeration pipes. The length of aeration pipe is 60～80cm with 10cm exposure out of soil on the top.

Carry out pruning on tree crown in April～May the same year, in addition to thinning and removing deadwood, sick branch and overcrowded branches, cutting back the reserved main branches, so as to make the tree crown decease 1/3～1/2, and implement disinfection treatment on the cut.

- Every year, professional technicians will inspect periodically the growth situation of trees, and solve problems in time. In every 2—3 years, carry out fertilization, excised roots treatments and etc.

7.6.2.2 Technical proposal for in situ conservation Scheme for old trees and big trees

- Purpose: same as conservation Scheme

- Main construction procedures and requirements:

  - First year, promote growth of tree or big trees rejuvenation: same as conservation technical proposal.

  - Second year, excised roots treatment: Same as conservation technical proposal.

  - Third year, make concrete diaphragm wall and pruning. Carry out pruning on the tree crown in March the same year, in addition to thinning and removing deadwood, sick branch and overcrowded branches, cutting back the reserved main branches 1/3～1/2, and handle the cut. Then, take trunk as the center, 12m as side length, make a square cast in place concrete diaphragm wall, bottom of impervious wall into soil to batholith, 0.7～1.9m higher than ground level, that is about 1.2m higher than the design level. Secondly, select in the impervious wall any two opposite wall as the outer wall, make square shape absorbing well with inner diameter 70cm, the well top is 50cm higher than the original ground, well bottom 1.3m lower than the original ground, namely the depth of well is 1.8m. wall of the absorbing well will be made with bricks, base is fixed with cement mortar, no cement joint in the middle, apply cement around the well mouth, cover with iron cover with holes on it, fix the well wall with square iron. Finally, fill in nutrition soil to impervious wall, and keep the same height with absorbing well mouth.

During the rainy season, water in the soil penetrates into absorbing well, which should be pumped out by special person, so as to ensure no water accumulation in main distribution
layer of the root systems. Furthermore, absorbing well can be used as soil watering pipe in the dry season, at the same time; it is the exchanging passage of root system of trees with outside air, which has functions of drainage, watering and aeration.

□ If the original ground is lower than the design level, fill in nutrition soil 50cm to the impervious wall in every 2 years and raise the height of absorbing well accordingly, till the soil is 1m higher than the design level, that is 20cm lower than the impervious wall. Then plant 3~4 young Cinnamomum camphora with diameter about 2cm around the trunk, connect 4~5 young Cinnamomum camphora with the base of old trees in the second year. Drill holes uniformly according to different height on the impervious wall above the design level in the third year after the connection, so as to let the root system in the wall to exchange with outside that has the function of aeration and drainage.

In order to reach the purpose of grafting in advance and form high level root mass earlier, excised roots treatment can be carried out at the same time in the second year, utilize engineering method to fix 3~4 large vessels with seedling trees close to the trunk 1~1.3m higher than the design level, and then carry out grafting. Moreover, few years later, decide whether to fill absorbing well with soil in order to level it with the ground according to the growth situation of high level root system.

□ Check periodically the growth situation of trees every year, and solve the problem in time. Carry out fertilization, excised roots treatment and etc for trees in every 2—3 years.

7.7 Technical Proposal for Transplant Conservation for Old Trees and Big Trees

7.7.1 Applicable object

□ Old trees and big trees outside protection embankment with difference between elevation of root crown and design level less than 1m (diameter at the breast height 80cm below);

□ Old trees and big trees outside protection embankment with difference between elevation of root crown and design level less than -0.7m;

□ Transplanting required by the project;

□ Big trees and old trees that protection embankment body will be heighten more than 1.2m.

7.7.2 Technical classification of transplantation

Tree transplantation can adopt different transplanting scheme in accordance with its size, growth status and etc:

□ For Cinnamomum camphora with diameter at the breast height 20cm and below, bare root or transplant with soil, the transplanting technology will select Scheme □.

□ For Cinnamomum camphora with diameter at the breast height 21~40cm, in order to improve the transplant survival rate, it should select transplanting Scheme □.

□ For Cinnamomum camphora with diameter at the breast height 41~80cm, it should select
comprehensive transplanting technology due to its large size, deep main root and soft soil, select transplanting Scheme □.

For Cinnamomum camphora with diameter at the breast height 81-100cm and above 100cm, adopt as possible on the spot protective measures in principle, for individuals required to be transplanted (such as in the ship lock), adopt transplanting Scheme □.

7.7.3 Technical proposal for transplantation

7.7.3.1 Technical proposal for transplantation

Applicable object: Cinnamomum camphora with diameter at the breast height less than 10~20cm.

Soil texture and tree growth status: most soil texture is fine silt, sandy loam or silty clay. The trees are in natural growth status, usually no caring measures is adopted. Since the soil texture is suitable, as well as warm weather of Taihe County with abundant rainwater, most trees grow normally and well.

Tree species characteristics: trunk of Cinnamomum camphora usually is not clear but with strong power of sprouting from stools and strong branch forming; Rich main roots, less side and fibrous roots, but strong new power of sprouting from stools, which is an easy transplanting tree species

Technical measures

Transplanting time: arrange at the end of February to middle of March as possible;

Tools and machines: spade and sharp shovel, handsaw, hay band, grass bag, transport vehicle and etc.;

Transplanting method: bare root transplant;

Personnel requirements: assign experienced technicians to guide the transplanting, which must be operated by skilled gardener.

Construction operating method and key points:

A. Pruning and cut treatment: repruning tree crown before the transplantation. Determine height of stem is usually 2.5~3.5m, trunk and branch higher than this level shall be cut, reserve 3~4 main branches in the main trunk with length 0.5~1.0m. If the branch height of tree is high, trunk cutting pruning method can be adopted. Avoid pull apart when sawing the large branches and flattening the cut, and then apply “wound coating agent” or “wound maintenance film” to protect the cut.

B. Excavation and root protection: usually 40~70cm from trunk is radius round furrow excavation. The depth should be below the distribution layer of main root system, usually 50~70cm. Brush out ball clay surface layer rootless floating earth before the excavation according to actual situation. During the excavation, saw up large root with handsaw, no rude shovel is allowed in order to avoid pull crack. All root system cut should be smooth.
The falling tree should bring with soil (heart protection soil) as possible, and bind with damp grass bag, and then tie with hay band.

C. Transport and trunk protection: excavated Cinnamomum camphora should bind with hay band on main trunk and reserved main branches, and spray wet the hay band in order to keep water of tree body, at the same time prevent damage during the transport and planting. Load after binding, stack in order and cover with awning.

D. Plant: plant hole should be over 20～30cm larger than root breadth of soil ball and height, and the hole bottom should apply thoroughly decomposed base fertilizer. Carry out spray application on the hole bottom contact with roots and around with “Root Power” or “Plants Mineral Elements” and “Root Rot Medicine” (water with aqueous solution).

Put the tree into hole, the root system flat and stretch, fill planting soil into the tree hole. Fill solid the space of root system. When filling to half height, pull upward gently or shake, connect closely planting soil with root system, water it after tamping. Add soil after water seeping downward fully, and then water cofferdam after add to 10～15cm above the ground.

E. Curing: transplanting land should select land with higher terrain without water accumulation but convenient for irrigation. The trees should present row line with drainage ditch around.

Water sufficiently after planting, water the second time 2～3 days later, and then water the third time after one week, water according to the soil situation, and be “dry totally and then water enough at one time”.

Water often the tree body with hay band and around with in high temperature of summer time, 4～5 times a day, water to a degree of wet but not drop water so as to prevent water accumulation at root.

Since temperature is high in summer time, the tree has strong transpiration, in order to reduce water disperse of tree body. Shed should be set up. The shed should keep more than 50cm distance from the tree body so as to ensure air flow in the shed.

7.7.3.2 Tree transplanting Scheme

- Applicable object: Cinnamomum camphora with diameter at the breast height 21～40cm.
- Soil texture and tree growth status: same as Scheme
- Tree species characteristic: same as Scheme
- Technical measures
- Transplanting time: arrange as possible at the end of February to middle of March every year
Tools and machines: spade and sharp shovel, handsaw, hay band, lifting rope, grass bag, truck guard plate, crane, transport vehicle and etc.

Transplanting method: excised roots transplant method

Personnel requirements: same as Scheme.

Construction operating method and key points

Excised roots: carry out excised roots treatment 1~2 years before the transplanting. In spring time the first 1 year, draw a circle 2~3 times as radius (50~90cm or so) around the trunk of trees with diameter at the breast height, and then divide the circle into 4 parts, select 2 opposite circular arcs to excavate furrow outward with depth 60~70cm, cut lateral roots in the inner section of furrow, the cut mouth should be flat. Not cut up large lateral roots (above 5cm) but skin in the inner section, and then apply 0.1% naphthylacetic acid solution on the wound of root pruning and ring skin place, and refill solid. Pruning the roots and refill on the other two circular arcs with the same method at autumn of that year or spring the next year.

Pruning and wound treatment: transplant in the spring of the third year after the first excised roots. Prune before the transplanting. Determine height of stem usually is 3.5~5.5m, reserve 3~5 main branches stretching in different directions with length about 0.7~1.3m. Prevent pull crack when saw up large branches and smooth the wound, and then apply “wound coating agent”, or “wound maintenance film”.

Excavation and root protection: method is basically the same as Scheme, but excavate furrow outward at 15~20cm in the inner section of original excised roots. The excavation depth should be 10~15cm deep than that of excised roots.

Transport and trunk protection: basically the same as Scheme, pay attention to the following points:

A Spray apply transpiration controlling preparation on the tree body before the loading in order to reduce water loss;

B Bind with hay band and gunny bag piece at hoisting place of listing rope, and nail with guard plate, center of gravity of tree is at lower part of soil ball;

C Fix both sides of soil ball with sandbag after loading on the truck, pad the trunk with soft materials at contacting surface with the carriage in order to avoid wear the tree skin and fix the trunk on the carriage;

D Shorten the transport time as possible.

Plant: basically same method as Scheme, but the planting depth can be shallower, hole depth should be 3/4 of the soil ball height.

Curing: method basically the same as Scheme, use continuously “tree power”, “plants mineral elements” or “core energy element” after planting for trunk transfusion, and directly supplement the nutrition and water the tree body.
7.0 Special Assessment of Impacts on Large & Old Trees

- Applicable object: Cinnamomum camphora with diameter at the breast height 41~100cm. Cinnamomum camphora with diameter at the breast height 81~100cm and over 100cm shall be locally protected in principle, individual trees requiring to transplant (such as the trees within ship lock) shall be transplanted as per Scheme III.

- Soil texture and tree growth status: most soil texture is sandy loam, fine silt or silty clay, which is suitable for the growth of Cinnamomum camphora. The tree growth trend is different due to different trees, among them, most Cinnamomum camphora with diameter at the breast height 40~80cm grow normal or fine, while some trees with diameter at the breast height over 80cm have the problem of local rot in main trunk, root system exposure and lose plant phenomenon at the tip, some become apparently weak and even already weak.

- Tree species characteristics: (same as Scheme □)

- Technical measures

- Transplanting time: arrange as possible at the end of February to middle of March, in cloudy sky or sunshine day without wind.

- Tools and machines: spade, shovel, handsaw, hay band, grass bag, guard plate, harness, crane, transport vehicle and etc.

- Personnel requirements: (same as Scheme □)

- Transplanting method: excised roots transplanting.

- Construction operating method

- Big trees rejuvenation:

A. Early spring of that year (at the end of January and beginning of February), dig furrow in circular shape for fertilization at drip moulding of tree crown, furrow width and depth 30~40cm, apply bean cake fertilizer 10~15 jin for each tree, compound fertilizer 3~5 jin, mix with soil and back fill and cover with soil.

B. Carry out leaf fertilization on the tree crown with high pressure air atomizer in April ~ June, concentration is carbamide 0.1%, potassium dihydrogen phosphate 0.2%, once half a month, apply alternatively.

C. Tree hole cleaning and fill. When cleaning tree hole, remove the dust first, scraping deadwood in the hole, and clean with wire brush or hair brush, and then spray 0.3% copper sulphate aqueous solution to the hole wall 2 times with an interval 30min, apply bitumastic solution (wood tar) antifungin in the inner wall of hole after being dried or repair tree body with polyurethane and polysulfide sealant, or fill directly with bricks and stone and cement mortar.

D. Pest control. For some trunk borer pest, such as bark beetle or longhorn beetle species, control with atgard or 40% dimethoate with water l000 times liquid.

- Excised roots treatment: excised roots same method as Scheme □, section from the trunk radius is 100~220cm, the depth reaches 70~120cm.

- Pruning and wound treatment: same method as Scheme □, topping height: for big trees
7.0 Special Assessment of Impacts on Large & Old Trees

with diameter at the breast height 50～60cm is 6～8.5m, reserve 3～5 main branches and small amount of secondary branches, main branches 1～1.5m long and secondary branches 0.5～1m long; for big trees with diameter at the breast height 70～80cm, determine height of stem is 7～10m, reserve 1.2～1.8m long main branches, and secondary branches 0.8～1.3m.

- Excavation and root protection: same method as Scheme □.
- Transport and trunk protection: same method as Scheme □.
- Plant: Same method as Scheme □
- Curing: basically same method as Scheme □, install mini nozzle on the wire drawing of canopy net or branch, spray many times everyday in summer time, so as to advance air humidity in the shed and reduce the temperature in the shed.

7.8 Expenses calculation of protective measures for old trees and big trees
- See Table 7.8—1 for budgetary estimate for transplantation of single old trees, big trees.

- Implement transplantation and in situ conservation for old trees and big trees in project area, observation and maintenance expenses for riverbank slope protection and project operating period 5 years will be 9.5506 million yuan. See Table 7.8—2 for details.
### Table 7.8—1 Budgetary estimate for single old trees and big trees transplanting

<table>
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<th>Name of item</th>
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<td></td>
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<tr>
<td>II</td>
<td>Maintenance direct charges</td>
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<td>Other direct charges</td>
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<td>Total expenses</td>
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<tr>
<td>VII</td>
<td>Tax</td>
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<td></td>
<td>Total</td>
<td>□VI + □VII</td>
<td>152487.09</td>
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1. Auxiliary material cost includes hay band, sling, guard plate, gunny bag, bearing material, fertilizer, iron pipe, sunshade net, sprinkler irrigation facilities, antifreeze material and etc.
2. Mechanical charges include crane handling, transport vehicle transportation, excavation vehicles dig ditch, dig hole and etc.
3. Other direct charges refers to productive tools, appliance use charges, engineering positioning resurveying, site cleaning charges, temporary facilities charges and etc.
4. Comprehensive overhead charge include subsidy and travel and traffic expenses of staffs, labor protection cost of staffs, technology training expenses, material purchasing holding cost and etc. (5 years).
5. Maintenance direct charges include maintenance expense within 5 years after planting.
### Table 7.8—2 Expense calculation of old and big trees in project area and environmental protection of nature protection area

<table>
<thead>
<tr>
<th>NO.</th>
<th>Name of item</th>
<th>Quantity</th>
<th>Unit price</th>
<th>Sub total</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>10000 yuan</td>
<td>10000 yuan</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>riverbank slope protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pier perdue</td>
<td>1070m</td>
<td>0.2681</td>
<td>286.87</td>
<td>299.86</td>
</tr>
<tr>
<td></td>
<td>Slope protection wall body</td>
<td>1070m</td>
<td>0.0114</td>
<td>12.99</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Breast wall protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Breast wall body</td>
<td>18 items</td>
<td>1.13</td>
<td>20.34</td>
<td>45.90</td>
</tr>
<tr>
<td></td>
<td>Earth work</td>
<td>18 items</td>
<td>0.22</td>
<td>3.96</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planting measures</td>
<td>18 items</td>
<td>1.2</td>
<td>21.60</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Impervious wall protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Impervious wall body</td>
<td>22 items</td>
<td>7.1</td>
<td>156.20</td>
<td>217.80</td>
</tr>
<tr>
<td></td>
<td>Plant and other measures</td>
<td>22 items</td>
<td>2.8</td>
<td>61.6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Transplantation</td>
<td>6 trees</td>
<td>15.25</td>
<td>91.5</td>
<td>91.5</td>
</tr>
<tr>
<td>5</td>
<td>Comprehensive maintenance</td>
<td>5 years</td>
<td>30.00</td>
<td>150.00</td>
<td>150.00</td>
</tr>
<tr>
<td></td>
<td>management expenses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Special charges of emergency</td>
<td></td>
<td></td>
<td>150.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>protection for old trees</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td>955.06</td>
<td></td>
</tr>
</tbody>
</table>

Note: Comprehensive maintenance management expenses refer mainly to observation, maintenance management expenses of in situ conservation trees on the dyke and outside the dyke for 5 years during the project operating period.

Special charges of emergency protection for old trees refer to reserved protection expenses for necessary measures adopted due to larger change of water level at the earlier stage of operation period during the construction period and operating period of prevention and control project, as well as unexpected technical problem or old and big trees involved but not discovered due to various causes during the protection period of old and big trees.
8.0 SPECIAL IMPACT ASSESSMENT ON FISHES AND SPAWNING SITES

8.1 Inventory Survey on Fish Resources and Spawning Sites

8.1.1 Brief introduction to regional fishery

The Kan River is located at the south bank of the midder and lower reaches of the Yangtze River, as the second largest tributary thereof. The Kan River lasts 788km, with a catchment of 83525km$^2$, making up half of Dongting Lake water system.

According to the site interview result of the resettlement report of the project, there are 7 professional fishing boats in the river section between the Shihutang dam site and upstream Taihe Pivot (listed in the compensation scope of this project), in addition there are a small amount of non-professional fishing boats. The professional fishing boats in the upper reach catch about 3 tons of fish a year, and the non-professional boats about 1 ton (gross annual catch totals 83 ton). There are 273 fishing boats from the Shihutang dam site to the downstream Xiajiang, to catch about 408 t a year.

8.1.2 Survey on fish spawning sites

8.1.2.1 Brief of fish spawning sites within the reservoir area

In history the Kan River is a major source of fish fry with many fish spawning sites distributed. Literature shows that there are the following spawning sites as Ganzhou, Wangqian Shoal and Liangkou Shoal at upper Wan’an, and Baijiaxia, Taihe, Yanxidu, Jishui, Xiaogang, Xiajiang, Xingan and Sanhu at down Wan’an, among which Yanxidu, Jishui, Xiaogang and Xiajiang are the major spawning sites.

In accordance with literature and data from fishery departments, there are three spawning sites in this reach of Kan River involved in Shihutang Project, namely Taihe(Chengjiang), Yanxidu and Baijiaxia, of which the spawning sites in Baijiaxia is located in the upper reach at the tail of inundation area, within the range of Taihe Pivotal Project under planning for construction, thus beyond assessment this time.

Historic literature shows that the Taihe Spawning Site is located at the reservoir area of this Project, 2.1km long, 118hm$^2$, main spawning fishes are grass carp, snail carp, silver xenocypris, bream fish and carp and that the Yanxidu Spawning Site is located also at the reservoir area of this Project, 2.3km long, 126hm$^2$, main spawning fishes are snail carp, cyprinoid, silver xenocypris and grass carp etc. For details of these two spawning sites, see Table 8.1-1, Table 8.1-2 and Table 8.1-3.
### Table 8.1—1 Profile of Spawning Sites

<table>
<thead>
<tr>
<th>Spawning grounds</th>
<th>Location</th>
<th>Length</th>
<th>Area</th>
<th>Major spawning fishes</th>
<th>Gross fecundity ($10^8$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taihe</td>
<td>E114°50'35.03&quot;, N26°46'59.06&quot;</td>
<td>2100</td>
<td>118</td>
<td>Grass carp, herring, silver xenocypris, Hemibarbus maculates, freshwater bream, carp cyprinoid</td>
<td>0.98</td>
</tr>
<tr>
<td>Yanxidu</td>
<td>E114°57'53.60&quot;, N26°48'27.98&quot;</td>
<td>2300</td>
<td>126</td>
<td>Herring, carp cyprinoid, silver xenocypris, grass carp</td>
<td>1.01</td>
</tr>
</tbody>
</table>

### Table 8.1—2 Major Spawning Fishes & Gross Fecundity of Taihe Spawning Site

<table>
<thead>
<tr>
<th>Fish</th>
<th>Spawning Period</th>
<th>Estimated resources (t)</th>
<th>Estimated Fecundity ($10^4$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass carp</td>
<td>Late Apr.—end of June</td>
<td>0.89</td>
<td>2283.84</td>
</tr>
<tr>
<td>herring</td>
<td>Late Apr.—end of June</td>
<td>0.58</td>
<td>2050.42</td>
</tr>
<tr>
<td>Carp cyprinoid</td>
<td>April to June</td>
<td>0.84</td>
<td>1032.08</td>
</tr>
<tr>
<td>Fresh-water bream</td>
<td>May to June</td>
<td>0.71</td>
<td>862.11</td>
</tr>
<tr>
<td>Silver xenocypris</td>
<td>March to May</td>
<td>1.34</td>
<td>2720.21</td>
</tr>
<tr>
<td>Hemibarbus maculates</td>
<td>Middle &amp; Late April</td>
<td>0.82</td>
<td>851.34</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>5.18</td>
<td>9800</td>
</tr>
</tbody>
</table>

### Table 8.1—3 Major Spawning Fishes & Gross Fecundity of Yanxidu Spawning Site

<table>
<thead>
<tr>
<th>Fish</th>
<th>Spawning Period</th>
<th>Estimated resources (t)</th>
<th>Estimated Fecundity ($10^4$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carp cyprinoid</td>
<td>April to June</td>
<td>1.18</td>
<td>2124.29</td>
</tr>
<tr>
<td>Silver xenocypris</td>
<td>March to May</td>
<td>1.56</td>
<td>3130.42</td>
</tr>
<tr>
<td>Grass carp</td>
<td>Late Apr.—end of June</td>
<td>0.97</td>
<td>2568.27</td>
</tr>
<tr>
<td>Herring</td>
<td>Late Apr.—end of June</td>
<td>0.86</td>
<td>2277.02</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4.57</td>
<td>10100</td>
</tr>
</tbody>
</table>

### 8.1.2.2 Inventory survey on fish spawning sites
8.0 Special Impact Assessment on Fishes and Spawning Sites

During the spawning period of 2007 (April to June), the project team has executed site survey on the two spawning sites. We set one spawn collecting point at the Taihe (Chengjiang) Spawning Site and the Yanxidu Spawning Site respectively, each point is equipped with a motor boat and a small wooden boat for collecting spawns, 80cm large spawn net will be equipped on the motor boat for collecting spawns. Altogether there are 478 times of laying nets in the two spawning sites, including 236 times in Taihe and 242 times in Yanxidu. The total collected spawns are 2.3569 million grains, only accounting for 1.18% of historic spawning quantity. Meanwhile, fishes accumulating phenomenon is not found in the said two sites, and the river section is severely sand dredged and flows moderately and has sparse aquatic plants. It is told by the local fisherfolks that no large fishes spawning in these two sites have been found, which indicates that these two spawning sites have been severely degraded.

8.1.3 Survey on fishes resource at the project river section

8.1.3.1 Inventory survey on fishes resource and fishing harvest analysis

Site fishes resource surveys were made at Zhongjia, Shihutang dam site, Yanxidu, Wanhe, Tongjiazhuang and Chengjiang of the assessed river section at dry season (February), rich season (July) and spawning season (April–June), (see DRAWING NO.27). Most of fish samples are collected through drift net, silk net, and fixed net etc. a small portion of fish samples are bought from the markets and fishing boats. Fishing harvests were classified and determined and routine biological surveys were made. Main fishing harvest statistics is shown in Table 8.1, total fishing harvest statistics is shown in Table 8.1.
### Table 8.1 — 4

Main fishing harvest statistics

<table>
<thead>
<tr>
<th>Fishes</th>
<th>Quantity(^{\text{pcs}})</th>
<th>Weight(^{\text{g}})</th>
<th>Length(^{\text{cm}})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frebruary</td>
<td>April (\square) June</td>
<td>July</td>
</tr>
<tr>
<td>Silver xenocypris</td>
<td>618</td>
<td>203</td>
<td>156</td>
</tr>
<tr>
<td>Hemibarbus maculates</td>
<td>27</td>
<td>94</td>
<td>96</td>
</tr>
<tr>
<td>Pelteobagrus fulvidraco</td>
<td>70</td>
<td>89</td>
<td>56</td>
</tr>
<tr>
<td>Shining pelteobagrus fulvidraco</td>
<td>57</td>
<td>98</td>
<td>48</td>
</tr>
<tr>
<td>Silver gudgeon</td>
<td>43</td>
<td>65</td>
<td>60</td>
</tr>
<tr>
<td>Pseudolaubuca sinensis</td>
<td>29</td>
<td>43</td>
<td>36</td>
</tr>
<tr>
<td>Bream fish</td>
<td>23</td>
<td>72</td>
<td>87</td>
</tr>
<tr>
<td>Bullhead</td>
<td>22</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>Red-fin anabarilus grahami</td>
<td>19</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>cyprinoid</td>
<td>18</td>
<td>24</td>
<td>17</td>
</tr>
<tr>
<td>grass carp</td>
<td>11</td>
<td>36</td>
<td>17</td>
</tr>
<tr>
<td>Snail carp</td>
<td>9</td>
<td>43</td>
<td>26</td>
</tr>
<tr>
<td>Red-eye trout</td>
<td>16</td>
<td>79</td>
<td>42</td>
</tr>
<tr>
<td>Crucian carp</td>
<td>12</td>
<td>64</td>
<td>21</td>
</tr>
<tr>
<td>Big-eye mandarin fish</td>
<td>11</td>
<td>56</td>
<td>89</td>
</tr>
<tr>
<td>Sarcocochilichthys</td>
<td>7</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>
### 8.0 Special Impact Assessment on Fishes and Spawning Sites

<table>
<thead>
<tr>
<th>Fishes</th>
<th>Quantity [pcs]</th>
<th>Weight [g]</th>
<th>Length [cm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>February</td>
<td>April  - June</td>
<td>July</td>
</tr>
<tr>
<td><em>Sarcoceltichthys nigripinnis</em></td>
<td>2</td>
<td>28</td>
<td>16</td>
</tr>
<tr>
<td><em>Mystus macropterus</em></td>
<td>9</td>
<td>41</td>
<td>18</td>
</tr>
<tr>
<td><em>Erythoculter ilishaeformis</em></td>
<td>6</td>
<td>36</td>
<td>18</td>
</tr>
<tr>
<td><em>Silurus</em></td>
<td>6</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td><em>Bighead</em></td>
<td>4</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td><em>Rhinogobio typus</em></td>
<td>6</td>
<td>17</td>
<td>28</td>
</tr>
<tr>
<td><em>Erythoculter mongolicus</em></td>
<td>5</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td><em>Cobitis sinensis</em></td>
<td>5</td>
<td>18</td>
<td>37</td>
</tr>
<tr>
<td><em>Long body mandarin fish</em></td>
<td>5</td>
<td>13</td>
<td>6</td>
</tr>
</tbody>
</table>
### Table 8.1 — Total fishing harvest statistics

<table>
<thead>
<tr>
<th>Species</th>
<th>% of total harvest</th>
<th>Habitat &amp; habit</th>
<th>Type</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>silver xenocypris</td>
<td>39.69</td>
<td>Middle &amp; lower layer of water body with plankton as food</td>
<td>Key economic fish</td>
<td>Distributed at assessment river section</td>
</tr>
<tr>
<td>hemibarbus maculates</td>
<td>5.56</td>
<td>Middle &amp; lower layer of running or static water with aquatic insects, fishworm, snail &amp; clam as food</td>
<td>Key economic fish</td>
<td>ditto</td>
</tr>
<tr>
<td>Pelteobagrus fulvidraco</td>
<td>8.65</td>
<td>Bottom of static water or slack stream with aquatic insects, small fish &amp; shrimp as food</td>
<td>Have a certain economic value</td>
<td>ditto</td>
</tr>
<tr>
<td>Shining Pl. fulvidraco</td>
<td>6.41</td>
<td>Middle &amp; lower layer of river &amp; lake with aquatic insects, small fish &amp; shrimp as food</td>
<td>ditto</td>
<td>ditto</td>
</tr>
<tr>
<td>Silver gudgeon</td>
<td>4.08</td>
<td>Slack stream open water area with mosquito larva as food</td>
<td>ditto</td>
<td>ditto</td>
</tr>
<tr>
<td>Pseudolaubuca sinensis</td>
<td>2.75</td>
<td>Upper layer of slack stream or static water with algae aquatic plants and small fish and shrimp as food</td>
<td>ditto</td>
<td>ditto</td>
</tr>
<tr>
<td>Bream fish</td>
<td>3.18</td>
<td>Middle &amp; lower layer of water body with fishworm, shrimp etc. as food</td>
<td>Key economic fish</td>
<td>ditto</td>
</tr>
<tr>
<td>Bullhead</td>
<td>2.09</td>
<td>Bottom of water body with fishworm, frog, small fish etc. as food</td>
<td>Economic fish</td>
<td>ditto</td>
</tr>
<tr>
<td>Red-fin anabarlilus grahami</td>
<td>1.80</td>
<td>Middle and upper layer of slack stream or static water with small fish, shrimp &amp; aquatic insect as food</td>
<td>Key economic fish</td>
<td>ditto</td>
</tr>
<tr>
<td>cyprinoid</td>
<td>1.71</td>
<td>Lower layer of running water or static water, omnivory</td>
<td>Key economic fish</td>
<td>ditto</td>
</tr>
<tr>
<td>grass carp</td>
<td>1.57</td>
<td>Middle &amp; lower layer of river and lake and alongshore aquatic plants rich area with aquatic higher plant as food</td>
<td>Key economic fish</td>
<td>ditto</td>
</tr>
<tr>
<td>Snail carp</td>
<td>1.28</td>
<td>Middle and lower layer of large water area with many snails at bottom with snail, mussel, clam as food</td>
<td>Key economic fish</td>
<td>ditto</td>
</tr>
<tr>
<td>Red-eye trout</td>
<td>3.52</td>
<td>Middle layer of slack stream with algae &amp; aquatic higher plant as food</td>
<td>Key economic fish</td>
<td>ditto</td>
</tr>
<tr>
<td>Crucion carp</td>
<td>1.14</td>
<td>Lower layer of running or static water, omnivory</td>
<td>Key economic fish</td>
<td>ditto</td>
</tr>
<tr>
<td>Big-eye mandarin fish</td>
<td>1.04</td>
<td>Middle &amp; lower layer of running water body with fish &amp; shrimp as food</td>
<td>Key economic fish</td>
<td>ditto</td>
</tr>
<tr>
<td>Sarcocheilichthys sinensis</td>
<td>0.66</td>
<td>Middle and lower layer of slack stream with benthic invertebrate,</td>
<td>Small economic</td>
<td>ditto</td>
</tr>
<tr>
<td>Species</td>
<td>% of total harvest</td>
<td>Habitat &amp; habit</td>
<td>Type</td>
<td>Distribution</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Sarcoccephalichthys nigripinnis davidi</td>
<td>0.19</td>
<td>Middle and lower layer of running or static water with benthic invertebrate, aquatic insect as food</td>
<td></td>
<td>Ditto</td>
</tr>
<tr>
<td>Mystus macropterus</td>
<td>0.85</td>
<td>Lower layer of running water with zoobenthos as food</td>
<td>Have a certain economic value</td>
<td>Ditto</td>
</tr>
<tr>
<td>Eilishdeformis</td>
<td>0.57</td>
<td>Lower layer of running or static water with small fish and shrimp as food</td>
<td>Key economic fish</td>
<td>Ditto</td>
</tr>
<tr>
<td>Silver carp</td>
<td>1.19</td>
<td>Middle and upper layer of water body, filter feeder, mainly eating zooplankton</td>
<td>Key economic fish</td>
<td>Ditto</td>
</tr>
</tbody>
</table>

Table 8.1—5 Cont’d Total fishing harvest statistics

<table>
<thead>
<tr>
<th>Species</th>
<th>% of total harvest</th>
<th>Habitat &amp; habit</th>
<th>Type</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bighead</td>
<td>1.09</td>
<td>Middle layer of water body, filter feeder, mainly eating zooplankton as rotifer, and also phytoplankton.</td>
<td>Key economic fish</td>
<td>Distributed at the assessment river section</td>
</tr>
<tr>
<td>Rhinogobio typus</td>
<td>1.57</td>
<td>Bottom of river and lake, with benthic invertebrate as food</td>
<td>Small economic value</td>
<td>Ditto</td>
</tr>
<tr>
<td>Erythroculter mongolicus</td>
<td>0.47</td>
<td>Upper and middle layer of slack bay and lake, with small fish and shrimp as food</td>
<td>Key economic fish</td>
<td>Ditto</td>
</tr>
<tr>
<td>Cobitis sinensis</td>
<td>1.47</td>
<td>Bottom of running water, with small benthic invertebrate and algae as food</td>
<td>Have a certain economic value</td>
<td>Ditto</td>
</tr>
<tr>
<td>Long body mandarin fish</td>
<td>0.47</td>
<td>Clear running water with stone bed sediment, with small fish, shrimp, aquatic insect as food</td>
<td>Key economic fish</td>
<td>Ditto</td>
</tr>
<tr>
<td>Acheilognathus hypselonotus</td>
<td>0.28</td>
<td>Fresh water bottom, with algae as food</td>
<td>Small economic value</td>
<td>Ditto</td>
</tr>
<tr>
<td>Saurogobio dabryi</td>
<td>2.38</td>
<td>Middle and lower layer of river and lake, with aquatic insect and aquatic plant or algae as food</td>
<td>Small economic value</td>
<td>Ditto</td>
</tr>
<tr>
<td>A kind of fish</td>
<td>0.38</td>
<td>Upper layer of slack open water area or static water with aquatic insect and algae as food</td>
<td>Have a certain economic value</td>
<td>Ditto</td>
</tr>
<tr>
<td>Pseudobagrus tenuis</td>
<td>0.28</td>
<td>Bottom of static water or slack stream, with aquatic insect, small fish and shrimp as food</td>
<td>Have a certain economic value</td>
<td>Distributed at the river section of Taihe County Seat</td>
</tr>
<tr>
<td>Elopichthys bambusa richardson</td>
<td>0.28</td>
<td>Middle and upper layer of water body with other fishes as food</td>
<td>Key economic fish</td>
<td>Distributed at the assessment river section</td>
</tr>
</tbody>
</table>
8.0 Special Impact Assessment on Fishes and Spawning Sites

<table>
<thead>
<tr>
<th>Species</th>
<th>Abundance</th>
<th>Habitat Description</th>
<th>Economic Value</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbottina rivularis</td>
<td>0.28</td>
<td>Bottom of slack stream, with small benthic invertebrate as food</td>
<td>Small</td>
<td>Distributed at the river section of Taihe County Seat</td>
</tr>
<tr>
<td>Erythroculter dabryi</td>
<td>0.28</td>
<td>Lay bay with depth 1m around, with small fish and shrimp as food</td>
<td>Key</td>
<td>ditto</td>
</tr>
<tr>
<td>Pseudorasora parva</td>
<td>0.19</td>
<td>Shoal water area of river, lake and pond, with zooplankton as food</td>
<td>Small</td>
<td>ditto</td>
</tr>
<tr>
<td>Pseudobrama simoni</td>
<td>0.19</td>
<td>Middle and upper layer of slack bay and lake with consoliolative algae, higher plant chip and crustacea as food</td>
<td>Key</td>
<td>ditto</td>
</tr>
<tr>
<td>Opsarichthys uncirostris amurensis</td>
<td>0.09</td>
<td>Gully rivulet, especially rapid stream shoal, rivulet or tributary with sandstone bed, with small fish and aquatic insect as food</td>
<td>Have a certain economic value</td>
<td>ditto</td>
</tr>
<tr>
<td>Distoechodon tumirostris</td>
<td>0.09</td>
<td>Middle and lower layer of river and lake, with consoliolative algae and plant chip as food</td>
<td>Economic</td>
<td>ditto</td>
</tr>
<tr>
<td>Plagiognathops microlepis</td>
<td>0.09</td>
<td>Middle and lower layer of water body, with plankton as food</td>
<td>Economic</td>
<td>ditto</td>
</tr>
<tr>
<td>Paracheilognathus imberbis</td>
<td>0.09</td>
<td>Low elevation slack water area or gully with aquatic plant, with consoliolative algae, zooplankton and aquatic insect as food</td>
<td>Small</td>
<td>ditto</td>
</tr>
</tbody>
</table>

8.1.3.2 Species composition of fish resources

In accordance with the literature, fishes in the Kan River total 118 species, classified into 11 orders, 22 families and 74 genera, of which the Cyprinidae makes up the majority about 58.5% in total, followed by Bagridae, 9.3%; by Cobitidae, 5.9%; by Serranidae, 5.1% while such fishes as Setipinna taty, Salangidae, Catfishes, Eleotridae, Aeoliscus scuttatus, Osphronemidae and Eleotridae each contributing to 1.7% with the remained 11 families making up 9.3%. Of Cyprinidae, Gobioninae and Anabarilius grahami each averages 23.2% followed by ugui minnow and Acheilognathinae, each making up 14.4% while barb 8.7% silver xenocypris 7.3% carp cyprinoid and Gobiobotinae and Hypophthalmichthys moritrix each contributing 2.9%.

There are altogether 41 species of recorded fishes through investigation of the assessed river section, classified into 3 orders and 7 families, of which the Cyprinidae makes up the majority about 73.17% in total. These species are all common fresh water fishes without special species, among which there are key economic fishes as silver xenocypris, hemibarbus maculates, bream, red-eye trout, mandarin fish, pelteobagrus fulvidraco, shining pelteobagrus fulvidraco, etc. and migration fishes as “four major Chinese carps”.

This investigation has not recorded some valuable and rare migration fishes recorded in literature (as Acipenser dabryanus Dumeril, Psephurus gladius Martens), Myxocyprinus
8.0 Special Impact Assessment on Fishes and Spawning Sites

8.1 Assessment of Impacts on Fishes and Spawning Sites

8.1.4 Assessment conclusions

In accordance with the literature, fishes in the Kan River total 118 species, classified into 11 orders, 22 families and 74 genera, of which the Cyprinidae makes up the majority (about 58.5%) in total, followed by Bagridae, 9.3%; by Cobitidae, 5.9%; by Serranidae, 5.1%, while such fishes as Setipinna taty, Salangidae, Catfishes, Eleotridae, Aeoliscus scuttatus, Osphronemidae and Eleotridae each contributing to 1.7% with the remained 11 families making up 9.3%. Of Cyprinidae, Gobioninae and Anabarilius grahami each averages 23.2%. followed by ugui minnow and Acheilognathinae, each making up 14.4%, while barb 8.7%, silver xenocypris 7.3%, carp cyprinoid and Gobiobotinae and Hypophthalmichthys moritrix each contributing 2.9%. There are altogether 41 species of recorded fishes through investigation of the assessed river section, classified into 3 orders and 7 families, of which the Cyprinidae makes up the majority (about 73.17%) in total. These species are all common fresh water fishes without special species, among which there are key economic fishes as silver xenocypris, hemibarbus maculates, bream, red-eye trout, mandarin fish, pelteobagrus fulvidraco, shining pelteobagrus fulvidraco, etc. and migration fishes as “four major Chinese carps”. This investigation has not recorded some valuable and rare migration fishes (as Acipenser dabrganus Dumeril, Psephurus gladius Martens, Myxocyprinus asiaticus (Bleeker), Anquilama japonica J.et.s, Coilia ectenes J.et.s and hilsa herring etc.).

Historic literature shows that the Project is involved in two spawning sites as Taihe (Chengjiang) Spawning Site and the Yanxidu Spawning Site. The document provided by fishery department shows that the main spawning fishes of these two sites are mandarin fish, grass carp, snail carp, silver xenocypris, bream fish and etc. During the spawning period of 2007 (April to June), the project team has executed site survey on the two spawning sites. The total collected spawns are 2,356,900 million grains, only accounting for 3.1% of historic spawning quantity. Meanwhile, fishes accumulating phenomenon is not found in the said two sites, and the river section is severely sand dredged and flows moderately and has sparse aquatic plants. It is told by the local fisherfolks that no large fishes spawning in these two sites have been found, which indicates that these two spawning sites have been severely degraded.

8.2 Assessment of Impacts on Fishes and Spawning Sites

8.2.1 Impacts on fishes during construction

☐ Suspended solid (SS) increase by construction will reduce light transmittance of water. Too high suspended solid content in water will cause fine sediment to deposit onto fish parotid gland, severely harmful to filter and breathing function of parotid, even resulting in death by...
8.0 Special Impact Assessment on Fishes and Spawning Sites

suffocation. Different fishes have different SS endurable ranges. Test data show that fishes can survive for only one day at longest when SS is $8 \times 10^4$ mg/L; and that fishes can survive for only one week at longest when SS is 6000 mg/L; if the water is agitated for a short time every day to well up deposited sludge, keep SS content at 2300 mg/L, fishes can survive for 3~4 weeks. It is generally agreed that aquatic organisms of fishes etc. in water body with SS content of 200 mg/L will not directly die, while SS bigger than 125 mg/L will have a certain impacts on aquatic larva. Nanhai Aquatic Products Institute of China once cleaned up domestic and foreign documents about fatal SS content and obviously affected SS content of fishes and shrimps. Details are shown in Table 8.2.

Table 8.2—1 Fatal SS content and obviously affected SS content of organisms

<table>
<thead>
<tr>
<th></th>
<th>Adult</th>
<th></th>
<th>Larva</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fatal SS content</td>
<td>Obviously affected SS content</td>
<td>Fatal SS content</td>
<td>Obviously affected SS content</td>
</tr>
<tr>
<td>Fishes</td>
<td>52000</td>
<td>500</td>
<td>250</td>
<td>125</td>
</tr>
<tr>
<td>Shrimps</td>
<td>8000</td>
<td>500</td>
<td>400</td>
<td>125</td>
</tr>
<tr>
<td>Crabs</td>
<td>9200</td>
<td>4300</td>
<td>700</td>
<td>125</td>
</tr>
<tr>
<td>Shells</td>
<td>700</td>
<td>500</td>
<td>250</td>
<td>125</td>
</tr>
</tbody>
</table>

Impact upon fish resources

Adult fish has stronger moving ability, construction impact on fish mostly appears as “dissipation effect”, protection of fish species resource will not be affected. Due to change in water quality in the construction site, and reduction of plankton and benthonic organism, the original habitat, survival and reproduction has changed for the fishes, which will be forced to move to other places and thus the density of fishes will decrease during construction period. There will be impacts by the project construction on the site only, no impact upon fish resource protection will be caused due to fishes moving to other places.

During construction diversion period, the Kan River will not be totally closed, and the Kan River will basically assure navigational for the whole construction period (except Phase II cofferdam for about two months non-navigation), when Phase II cofferdam is constructed, navigation is not allowed for two months, but the river will not be dammed off, only because the narrow navigational river channel, flow velocity and river width can not meet navigation requirements. Therefore construction diversion will not affect obvious obstruction impacts on fishes.

Impact upon spawning sites

Over-water construction of this Project will be concentrated on the pivotal region. There are two spawning sites in the upper reach of the dam site with long distances (Taihe Spawning Site is about 21.4km away from the dam site, the Yanxidu Spawning Site is about 13.9km). Despite negative impact upon water quality, plankton and benthonic organism from such underwater construction as cofferdam, foundation pit excavation and cofferdam removal the
8.0 Special Impact Assessment on Fishes and Spawning Sites

construction site is far away from the spawning sites and there will be no water flow interception, thus there is no severe impact upon spawning sites during construction period.

8.2.2 Impacts on fishes during operation

Completion of Shihutang Project will produce change in some of the natural reach of the Kan River close to Taihe County, thus to create some impacts on aquatic organisms, the original eco-balance is broken to establish a new balance by way of regulation of fishes and foodstuff organism.

After the construction, the reservoir will gradually impound water under the premise of assuring the release flow of 187 m³/s to meet the shipping requirement of the dam downstream at initial impounding stage. That release flow can also meet the productive, domestic and ecological water consumption requirement of the dam downstream.

After the project is put into operation, the river section from the dam site to the tail of the reservoir will become the reservoir area, the levels of different sections of the river will be raised to different extents than before. When the reservoir is under operation, at the same flow, the flow of the reservoir area river section will be slowed down than before when the reservoir area is impounding, the water depth will be increased, so that sunshine will not reach the bottom, which makes it difficult to grow for algae and aquatic organism, and benthic invertebrate will decrease accordingly. On the contrary, plankton will multiply to create desirable ground for fishes that feed on plankton. Meantime, rising of water level will bring some water grass under inundation, to produce negative impacts upon fishes whose eggs are attached to the grass. This will cause great impacts on fishes laying adhesive spawns. The completion of the dam will reduce flow velocity and water level of the dam downstream river section to severely threaten the spawning and breeding of such fishes as enjoy flowing water.

After the reservoir is impounded a great deal of suspended sediment will deposit to greatly improve transparency. With increase of incident sunshine, aquatic plants will grow better to increase the quantity of herbivore. In the shallow nearshore waters there will be emergent aquatic plants and filamentous algae, which are desirable for grass carp, fresh water bream and red-eye trout. After rot of residual plants they provide nutritive materials to the water body. In the downstream reach due to decrease in sediment, benthonic organism will multiply. Most of the river bed of the Shihutang Project is of sandstone it is estimated that such species as algae and filamentous algae will multiply with abundant benthonic organism. Limited sediment bottom will be desirable for pondweed, for mussel and Corbiculidae. There will be obvious increase of fishes eating benthonic organism in the downstream reach.

The Kan River is one of the major habitats of the four major Chinese carps, whose spawning ground is of certain special topographical and hydrographic characters. Every year from April to July when water temperature reaches over 18, the four carps will go to their spawning grounds for bleeding, whose scale is related to swelling flow and flood duration. When an unprecedented flood arrives there will be more oviferous laying, while a small-scaled flood there will be limited egglaying or no reproduction at all. Such behavior is a way
to adapt to runoff of the Kan River, as the genetic property of the four carps. There are two spawning grounds at the Taihe river section of the Kan River, namely Taihe and Yanxidu. In natural state, one flooding process will last several days or longer, when the flow will increase with the time going on and abrupt flood peak will develop and then decrease step by step until the river flows relatively smoothly. The four major Chinese carps start to spawn on the first or second day of swelling and will stop spawning if the river does not rise much or stops rising. In the project section of the Kan River in May and June the spawning will make up 70%-80% of the whole spawning season. After operation of the Project, flow of the incoming water from upstream of the dam will be the same with the current flow, that is, no change of upstream flow of the dam will happen. Compared the flow after operation of the Project with the flow after completion of planned flood control dike, the flow will be increased by only -1.38%--0.11%. According to the operation management rule of the Shihutang Project, during the period from March to June (upstream incoming water flow is bigger than and equal to gate opening critical flow), all the scouring sluices of Shihutang Project will be opened for flood discharge, in order to avoid raising upstream flood level of the dam, to basically keep natural condition, the upstream level increase of Shihutang Dam will be smaller during flood season. According to the flood regulation calculation, after the Shihutang Project is finished, the backwater height of pre-dam water level is 0.07~0.18m while the design flood frequency is P=50%~P=0.33%. Through calculation and analysis and comparison of the design water level under current condition and the design water level after completion of the Project, the backwater level increase at upstream of the dam after completion of the Project during flood season will not be big either, the backwater height of pre-dam water level is 0.05~0.24m while the design flood frequency is P=50%~P=5%.

In a word, in the fish spawning season (flood season), all the scouring sluices of Shihutang Project will be opened for flood discharge, in order to avoid raising upstream flood level of the dam and to basically keep the upstream at natural condition. After completion of the Project, in the fish spawning season (flood season), the change of flood flow and duration is smaller, impacts on fish spawning within the reservoir area spawning sites is relatively smaller.

After completion of the Project, the dam will block the migration passage of migration fishes. Some migration and semi-migration fishes can not swim back to the upstream for raising up seeds. Because the upstream spawning site nearer to the reservoir area is of short flow stream, floating and semi-floating spawns flow into static water of the reservoir area too early during drifting incubation, with growth affected. Some spawns or fries flow down with the water flow, and can not bear impact of enormous energy and can not survive, even if they can survive, they can not swim back to upstream for making up group resource. According to site survey and information of fishery department, though some valuable and rare migration fishes (as eels, Chinese sturgeon and hilsa herring) of this river section have disappeared, and the population quantity of some common migration fishes (as four major Chinese carps) is less, on the viewpoint of fish resource protection of the whole Kan River, it is necessary to build fishpass to lessen impacts of the Project on fish resources.
After completion of Shihutang Project, there will be change in such hydrologic factors as water level, water temperature and flow velocity, only to change original spawning grounds in Taihe (Chengjiang) and Yanxi, to result in considerable bio-mass loss of such cash fishes stocks. Such negative impact upon spawning, breeding and growth will be unfavorable for fish stocks. Estimated at the most unfavorable condition (disappearance of the mentioned two spawning grounds), based on site collection of spawns and experience from fish men, larval fish loss = total breeding × hatchability (10%) × survival rate (10%), the maximum losses of spawns and larval fish during the operation period are 199 million grains and 1.9898 million pcs, see Table 8.2—2.
Table 8.2—2  Maximum losses of spawns and larval fish during operation period

<table>
<thead>
<tr>
<th>Spawning ground</th>
<th>Fishes</th>
<th>Maximum loss of spawns ((10^4))</th>
<th>Maximum loss of larval fish ((10^4))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taihe</td>
<td>Herring</td>
<td>2050.42</td>
<td>20.5</td>
</tr>
<tr>
<td></td>
<td>Grass carp</td>
<td>2283.84</td>
<td>22.84</td>
</tr>
<tr>
<td></td>
<td>Parabramis pekinensis</td>
<td>862.11</td>
<td>8.62</td>
</tr>
<tr>
<td></td>
<td>Hemibarbus maculates Bleeker</td>
<td>851.34</td>
<td>8.51</td>
</tr>
<tr>
<td></td>
<td>Common carp</td>
<td>1032.08</td>
<td>10.32</td>
</tr>
<tr>
<td></td>
<td>Xenocypris argentea</td>
<td>2720.21</td>
<td>27.2</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>9800</td>
<td>97.99</td>
</tr>
<tr>
<td>Yanxi</td>
<td>herring</td>
<td>2277.02</td>
<td>22.77</td>
</tr>
<tr>
<td></td>
<td>grass carp</td>
<td>2568.27</td>
<td>25.68</td>
</tr>
<tr>
<td></td>
<td>common carp</td>
<td>2124.29</td>
<td>21.24</td>
</tr>
<tr>
<td></td>
<td>Xenocypris argentea</td>
<td>3130.42</td>
<td>31.3</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>10100</td>
<td>100.99</td>
</tr>
</tbody>
</table>

8.2.3 Impact of the Project on the downstream Xiajiang~Xingan hilsa herring spawning site

China has three large hilsa herring formations: Yangtze hilsa herring, Pearl River hilsa herring and Qiantangjiang River hilsa herring. Some information shows that Yangtze hilsa herring is the important fishing object of the Yangtze River before 1970’s, with its output fluctuated at 3096584t in 1960’s and 74157t in 1970’s. From late 1970’s, its output is reduced year by year, the output of 1980’s is about 12192t, only 12t in 1986, which could not form fishing season. From 1987 up to now, according to the monitoring result of Changjiang Aquatic Product Institute, only one 1.5kg hilsa herring was caught in Jiangsu Province in 1998. From 1980’s, Pearl River hilsa herring output began to descend, fluctuated at 78175t during 19801988 averaged 144t equivalent to 1/6 of output in 1960, the output in 1996 was 0.6t only. Qiantangjiang River hilsa herring basically disappeared in 1970. Pearl River hilsa herring mostly enter the Xijiang River, parent hilsa herring going to upstream could reach at Guiping in 1970’s, concentrated and distributed at Cangwu, Teng County, Pingnan and Guiping. A small portion enters the Dongjiang River to reach Huizhou. Since 1980’s, hilsa herring upstream of Wuzhou of Guangxi has been on the brink of extinction. Hilsa herring to Qiantangjiang River could reach Tonglu and Fuyang at farthest before construction of Xin’ anjiang dam and has now perished already.

Hilsa herring breeding groups to the Yangtze River in 1970’s mostly entered the Poyang Lake, and then to Kan River spawning sites. A small part of groups went further along the
Yangtze River trunk stream via Jiujiang to Chenglingji, then divided into two routes, one continued to go west along the Yangtze trunk stream to reach Yichange at furthest, the other entered the Dongting Lake via Yueyang, then to Xiangjiang River to Changsha and Xiangtan section for spawning. In 1980, only a small amount of hilsa herring entered the Kan River, hilsa herring of other routes have disappeared.

As per literature, the Kan River hilsa herring spawing sites (Xiajiang~Xingan) are located at more than 90km long river section upstream of Xinganshikou and downstream of Ji’an, among which the main spawning sites are located at 30km long river section of upstream and downstream of Xiajiang County seat. Xiajiang~Xingan hilsa herring spawning sites are located at about 90km~120km downstream of this dam. (see Drawing No.1.7 □3).

Xiajiang hilsa herring is a rare edible fish. In fishes taxology, Xiajiang hilsa herring belongs to herring family, large mouth, toothless, a jag at center of upper jaw, without lateral line, big and thin scale with hair crack, narrow in abdomen, sawing device type large and sharp keeled scale. It is of fat meat and delicate taste, high fat content and famous at all times. At end of spring and early summer, fish group of well upgrown sex gland is anadromously migrating for breeding, from offshore to river fresh water area for breeding. The breeding group is composed mainly of four-year-old hilsa herring, with small amount of three-year-old and five-year-old hilsa herrings. The spawning period is June to July. Spawned parent fish then swims back to the sea. Fertilized eggs hatch out fries after 20 hours, which will enter lakes or shallow bay for food after having swimming ability, thereafter, migrated into the sea for getting fat, after the sex is mature, they will go upbound to river for spawning and bleeding. They eat zooplankton as main food, in addition, dayfly larva, rotifer, diatom, and organic chip are also their foods.

Sexually mature hilsa herring enters the river from the sea April to May each year, going countercurrently upward to arrive at Xiajiang Spawning Site at end of May and early June, after spawning, returns to the sea. Prosperous flood season normally happens from June 15 to July 15 each year. Since 1970’s, the breeding characteristics of the Yangtze hilsa herring has changed apparently: group quantity has been reduced, mature individual fish has become small, its sexual maturity ahead of time, young-aged fish increased, old-aged fish decreased, group average age descended. In 1980’s, group quantity of hilsa herring entering Xiajiang Spawning Site has been reduced year by year, from 119 fish in 1980 to 17 fish in 1989. In 1990’s, Ils herring entering Xiajiang Spawning Site has basically disappeared. During June 14 to July 8, 1996, fisherfolks were organized for trial catching in the Xiajiang Spawning Site for 21 days, 414.5 hours, 93 ship times, except that fishing stopped on June 19 and 23 due to strong wind, even one hilsa herring was not caught.

This site survey has not recorded hilsa herring. At the same time, the fisherfolks feedback that no hilsa herring has been caught in recent more than ten years. And in the investigation of fishes at lake intake in recent years, no adult hilsa herring has been found to enter the lake or fries found to go out of the lake.
After operation of Shihutang Project, the annual average, monthly average and daily average flows and levels at downstream of the dam will hardly change. In order to assure the release shipping basic flow of the hydropower station bigger than or equal to 187m³/s and to meet the downstream shipping requirement of the dam, incoming water flow of one day will be properly adjusted. Maximum flow at the downstream of the dam on a typical day during non-flood period will be reduced from current 2278m³/s to 2100m³/s, Minimum flow at the downstream of the dam on a typical day during non-flood period will be increased from current 162m³/s to 187m³/s. That is, after operation of Shihutang Project, the large flow at the downstream of the dam on a typical day during non-flood period will be cut down, the small flow will be supplemented properly, the flow change range at the downstream of the dam on a typical day will be reduced from current 2116m³/s to 1913m³/s.

Because the Shihutang reservoir has extremely poor runoff control ability, i.e. control of daily runoff, its control ability is limited too, because Shihutang is a natural riverway, when flow increases, its level will rise accordingly, wetted area of the same section will increase accordingly, therefore, the change of flow at downstream of Shihutang dam after operation will be smaller compared with the flow under current situation.

Xiajiang hilsa herring (Xiajiang~Xingan) spawning site is over 90km away from Shihutang dam, such a long distance can basically resume the physical properties of water as water temperature etc. to be changed by the dam. And Shihutang Pivot belongs to low head dam, runoff type development mode, and hardly runoff control performance. The operation mode of the Shihutang hydropower station will utilize the power generating drain flow of the Wan’an hydropower station plus sectional flow as its power generating flow. The annual average, monthly average and daily average flows and levels of downstream of the Shihutang dam in the design representative year all will be the same with the runoff and level of the Shihutang dam under current condition in the design representative year.

Overall, Shihutang Project will cause very limited impacts on the Xiajiang hilsa herring spawning site, the main negative impacts on the Xiajiang hilsa herring spawning site by the Kan River hydropower development will not come from the Shihutang Project.

8.3 Protection Measures of Fishes and Spawning Sites and Technoeconomic Appraisal

Considering the hydropower development actuality of the drainage area and the special features of this project, the size, habit and operation management conditions of fishes at the Taihe section of the Kan River, this EIA applies measures to build fishpass, to construct fish proliferation and fry releasing station, to construct substitute fish habitat, to execute monitoring and study, to strengthen fishery administration etc. to mitigate adverse impacts of the project construction on fishes and spawning sites.

8.3.1 Fish pass

8.3.1.1 Fish passing objects and necessity of fish pass construction

After the completion of this project, it will change the original hydrological conditions of reservoir area and certain section of downstream river, and basically obstruct the upstream-
bound passage of migration fishes and semi-migration fishes, which causes fishes habitat broken, and decrease or even vanish of fishes exchange organism.

According to the situation of the investigated migration fishes and semi-migration fishes in the Kan River, combining the characters of the project, selected fish passing objects are: female or male parents and adults of semi-migration fishes, such as grass carp, snail carp, silver carp, bighead carp and etc. The water retaining height of the project is 9.8m, which belongs to low head structure, spawning ground of fish passing objects exists on the dam; parent fish after spawning and young fish may enter the river from drainage openings; it has the basic conditions for construction of fish pass structure, which is suitable for building the fish pass structure. Main fishes passing protective objects are migration fishes and semi-migration fishes in the Kan River, among which semi-migration fishes are mainly economic fishes of “four major Chinese carps”. Setting fish pass structure can create basic conditions for valuable and rare fishes to return back to middle and lower reaches of the Kan River and can also provide upstream-bound passage of migration fishes(grass carp, snail carp, silver carp, bighead carp), which is favorable for the recovery of fishes composition and varieties in the Kan River and for raising the fishery economic output value of the Kan River.

The main fish passing objects of the fish pass are the main information for designing fish pass, on this basis, type and size of fish pass suitable for those fishes can be correctly selected and designed, which shall be decided as per the specific situation of different rivers of China.

In accordance with the inventory survey result and the literature, fishes in the Kan River total 118 species, classified into 11 orders, 22 families and 74 genera, of which the Cyprinidae (grass carp, snail carp, silver carp, bighead carp etc.) makes up the majority about 58.5% in total. In addition, historic record shows that there are ocean and inland river migration fishes as hilsa herring and eel etc. According to this feature, the river migration fishes, mainly economic fishes of “four major Chinese carps” are selected as fish passing objects. Setting fish pass structure can create basic conditions for valuable and rare fishes (as hilsa herring) to return back to middle and lower reaches of the Kan River.

8.3.1.2 Comparison and selection of fish pass structure schemes
Fish pass structure of the dam consists of fish pass, fish lock, fish elevator, fish boat for collection and transportation and etc, according to overseas experiences, fish elevator, fish boat for collection and transportation are usually suitable for high dam, which is used mainly for fishes of strong migration and large sized fishes. The water retaining height of the project is 9.8m, which belongs to low head structures, hence, it is unnecessary to build large sized fish pass structure, such as fish elevator or fish boat for collection and transportation.

As per the characteristics of the practical situation of comprehensive drainage area hydroelectric development and the project, and fishes size, habit and operating management conditions in the Taihe County section of the Kan River, we recommend to build fish pass and fishes proliferation and releasing station, to execute monitoring and research, to build fishes alternative habitat, and to strengthen fishery administration management, so as to
reduce unfavorable impact on fishes.

8.3.1.3 Fish pass design scheme

- Comparison and selection of fish pass types

As per structure type, fish pass can be divided into pond type fish pass, trough type fish pass and diaphragm type fish pass (cascade fish pass). Pond type fish pond is very close to condition of natural waterway, fish rest condition in pond is good, but its applicable head is very small, and it occupies a larger plan location, and requires a suitable landform, therefore, its practicability is somewhat restricted. Trough type fish pass is divided into simple trough type and Daniel type, simple trough type fish pass is of a water trough to connect upstream with downstream, without any energy dissipation device, only relying on elongating water flow path and trough circumference coefficient of roughness for energy dissipation. This type fish pass is of moderate slope, a very long length, a very small applicable head, therefore it is rarely applied. Daniel type fish pass is to set dense baffle walls and ridges at the trough wall and bottom, which is normally applicable to strong fishes and place without big level difference. Diaphragm type fish pass is to apply diaphragm to separate the total level difference of upstream and downstream of fish pass into many cascades, and to apply water cushion and course friction and current impact and diffusion for energy dissipation, to achieve flow regime improvement and fish pass flow reduction requirement, its water flow condition is easy to control, it can be applied in the place with bigger water level difference, ponds of different cascades are good rest places for fishes, and the type, position and size of fish pass hole can be adjusted to suit the passing requirement of fishes of different habits, it is of simple structure and convenient maintenance, therefore most of neoteric fish passes apply this type.

On the ground of the landform and level of the river section where this project is situated, diaphragm type fish pass is recommended.

- Parameter selection of fish pass

- Main fish passing objects

The main fish passing objects of the fish pass are the migration fishes of the Kan trunk and river migration fishes, mainly economic fishes of “four major Chinese carps”. Setting fish pass can create basic conditions for valuable and rare fishes (as hilsa herring) to return back to middle and lower reaches of the Kan River.

- Main passing season of fish pass

Passing season refers to time interval for main fish passing objects of fish pass to pass through the fishpass. Hilsa herring spawning time is at 12:00~18:00 pm of June to July; Snail carp swims to the place with high flow velocity at the middle and lower reaches of the Yangtze River in May ~July for spawning; Grass carp begins to spawn at late April; Silver carp begins to spawn in mid-April; Bigheat spawning time is from April to June each year.
According to the above information, it is decided that the main fish passing season of the fishpass is from April to July each year.

- Upstream and downstream levels of main fish passing season of fish pass

Upstream and downstream service levels of fish pass are directly related with whether the fish pass possesses proper fish passing condition or not during fish passing season; Upstream and downstream level change range of fish pass will also affect water surface connection of inlet and outlet of fishpass and pond water flow condition, resulting in that fishes arriving at outlet can not enter the reservoir, and fishes arriving at vicinity of inlet downstream can not enter the fishpass. Upstream and downstream levels of the dam are shown in Table 8.3.1. Upstream level during fish passing season is to select the normal impounded level of reservoir 56.50m, downstream level is to select average low level of April-August 47.16m, maximum design level difference is 9.34m.

<table>
<thead>
<tr>
<th>Table 8.3—1 Upstream and downstream levels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reservoir level</strong></td>
</tr>
<tr>
<td>Design flood level</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Maximum flood level</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Normal impounded level</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Dead water level</td>
</tr>
</tbody>
</table>

- Design flow velocity of fish passing hole of fish pass diaphragm

Design flow velocity of fish pass refers to the maximum flow velocity of fish passing hole of fish pass diaphragm under condition of design level difference. Factors to affect design flow velocity are fish passing object, geographical location, pond water flow condition etc. Design flow velocity is better to decide through test. It is stated that ability of fishes to overcome flow velocity is increased with length increase of its body, therefore, at the stage of fish pass design, body length of main fish passing object can be based to determine design flow velocity of fish pass. In accordance with some outdoor and indoor tests and observation information of China, for cyprinoid with body length bigger than 30cm, design flow velocity of fish pass is 1.0-1.2m/s; hilsa herring fond flow velocity is 0.7-1.0m/s, so design flow velocity of fish passing hole of fish pass diaphragm is decided as 0.7-1.2m/s.

- Fish pass conceptual design

- Fish pass dimension
Fish pass water depth: 2m
Pond width: 3m
Pond length: 3.6m

Fish pass length
The total head of Shihutang fish pass is 9.34m, head difference of each diaphragm is 0.06m, diaphragm quantity \( n = \frac{9.34}{0.06} = 155.7 \), take 156 pieces.

Fish pass has altogether 156 diaphragms to form 155 water ponds, each pond is 3.6m, so grade section length of fish pass with diaphragms is \( L_1 = 155 \times 3.6 = 558 \text{m} \)

Corner section, sight chamber section, rest room section, upstream outlet gate section and downstream inlet gate section of designed fish pass all are of flat bottom, its total length \( L_2 \) is to be decided as per the length of final line location, specific requirements are as follows:

- Rest pond: a rest pond is set for every 10 diaphragms, altogether 15 rest ponds, each rest pond is 7m long and 3m wide at bottom.
- Corner section: Each corner section is of axial line length 10m and bottom width 3m, corner quantity is to be decided as per the final line location, corner section can also be used as rest pond.
- Upstream outlet gate section: 10m long, 3m wide at bottom.
- Downstream inlet gate section: 10m long, 3m wide at bottom.

Total length of fish pass \( L = L_1 + L_2 = 683 \text{m} \) excluding corner sections.

Inlet and outlet elevations of fish pass
As per upstream and downstream design levels and depths of fish pass, the downstream inlet elevation of fish pass is 44.16m, the upstream outlet elevation is 53.50m, via moderate slope to connect with downstream and upstream river beds respectively.

Section type of fish pass trough
This Project is situated between Ji’an city urban area and Taihe county seat at middle reaches of the Kan River in which there are rich fish resources and many cash fish species. Through integrated comparison among the habits of main fish passing objects (snail carp, grass carp, silver carp, bighead and hilsa herring), level difference and level change range etc. the design fish pass trough section is 3m wide at bottom, height of side walls of both sides 1.8m, height of 1:2 slope to connect upward 0.7m, altogether 2.5m high. Recommended diaphragm fish pass layout is shown in DRAWING NO.39.
8.0 Special Impact Assessment on Fishes and Spawning Sites

- Type of diaphragm fish passing hole

Composite type diaphragm is recommended for use, with one side “vertical holes – graded holes”, the other side overflow holes. Fish pass structure type is shown in DRAWING NO.40.

8.3.1.4 Fish pass work

As per the above-defined fish pass parameters, layout of hydraulic structures, hydrological conditions, topographical condition and geological conditions of hydropower station, the following fish pass scheme is drawn up:

Fish pass is located at the left bank, going through the dam and along the bank with total length of 713m. Fish pass is of open canal with inlet section length of 10m, bottom plate as flat section, bottom plate elevation of 44.16m, longitudinal bottom slope 1:60, and clear width 3m.

Key factors for success of fish pass not only include the selected type and design parameters of fish pass which shall meet the requirement of the site and task, but also include its location and water consumption. As per the domestic and foreign design experiences of fish pass inlet, all the fish pass inlets are located at upper of draft tubes of hydropower stations, applying the released water of hydropower stations to seduce fishes or located at sides of spill ways. The fish pass inlet of the aforesaid fish pass scheme is atat upper of draft tube of hydropower station, tailwater of hydropower station is the downstream routine water flow, under attraction of tailwater, fishes are concentrated at front and both sides of powerhouse tailwater, therefore here is the best inlet of hydropower station type fish pass.

Functions of fish pass auxiliary facilities are to seduce fishes to enter fish pass and block water surface floats. The main auxiliary facilities are approach, regulating gate and trash rack etc. Whereas the level of design detail at this stage is limited, auxiliary facilities are temporarily not considered, it is recommended to jointly consider auxiliary facilities when model test for optimizing fish pass design is carried out.

The specific location of fish pass in the general layout of the Project is given in DRAWING NO.09.

This scheme is technically consulted by Changjiang Aquatic Product Institute employed by the Owner and designed in accordance with the literatures, test results and analog of typical fish passes of different fish passing objects at home and abroad.

Fish pass design shall make full consideration of river water conservancy condition, fish biological features of passing objects, environment adaptability etc., the design parameters of fish pass will be adjusted and modified to meet the fish passing requirement of fish pass in the engineering design of the next stage as per the test result through physical model test.
Currently, the Owner is authorizing a contractor for physical model test of fish pass of this Project. (see Appendix 13).

8.3.2 Manual proliferation and fry releasing

Manual proliferation and fry releasing is the popular proliferation method of aquatic resources both at home and abroad. The former Soviet Union, USA and Japan and other countries have obtained apparent benefits in fish resources recovery by utilizing artificial proliferation and fry releasing method, manual proliferation and fry releasing activities have got some ecological benefits in areas of the Yangtze River, the Heilongjiang River, the Pearl River, and the Yellow Sea in recent years, such as Gezhouba Dam junction adopts artificial proliferation and fry releasing method for Chinese sturgeon, and obtained some effects. Manual proliferation and fry releasing is an important method to recover natural fishery resources, through planned manual releasing germchit, it can increase quantity of middle and low aged and young fishes in the fish population structure, enlarge group scale, store sufficient quantity of proliferation reserved population, which can solve fundamentally insufficient quantity of natural fish resources.

To build fish proliferation and fry releasing station is the basic measure for fish proliferation and fry releasing. The target and main task of fish proliferation and fry releasing station is to carry out wild parent fishing, transport, domestication of fishes implement artificial propagation and seedlings incubation provide seedlings for releasing, and reach the purpose to control decline of fish resources in the Kan River by manual fish proliferation and fry releasing method.

- Selection of proliferation and releasing objects
  Proliferation and releasing objects are mainly protective fishes and endemic fishes, and secondarily main economic fishes. Considering from technical angle, proliferation and releasing should be carried out according to the principle of from easy to difficult, at the same time, according to the monitoring result of fish resources and fish resources situation in the reservoir, adjust gradually the proliferation and releasing object.
  At present, fishes in inundation area of the Shihutang Project mainly are cyprinoid fish, golden carp, Culter alburnus, grass carp, snail carp, bream, silver carp, Pelteobagrus fulvidraco and etc., among which, fishes that need running water stimulation for spawning are affected greatly due to the project, including grass carp, snail carp, silver carp, bighead carp and etc., hence proliferation and releasing objects are the four major Chinese carps.

- Standard, quantity and size of proliferation and releasing seedlings
  Releasing young fish must be first filial generation of wild parent artificial propagation. The releasing seedlings must be free of wound, disability, disease and be healthy. It is suggested to refer to Regulations on Aquatic Breeding Seedlings.
Quantity and size of proliferation and releasing seedlings

The releasing quantity is considered mainly from the aspects of species protection and ecological compensation on the basis of economical rationality in order to increase and compensate the quantity of fish species and stop the decline of fish resources. After comprehensive consideration of maximum spawn and fry losses, benthos loss, caused during operation, as well as factors of aquatic site, seedlings cost, lowest demand of survival rate and releasing and so on, releasing quantity at the early stage of the operation period is decided as 2.2 million fishes per year, the fry releaseing will continue for a long period during operation. The size of seedlings should be controlled about 1 year with a total length 10-20cm; the releasing ratio of four major Chinese carps (grass carp, snail carp, silver carp, bighead carp) will be temporarily 1:1:1:1, the releasing time will be April - July every year, and the releasing place should be 2 spawning grounds convenient for releasing. Releasing species and quantities will be adjusted gradually during the operating period in accordance of investigation analysis on proliferation and releasing result and monitoring investigation analysis basis on fish eggs and fry quantity, fish species, quantity, population dynamics, habitat condition changes of 2 spawning grounds.

Construction of proliferation and fry releasing station

The planned land occupation of proliferation and releasing station is about 60mu, which is planned to be arranged in Wanhe Township, see DRAWING NO. 15 for detailed location.

Fish proliferation and releasing station consists of 18mu parent fish & breeding protection pond, 6mu circulating warm current aquatic breeding pond, 24mu seedling pond, 3mu productive and living houses and auxiliary facilities of energy supply facilities, feed processing equipment, fences and roads and so on. The construction period is 1 year. See DRAWING NO. 8.3-1 for plan layout of proliferation and releasing station.

Water inlet  18mu parent fish & breeding protection pond  6mu circulating warm current 3mu productive and living aquatic breeding pond   houses

Closed canal for drainage, road, 24mu seedling pond
8.0 Special Impact Assessment on Fishes and Spawning Sites

Drawing No.8.3—1 Plan layout of proliferation and releasing station
Apparatus & equipment required for proliferation and releasing station are: 4 desk top computers, 1 camera, 2 digital cameras, 1 microscope, 1 anatomical lens, 1 water quality monitoring equipment, 1 transport vehicle, 5 air conditioners, 2 refrigerators and communication equipments and etc.

8.3.3 Setting of artificial fish nest
After water storage in the reservoir area, since a large amount of terrestrial plants will be immerged, fishes that lay viscid eggs lose adhesive materials, which will affect the population quantity. Therefore, artificial fish nest can be set to provide spawning conditions during the fishes spawning season, plant a large quantity of aquatic plants, such as reeds with a planting area 140hm², in order to provide spawning conditions for fishes that lay viscid eggs (cyprinoid fish, golden carp, bream, white fish and etc.) at shoal waters of inundation area in Huangkengpengxia ~Xinzhou, Mazhou City, Tianmazhou (see Table 8.3—2 and DRAWING NO. 15 for details), so as to make up the loss of fish eggs and fish resources resulted due to the project. At the same time, reeds have active functions in control soil erosion, prevent mud and sand from silting in the reservoir, and prolong the service life of the reservoir.

Table 8.3—2 Artifical fish nest planting area

<table>
<thead>
<tr>
<th>No</th>
<th>Location</th>
<th>Planting area hm²</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Huangkengpengxia Xinzhou</td>
<td>21.0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Mazhou City</td>
<td>64.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Tianmazhou</td>
<td>55.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>140.0</td>
<td></td>
</tr>
</tbody>
</table>

As for reeds planting, reed roots shall be collected before the water storage of reservoir, and 800pcs/mu reeds shall be planted, in addition, other emerging plants may be planted as well, such as: cattail, cane shoot, reed and etc.

8.3.4 Fishery administration strengthening
Local fishery department shall strengthen fishery administration during construction and during operation, to avoid artificial event occurrence of fish stealing, fishing and fish explosion etc. in the fish pass and nearby waters and artificial fish nest waters and to instruct and monitor the artificial proliferation and fry release work of the owner.

8.4 Cost Estimate of Protection Measures of Fishes and Spawning Sites
The total investment of fish pass is 7.1614 million yuan. Details are shown in Table 8.4—1. The estimated cost of protection measures of fishes and spawning sites is 25.5406 million yuan, including cost of fishes monitoring and proliferation and fry releasing during operation. Details are given in Table 8.4—1.
Table 8.4—1  Cost estimate of fish pass

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Qty.</th>
<th>Unit price (yuan)</th>
<th>Total price (10^4 yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Civil works</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3 m³ hydraulic excavator for excavation and loading, 15t dump truck for transport</td>
<td>m³</td>
<td>6</td>
<td>13.55</td>
<td>85.6099</td>
</tr>
<tr>
<td>2</td>
<td>3 m³ hydraulic excavator for excavation and loading, 15t dump truck for transport</td>
<td>m³</td>
<td>6</td>
<td>13.55</td>
<td>5.5331</td>
</tr>
<tr>
<td>4</td>
<td>Apron wheel compacted earthwork, dry density 1.7t/m³</td>
<td>m³</td>
<td>5</td>
<td>3.82</td>
<td>1.3202</td>
</tr>
<tr>
<td>1</td>
<td>Cast-in-situ concrete fish pass beam slab, C25</td>
<td>m³</td>
<td>3</td>
<td>386.29</td>
<td>14.8255</td>
</tr>
<tr>
<td>2</td>
<td>Cast-in-situ concrete fish pass side wall, C20</td>
<td>m³</td>
<td>6</td>
<td>301.74</td>
<td>201.338</td>
</tr>
<tr>
<td>1</td>
<td>Cast-in-situ concrete fish pass beam slab, C25</td>
<td>m³</td>
<td>5</td>
<td>386.29</td>
<td>22.0961</td>
</tr>
<tr>
<td>2</td>
<td>Cast-in-situ concrete guide wall body, gravity type, C20</td>
<td>m³</td>
<td>5</td>
<td>301.74</td>
<td>169.937</td>
</tr>
<tr>
<td>22</td>
<td>Reinforcement processing, lock head superstructure, longitudinal &amp; transverse grid beam, energy dissipation room, flume, wall body, beam, slab, column etc.</td>
<td>t</td>
<td>5</td>
<td>5399.01</td>
<td>199.576</td>
</tr>
<tr>
<td>1</td>
<td><strong>Erection work of metal framework and equipment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Water gate equipment and erection work</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Fishpass gate</td>
<td>t</td>
<td>6</td>
<td>11376.0</td>
<td>6.8257</td>
</tr>
<tr>
<td>2</td>
<td>Fishpass gate embedded parts</td>
<td>t</td>
<td>2.4</td>
<td>11794.9</td>
<td>2.8308</td>
</tr>
<tr>
<td>1</td>
<td>Water gate headstock gear and erection work</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Fishpass electrical hoist 2.2t/set</td>
<td>set</td>
<td>1</td>
<td>62446.6</td>
<td>6.2447</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>716.14</strong></td>
</tr>
</tbody>
</table>
### Table 8.4—2 Cost Estimate of Protection Measures of Fishes and Spawning Sites

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Qty.</th>
<th>Unit price (10^4 yuan)</th>
<th>Total price (10^4 yuan)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Environment protection measures</td>
<td></td>
<td></td>
<td></td>
<td>1279.14</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Fishpass</td>
<td>Item</td>
<td>1</td>
<td></td>
<td>716.14</td>
<td>Incl. into the main project</td>
</tr>
<tr>
<td>2</td>
<td>Fish proliferation &amp; releasing station</td>
<td>Item</td>
<td>1</td>
<td></td>
<td>500.0</td>
<td>ditto</td>
</tr>
<tr>
<td>3</td>
<td>Artificial fish nest</td>
<td>Mu</td>
<td>2100</td>
<td>0.03</td>
<td>63.0</td>
<td>ditto</td>
</tr>
<tr>
<td>II</td>
<td>Fishes monitoring during construction</td>
<td>Year</td>
<td>5</td>
<td>8.0</td>
<td>40.0</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Separate cost</td>
<td></td>
<td></td>
<td></td>
<td>212.99</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Environment management fee</td>
<td>Item</td>
<td></td>
<td></td>
<td>2.84</td>
<td></td>
</tr>
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<td>2</td>
<td>Project quality supervision fee</td>
<td>Item</td>
<td></td>
<td></td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Consultation fee of fishpass and fish proliferation &amp; fry releasing station</td>
<td>Item</td>
<td></td>
<td></td>
<td>30.0</td>
<td>Incl. into the project engineering design fee</td>
</tr>
<tr>
<td>4</td>
<td>Physical model test fee of fishpass</td>
<td>Item</td>
<td></td>
<td></td>
<td>60.0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Design fee of fish proliferation &amp; fry releasing station</td>
<td>Item</td>
<td></td>
<td></td>
<td>120.0</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Basic contingency fund</td>
<td></td>
<td></td>
<td></td>
<td>91.93</td>
<td>6分 of sum of Items I, II &amp; III</td>
</tr>
<tr>
<td>V</td>
<td>Fee for fishes monitoring and proliferation and fry releasing during operation</td>
<td></td>
<td></td>
<td></td>
<td>930.00</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Fishes proliferation and fry releasing</td>
<td>Year</td>
<td>20</td>
<td>44.0</td>
<td>880.0</td>
<td>Long-term fry release for 20 years, incl. into operating cost of the project</td>
</tr>
<tr>
<td>2</td>
<td>Monitoring of fishes and aquatic ecosystem</td>
<td>Year</td>
<td>5</td>
<td>10.0</td>
<td>50.0</td>
<td>Incl. into operating cost of the project</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>2554.06</td>
<td></td>
</tr>
</tbody>
</table>
9.0 ENVIRONMENTAL RISK ANALYSIS

According to the requirements of State Environmental Protection Administration of China (90) HG Zi No. 057 Notice on Risk Evaluation of Significant Environment Pollution Accident Hidden Danger and State Environmental Protection Administration of China HF No. [2005]152 Notice on Strengthening Management on Environmental Impact Assessment to Prevent Environmental Risk, in compliance with the requirements of Technical Guidelines for Environmental Risk Assessment on Projects (HJ/T169-2004), to carry out environmental risk assessment by risk identification, risk analysis and risk consequence calculation, so as to provide information and basis for project design and environment management, thus to achieve the goal of reducing danger and harm.

9.1 Environmental risk identification and assessment working level

9.1.1 Environmental risk identification

The environmental risks of shipping junction mainly are dam safety environmental risk and water way operation environmental risk, moreover; during the construction period, there are some other environmental risks, such as construction blasting risk and population health risk and etc.

9.1.1.1 Water way operation environmental risk identification

The accident types in the water way operation include collision accident, hull piling up, boat fire and shipwreck accident and etc.

□ Substance of danger potentiality identification

According to the forecasting analysis of project design, the transportation goods types of ships sailing in the reservoir area water way are coal, metallic substance, steel, petroleum, natural gas, mine and building materials, cement, wood, non-metallic ore, chemical fertilizer and agricultural chemicals, grain, machine, equipment, electrical appliance, chemical raw material and products, light industry and medical products, agricultural, forestry, animal husbandry and fishery products, and container etc. In the year 2020, the transportation quantity crossing the dam will be 8.43 million tons, of which, coal, mine and building materials, agricultural, forestry, animal husbandry and fishery products take up 80.4%, and oil product transportation is about 5.9%; in 2030, the transportation quantity crossing the dam is 13.33 million tons, of which coal, mine and building materials, agricultural, forestry, animal husbandry and fishery products take up 81.8%, and oil product transportation is about 5.3%.

According to relevant regulations in Substance Potentiality of Danger Standard, Important Dangerous Source Distinguish (GB18218—2000), and Classification of Health Hazard Levels for Occupational Exposure to Toxic Substances (GB50844-85), the dangerous substances
involved in the project operation period are diesel oil (water insoluble) and methanol (water soluble).

- **Dangerous substance toxicological property**

- **Diesel oil**

Diesel oil is a dangerous oil product, the dangerous characteristics mainly are:

- **Inflammable and explosive**

According to the Code for Fire Prevention Design of Petrochemical Enterprises (GB50160-92, 1999 version) and Design Specifications of Oil Depot (GB50074-2002), diesel oil belongs to high flash point inflammable liquid with a fire dangerous class of Third A.

- **Easy flow**

Diesel oil is liquid with a low viscosity and good flowability. During the process of storage and transportation, if leakage occurs, it could not only cause economic loss and environment pollution, but also may cause fire and blasting accident.

- **Highly volatile**

Diesel oil has a low boiling point, and could evaporate in normal temperature. In the normal work and storage process, volatilization of the materiel is unavoidable. If the steam of finish oil product leakage or normal volatilization mixing with the air reach the explosion limit range, it is easy to explosion. So measures should be adopted to reduce volatilization, or reduce oil gas concentration by measures of ventilation etc. so as to prevent the formation of explosive mixed gas.

- **Easy to accumulate static electricity**

The product oil has a weak conductivity, during the process of flow, filter, mixing, ejecting, washing, charging and shaking, it could produce and accumulate electric charge. In the process of storage and transportation, the crush and friction between flammable liquid and flammable liquid, flammable liquid and pipeline, container, filtration medium, water, impurity and air etc. might cause static electricity accumulation. Static electricity discharge is an important cause of fire and explosion accident.

- **Heat expansibility**

When oil product is heated, temperature rises and volume expands, if the container is over charging, and exceeds the safe capability, this may cause the damage of container or pipeline, and bring about oil product overflow and leakage, and increase the fire and explosion danger.

- **Toxicity**

There are two poisonous expressions of petroleum products, first is special irritant gas, and second is poisonous liquid or steam.

Steam of petroleum products can cause irrigative symptom of eyes and upper respiratory tract, if the concentration is too high, it might only take several minutes to cause anoxia such as dyspnea, and bring harm to human body through alimentary tract, respiratory tract and skin.
See Table 9.1-1 for details of physical and chemical and toxicological property of diesel oil.

To carry out potentiality of danger identification on the poisonous, harmful, inflammable and explosive substances which are concerned in the project according to Technical Guidelines for Environmental Risk Assessment on Projects (HJ / T169-2004), see Table 9.1-2 for the risk identification standard.

- **Methanol**

Methanol is toxic, interblendable with water, alcohol and ether. Absorption and inhalation of methanol will cause poisoning, even blindness and death, it is very flammable, easy to oxidizing, or dehydrogenation to form formaldehyde, formic acid. Risk analysis of methanol is given in Table 9.1-3.

9.1.1.2 Dam environmental risk identification

The main risk is collapse of dam, which could be caused by flood overtopping the dam, construction quality and geologic hazard accidents such as earthquake etc. The causes of formation of flood overtopping the dam are flood exceeding criterion, mud and sand sedimentation invading the flood control reservoir capacity etc.

9.1.2 Assessment working level

According to the regulations of environmental risk assessment working level division in Technical Guidelines for Environmental Risk Assessment on Projects, the project itself has no substance potentiality of danger and functionality danger sources; the risk probability is resulted in indirect behaviors. Therefore the environmental risk assessment working level of the project is Level 2.
### Table 9.1—1  Physical, chemical and toxicological property of diesel oil

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>Diesel oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical and chemical property</td>
<td>Appearance and characteristics</td>
<td>Brown liquid with little viscosity</td>
</tr>
<tr>
<td></td>
<td>Melting point/boiling point</td>
<td>-18°C 282-338</td>
</tr>
<tr>
<td></td>
<td>Relative density</td>
<td>To water 0.87-0.9, to air &gt;1</td>
</tr>
<tr>
<td></td>
<td>Solubility</td>
<td>Water insoluble, freely dissolve in benzene, carbon bisulfide and alcohol, can dissolve in fat</td>
</tr>
<tr>
<td></td>
<td>Flash point/ignition temperature</td>
<td>50°C 227-257</td>
</tr>
<tr>
<td></td>
<td>Explosion limit (vol%)</td>
<td>1.4—4.5</td>
</tr>
<tr>
<td></td>
<td>Stability</td>
<td>Stable</td>
</tr>
<tr>
<td>Combustion and explosion danger potentiality</td>
<td>Building regulation fire hazard leveling</td>
<td>Third A type</td>
</tr>
<tr>
<td></td>
<td>Explosion hazard group and type</td>
<td>T3 A high flash point inflammable liquid</td>
</tr>
<tr>
<td></td>
<td>Dangerous characteristics</td>
<td>Naked fire, high temperature and oxidizer have the hazard to cause burning and explosion, and high temperature can increase container internal pressure, which has the danger of dehiscing and explosion.</td>
</tr>
<tr>
<td></td>
<td>Fire fighting measures</td>
<td>Fire extinguishing agent types: carbon dioxide, foam, dry chemical and sandy soil</td>
</tr>
</tbody>
</table>

### Table 9.2—2  Diesel oil substance of danger potentiality standard

<table>
<thead>
<tr>
<th>Category</th>
<th>Level</th>
<th>LD₅₀(Big mouse from mouth) (mg/kg)</th>
<th>LD₅₀(Big mouse from skin) (mg/kg)</th>
<th>LC₅₀(Small mouse breath in 4 hours) (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poisonous substance</td>
<td>1</td>
<td>&lt;5</td>
<td>&lt;1</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5&lt;LD₅₀&lt;25</td>
<td>10&lt;LD₅₀&lt;50</td>
<td>0.1&lt;LC₅₀&lt;0.5</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>25&lt;LD₅₀&lt;200</td>
<td>50&lt;LD₅₀&lt;400</td>
<td>0.5&lt;LC₅₀&lt;2</td>
</tr>
<tr>
<td>Inflammable substance</td>
<td>1</td>
<td>Flammable gas— substance that gaseous state and mixing with air to form flammable mixture under normal pressure: and its boiling point (under normal pressure) is 20°C or lower than 20°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Inflammable liquid— Substance with a flash point lower than 21°C, and a boiling point of above 20°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Flammable liquid— substance that has a flash point lower than 55°C, remaining in liquid state under pressure, and can cause major accident under practical operation condition (such as high temperature and high pressure)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explosive substance</td>
<td></td>
<td>Substance that could explode influenced by flame, or more sensitive to strike and friction than nitrobenzene</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 9.1-3  Methanol risk analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Physico-chemical property</th>
<th>Combustion and explosion features and harms on human body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>Colorless, transparent, volatile, highly polar liquid, having weak alcohol smell, interblendable with water, alcohol and ether.</td>
<td>Methanol is toxic. Absorption and inhalation of methanol will cause poisoning, even blindness and death, it is very flammable, easy to oxidizing, or dehydrogenation to form formaldehyde, formic acid, finally form CO₂. Methanol vapor can form explosive admixture with air.</td>
</tr>
</tbody>
</table>
9.2 Analysis of Channel Environment Risk during Operation

9.2.1 Analysis of channel environment accident frequency during operation

According to the statistics of greater accidents both domestic and abroad, sudden accident oil spillage has a certain risk probability. Since there is no mature calculating method, risk probability analysis of a project is usually carried out by adopting statistics data due to the effect of objective conditions and uncertainty.

According to the statistics of Ji’An City maritime affairs bureau, only one marine safety accident occurred in recent 3 years (2004~2006) in Kan River of Taihe County section, and there was no cargo falling into the river and oil material leakage. Analogy method is adopted to determine the risk probability of ship oil spillage accident of the project. The analogy project is the statistics of ship oil spillage accident of Hanjiang River waterway in Hubei. Hanjiang River and Kan River are branch rivers of Yangtze River, hydrological and waterway conditions are similar.

Risk probability of ship oil spillage accident in Xinglong of Hubei~Hanchuan section of Hanjiang River is 0.03~0.08times/year. Hence, maximum risk probability of oil spillage accident this project is once every 33 years ~12.5 years.

9.2.2 Impact forecast analysis of oil spillage accident during waterway operation period

9.2.2.1 Accident source item

- The appraisal is considered according to ship collision in the waterway of reservoir area, which causes fuel tank broken and diesel oil leakage into the river, diesel oil leakage amount will be considered on the basis of 5t. oil spillage form is sudden instant point source discharge.

- The appraisal is considered according to ship collision in the waterway of reservoir area, which causes methanol leakage into the river, methanol leakage amount is considered on the basis of 5t. Methanol spillage form is sudden instant point source discharge.

9.2.2.2 Impact forecasting of diesel oil accidental spillage

(1) Physicochemical change process of oil spillage

- Convection and diffusion principles

Movement of oil spillage on the water is carried out mainly through convection and diffusion. The convection is mainly limited by upper wind of oil film and water current under oil film. Diffusion is a phenomenon caused by kinetic balance among gravity, inertia force, friction force, glutinous and surface tension. Impact of wind to oil film reflects as drift generated by wind. Oil film diffusion (or widen) is also very complex process. Comparing detailed researches of Bonit (1992) and Fay (1969, 1971) . These researches are limited mainly in
oil film on dead water, while natural rivers are more complicated due to impact of factors, such as bank reflection and unidirectional flow. Oil film diffusion is divided into three stages: inertial stage, glutinous stage and surface tension stage.

- Evaporation
1/2~2/3 oil spillage will be evaporated within a few hours and one day. Physical and chemical property of oil film will generate important changes due to evaporation. Since evaporation depends on multiple factors and these factors changes at any time, it is difficult to calculate the evaporation rate accurately.

- Dissolution
Hydrocarbon dissolved in the water has potential toxicity for the water biological system, however, oil spillage dissolution will not reach the degree of a few percentage, it does not matter from the point view of oil spillage amount. This means that dissolution rate may not be considered when analyzing movement of oil film.

- Vertical diffusion or vertical transportation
Duration of oil film on the water is usually limited by vertical transportation of oil point to the water body or emulsification of oil in the water.

- Formation of emulsified emulsion
Heavy crud oil has higher glutinous, it usually form more stable emulsion shape oil, while existence of asphaltene and high molecular weight cere has close relations with the formation of emulsion.

- Sedimentation
Various oils may be adsorbed by sediments granule to sink into the water or stick to the bank. Oil penetration in the silt sediments is the smallest; only a few centimeters on the upper layers will be affected.

In a word, convection and diffusion are the most important process to affect the oil spillage, through the numerical model of convection and diffusion of oil spillage, the appraisal gives out the approximate distribution outline of oil film of oil spillage, from these outlines, we can forecast where the most dangerous oil spillage may appear, as well as its impact range.

(2) Calculation mode of oil spillage diffusion
Oil film diffusion plays a leading function at the initial stage, while diffusion plays a leading function at the final stage. Although there are a lot of formulas of diffusion range calculation, many formulas are simplified due to complicated influential factor, and the calculating results are different as well. Fay formula is thought high widely to be one of the formulas for the expansion function of oil film in numerous results.

Fay divides the expansion process into three stages:

(1) Inertial expansion stage
Environmental Risk Analysis

\[ D = K_1 (\beta g v)^{1/4} t^{1/2} \]

(2) Glutinous enlarging stage

\[ D = K_2 (\beta g v^2 / \sqrt{\rho w})^{1/4} t^{1/4} \]

(3) Surface tension expansion stage

\[ D = K (\delta / \sqrt{\rho w})^{3/4} t^{3/4} \]

(4) Before the completion of expansion, oil film diameter keeps the same

\[ D = 356.8 V^{3/8} \]

Formula: 
- \( D \) — oil film diameter (m);
- \( g \) — acceleration of gravity (m/s\(^2\));
- \( V \) — total volume of oil spillage (m\(^3\));
- \( t \) — time experienced from oil spillage (s);
- \( \beta = \frac{1}{\rho_o / \rho_w} \);
- \( \rho_o \) — oil density (t/m\(^3\));
- \( \rho_w \) — water density (t/m\(^3\));
- \( \delta_{aw} \) — surface tension coefficient between air and water (kg/m);
- \( \delta_{oa} \) — surface tension coefficient between oil and air (kg/m);
- \( \delta_{ow} \) — surface tension coefficient between oil and air (kg/m);
- \( K_1 \) — experience coefficient of inertial expansion stage;
- \( K_2 \) — experience coefficient of glutinous expansion stage;
- \( K_3 \) — experience coefficient of surface tension expansion stage;

Oil film expansion increases the area of oil film and reduces the thickness. When oil film thickness is larger than critical thickness (that is after expansion, oil film diameter keeps the same thickness), oil film keeps integrity. When oil film thickness equals or less than critical thickness, oil film starts to split into fragment, and continue to diffuse.

(3) Calculation method of oil film drifting analysis

Oil spillage diffuses oil film after entering the water, and then drift under the function of water current and wind-drift current, at the same time, equivalent oil film of oil spillage self diffusion is diffusing and increasing continuously. Hence, oil spillage pollution range is the water area passed by this continual diffusing and increasing drifting equivalent oil film. Drifting is different from expansion, it has no relations with oil quantity, drifting size is usually judged in accordance with center shift of oil film equivalent. If oil film takes initial
position as $S_0$, after $t$ time, its position $S$ is calculated in the following formula:

$$S = S_0 + \int_{t_0}^{t_0+\Delta t} V_0 \, dt$$

Center drifting speed $V_0$ of oil film in the formula is obtained from the following formula:

$$V_0 = V_S + V_{sk}$$

$$V_{sk} = u_{10} \times K$$

Formula: $u_{10} = 10$ m height wind velocity

$K$ — wind factor coefficient, $K = 3.5\%$

$V_{sk}$ — flow velocity.

(4) Forecasting result analysis

Forecasting according to calculation of diesel oil into the river 5t, see Table 9.2-1 for details of oil film diffusion result in case of oil spillage accident, and see Table 9.2-2 for detailed pollutants diffusion eigenvalue.

According to accident spillover forecasting result, it shows: oil spillage of oil product from the beginning to 6'45" is the film shape inertial expansion stage, from 6'45" ~ 17'32" is film shape glutinous expansion stage, from 17'32" ~ 3h47'14" is film shape tension expansion stage, after 3h47'14", continuous film shape does not existed, the critical thickness of film now is 0.01 mm. Continual film drifting distance is 12.17 km.

Gouzinao water intake and its water-source reserve and Nanmenzhou water intake and its water-source reserve are distributed in the project reservoir area. In addition, water intake of Shangtian Water Works and its water-source reserve that will be constructed according to the remote planning. If the place of accident is located in water intake of upper reaches with a distance larger than 12.17 km, pollution effect to the water quality of water intake is relatively light; if the place of accident is located in water intake of upper reaches with a distance less than 12.17 km, it will generate serious pollution effect to water quality of water intake; If the place of accident is located in water intake of lower reaches within the range of water source reserve, pollution effect to the water quality of water intake is comparatively limited. If the accident place is at approach channel at downstream of the dam, because the nearest water intake at the downstream of the dam is about 21.4 km to the dam site, once oil spillage accident happens, it will cause very limited pollution impacts on the water quality of the water intake.

Once spillover accident occurs in the waterway of reservoir area, oil spillage will diffuse into oil film soon after entering the water, and drift under the function of water current wind current, at the same time, diffusion equivalent oil film of oil spillage itself will diffuse and increase gradually, pollution range of oil spillage is the expanding and drifting equivalent oil.
film. After oil film is destroyed, it will generate continuously vaporing dissolving dispersing emulsification oxidation biodegradation under the function of water force and wind force, and disappear gradually due to impact by physicochemical change of environment factor. Fuel fall in the water will cause pollution effect to the aquatic environment and ecological environment, as well as to the water intake of drinking water in the vicinity of place of accident.

### Table 9.3-2  Accident oil spillage diffusion eigenvalue

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Diesel oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inertial expansion stage (s)</td>
<td>0-405</td>
</tr>
<tr>
<td>Glutinous expansion stage (s)</td>
<td>405-1052</td>
</tr>
<tr>
<td>Surface tension expansion stage (s)</td>
<td>1052-13634</td>
</tr>
<tr>
<td>Critical thickness (mm)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

In order to protect reservoir area water quality, these accidents must be stopped as possible through strict environment management, establish relative system, perfect equipment, advance personnel quality and establish oil spillage contingency plan, and adopt proper control measures for oil spillage accident, so as to control pollution of oil spillage accident. Once risk accident occurs in the waterway, start immediately oil spillage contingency plan, adopt accident emergency measures, and reduce impact of oil spillage accident to aquatic environment of reservoir area.
### Table 9.3-1 Oil film diffusion forecast result

<table>
<thead>
<tr>
<th>No.</th>
<th>Time (s)</th>
<th>Diameter (m)</th>
<th>Area (m²)</th>
<th>Thickness (mm)</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>30.78</td>
<td>743.84</td>
<td>7.91</td>
<td>169</td>
</tr>
<tr>
<td>2</td>
<td>180</td>
<td>53.32</td>
<td>2231.51</td>
<td>2.64</td>
<td>501</td>
</tr>
<tr>
<td>3</td>
<td>300</td>
<td>68.83</td>
<td>3719.18</td>
<td>1.58</td>
<td>834</td>
</tr>
<tr>
<td>4</td>
<td>480</td>
<td>83.46</td>
<td>5467.55</td>
<td>1.08</td>
<td>1334</td>
</tr>
<tr>
<td>5</td>
<td>600</td>
<td>88.24</td>
<td>6112.91</td>
<td>0.96</td>
<td>1668</td>
</tr>
<tr>
<td>6</td>
<td>720</td>
<td>92.36</td>
<td>6696.36</td>
<td>0.88</td>
<td>2002</td>
</tr>
<tr>
<td>7</td>
<td>840</td>
<td>95.99</td>
<td>7232.89</td>
<td>0.81</td>
<td>2335</td>
</tr>
<tr>
<td>8</td>
<td>900</td>
<td>97.66</td>
<td>7486.75</td>
<td>0.79</td>
<td>2502</td>
</tr>
<tr>
<td>9</td>
<td>1140</td>
<td>107.90</td>
<td>9140.13</td>
<td>0.64</td>
<td>3169</td>
</tr>
<tr>
<td>10</td>
<td>3000</td>
<td>222.95</td>
<td>39019.07</td>
<td>0.15</td>
<td>8340</td>
</tr>
<tr>
<td>11</td>
<td>4200</td>
<td>286.95</td>
<td>64635.18</td>
<td>0.09</td>
<td>11676</td>
</tr>
<tr>
<td>12</td>
<td>5400</td>
<td>346.46</td>
<td>94229.24</td>
<td>0.06</td>
<td>15012</td>
</tr>
<tr>
<td>13</td>
<td>6600</td>
<td>402.74</td>
<td>127324.19</td>
<td>0.05</td>
<td>18348</td>
</tr>
<tr>
<td>14</td>
<td>7800</td>
<td>456.49</td>
<td>163582.54</td>
<td>0.04</td>
<td>21684</td>
</tr>
<tr>
<td>15</td>
<td>9000</td>
<td>508.21</td>
<td>202749.04</td>
<td>0.03</td>
<td>25020</td>
</tr>
<tr>
<td>16</td>
<td>10800</td>
<td>582.68</td>
<td>266520.53</td>
<td>0.02</td>
<td>30024</td>
</tr>
<tr>
<td>17</td>
<td>13200</td>
<td>677.32</td>
<td>360127.21</td>
<td>0.02</td>
<td>36696</td>
</tr>
<tr>
<td>18</td>
<td>14400</td>
<td>693.44</td>
<td>377470.19</td>
<td>0.01</td>
<td>40032</td>
</tr>
<tr>
<td>19</td>
<td>15600</td>
<td>693.44</td>
<td>377470.19</td>
<td>0.01</td>
<td>43368</td>
</tr>
</tbody>
</table>

#### 9.2.2.3 Methanol emergency overflow impact prediction

- Transport and diffusion mode of methanol emergency overflow at instantaneous point source:

\[
C = \frac{M}{4\pi HDt} \exp \left[ -\frac{(x-ut)^2 - y^2}{4Dt} \right]
\]

Where, $M$ —— Pollution source intensity (g);

$H$ —— Water depth (m);

$D$ —— Horizontal diffusion coefficient (m²/s);

$D = 0.8u_h$ (m²/s);

$X$ —— Longitudinal distance (m);

$T$ —— Time (S).

- Predicted result analysis

Based on 5t methanol overflowed into the river, corresponding flow of 95% design condition
is selected for calculated. The predicted results are shown in Table 9.2-3.

Table 9.2-3  Predicted axial maximum concentration of methanol emergency overflow pollution impact

<table>
<thead>
<tr>
<th>Location</th>
<th>14.695km</th>
<th>21.4km</th>
<th>21.5km</th>
<th>27km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (s)</td>
<td>Concentration (mg/l)</td>
<td>Time (s)</td>
<td>Concentration (mg/l)</td>
<td>Time (s)</td>
</tr>
<tr>
<td>29378</td>
<td>3.00</td>
<td>42788</td>
<td>2.07</td>
<td>42988</td>
</tr>
<tr>
<td>29919</td>
<td>2.00</td>
<td>43659</td>
<td>1.00</td>
<td>43859</td>
</tr>
<tr>
<td>30272</td>
<td>1.00</td>
<td>44012</td>
<td>0.50</td>
<td>44212</td>
</tr>
<tr>
<td>30524</td>
<td>0.50</td>
<td>44587</td>
<td>0.10</td>
<td>44790</td>
</tr>
<tr>
<td>28.5km</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time (s)</td>
<td>Concentration (mg/l)</td>
<td>Time (s)</td>
<td>Concentration (mg/l)</td>
<td>Time (s)</td>
</tr>
<tr>
<td>56988</td>
<td>1.55</td>
<td>59988</td>
<td>1.47</td>
<td>64988</td>
</tr>
<tr>
<td>57768</td>
<td>1.00</td>
<td>60739</td>
<td>1.00</td>
<td>65684</td>
</tr>
<tr>
<td>58245</td>
<td>0.50</td>
<td>61248</td>
<td>0.50</td>
<td>66249</td>
</tr>
<tr>
<td>58957</td>
<td>0.10</td>
<td>61988</td>
<td>0.10</td>
<td>67037</td>
</tr>
</tbody>
</table>

The predicted results indicate that the maximum methanol concentration at 14.695km satisfies the standard requirement (maximum allowed harmful substance concentration at water body of USSR is 3.0mg/L). The reservoir area of the Project has Gouzinao water intake and its water source protection area, Nanmenzhou water intake and its water source protection area, and the water intake and water source protection area of the Shangtian Water Plant to be built in the long range plan. When overflow emergency happens in the channel of the reservoir area, if the accident place is over 14.695km away from upstream of water intake, its pollution impact on water quality of the water intake will be relatively lighter; if the accident place is less than 14.695km away from upstream of water intake, its pollution impact on water quality of the water intake will be serious; if the accident place is at downstream of water intake and beyond the scope of the water source protection area, its pollution impact on water quality of the water intake will be limited.

Once emergency overflow happens in the reservoir area, gates shall be immediately opened for water release, so as to mitigate pollution impacts on the water intake, and Accident Emergency Plan shall be started up swiftly, and the water quality monitoring of the water intake shall be strengthened to assure water quality safety of the water intake.

If emergency overflow happens at the downstream approach channel of the dam, the neareast water intake at downstream of the dam is about 21.4km to the dam site, once emergency overflow happens, maximum methanol concentration at 21.4km is 2.07mg/L, which can meet maximum allowed harmful substance concentration at water body of USSR -- 3.0mg/L and will have limited polluted impacts on water quality of the water intake.

Because overflow quantity and time are uncertain, once emergency overflow happens at the
9.0 Environmental Risk Analysis

dam site, immediately inform the downstream water intakes to stop intaking, and swiftly start up Accident Emergency Plan, strengthen water quality monitoring of water intakes to assure water quality safety of the water intakes.

In order to protect reservoir area water quality, these accidents must be stopped as possible through strict environment management, establish relative system, perfect equipment, advance personnel quality and establish oil spillage contingency plan, and adopt proper control measures for oil spillage accident, so as to control pollution of oil spillage accident. Once risk accident occurs in the waterway, start immediately oil spillage contingency plan, adopt accident emergency measures, and reduce pollution impact of oil spillage accident to aquatic environment of reservoir area and the river section downstream of the dam site.

9.3 Risk analysis of aquatic ecological environment

9.3.1 Acute poisoning effect

Once there is an oil spillage pollution accident, it will pollute water area in a certain range, it may also pollute water intake of living water along the line, which has greater impact to boogies, fishes and residents that take Kan River as the water resources of farming irrigation. Take petroleum pollution as example, its danger mainly comes from the chemical composition, properties and the existing form in the waterway of petroleum. In the different components of petroleum, low boiling point aromatic hydrocarbon is toxic to all biology, while high boiling point aromatic hydrocarbon belongs to long acting toxicity, which will be a threat, damage and even death to life of aquatic biology.

9.3.2 Impact to fishes

- **Acute toxicity test of fishes**

  According to the toxicity test result of kinds of different fish fry in recent years, cyprinoid fish fry 96hLC50 value of petroleum is 0.5~3.0mg/L, so, instantaneous high concentration discharge (that is accident discharge) in pollution belt may cause acute poisoning fish death accident, hence, petroleum transportation ship in the waterway must be managed and controlled strictly.

- **Analysis of accumulation residue of petroleum in fish body**

  Accumulation and residue of petroleum in fish body may cause fishes slow poisoning and result in long acting pollution effect, which can cause not only changes of fish resources, but also fish idioplasmatic degeneration. Once fishes contact with the oil molecule, it will generate oil stinking in a short time, and affect its edibility. Taking No.20 fuel oil as example, when petroleum concentration is 0.01mg/L, most fishes and shrimps will have oil taste within 7 days, and most fishes will have peculiar smell within 30 days.

9.3.3 Impact to phytoplankton
According to experiment, petroleum will destroy phytoplankton cell, damage the exchange of chlorophyl and Interfering gas, by this way hamper their photosynthesis. The damage degree is determined by the type of petroleum, concentration and phytoplankton species. According to toxic experiment results both domestic and abroad, as the basis of feedstuff, phytoplankton has very low withstanding capacity to various oils. Acute poisoning fatal concentration of petroleum for general phytoplankton is 0.1~10.0mg/L, usually is 1.0~3.6mg/L; For sensitive species, when oil concentration is lower than 0.1mg/L, it will hamper the speed and growth of cell split.

9.3.4 Impact to zooplankton

Acute poisoning fatal concentration range of petroleum for zooplankton is usually 0.1~15mg/L, through tests of copepod larva in different petroleum concentration environment, it shows that sensitivity of permanent (lifetime) zooplankton larva is larger than stage (temporary) benthos larva, and their sensitivity of larva is larger than adult.

In summary, once oil spillage accident occurs in the waterway of reservoir area, pollution factors petroleum and methanol will generate acute poisoning to fishes in the waterway, the accumulation and residue in the fish body will generate greater negative effect to the fish mutagenicity, as well as certain effect to phytoplankton and animals; hence, risks protective measure and accident emergency response plan must be strictly implemented.

9.4 Environmental risk analysis of dam safety

9.4.1 Flood dam overtopping

According to statistical records, about 1/3 of the dam accidents in China and of the world are caused by dam flood overflowing that is closely related to the design standard for flood control of the dam. According to the existing flood design standard, the analysis of the dam safety shows that, from the hydrological point of view, the theoretical rate of dam flood overflowing is by far higher than the actual rate of accidents. This indicates that the dam normally has certain potential capacity for flood control that results mainly from the following two aspects. The first one is the impacts of the uncertainties of the random hydrological and hydraulic features, which makes the designer leave some safety margins when making decision of the flood control computation, designing scales of flood discharging structure and elevation of dam top etc. The second one is due to impacts of the vague uncertainties of project construction and management that lead to the fuzzification of the critical limit values for dam failure of flood overflowing. Normally, when the flood water level is slightly above the dam top, accidents will not occur.

Shihutang navigation and power junction project belongs to Grade II large (II) type hydropower project. The normal water storage level of the project is 56.50m with a total reservoir capacity about 632,000,000m3, permanent water retaining and water release
structures of the junction project is designed in accordance with return period of flood once every 50 years, examination of return period of flood adopts 300 years; as a part of water retaining structures, the design and examination of flood standard of workshop and ship lock should be the same with water retaining structures; Energy dissipation and protective works of water release structures in the downstream will be designed according to return period of flood of once every 30 years. Main structures of the project, such as flood discharge flushing sluice, water retaining section of ship lock, workshop and earth rockfill dam of joint of left and right banks, will be designed according to Class III structures, secondary structures will be designed according to Class IV structures and temporary structures Class V, so as to satisfy the requirements of the design specifications, which can guarantee the safety of dam once every 300 years with relative maximum overflow discharge 4700m³/s, without risks of overtopping and collapse of dam. Since Wan’An power station in the upper reaches has peaking capability, no dam overtopping and collapse risks will happen even if flood once every 300 years through the peaking regulation of Wan’An power station.

Flood regulation operating method of Shihutang navigation and power junction project will adopt upstream incoming water flow rate to indicate flood regulation operating method. The detailed flood regulation operating method is: when flow rate of upstream Dongbei station is larger than switch off critical flow rate (4330m³/s, corresponding flow rate of Shihutang dam site 4700m³/s) and outlet flow rate of Guanyuanshui is larger than switch off critical flow rate (70.0m³/s) and flood still has rising tendency, or flow rate of Dongbei station is less than switch off critical flow rate but outlet flow rate of Guanyuanshui is larger than switch off critical flow rate and flood still has rising tendency, Shihutang junction flood gate and flood control regulating sluice of outlet flow rate of Guanyuanshui will all be open (at this time, flood control regulating sluice of guide discharge channel of Guanyuanshui will be closed) to release flood, and the river way keeps basically natural state. The water retaining height of the project is 9.6m, maximum height of concrete dam is only 26.5m, which belongs to low head structures. The water level difference of upper reaches and lower reaches is less than 0.5m under the flood water regime, which is near natural; in case of project accident, the loss caused to the lower reaches will be smaller.

The project design has established water regime automatic forecasting system, and arranged 19 water and rain regime report station and point, which can ensure the safety and economic operation of Shihutang navigation and power junction project. Protection area works will be used safely under the design flood standard condition, thus, dam collapse due to flood can be controlled effectively.

9.4.2 Sediment accumulation invades flood control reservoir capacity

The second risk of flood overtopping comes from sediment accumulation invading into the flood control reservoir capacity. Bottom elevation of flood gate of Shihutang navigation and power junction project is 47.0m, which is very low, almost the same level with the original river bed, the project flood gate is favorable for sand discharge. In addition, the regulation operating method of junction project adopts upstream coming water volume to indicate the open degree of flood gate; when the dam coming water volume exceeding after flood once
every 2 years, all flood gates should be opened for flood releasing and sediment-flushing. Sand content of Gan River is small with fine granule, Mean annual sediment load of Shihutang dam site is 428×10^4t. Considering from the project general layout and operating regulation method, as well as the reservoir type, water current form is smaller than natural situation, especially in flood season with larger incoming sediment. Since the discharge capacity of flood gate is large and all are opened for flood releasing that doesn’t change the water current formation and hydraulic element; moreover, the sand granule of the river is smaller, mud and sand are difficult to deposit at the end of reservoir, and most coming sand from the upstream dam site can be discharged from the reservoir with water current. However, Shihutang reservoir backwater is comparatively long, transported sediment is difficult to move to in front of dam, mud and sand that move to the dam front will be brought to the dam below due to low bottom elevation of flood gate of junction project that is favorable for sediment releasing. Hence, sediment accumulation in Shihutang reservoir is expected to become a small scale delta mud accumulation, sediment accumulation of reservoir end and dam front is less. Mud accumulation in Shihutang reservoir has smaller operating impact to water surface line of reservoir area and the project, which will not affect apparently the flood control reservoir capacity.

9.4.3 Stability of reservoir bank affects flood control capacity

Reservoir area banks of Gan River Shihutang Navigation and Power Junction Project are mainly river alluvial plain landform, hill landform is distributed as well. Total length of bank slope of reservoir bank is about 109.55km (including branch river Shushui River bank), according to geological disaster development degree, the bank slope of reservoir bank can be divided into three levels, namely better stability, middle stability and instability. Total length of nature bank slope with better stability is about 46km. Total length of nature bank slope with middle stability is about 40km. Total length of nature reservoir bank with instability is about 24km, the bank slope is mainly distributed in dam site of east bank of Jiangjiazhou of Gan River—Huwei, Weijia in east bank of reservoir end of Gan River and Shushui River enters into two banks of Gan River section. Bank slope is formed by Quaternary System unyoke alluvial layer, lithology has obvious dualistic structure, the upper part of which is formed by clay, clayey soil, clayey loam, usually thickness 1—4m, terrace structure is loose, the lower part of which is formed by conglomeratic sand soil, ovum gravel, usually thickness 2—3m, natural rocky ledge may generate collapse in flood season every year due to no management, now most landslide debris are flushed away by water current, there is small amount of residual, which has small impact to the project and no apparent flood control reservoir capacity. Anterior border around the reservoir exist small scale bank failure phenomenon; design of protective works of reservoir area in the project design has adopted corresponding protection measures, which can effectively control unfavorable geological phenomenon, such as collapse, landslide.

According to buried depth of ground water level and relative immersion standard of backwater height of water storage provided by geological specialty, in addition to inundation area (field lift treatment in Mashi immersion area), sections that may be affected by immersion in the reservoir area are all in protection areas of reservoir area. In the protective
works design of protection areas, heighten, fasten and build new protection embankment has formed basically closed protection circle; vertical anti seepage treatment has been carried out for permeable layer of binary embankment foundation of protection embankment; drainage ditch system in the flat ground of the area has been renovated and dredged, drainage pumping station and drainage culvert and sluice are established in the inland inundation and subsurface drainage outlets; It guides the slope coming water in the area. Hence, immersion problem in protection areas have been solved basically.

Through summarizing the examples of reservoir accidents caused by flood, it is known that:

(1) Flood may cause danger to the dam;
(2) In existing reservoirs, the probability of dam accidents caused by flood will be several in a ten thousand;
(3) There are two kinds of accidents of dam: dam overflowing and dam breaking. The former has less risky strength while the latter has extremely strong risk strength.
(4) Dam type is closely related to the probability of flood risk. When the dam encounters over-limit flood, the concrete gravity dam will only have overflowing.

9.4.4 Construction quality

Construction quality cannot be ignored among the factors that may cause dam breaking. In recent years, accidents that were caused by construction quality can be found frequently. Such risk can be avoided through enhancement of construction management.

9.4.5 Analysis of reservoir induced earthquake

The seismic peak ground acceleration of reservoir area is lower than 0.05g, and relative earthquake basic intensity is lower than Grade Ⅳ degree. In the recent years there is no active geological fault, and no geological structure background to form violent earthquake, the area is structure relative stable area. The reservoir area is located in the south central Ji-Tai basin, and the basin stratum is mainly made up with cretaceous redbed with usually weak perviousness. The faulted structure is mainly the consortium break and small scale basin back break lying concealed in cretaceous stratum, there is no permeating channels to deeper part for reservoir water. After building up and operation of reservoir, the uplift water head is not high, and the earth stress changes moderately, and the possibility of reservoir induced earthquake is minor. It is observed that the dam collapse risk of reservoir caused by earthquake is minor.

In summary of the examples of dam failure caused by earthquake, it is known that:

(1). As for the dam failure caused by earthquake, whatever in the total numbers of dams or in the number of failures, the probability tends to be lower that is by far lower than that caused by flood.
(2). In addition to the structural earthquake that may cause dam failure, the earthquake caused by reservoir may also cause dangers to the dam. The probability of the dam failure caused by reservoir-induced earthquake accounts for about one third of the total dam failures.

(3). The consequences of dam failure are cracks and damage to facilities that will affect the normal dam operation. Up to now, there is not any report in this regard, of which, the losses will be much less than dam overflowing and dam breaking.

(4). Concrete gravity dam is better than other type of dam. Its anti seismic capacity is better than that of other kinds of dams.

9.5 Other environmental risk impact analysis

- Construction blasting risks
  During the project construction process, blasting will be carried out for bedrock in the foundation pit after the formation of coffer wall. Impact of construction blasting to the environment of land area is limited, which will not generate impact to aquatic biology.

- Storage and transportation risk of dangerous articles during the construction period
  Certain environmental risk during the transportation and storage process exists due to combustible and explosion hazard in the construction period

- Population health risks
  During construction period, due to inferior sanitary conditions, outside people frequently come and go. Construction team people are relatively concentrated showing high population density. Such will bring and spread some diseases.

9.6 Risk acceptance analysis

Shihutang navigation and power junction project is comprehensive utilization shipping and water conservancy junction project that takes shipping as main and generates electricity and flood control at the same time. It belongs to a traffic transport project, hence, its risk evaluation is different from environmental risk assessment for production, utilization, storage and transportation projects of poisonous and harmful and combustible and explosive substances.

The project environmental risk is divided mainly environmental risk of dam safety and environmental risk of waterway operation.

Main structures of the project junction follows the design standard that can guarantee dam safety of no risks of dam overtopping and dam breach even if flood once every 300 years; however, it has flood dam breach risks only when hydrological risks of coming water from upper reaches exceeding once every 300 years, since Wan’an power station in the upper reaches has peak regulation capacity, in case of flood once every 300 years, no risks of dam overtopping and dam breach will happen through peak regulation and joint peak regulation of Wan’an power station. The project water retaining height 9.6m, which belongs to low head structures, it has small loss impact to the lower reaches in case of project accident. The project design has set up water regime automatic forecasting system, which can ensure the safety and
economic operation of Shihutang navigation and power junction project, protection area works will be used safely under designed flood standard conditions, and dam breach risks due to flood can be controlled effectively. Sediment accumulation in the reservoir has small impact to the water surface profile of reservoir area and project operation, which will not apparently affect flood control storage capacity. Possibility of earthquake induced by reservoir is small; it is observed that reservoir dam breach risk caused by earthquake is small.

According to project design forecast, dam-cross transportation quantity in 2020 will be 8.43 million tons, among which, 80.4% of them are coal, mine construction materials, farming, forestry, animal husbandry and fishery products; oil product transportation ratio is about 5.9%; Dam-cross transportation quantity in 2030 will be 13.33 million tons, 81.8% of them are coal, mine construction materials, farming, forestry, animal husbandry and fishery products, and oil product transportation ratio is about 5.3%. at present, there is almost no real wharf in the reservoir area, according to Jiangxi Province Inland Navigation Development Plan, Jiangxi Province inland ports are planned in accordance with their scales: main port, regional key port, common port is divided into three layers, Taihe County is positioned as common port without large scale port and wharf development plan. Maximum risk probability of ship oil spillage accident in the waterway of reservoir area during the operation period is once every 33 years ~12.5 years.

According to analogy analysis of similar project, value at risk of maximum confident accident Rmax of the project is less than maximum acceptable level Rl in the same industry, hence, the construction risk level of the project is acceptable.

9.7 Risk protective measures and emergency plan

9.7.1 Protective measures of shipping risks and emergency response plan

9.7.1.1 Emergency response plan for regional accident risk

For sudden waterway environment pollution accident, emergency response plan for regional marine accident risk should be set and set up permanent regional accident risk emergency reaction center. Once a sudden marine accident occurs, it can carry out timely, fast, accurate and effective treatment, and reduce to the maximum extent damage of life, property and environment caused by pollution accident.

A perfect regional accident risk control management system has been set up by the Ji’An City government and relevant functional departments, as well as a permanent accident risk emergency reaction center. Once risk accident occurs, accident emergency measures can be adopted. Following is the main contents of Ji’An City Emergency Response Plan for Handling Marine Sudden Event JiFuBanZi [2006] No.83 (April 12, 2006) issued by Ji’An City government:

- Emergency response system and main responsibilities

Ji’An City Handling Marine Sudden Event Emergency Response Headquarters is the
command organ to handle marine sudden event emergency response work and guide marine sudden event emergency treatment work of the city.

 Main responsibilities of city emergency response headquarters:

 Implement the decision and instruction of City Emergency Response Command Office.

 Organize uniformly and command serious, major and greater marine sudden event emergency treatment, decide to set up on-the-spot command, out forward suggestion to the City Emergency Response Command Office to terminate the emergency status.

 Research and decide major decision and work opinion on marine sudden event emergency work of the city.

 Guide the rescue work of the city marine sudden event emergency.

 Member of City Emergency Response Headquarters:

 Commander in chief: deputy mayor of the city government in charge of marine traffic safety

 Deputy commander in chief: director of bureau of communications, director of local marine department, deputy secretary general of city government, public safety department, and principal of city administration of work safety.

 Member: city government office, city communications bureau, city public safety department, city work safety supervision management bureau, city agriculture bureau, city health bureau, city tourist bureau, city bureau of civil affairs, city finance bureau, city bureau of water resource, city bureau of state land and resources, city environmental protection bureau, city meteorological bureau, city fire control branch, relative principal of city local marine department.

 Standing body

 City emergency response headquarters has set up office and established Ji’An City marine search and rescue center under the city local marine department, as the working organ of city emergency response headquarters, which is responsible for the daily work of city emergency response headquarters, and undertakes marine search and rescue operating management.

 Director of city marine search and rescue center: deputy director in charge of city communications bureau; Deputy Director of city marine search and rescue center: section chief of city local marine department, section chief of city port navigation department.

 Main responsibility of Ji’An City marine search and rescue center:

 Implement the decision and instruction of city emergency response headquarters.

 Establish relative regulations of city level marine rescue work, compile the budget of city level marine search and rescue.

 Be responsible for the draft, operation and management of city level marine sudden event emergency response plan.
- Decide the responsible region of city marine search and rescue organ, and carry out business guidance.

- Sign interlocal marine search and rescue agreement with neighboring cities, establish emergency cooperation and linkage organism.

- Undertake the emergency on duty of city marine search and rescue, be responsible for the comprehensive coordination and relative organization management work of city marine search and rescue work.

- Undertake the city marine oil pollution emergency and reception and liaison work of marine security alarm.

- Organize the city marine search and rescue emergency drill and emergency exercise.

- Organize the training and marine safety knowledge propaganda of safety, specialty knowledge, new technology application of the city marine search and rescue personnel.

- On-the-spot command

After serious, major and greater marine sudden event happen, city emergency response headquarters will establish on-the-spot command in the accident place if necessary. Main leader of the local county (city, district) government will be the commander in chief, or designate by provincial or city emergency response headquarters; According to sudden event situation, members of on-the-spot command will be organized by leaders of relative departments, units and local town government of county (city, district). On-the-spot command will set some special groups in accordance with necessity, see figure 9.7-1 for details.

- Emergency response organization organ

See figure 9.7-2 for detailed organization structure of emergency response system, see figure 9.7-3 for detailed work flow of emergency response system.
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现场指挥部
水上搜救抢险组
水上交通警戒保卫
综合协调组
医疗救护组
后勤保障组
善后处理组
On-the-spot command
Marine search and rescue group
Marine traffic alert safeguard
Comprehensive coordination group
Medical assistance group
Logistics support group
Aftermath handling group

进一步核查
信息不详
其他信息来源
市水上搜救中心对遇险信息进行分析
误报警
险情排除
进一步核查
信
息不详
其他信息来源
市水上搜救中心对遇险信息进行分析
误报警
险情排除

是否在本责任区
是
否
按规定上报事故并报告水上突发事件应急反映动态
通知相应责任区应急指挥机构

先期处置
（事发地人民政府和有关单位）

A

特大或重大、较大突发公共事件发生报警
进一步核查
信息不详
其他信息来源
市水上搜救中心对遇险信息进行分析
误报警
险情排除

Serious or major, greater sudden public incident alarm
Further examination
No detailed information
Other information sources
City marine search and rescue center make analysis on distress message
False alarm
Dangerous situation elimination
<table>
<thead>
<tr>
<th>险情确认</th>
<th>Dangerous situation confirmation</th>
</tr>
</thead>
<tbody>
<tr>
<td>是否在本责任区</td>
<td>Whether in the responsible district</td>
</tr>
<tr>
<td>是</td>
<td>Yes</td>
</tr>
<tr>
<td>否</td>
<td>No</td>
</tr>
<tr>
<td>按规定上报事故并报告水上突发事件应急反应动态</td>
<td>Report the accident and report dynamic marine sudden event emergency according to regulations</td>
</tr>
<tr>
<td>通知相应责任区应急指挥机构</td>
<td>Notice emergency command organ in the corresponding responsible district</td>
</tr>
<tr>
<td>先期处置（事发地人民政府和有关单位）</td>
<td>Advanced treatment (local government and relative units)</td>
</tr>
</tbody>
</table>
Figure 9.7—3  Work flow of emergency response system

启动应急预案（市应急委员会批准）

应急响应（事发地县、市、区人民政府为主）

应急救援行动

应急救援结果评估

人员已获救或无生还可能

现场清理

解除警戒

善后处置（事发地县、市、区人民政府和市政府有关部门）

搜救效果和应急管理总结（市应急委员会或市政府有关部门会同事发地县、市、区人民政府）

恢复重建（事发地县、市、区人民政府和市政府有关部门）

应急队伍保障

应急装备保障

应急技术保障

启动应急预案

调动应急力量

建立应急通信

启动专家系统

指定现场指挥

人员救助

险情控制

医疗救助

现场监测

人员到

启动

应急

响应

应急救援

应急救援结果评估
9.0 Environmental Risk Analysis

指挥人员到位

建立应急通信

启动专家系统

指定现场指挥

应急响应（事发地县、市、区人民政府为主）

应急队伍保障

应急装备保障

应急技术保障

人员救助

险情控制

医疗救助

现场监测

应急救援行动

发生污染事故启动污染应急预案

调整应急救援计划

应急救援结果评估

人员已获救或无生还可能
9.0 Environmental Risk Analysis

应急结束（市应急委员会批准）

现场清理
解除警戒
善后处置（事发地事发地县、市、区人民政府和市政府有关部门）

搜救效果和应急经验总结（市应急委员会或市政府有关部门会同事发地县、市、区人民政府）

恢复重建（事发地事发地县、市、区人民政府和市政府有关部门）

建立档案
Figure 9.7-2  Organization structure of emergency response system
<table>
<thead>
<tr>
<th>Chinese</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>市应急委员会</td>
<td>City Emergency Response Committee</td>
</tr>
<tr>
<td>市应急指挥部</td>
<td>City Emergency Response Headquarters</td>
</tr>
<tr>
<td>市应急指挥部各成员单位</td>
<td>Members of City Emergency Response Headquarters</td>
</tr>
<tr>
<td>现场指挥部</td>
<td>On-the-spot command</td>
</tr>
<tr>
<td>专家组</td>
<td>Expert group</td>
</tr>
<tr>
<td>县（市、区）应急指挥部</td>
<td>County (City, District) Emergency Response Headquarters</td>
</tr>
<tr>
<td>市水上搜救中心</td>
<td>City marine search and rescue center</td>
</tr>
<tr>
<td>乡（镇）应急指挥部</td>
<td>Township Emergency Response Headquarters</td>
</tr>
<tr>
<td>县（市、区）应急指挥部办公室</td>
<td>County (City, District) Emergency Response Command Office</td>
</tr>
<tr>
<td>乡（镇）应急指挥部办公室</td>
<td>Township Emergency Response Command Office</td>
</tr>
<tr>
<td>水上应急救援力量</td>
<td>Marine emergency rescue assistance force</td>
</tr>
<tr>
<td>海事专业力量</td>
<td>Marine professional force</td>
</tr>
<tr>
<td>消防专业力量</td>
<td>Fire control professional force</td>
</tr>
<tr>
<td>军队专业力量</td>
<td>Military professional force</td>
</tr>
<tr>
<td>政府公务力量</td>
<td>Government public affairs force</td>
</tr>
<tr>
<td>其他社会力量</td>
<td>Other social force</td>
</tr>
</tbody>
</table>
Emergency response procedure

Members of city emergency response headquarters should establish perfect monitoring organs, analyze comprehensively possible early warning information of serious, major and greater marine sudden event and report relative information to city emergency linkage center and city marine search and rescue center.

Relative units, ships and personnel engaged in marine activities should pay attention to receive early warning signal, adopt corresponding protective measures according to different early warning grade, so as to prevent damage of marine sudden event to life, property and environment.

City emergency response headquarters and member units should do well relative preparation work in accordance with early warning information and their responsibilities. Marine professional emergency teams at all levels should enter into armed state and preparation for emergency rescue assistances.

After marine sudden event occurs, person in danger or eyewitness near the site should report immediately to the local marine management department or public security, fire control departments, ship in danger should simultaneously report to the aforesaid units. The public security, fire control and ship departments should inform in time the local marine sudden event emergency command organ or marine management organ as soon as receiving the report. After marine sudden event emergency command organ or marine management organ receiving the report, through examination, should immediately ask for instructions of standing deputy commander in chief and inform local marine office (team) and ship management pointing in the local accident section both upper reaches and lower reaches to implement traffic control for the upstream and downstream ships for ships with dangerous articles that have combustion, explosion, leakage, pollution accident that may endanger the normal shipping of other ships, endanger units and residents safety. Start emergency response plan to implement traffic control in the entire navigation district in necessary.

Emergency treatment for pollution accident

Carry out rescue assistance for accident wounded

Judge the accident nature, the professional personnel should guide the ship to start self help according to the ship oil spillage contingency plan, and evacuate the persons on the spot in case of combustion or explosion dangers

According to the site situation, organize people to evacuate from the accident water area or other ships entering into safety water area

Pollution oil fence control recovery team should use existing emergency materials, and carry out fence control and recover the leakage oil product
9.0 Environmental Risk Analysis

- Escort the leakage ship in time to designated wharf, unload hazardous goods and organize relative ships to carry out overside transport for ships that cannot sail by itself or dangerous articles ship with heavy load.
- Organize personnel and equipment to eliminate pollution
- Alarm method

See Table 9.7—1 for detailed common alarm, report and notice telephone

The following contents should be included when reporting marine dangerous message:

- Accident time, place, dangerous situation, ship in danger; name, category, contact method and etc of aircraft or person in distress
- Person that gave alarm should provide as possible the following information:
  - Main size, owner, agent, operator and carrier of ship or aircraft
  - Quantity and casualty situation of person in danger
  - Freight situation, especially hazardous goods, name, category and quantity of cargo
  - Direct accident cause, adopted measures, rescue assistant requirements
  - Weather, hydrological information of accident site Including wind power, wind direction, velocity of wave, wave height and etc

<table>
<thead>
<tr>
<th>Unit</th>
<th>Telephone on duty</th>
<th>Fax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special telephone for marine search and rescue</td>
<td>District number +12395</td>
<td></td>
</tr>
<tr>
<td>China maritime search and rescue center</td>
<td>010-65292218</td>
<td>010-65292245</td>
</tr>
<tr>
<td>China Maritime Search and Rescue Centre of Ministry of Communications</td>
<td>010-65292218</td>
<td>010-65292245</td>
</tr>
<tr>
<td>City marine search and rescue center</td>
<td>0796-8223140 working date</td>
<td></td>
</tr>
<tr>
<td>City marine search and rescue center</td>
<td>8224639 8238458(city local marine department) holidays, evening</td>
<td></td>
</tr>
<tr>
<td>Public security</td>
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<td></td>
</tr>
<tr>
<td>Fire control</td>
<td>119</td>
<td></td>
</tr>
<tr>
<td>Ji’An city environment protection bureau</td>
<td>0796-8230629</td>
<td></td>
</tr>
</tbody>
</table>

9.7.1.2 Protective measures for project shipping accident

The construction period of the project junction will generate impact to the shipping in river
section of the project, in order to prevent shipping accident risk, necessary protective measures should be adopted.

Shipping flow of approach channel of ship lock during the project operation period is larger, in order to prevent shipping accident risk when ships passing through the ship lock and approach channel, necessary protective measures should be adopted.

See Table 9.7-2 for detailed protective measures for ship accident risk during the project construction period and operation period.

At present, Ji’An City marine emergency equipments mare mainly 26 ships of Ji’An City local marine department, including 2 maritime affairs ships of Taihe County, 4 beacon vessels. Considering ship flow in reservoir area during the project operation period will increase greatly, we suggest relevant department to increase marine emergency equipments of relative department in the project site, so as to reduce the loss of probability of sudden accident and accident pollution. In addition, we suggest perfecting the regional salvage rescue assistance mechanism. Along with the improvement of shipping conditions and growth of transportation ships, salvage rescue assistance organ and supporting equipments should be perfected, so as to provide effective rescue assistance treatment in case of accident.
Table 9.7—2 Protective measures adopted for ship accident risk of the project

<table>
<thead>
<tr>
<th>Time interval</th>
<th>Protective measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction period</td>
<td>Port navigation safety supervision will be implemented during the construction period of the project junction in order to prevent ship accident risk.</td>
</tr>
<tr>
<td></td>
<td>6 beacon lights will be set to prevent ship accident risk</td>
</tr>
<tr>
<td></td>
<td>12 sign boards will be set for 3 water intakes of drinking water and water-source reserves, prompt passing ships to protect water sources remind passing ships to strengthen safety consciousness prohibit ships to anchor in these areas prohibit ships to discharge all pollutants in this water area.</td>
</tr>
<tr>
<td></td>
<td>Set 10 travel assistance mark plates, warm passing ships to pay attention to strengthen safety consciousness dial immediately emergency call to inform accident emergency organization in case of accident</td>
</tr>
<tr>
<td></td>
<td>☐ Spillover intercepting equipment: accessory equipments, such as oil fence 800m □, buoy, anchor, anchor rope and etc.</td>
</tr>
<tr>
<td></td>
<td>☐ Spillover recovery equipment: oil absorption felt 2t □, blotter 1 set □.</td>
</tr>
<tr>
<td></td>
<td>☐ Working ship: can carry out oil fence laying, recover spillover operation marine working ship 1 ship □.</td>
</tr>
</tbody>
</table>

9.7.2 Protective measure of dam risks and emergency response plan

To assure the safety of the dam, the Project Office has set Dam Safety Team that is responsible for framing work outlines of Dam Safety Team, preparing the dam safety report (including construction supervision and quality assurance plan, observation apparatus plan, operation and maintenance plan and emergency preparation plan).

9.7.2.1 Protective measure of dam risks

☐ According to possible hydrological risks, flood observation and prediction work should be strengthened. Considering risks of sediment accumulation breaking into reservoir storage capacity, since expectable risk mainly comes from soil erosion; hence, strengthen soil erosion monitoring in the reservoir rain collection range in order to regulate existing soil erosion area and stop generating new soil erosion. In order to master water (rain) regime in the upper reaches above Shihutang dam site and reach timely and accurately flood control command center at all levels, especially to pay attention to flood exceeding the safety design standard, provide scientific basis for the safety operation of dam, and get more time to resist flood exceeding the standard, the project design has set up water (rain) regime automatic forecasting system.

The project has arranged 19 water and rain regime report station and point, including Shihutang dam below, Dongbei and Kinkeng are hydrological stations, namely survey water level, rainfall amount, flow rate and mud and sand. Shihutang dam set a water level report station, the rest 15 stations and points are rainfall stations. See Table 9.7—3 and 9.7—4 for details. Adopt ultrashort wave report communication network. Adopt public data network for the communication between Shihutang to Wan’An Hydraulic Power Plant and Shihutang to Ji’An.
- Carry out reservoir bank stability monitoring during the project operation period
- Carry out soil erosion monitoring during the project construction period and operation period.

(4) Aiming to the risk of construction quality, it is necessary to undertake legal effective control over the construction, renew the consciousness of quality of the contractor and construction team workers, so as to avoid possible dam breaking caused by construction quality.

<table>
<thead>
<tr>
<th>No.</th>
<th>Water regime report ultrashort wave network</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Central station</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Sub-center station</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Rainfall station</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>Water level station</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Hydrological station</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Relay station</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>
Table 9.7—4 Project water regime automatic forecasting system station arrangement

<table>
<thead>
<tr>
<th>No.</th>
<th>Station name</th>
<th>Station nature</th>
<th>Observation point location</th>
<th>Observation item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shihutang dam below</td>
<td>Hydrological</td>
<td>Cangyuan Village of Wanhe Town of Taihe County</td>
<td>Water level, flow rate, mud and sand, rainfall</td>
</tr>
<tr>
<td>2</td>
<td>Shihutang dam upper</td>
<td>Water level</td>
<td>Shihutang dam upper</td>
<td>Water level</td>
</tr>
<tr>
<td>3</td>
<td>Dongbei</td>
<td>Hydrological</td>
<td>Dongbei Village of Baijia Town of Wan’an County</td>
<td>Water level, flow rate, mud and sand, rainfall</td>
</tr>
<tr>
<td>4</td>
<td>Linkeng</td>
<td>Hydrological</td>
<td>Linkeng Village of Gaopo Town of Wan’an County</td>
<td>Water level, flow rate, mud and sand, rainfall</td>
</tr>
<tr>
<td>5</td>
<td>Yangmeikou</td>
<td>Rainfall</td>
<td>Yangmeikou Village of Jiantou Town of Wan’an County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>6</td>
<td>Xingzhou</td>
<td>Rainfall</td>
<td>Lizhou Village of Huang’ao Town of Jinggangshan</td>
<td>Rainfall</td>
</tr>
<tr>
<td>7</td>
<td>Wudoujiang</td>
<td>Rainfall</td>
<td>Baishi village of Wudoujiang town of Suichuan county</td>
<td>Rainfall</td>
</tr>
<tr>
<td>8</td>
<td>Che’ao</td>
<td>Rainfall</td>
<td>Che’ao Village of Wudoujiang Town of Suichuan County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>9</td>
<td>Xinjiang</td>
<td>Rainfall</td>
<td>Xinjiang Village of Xinjiang Town of Suichuan County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>10</td>
<td>Wanzhou</td>
<td>Rainfall</td>
<td>Wanzhou Village of Shuangqiao Town of Suichuan County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>11</td>
<td>Baitujie</td>
<td>Rainfall</td>
<td>Qishan Village of Suxi Town of Taihe County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>12</td>
<td>Taihe</td>
<td>Rainfall</td>
<td>Shangtian Village of Shangtian Town of Taihe County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>13</td>
<td>Longtankou</td>
<td>Rainfall</td>
<td>Longtankou Village of Chongxian Town of Xingguo County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>14</td>
<td>Laoyingpan</td>
<td>Rainfall</td>
<td>Shangpi Village of Shangpi Town of Taihe County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>15</td>
<td>Guanchao</td>
<td>Rainfall</td>
<td>Guanchao Village of Guanchao Town of Taihe County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>16</td>
<td>Longxia</td>
<td>Rainfall</td>
<td>Longxia Village of Zhonglong Town of Taihe County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>17</td>
<td>Wanxi</td>
<td>Rainfall</td>
<td>Wanxi Village of Wanxi Town of Taihe County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>18</td>
<td>Shangjiang</td>
<td>Rainfall</td>
<td>Shangjiang Village of Guanxi Town of Taihe County</td>
<td>Rainfall</td>
</tr>
<tr>
<td>19</td>
<td>Yuanqian</td>
<td>Rainfall</td>
<td>Meishan Village of Yuanqian Town of Taihe County</td>
<td>Rainfall</td>
</tr>
</tbody>
</table>

(5) According to the conclusion of geological assessment, even though the possibility of earthquake in this district is very less, due to the consequences of dam breaking, it is required to enhance communication with local earthquake station and the earthquake monitoring.

- Organize dam safety monitoring group

Dam safety group is the important guarantee to implement protective measure of dam risks.
Responsibility of dam safety group

To supervise and inspect relevant issues in connection with the project construction, including the overall arrangement of the main structures of the Shihutang dam, hydro-power station, water gate and reservoir area protection, accuracy of the engineering geological prospecting results, correctness of the analysis of the hydraulic model test, dam foundation design, stability of the natural and cutting slopes, engineering technology and methods for foundation construction, rationality of investment budget and geological issues etc.

The group will inspect the degree of influence on the project by the key fracture layer and geological fault within the range of the dam site. It also inspects the influence of weak ground on the dam body as well as the reliability and rationality of the treatment measures.

(2) The group will inspect concerned design basis, use of parameters and result of computation for the structures of the dam in different stages (including the body structures). It will also inspect the rationality of the designed water level, hydraulic design and check water level, thus to ensure the safety requirement for water blocking. The group will independently compute and inspect the reliability of the relative materials in connection with sudden rainfall and flow volume caused by different frequencies, as well as the treatment schemes for dam water blocking and leakage prevention.

(3) The group will inspect concerned issues in connection with the analysis of silt sediment, correctness of computed results of incoming silt sediment and the reservoir operating methods. It will inspect the influences on the lower navigating channels and water works by the short-term sediment and long-term reservoir systematic scouring.

(4) The group will inspect concerned technical documents in connection with the bidding for the main works of the project, as well as inspect the equipment selection of the project.

(5) The group will inspect the construction management plan, time schedule, progress plan, establishment of project construction management and the personnel scheduling etc.

(6) The group will inspect the applicable standards and structural types for diversion of the reservoir, as well as inspect the feasibility and effectiveness of the flood control schemes in construction period, protective measures and emergency measures.

(7) The group will inspect the feasibility and effectiveness of the supervisor’s management plans, enforcement regulations, quality control ensuring system, supervising means and measures etc. for the facilities and main works of the reservoir. It will also assist and oversee the supervisor to fulfill its obligations as well as control quality, progress and project investment costs etc.

(8) The group will provide with improving suggestions for the special works of the project, such as land requisition and environmental protection, so as to minimize the negative impacts
and gain greater achievement.

(9) The group will inspect the results of hydraulic computation under various flows, including the operational schemes in the dam's initial stage, the schemes of flood control and the schemes of flood discharge, so as to ensure the safety of the dam.

(10) Others: the group will inspect other issues that are in connection with the safety of the Pivot.

☐ The Dam Safety Group is the important factor to assure the implementation of the risk preventive measures for the dam.

As for this project, the Project Office shall establish the Dam Safety Group according to the requirement of the World Bank, whose main tasks are to provide with safety evaluation and technical consultation for the whole process of construction of the project from design, bidding, construction to the dam’s initial operation. During the period of project construction, the group, according to the requirement of the project, will mobilize more experts, including experts in geology, seismology, reservoir sedimentology, concrete construction technology, environmental protection and reservoir land requisition and removal, to provide with technical consultation and temporary assistance to the project construction.

9.7.2.2 Dam risks emergency plan

The risk of dam breaking is little which would also be easily ignored. In order to avoid being in horror during dam breaking, there should be a set of emergency plans for dam breaking. As for the places in lower reaches, dam breaking of reservoir means the breakout of over-limit flood. However, the situation of dam breaking is quite different from the normal over-limit flood. As for dam breaking, due to high dam and large storage, the draining volume is extraordinary big but lasts for short time. Therefore, the emergency plans for dam breaking have included into the existing regional flood control plans.

9.7.3 Protective measures for other environmental risks

9.7.3.1 Protective measure for aquatic ecology risks in the construction blasting

☐ Blasting operation in construction should avoid fishes mating season in April – July of the river section as possible.

☐ Blasting will adopts millisecond electric detonator elementary error squeeze blasting, and shorten the blasting impact range as possible.

9.7.3.2 Protective measure for dangerous articles storage and transportation risk during the construction period

☐ Regulations of hazardous goods transportation should be followed strictly during the transportation process, mixed loading of dynamite and detonator in transportation is not allowed.
9.0 Environmental Risk Analysis

- Arrangement of explosive store and oil depot should satisfy the requirements of relative safety production specifications, and keep necessary safety distance from the residential point and construction camp.

- Management system for explosive store and oil depot must be strict, no smoking or naked flame, set lightning protection facilities, so as to avoid accident as possible.

9.7.3.3 Protective measures for population health risks

- Population health (epidemic situation) monitoring will be carried out during the project construction period and operation period.

- During the construction period, pay attention to improvement of hygiene conditions, avoid pollution to drinking water, implement strict disinfection on drinking water, strengthen living area hygiene, epidemic prevention management, and implement domestic wastewater, rubbish and manure treatment, so as to reduce or eliminate site of disease mosquito-borne breeding site as possible.
10.0 ENVIRONMENTAL PROTECTIVE MEASURES AND ECONOMIC AND TECHNICAL EVALUATION

10.1 Water Environmental Protective Measures

10.1.1 Construction period

10.1.1.1 Sandstone aggregate preparation system flushing wastewater treatment measures and economic and technical evaluation

☐ General situation of wastewater
A sandstone aggregate preparation system will be set at the right and left banks of the project junction area respectively. Average discharge amount of sandstone flushing wastewater is 120m³/h; peak value 240m³/h; SS discharge concentration 50000mg/L. main pollutants of sandstone flushing wastewater is SS, which has characteristics of large wastewater amount, high SS concentration, if it discharges directly without treatment, it will cause greater impact to the downstream water quality of project river reach during the flat and dry season.

☐ Treatment target
Suspended matter concentration of sandstone wastewater after treatment should be less than 70mg/L, so as to realize wastewater recycle utilization.

☐ Selection of treatment scheme

☐ Selection of wastewater treatment scheme
According to wastewater characteristics of sandstone material processing system, we plan 2 schemes in order to carry out technical economy comparison.

Scheme I: adopt natural sedimentation method; see Figure 10.1-1 for treatment flow. Wastewater with high suspended matter flows from the screening building, enter into the sedimentation basin without using polycoagulant, carry out natural sedimentation in the sedimentation basin, and supernatant will be used circularly. The feature of this scheme is simple treatment flow, low requirement for technical capital construction technology, easy running operation and less operating expenses; however, in order to realize better treatment effect, which has a large sedimentation basin scale requirements, and it is difficult to meet the requirements of reclaimed water quality.
Figure 10.1—1 Process flow of natural sedimentation method

**Scheme II:** adopt coagulant sedimentation, see Figure 10.1—2 for treatment flow. Wastewater flows from screening building to remove coarse sand after primary sedimentation through desilting treatment unit, and then enter into the flocculating settling unit. Because of the adding of flocculant, suspended matter less than 0.035mm can be removed fast and effectively. The shortcoming is the increasing of equipment and operating expenses; Comparing with Scheme I, this scheme has a smaller land occupation with fine treatment technology effect, which can reclaim a large amount of fine sand.

Figure 10.2—2 Process flow of coagulant sedimentation

**Scheme II:** adopt coagulant sedimentation, see Figure 10.2—2 for treatment flow. Wastewater flows from screening building to remove coarse sand after primary sedimentation through desilting treatment unit, and then enter into the flocculating settling unit. Because of the adding of flocculant, suspended matter less than 0.035mm can be removed fast and effectively. The shortcoming is the increasing of equipment and operating expenses; Comparing with Scheme I, this scheme has a smaller land occupation with fine treatment technology effect, which can reclaim a large amount of fine sand.
<table>
<thead>
<tr>
<th>沉砂池</th>
<th>Desilting basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>加絮凝剂</td>
<td>Add flocculant</td>
</tr>
<tr>
<td>絮凝沉淀池</td>
<td>Flocculating settling basin</td>
</tr>
<tr>
<td>沉淀</td>
<td>Sedimentation</td>
</tr>
<tr>
<td>沉砂</td>
<td>Desilting</td>
</tr>
<tr>
<td>泥浆</td>
<td>Slurry</td>
</tr>
<tr>
<td>上清液回用</td>
<td>Supernatant</td>
</tr>
</tbody>
</table>

Considering from the maintenance management and operating expenses, Scheme I has greater advantages; As for treatment effect and land occupation, Scheme I has greater advantages. Most suspended matter in the sandstone aggregate processing wastewater of the project is inorganic grain, which has better sinking performance, but with very strict requirement for treatment target, under the situation of short of construction land use, Scheme I cannot satisfy apparently the requirements, hence we recommend Scheme II.

- Selection of treatment unit
- Desilting treatment unit

Scheme I: adopt combining method of sand settling basin and spiral sand-water separator. Flushing wastewater from screening building flow automatically into the sand settling basin, treatment water enters into the follow-up treatment unit, sand slime in the bottom of sand settling basin will be sent to spiral sand-water separator by pump to carry out mechanical dewatering, and water content after fine sand dewatering will be controlled around 30%, which can be reutilized. This method is the traditional coarse sand removing treatment method, while it has some problems during the practical operation, mainly spiral sand-water separator has poor grain sand-water separating effect less than 0.1mm, which increases the load of follow-up treatment unit, and increase slurry treatment amount and work volume.

Scheme II: adopt fine sand recovery processor. Pump provides high suspended matter wastewater to hydrocyclone, fine sand less than 0.035mm overfall through cyclone, water content of cyclone desilting through high power and efficiency dewater unit is about 20%, part of which can be recycled according to sandstone grading requirements. The device has been utilized widely in fine sand reclamation of sandstone processing plant both domestic and abroad, which has high economic benefit and environmental protection benefit.

Analysis from treatment effect, operation management, operating maintenance and project investment, as well as comprehensive analysis of environmental protection benefit, Scheme II has greater advantages than Scheme I. Scheme I can only guarantee the fine sand removal larger than 0.1mm; however, recovery of fine sand recovery processor for fine sand larger than 0.035mm can reach to 80%, which reduces to the maximum extent the follow-up sedimentation cleaning volume of work, and decrease greatly cleaning cost; sand settling basin of Scheme I is concrete placed in situ structure, which will be abandoned after the completion of the project; complete equipment of Scheme II is convenient for arrangement, which will not need to pour concrete base and can be reused in other project, it can save
investing cost of the Owner; in addition, Scheme II has higher automation degree, no special person is required for the operation management during the using process, and very convenient for operating maintenance.

Flocculating settling unit

Flocculating settling unit of sandstone processing wastewater treatment is planned primarily the following two alternative schemes:

Scheme I: it is planned to design two groups of rectangle filter tank for use in turn, in order to ensure the effluent water quality, add in flocculant before entering into the filter tank, water seepage from filter tank will be recycled, slurry on the filtering material will be dehydrated naturally through evaporation, filtering, insulation and etc by utilizing time interval, excavate with excavator and transport to the nearby slag yard. This scheme has less civil works volume, no mechanical equipment with low construction cost and better effluent water quality, however, since the slurry adopts natural dehydrating method with higher water content, large cleaning working volume and high expenses, as well as troublesome management.

Scheme II: water out from the desilting unit into advection flocculating sedimentation basin after reactive precipitation, slurry in the basin bottom will be sent to sludge dewatering machine house with traveling pump suction type mud sucker and transport outward to the nearby slag yard. This method has higher mechanization degree, which is simple for operating management and better effluent water quality, water content of slurry after pressure filtration dehydration is about 30%, slurry moulding, slurry amount decrease, which is convenient for transport and reduce greatly transport expenses. However, it has machine maintenance problem with comparatively larger floor area.

On the basis of better effluent water quality, looking from investing expense, primary investment of Scheme I is less, while the filtering material and cleaning expenses during the operation process are higher, considering comprehensibly the two schemes are basically the same; as for maintenance and management in the operation, soil discharging of Scheme I is not mechanical automation operation, which has large management volume of work, and management and maintenance for filtering material cleaning and desilting are complex. Considering reliability and practical management level of construction of hydraulic power plant, practical Scheme II is recommended, and especially to strengthen clear and transport of sludge and mechanical overhaul.

Recommended scheme design

Technological design

See Figure 10.1 for wastewater treatment process of sandstone aggregate preparation system. Wastewater of sandstone processing plant flows from screening building into wastewater regulating reservoir, the pump provides wastewater with high suspended matter to fine sand recovery processor, reclaim fine sand larger than 0.035mm about 80%, screening filtering water flows back into regulating reservoir, spill water flows automatically advection sedimentation basin, and then supernatant flows into reclamation system through flocculating settling, which will be used together with make up water for productive water of screening
building. Two groups of sedimentation basins will be used in turn, draw bottom mud out through mud sucker and pressure filtering with pressure filter, dehydration, pressure filtration water will flow automatically into regulating reservoir, transport mud cake to the nearby slag yard or backfill yard to excavate the base.

Desilting treatment unit

Fine sand recovery processor of the treatment unit is suggested to adopt complete equipment with mature technology, the equipment investment will be borne by the Owner, and indicate clearly in the bidding documents.
Figure 10.1-3  Process flow of wastewater and argillaceous silt treatment of sandstone material processing system

- 补充水 (Makeup water)
- 回用系统 (Reclamation system)
- 筛分楼 (Screening building)
- 调节池 (Regulating reservoir)
- 加絮凝剂 (Add flocculant)
- 细砂回收处理器 (Fine sand recovery processor)
- 细砂回收 (Fine recovery processing)
- 絮凝沉淀池 (Flocculating settling basin)
- 泥浆脱水 (Slurry dewatering)
- 上清液回用 (Supernatant)
- 泥运往渣场 (Mud transport to slag yard)

Flocculating settling unit

According to characteristics of high concentration of construction wastewater raw water, and simple construction management condition, the flocculating settling adopts advection sedimentation basin. After analysis of comparison and selection, flocculating settling unit of this stage adopts two grilles single basin advection sedimentation basin, which is planned for alternative use in case of overhaul and cleaning mud. Considering larger suspended matter concentration in the coming water, the silting is easy to become harden, we plan to adopt mud sucker for mud drainage.

Design flow speed of sedimentation basin is 8.3mm/s, residence time is 1.1h, surface load 2.26m/h, length of single grille sedimentation basin is 33m, effective depth 2.5m, net width of single grille 6.0m, total width of two grilles 13.2m(thickness of partition wall and side wall
are 0.4m), single grille operation, use alternatively. Since adopting mud sucker to remove mud, sedimentation basin can work continuously, which will be used in turn only in overhaul and stage mud cleaning.

Flocculant will select polyacrylamide (PAM), flocculation reaction basin may not be set. After flocculating settling, suspended fine particle less than 0.035mm in the wastewater will be removed further; SS after treatment can be kept below 70mg/L, which can be used circularly.

- Reclamation unit

The reclamation system consists of high and low level basin and reclaimed water pump. Dimensions of high and low level basin are 7.0m (long) ×7.0m (wide) ×5.0m (high) and 8.5m (long) ×8.5m (wide) ×5.0m (high) respectively.

- Main equipments and monitoring instruments

See Table 10.1 for main productive wastewater treatment equipments and monitoring instruments of a set of sandstone aggregate processing plant.

- Flushing wastewater treatment measures for sandstone aggregate preparation system during the construction period

A set of productive wastewater treatment unit will be set respectively in right and left banks of the construction area of this project to collect and treat the flushing wastewater from sandstone aggregate precessing system, together 2 sets.
10.1.1.2 Flushing wastewater treatment measures for concrete mixing system

□ General situation of wastewater

A set of 4×0.8m³ concrete mixing station and a set of 3XJ3-1.5 concrete mixing building will be set on both left and right banks of the project junction area. Flushing wastewater of concrete mixing system is calculated on the basis of 0.5m³/times•tank, wastewater presents alkalinity (pH value: 12), SS discharging concentration is 50000mg/L.

□ Treatment target

Suspended matter concentration of sandstone wastewater after treatment is less than 70mg/L, pH value is controlled in 6~9.

□ Treatment measures

According to characteristics of small quantity of concrete flushing wastewater and short flushing time, wastewater collection basins should be set on both left and right banks in the vicinity of mixing station with volume not less than one times of flushing wastewater volume, discharge flushing wastewater into the basin by utilizing shift changing time, and discharge till the next shift changing, and manual sand removal. See Table 10.1-1 for detailed dimensions of wastewater collection basin, and see Figure 10.1-4 for plan layout.

The flushing wastewater of mixing building will be discharged into a sedimentation basin (the other for standby) in every shift changing, add in flocculant and deposit for a shift and then discharge. Outlet of the basin should be flexible for the purpose of convenient for cleaning.

### Table 10.1-1 Main equipments and monitoring instruments

<table>
<thead>
<tr>
<th>Location</th>
<th>Name of main equipments</th>
<th>Quantity of main equipments</th>
<th>Main monitoring instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw water</td>
<td></td>
<td></td>
<td>Open channel meter</td>
</tr>
<tr>
<td>Regulating reservoir</td>
<td>Sand pump</td>
<td>2 sets(1 for operation and 1 for standby)</td>
<td></td>
</tr>
<tr>
<td>Sand-water separation</td>
<td>Sand pump</td>
<td>2 sets(1 for operation and 1 for standby)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fine sand recovery processor</td>
<td>1 set</td>
<td></td>
</tr>
<tr>
<td>Flocculating sedimentation basin</td>
<td>Traveling pump sucking type mud sucker</td>
<td>1 set</td>
<td>Ultrasonic sludge level</td>
</tr>
<tr>
<td>Dehydrator machine room</td>
<td>Belt type pressure filter</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dosing pump</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Liquor mixing tank</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sludge pump</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Air compressor</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Centralized control cabinet</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Supernatant effluent reclamation system</td>
<td>Pump</td>
<td>2 sets(1 for operation and 1 for standby)</td>
<td>Flow meter, solid suspended matter calcimeter</td>
</tr>
</tbody>
</table>
and transport and adjusting water level. Change to use the standby basin after sludge of the sedimentation basin depositing for a certain degree. The original basin should be dried automatically, transport sludge for the treatment in slag yard after anhydration.

**Table 10.1-2 Specification of wastewater collection basin**

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand settling basin</td>
<td>5m long × 1.5m wide × 2m high</td>
<td>Built two grilles, one is for standby, advection basin</td>
</tr>
<tr>
<td>Neutralized sedimentation</td>
<td>3m long × 3m wide × 2m high</td>
<td>Build two partition walls in the basin, install pH value calcimeter at outlet</td>
</tr>
</tbody>
</table>

**Figure 10.1-4 Plan layout of wastewater treatment of concrete mixing system**

- 进水 (Water in)
- 出水 (Water out)
- 沉砂池 (Sand sedimentation basin)
- 中和沉淀池 (Neutralized sedimentation basin)
- 加药 (Dosing)

### 10.1.1.3 Foundation pit drainage treatment measures

**Design target**

Drainage and discharging standard of the project foundation pit will follow Integrated Wastewater Discharge Standard (GB8978-1996) Grade one discharging standard, SS discharging concentration should be controlled under 70mg/L.

**Design scheme**

Drainage of the project foundation pit consists of mainly precipitation, water seepage, concrete pouring and maintenance water, excavation drainage of underground workshop, SS and pH are main pollutants. Additional treatment facilities will not be adopted for foundation...
pit drainage, add in flocculant in the water catchment of foundation pit, draw out to discharge after drainage still deposit for 2h, regular manual cleaning for rest sludge, this method has better effect.

According to characteristics of small volume of foundation pit wastewater, high suspended matter concentration and water body presents alkalinity, as well as treatment experiences of foundation pit wastewater of other hydroelectric power projects, no additional treatment facilities will be adopted for foundation pit wastewater, add only flocculant into the foundation pit, draw out to discharge after drainage still deposit for 2h, regular manual cleaning for rest sludge. The discharging technical measures of foundation pit wastewater is rational and effective, economized, which can solve foundation pit water problem in the practical. See Figure 10.1—5 for scheme flow for wastewater treatment design flow of foundation pit.

![Figure 10.1—5 Scheme flow for wastewater treatment design flow of foundation pit](image)

**Figure 10.1—5 Scheme flow for wastewater treatment design flow of foundation pit**

1. Flocculant
2. Foundation pit
3. Clear liquid discharge
4. Cleaning sludge transport to slag yard

10.1.1.4 Oil wastewater treatment measures for overhaul system

**Design target**

Oil wastewater treatment of the project construction area will follow Integrated Wastewater Discharge Standard (GB8978—96) Class II pollutants maximum discharge concentration grade one standard, petroleum treatment target is below 5mg/L.

**Treatment scheme**

Drainage ditch will be set respectively in the construction machinery parking area on both left and right banks of the project junction area construction area, under the inspection rack, collecting channel will be arranged around the maintenance station to collect mechanical cleaning wastewater in the drainage ditch. Steel plate will be set to separate the oil in the front end of collecting channel; thin plate weir overfall will be set at the outlet of collecting channel. Clean periodically waste oil gathered in front of steel plate, and clean sludge in the bottom.

See Figure 10.1—6 for wastewater collection and treatment flow of mechanical equipment curing. See Table 10.1—3 for specifications of collecting basin. Wastewater with oil will be discharged to the peripheral drainage system after deoiling and sedimentation.
### Table 10.1—3 Specifications of collecting basin

<table>
<thead>
<tr>
<th>Place</th>
<th>Area (m²)</th>
<th>Wastewater amount (m³/d)</th>
<th>Residence time (d)</th>
<th>Design volume (m³)</th>
<th>Specifications of collecting basin (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking area</td>
<td>300</td>
<td>6</td>
<td>1</td>
<td>12</td>
<td>4m long x 1.5m wide x 2m high</td>
</tr>
</tbody>
</table>

![Figure 10.1—6 Wastewater treatment flow of mechanical maintenance](image)

**Thin plate weir**

**Water out**

**Wastewater with oil**

**Thin plate weir**

### 10.1.1.5 Domestic sewage treatment measures and economic and technical evaluation

#### General situation of sewage

Domestic sewage source of the project comes from domestic water and feces drainage during the construction period. Construction personnel in the construction peak will be 1900 person/d, if the water consumption is 150 L/(person · d), calculate according to sewage discharge amount on the basis of 80% of water consumption, maximum discharge amount of domestic sewage will be 228 m³/d. Main pollution factors in sewage are COD and BOD5 if calculate the concentration on the basis of 300 mg/L and 200 mg/L respectively, discharge amount of COD, BOD5 will be 68.4 Kg/d and 45.6 Kg/d respectively.

#### Treatment target

Domestic sewage in construction area after treatment should reach Integrated Wastewater Discharge Standard (GB8978-1996) Grade one standard (BOD5, CODcr discharging concentration should be controlled under 20 mg/L, 100 mg/L respectively), drainage or used for irrigation locally.

#### Scheme comparison and selection

Scheme I: adopt septic tank. Domestic sewage during the construction period will be drained through septic tank after primary treatment; this scheme has advantages of low construction...
cost and low operating expenses, however, removal rate of pollutants is low, which is only suitable for project with smaller sewage volume and low requirements of discharging standard.

Scheme II: adopt complete domestic sewage treatment equipment. Since complete equipment has some advantages in technical index and economic index, it is more attractive in small sized domestic sewage treatment field.

As for this project, it has large volume of domestic wastewater, in order to reach the anticipated treatment effect and reduce domestic sewage of construction workers to the water quality of the project river segment, Scheme II is recommended.

Considering components and concentration of main pollutants in the sewage, we plan to adopt XHS corresponding domestic sewage complete treatment equipment. For selected XHS type sewage treatment complete equipment, under conditions of water in quality as $\text{BOD}_5 \leq 250 \text{mg/L}$; $\text{COD}_\text{cr} \leq 450 \text{mg/L}$; $\text{SS} \leq 300 \text{mg/L}$, effluent water quality can be $\text{BOD}_5 \leq 20 \text{mg/L}$; $\text{COD}_\text{cr} \leq 60 \text{mg/L}$; SS $\leq 50 \text{mg/L}$; and that can reach completely target value of domestic sewage treatment of the project.

☐ Process flow and explanation

See Figure 10.1—7 for process flow of XHS type sewage treatment complete equipment.

Figure 10.1—7 Process flow for XHS sewage treatment complete equipment

<table>
<thead>
<tr>
<th>污水</th>
<th>Sewage</th>
</tr>
</thead>
<tbody>
<tr>
<td>格栅</td>
<td>Grate</td>
</tr>
<tr>
<td>调节池</td>
<td>Regulating basin</td>
</tr>
<tr>
<td>沉淀池</td>
<td>Sedimentation basin</td>
</tr>
<tr>
<td>一级接触氧化池</td>
<td>Primary contact oxidation pond</td>
</tr>
<tr>
<td>二级接触氧化池</td>
<td>Secondary contact oxidation pond</td>
</tr>
<tr>
<td>污泥回流</td>
<td>Return-sludge flow</td>
</tr>
<tr>
<td>二沉池</td>
<td>Secondary sedimentation tank</td>
</tr>
</tbody>
</table>
10.0 Environment Protection Measures & Technoeconomic Analysis

<table>
<thead>
<tr>
<th>Chinese</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>鼓风机</td>
<td>Blower</td>
</tr>
<tr>
<td>沉淀池</td>
<td>Sedimentation basin</td>
</tr>
<tr>
<td>消毒池</td>
<td>Disinfecting tank</td>
</tr>
<tr>
<td>外运</td>
<td>Transport</td>
</tr>
<tr>
<td>排放</td>
<td>Discharge</td>
</tr>
</tbody>
</table>

Primary sedimentation: used to deposit infusible suspended matter, adopt vertical slant pipe sedimentation basin, surface load 1.5~3.0m³/(m²·h), residence time 1~1.5h, and the deposited sludge will enter into the sludge sump with air stripping device.

Contact oxidation pond: sewage after primary sedimentation will flow automatically into the pond for biochemical treatment, the pond is divided into two stages, total residence time not less than 6h, hang clean filling or fill in multi-surface hollow ball, aerating apparatus is micro-pore aerator with gas water ratio as (10~16): 1.

Secondary sedimentation tank: sewage will flow automatically into the secondary sedimentation tank after biochemical treatment, adopt vertical sedimentation basin, surface load is 0.9~1.2 m³/(m²·h), residence time is 1.5~2.0h, the part deposited sludge will be sent to sludge sump by air stripping device, and part return back to contact oxidation pond.

Sludge sump: primary sedimentation sludge and part sludge of the secondary sedimentation tank will be concentrated primarily here, water contents of sludge after concentration is less, which may be drawn out and transport the manure freely to the residents in the vicinity with dung-cart.

Blower house: 2~3 blowers (2 for standby), silencing equipment should be equipped at inlet and outlet on the ground or underground.

Power control cabinet: Power control cabinet is set in ground control room, which is equipped with PLC control system, and carries out control automatically on blower, pump and air stripping device, or controlled manually. Blower and pump standby equipment will switch automatically every 8 hours.

A set of complete treatment facility with be equipped each for living areas of left and right banks of the project junction construction area, altogether 2 sets.

10.1.1.6 Sewage treatment facilities of other construction points

Different wastewater of other construction points beyond the pivot area is strictly prohibited to directly drain into water body. Presently, most of local residents go out to work, there are many vacant houses there. We suggest that local residents’ houses be hired as construction camps with sewage to be treated by the existing facilities. For construction site with small wastewater amount and far away from the existing residence areas, septic tank or dry toilet shall be set for collection, after treated, it can be used as farmyard manure. It is strictly forbidden to directly drain into water body.

10.1.1.7 Oil sewage management measures for construction ship bottom

Average oil concentration of ship bottom oil sewage is 5000mg/l, if ship bottom oil sewage is
discharged directly without treatment, it will generate great impact to the water environment, and oil concentration after treatment should not be larger than 15mg/l.

According to relative regulations, ship bottom oil sewage must be discharged after reaching the standard through the treatment of oily water separator of the ship, discharge standard for petroleum products should not be larger than 15mg/l.

10.1.2 Operation period

10.1.2.1 Domestic sewage treatment measures for Management Department of Shihu Navigation And Power Junction Project

Calculate according to the staffs of project management department 129 persons, total domestic sewage discharge volume is 7062.75t/a. main pollution factors in the sewage are COD and BOD5, concentrations are 300mg/L, 200mg/L respectively, generating capacity of COD, BOD5 are 2118.83kg/a and 1412.55kg/a respectively. Discharge after reaching first grade discharge standard after adopting sewage treatment measures, COD, BOD5 discharge concentration are 100mg/L, 20mg/L respectively, and generating capacity are 706.28kg/a and 141.26kg/a respectively.

Adopt same complete domestic sewage treatment equipment with domestic sewage treatment measures during the construction period. One set of XHS corresponding model domestic sewage complete treatment equipment (treatment capacity over 9007t/a, treating the sewage of the project management department and ship sewage within the reservoir area and oil-contained bilge water preheated by oil/water separator) will be adopted. See Para.10.1.1.5 domestic sewage treatment measures and economic and technical evaluation for detailed proofs.

10.1.2.2 Ship sewage treatment measures for waterway of reservoir area

☐ Ship domestic sewage of waterway of reservoir area

Ship domestic sewage discharge amount of reservoir area waterway in 2020, 2030 will be 1079.1t/a, 1333.1t/a respectively. Ship domestic sewage to discharge directly in to the waterway without treatment will generate pollution effect to the aquatic environment of reservoir area aquatic environment. Ship domestic sewage discharge in the waterway should be prohibited. Ship domestic sewage should be collected with domestic sewage collection device on the ship and sent to sewage receiving ship at upstream and downstream of the ship lock for paid reception, then sent to ashore sewage treatment unit equipped at the project management department for treatment by sewage receiving ship, and discharged after reaching Grade One standard (COD, BOD5 concentration reach 100mg/l, 20mg/l respectively) stipulated in Integrated Wastewater Discharge Standard (GB8978-1996).

One workboat to be equipped for the project management department will be applied as sewage receiving ship.

☐ Ship bottom oil sewage of waterway of reservoir area

Average oil concentration of ship bottom oil sewage is 5000mg/l, generating capacity of ship bottom oil sewage in reservoir area waterway in 2020, 2030 will be 393.4t/a, 611t/a
respectively. If ship bottom oil sewage discharges directly without treatment, it will generate
great impact to the aquatic environment. Ship oil sewage discharge into the waterway should
be prohibited. ship bottom oil sewage should be collected with oil sewage collection device
on the ship and and sent to oil sewage sewage receiving ship at upstream and downstream of
the ship lock for paid reception. One workboat to be equipped for the project management
department will be applied as oil-contained wastewater receiving ship.

Collection and treatment process and description of sewage and bilge oil-contained
wastewater of ships passing through the ship lock

Project Management Department will be equipped with a wastewater treatment station with
land occupation area of 300m² and a work boat (ship wastewater reception boat) jetty. The
work boat (ship wastewater reception boat) jetty will be equipped with a ship sewage
reception pipeline (DN80) and a bilge oil-contained wastewater collection pipeline (DN80).
The wastewater treatment station will be equipped with a complete set of XHS type sewage
treatment equipment (treatment capacity is over 9007t/a, it can receive and treat the sewage
from the Project Management Department, ships within the reservoir area and pretreated bilge
oil-contained wastewater by oil/water separator) and with one 0.5t/h oil/water separator and
a complete set of treatment unit as separation tank etc. The plan layout of the wastewater
treatment station and oil-contained wastewater treatment process are shown in DRAWING
NO.41. The treatment process of sewage and bilge oil-contained wastewater of ships passing
through the ship lock is given in Drawing No.10-8.
Ship bilge oil-contained wastewater is sent to oil/water separator equipped at Project Management Department via oil-contained wastewater reception boat for treatment, after oil concentration is less than 10mg/l, it will be drained into the complete sewage treatment equipment of Project Management Department, it will be discharged after it satisfies Grade I (5mg/l) of Integrated Wastewater Discharge Standard (GB8978-1996).

Ship bilge oil-contained wastewater of the Project is about 2.1t/d (in 2030), separation tank with available volume of 12.5m³ and 0.5t/h oil/water separator are justified in meeting the demand.

10.1.2.3 Other management measures in reservoir area

Reservoir water storage and adjustment to runoff will change the hydrological regime and aquatic environment status of reservoir area and downstream segment of the dam site; hence generate certain impact to water resources of this area. In order to ensure the water quality of reservoir area and flow of drain reaching the living and productive requirements, we out forward the following protective measures and suggestions.

- Reservoir bottom cleaning: after desolate scene of broken walls, washroom and so on left by migrants are immerged in the reservoir bottom, leaching from organic substance and various harmful substance will become secondary pollution sources. In order to control secondary pollution of reservoir, reservoir bottom cleaning specifications must be followed strictly before the water storage, so as to implement completely various pollutants cleaning works in inundation area, and prevent water quality deterioration at the early stage of reservoir water storage.

- Pollution sources control in the upstream of dam site and reservoir area

According to water environment capacity prediction result, NH3-N environment capacity of the 1000m river section from Chengjiang drain to the water intake of Chengjiang Water Plant casting is 155.9t/a, pollutant discharge quantity is 137.87t/a at near future and 146.00t/a at far future, though NH3-N discharge quantity is lower than regional environment capacity, the remained environment capacity is very limited. In order to protect reservoir water quality, pollution enterprises should be prohibited around reservoir, all projects with pollution discharge nature must controlled strictly, various pollution sources are prohibited, and animal
and human excreta and rubbish are not allowed to discharge directly into the river. We suggest to perfect as soon as possible the sewage collection system and treatment facilities, as well as domestic waste handling facilities in the area, so as to reduce pollution due to discharge of sewage and rubbish on the water quality of reservoir area and avoid pollution effect to the water quality of reservoir area.

According to pollution characteristics of water quality at the early stage of water storage of similar built water conservancy project, at the first 5 days of water storage, suspended matter, organic substance, mineral substance and bacteria and malignant bacteria in the reservoir increased greatly. In order to guarantee the safety of water quality of water works in the reservoir area, monitoring frequency and monitoring density should be strengthened in water intake of water works and monitor in time the dynamic water quality of dinking water sources. In case of water quality deterioration, notice water works of Taihe County to strengthen the sterilization and purification treatment of tap water, so as to ensure the safety of drinking water for residents.

12 sign boards will be set for 3 water intakes of drinking water and water-source reserves, prompt passing ships to protect water sources; remind passing ships to strengthen safety consciousness; prohibit ships to anchor in these areas; prohibit ships overside transport in this water area; prohibit ships to discharge all pollutants in this water area.

Project Management Department will be equipped with auxiliary equipment, such as oil fence (800m), buoy, anchor, anchor rope and etc.; 2t oil absorption felt, one oil absorber and one work boat for oil fence laying and recovering spillover.

In order to protect the water quality of the reservoir area, especially water source protection areas, ship accidents must be avoided as possible through strict environment management, establishing relative system, perfecting equipment, improving personnel quality and establishing oil spillage emergency plan. Once risk accident occurs in the waterway, start immediately oil spillage emergency plan, adopt accident emergency measures, and mitigate and eliminate pollution impact of oil spillage accident on water quality of the water source protection areas.

Local government and local environment protection department shall strictly execute environment management, establish related systems and strengthen supervision and avoid emergency discharge from drains. Once risk accident occurs in the waterway, start immediately regional emergency plan, adopt accident emergency measures, and mitigate and eliminate pollution impact of oil spillage accident on water quality of the water source protection areas.

### 10.2 Ecological Environmental Protective Measures

#### 10.2.1 Precautions

In order to protect the vegetation and old trees of Tangzhou Town Zhujia Village County Level Small Natural Reserve (Jintan old trees community), set caution boards in project construction area, construction personnel is not allowed to stay in the non-construction area.
Strengthen education on the construction personnel the ecology protection of construction area with bulletin, leaflets and brochures, and prohibit the construction personnel to prey on frogs, snakes, birds, animals, fishes in the Kan River through systems, advocate greatly not to prey on wildlife so as to refuse impact of the construction to the local terraneous animals and plants, and adopt effective measures to restrict the harm of rodent.

Construction contractor during construction period should designate special person to be responsible for the patrol, monitoring on old trees, big trees and provincial level protected plants in the vicinity of the construction point, so as to prevent harm to old trees, big trees and protected plants due to construction activities or stealthily cut down trees. Adopt protective measures in time for valuable and rare animals and plants discovered in the construction.

Combining with water storage plan and ecological habit of wildlife, set up corresponding protection plan, and avoid as possible the dormancy period of amphibian and reptile at the primary water storage stage of the power station.

According to the investigation, the mating season of main fishes in Kan River is in April - July, hence, the underwater excavation works will be carried out as possible to avoid April - July.

Prohibit the construction personnel to throw any wastes directly into the water body, especially poisonous harmful substances.

Earth material yard will be excavated horizontally, surface soil will be stacked, cover the excavated surface with waterproof cloth in case of rain, after the borrow soil, cover soil for ecological recovery, recover to farmland if possible.

Clear plants in all reservoir area before the water storage and transplant trees if possible. Cut trees that cannot transplant, and utilize all that can be utilized, burn that cannot be utilized and wood ash should be used as manure.

Resume vegetation on the river shoal, stop reclaiming wasteland on river shoal in order to prevent bank landslide and collapse.

After water retaining of the dam, most of the animals that previously reside around the river banks will migrate to other places quickly, while there will be some animals staying behind looking during the primary period of water impounding to see whether they can adapt to the new environment. In this period, it is necessary to organize people to patrol for protection so as to avoid any animal hunting in the chaos of the animals or excessive disturbing. This will help to retain more animals to live in the reservoir area.

10.2.2 Protective measures for old trees and big trees

There are 21 old trees should be protected in the project, including 20 Cinnamomum camphoras and 1 Cupressus funebris; 27 big trees should be protected, including 26 Cinnamomum camphoras and 1 Castanopsis sclerophylla. Protective measures for old trees and big trees include on the spot protective measures and transplanting protective measures. See 7.0 Special appraisal on impact to old trees for details.
10.0 Environment Protection Measures & Technoeconomic Analysis

10.2.3 Old trees protection measures and economic and technical evaluation

Old and large trees protection scheme is shown in Chapter 7.0.

10.2.4 Protective measures for Zhujia Village County Level Small Natural Reserve

Protective measures for Tangzhou Town Zhujia Village County Level Small Natural Reserve (Jintan old trees) include: Change embankment line direction and implement cement laid stone masonry slope protection on the riverbank and etc. See 7.0 Special appraisal on impact to old trees for details.

10.2.5 Protection Measures of Fishes and Spawning Sites and Technoeconomic Appraisal

Protection measures include to build fishpass, to construct fish proliferation and fry releasing station, to construct substitute fish habitat, to execute monitoring and study, to strengthen fishery administration etc. Details are shown in Chapter 8.0.

10.2.6 Reduction of project land occupation and basic farmland protection scheme

To reduce inundation area of the reservoir area, the Project is to build five protection areas of Taihe County Seat, Wanhe, Yongchang, Yanxi and Zhangtang, altogether 2.687km² land inundated area is reduced, and 1980Mu farmland inundated areas is reduced. Farmland elevating measure is taken to protect 1237Mu farmland of the shallow inundated area at the left bank of the tributary Yunting River and Mashi Township.

Permanent and temporary acquisition of land will total 5725.9 mu, of which permanent acquisition of land reaches 2977.3 mu (including 198.27 mu of basic farmland), temporary acquisition of land totals 2748.6 mu, which will create some influence to agricultural activities. Permanent acquisition of land will involve only 1.18% of gross arable land (251295 mu), thus very limited in impact. By way of lifting the field and re-vegetation of temporary acquisition of land, crop loss may be compensated to some degree. Of the permanent acquisition of land, 198.27 mu is of basic farmland, which shall be under acquisition in line with Laws of Protection of Basic Farmland.

Temporary acquisition of land for construction encampment and auxiliary enterprises totals 532.05mu, consisting of paddy fields (37.2mu), dry land (218.1mu), and woodland (122.4 mu). For the sake of protection arable land, especially of paddy fields, there shall be proper adjustment of workyard on the left bank, to try to avoid temporary acquisition of 37.2 mu of paddy fields.

Land is an irregenerative resource, agricultural utilization value of land can not be replacedby other land use. Therefore, attentions shall be paid on earthwork longitudinal balance during design and construction to minimize quantities of borrow or spoil and to minimize land occupation. Borrow pit or spoil site are not allowed to be located at basic farmland protection area; Borrow pit or spoil site are prohibited to be located at Jintan Old Woods; Spoils are prohibited to dump at inner side of earth bank along the river way or below.
maximum level. Borrow pits shall be located at open forest land and brush land as many as possible to avoid farmland, and borrow pits shall be located at higher land, the borrow depth shall be decided as per the landform condition, the borrowed pit shall be kept basically flush with the surrounding land surface, without pit formed and resume its original ecological condition; Hummock wasteland shall be reasonably applied as spoil sites to minimize farmland occupation. For spoil site which can resume second plowing, peel and return surface soil and resume second plowing; For spoil site which can not resume second plowing, engineering protection and vegetation protection measures shall be considered to resume the vegetation of woodland and brush land occupied by spoil.

The project plans to have 17 borrow pits, to cover an area of 2391.9 mu (159.46hm²), of which dry land totals 283.65mu. To minimize farmland to be occupied by borrow pits, as per the concentrated borrow principle, this EIA suggests that Huangkeng Borrow Pit and Zoukeng Borrow Pit be combined, Zoukeng Borrow Pit be cancelled; Futang Borrow Pit be cancelled to be merged into Lianhuatang Borrow Pit; Wanhe Borrow Pit be cancelled to be merged into Chenjia Borrow Pit; Bainigang Borrow Pit, Lijia Borrow Pit and Tianhong Borrow Pit be cancelled to be merged into Shihutang Borrow Pit. After the above adjustment, altogether 11 borrow pits are set with occupied dry land of about 77.4Mu (5.16hm²) reduced.

There will be 38 construction spoil sites in this Project, to cover an area of 117.61hm². There will be 4 such spoil sites on the left and right banks of the Project, whose terraces are flat. The spoil sites belong to flat land and valley, occupying some dry land. In order to protect farmland, especially paddy field, it is suggested that spoil site 1# at the left bank of the pivot area be properly adjusted to keep away from 13.95Mu paddy field to be temporarily occupied. Temporary occupied land area of the embankment work and drainage work is 1564.35Mu, including 369.75Mu farmland (dry land), with a bigger farmland (dry land) area occupation. To minimize farmland occupation by spoil sites, as per the concentrated dumping principle, this EIA suggests that 22 spoil sites be cancelled, their spoil quantity be merged into the nearby spoil sites. After the above adjustment, altogether 16 spoil sites are set with occupied dry land of about 359.25Mu (23.95hm²) reduced.

At engineering design stage, land to be occupied by temporary work as construction camp, construction access road, stockyard and blending station etc. shall be minimized, especially farmland. The existing houses and yards at both sides of the embankment line shall be utilized as possible.

Soil plow layer protection design

Before entering the sites for levee construction, borrow pits and spoil sites and temporary construction sites etc., the plow layer soil with fertility of the surface layer of the above-mentioned sites shall be protected to facilitate the greening and vegetation resumption of the sites at later stage of construction. At excavation and site cleanup, mellow soil at surface layer shall be peeled off and temporarily stacked when vegetation at land surface is cleared.

Peeling, stacking and protection work shall be put forward or detailed in the design documentas per the aforesaid principle, and corresponding environment protection requirements shall be put forward for construction.
10.0 Environment Protection Measures & Techoeconomic Analysis

☐ Measures to resume and save farmland
In the principle of being convenient for construction, construction camps shall be arranged for different subprojects, local residents’ houses nearby will be hired as construction camps to minimize area of temporarily occupied land.

10.3 Water and soil conservation scheme

10.3.1 Control target of soil erosion
☐ Rational arrangement of control measures for water and soil conservation can not only bring the original soil erosion of the project construction under control, but also bring the newly increased soil erosion under effective control, and control the soil erosion intensity within the targeted value. The control target should reach the following six comprehensive target value, that will be the control index of the scheme, as well as the standard value of final acceptance of water and soil conservation, see Table 10.3—1 for detailed quantization control target.
Table 10.3—1 Construction period and control target value of year of design level

<table>
<thead>
<tr>
<th>Item and partition</th>
<th>Control targets of water and soil conservation</th>
<th>Disturbed land regulation rate</th>
<th>Total control degree of soil erosion</th>
<th>Control ratio of soil loss</th>
<th>Blocking slag ratio</th>
<th>Recovery ratio of forest and grass vegetation</th>
<th>Percentage of coverage of forest and grass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Secondary standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Junction project area</td>
<td>Construct period</td>
<td>*</td>
<td>*</td>
<td>0.5</td>
<td>90</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operating period</td>
<td>95</td>
<td>87</td>
<td>1.0</td>
<td>95</td>
<td>97</td>
</tr>
<tr>
<td>2</td>
<td>Engineering area of reservoir area protection</td>
<td>Construct period</td>
<td>*</td>
<td>*</td>
<td>0.5</td>
<td>85</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operating period</td>
<td>95</td>
<td>87</td>
<td>1.0</td>
<td>90</td>
<td>97</td>
</tr>
<tr>
<td>3</td>
<td>Junction project management area</td>
<td>Construct period</td>
<td>*</td>
<td>*</td>
<td>0.6</td>
<td>90</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operating period</td>
<td>95</td>
<td>87</td>
<td>1.0</td>
<td>95</td>
<td>97</td>
</tr>
<tr>
<td>4</td>
<td>Waste soil (slag) yard</td>
<td>Construct period</td>
<td>*</td>
<td>*</td>
<td>0.5</td>
<td>90</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>95</td>
<td>87</td>
<td>1.0</td>
<td>95</td>
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</tr>
<tr>
<td>5</td>
<td>Borrow pit area</td>
<td>Construct period</td>
<td>*</td>
<td>*</td>
<td>0.5</td>
<td>90</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>87</td>
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</tr>
<tr>
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<td>Traffic road area</td>
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<td>*</td>
<td>*</td>
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<td>90</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>95</td>
<td>87</td>
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<td>97</td>
</tr>
<tr>
<td>7</td>
<td>Construction productive and living area</td>
<td>Construct period</td>
<td>*</td>
<td>*</td>
<td>0.6</td>
<td>90</td>
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<td>8</td>
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<tr>
<td></td>
<td></td>
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<td>95</td>
<td>87</td>
<td>1.0</td>
<td>95</td>
<td>97</td>
</tr>
</tbody>
</table>

- Do well the site and road greening works, and enable the project area to form a stable green screen, improve obviously the ecological environment and advance the land use function of project area.
- Plant trees and grasses after the regulation of temporary use land in order to protect land resources and reduce soil erosion.

10.3.2 Control responsibility and control area of soil erosion

Control responsibility range of the project is divided into project construction area and direct influence area. Direct influence areas include project construction influence area, relocation influence area, borrow pit influence area, waste soil (slag) yard influence area and construction road influence area and etc. project construction area is 3206.99hm², direct influence area 180.59hm², and total area of control responsibility range is 3387.58hm².
According to the characters of construction and land occupation, the control area is divided into junction project control area, protection works control area of reservoir, junction project management area, construction productive and living control area, soil and rocks yard control area, waste soil (slag) yard control area, traffic road control area and resettlement area and etc. see Table 10.3—2 for details.

### Table 10.3—2  Soil erosion control area and responsibility range

<table>
<thead>
<tr>
<th>Partition</th>
<th>Sub-item</th>
<th>Area (hm²)</th>
<th>Boundary condition</th>
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</thead>
<tbody>
<tr>
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<td>Junction project area</td>
<td>28.33</td>
<td>Project management range</td>
</tr>
<tr>
<td></td>
<td>Protection works control area of reservoir</td>
<td>258.53</td>
<td>Project management range</td>
</tr>
<tr>
<td></td>
<td>Project management area</td>
<td>3.33</td>
<td>Project management range</td>
</tr>
<tr>
<td></td>
<td>Traffic road area</td>
<td>30.53</td>
<td>Actual land occupation</td>
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<tr>
<td></td>
<td>Construction productive and living area</td>
<td>64.20</td>
<td>Actual land occupation</td>
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<tr>
<td></td>
<td>Soil and rocks yard area</td>
<td>159.46</td>
<td>Actual land occupation</td>
</tr>
<tr>
<td></td>
<td>Waste soil (slag) yard area</td>
<td>117.60</td>
<td>Actual land occupation</td>
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<td>Reservoir inundation area</td>
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<td></td>
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<tr>
<td>Direct influence area</td>
<td>Resettlement area</td>
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<tr>
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<td>Borrow pit influence area</td>
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<tr>
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<td>Waste soil slag yard influence area</td>
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<tr>
<td></td>
<td>Construction road influence area</td>
<td>12.45</td>
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<td>Influence area around reservoir</td>
<td>51.10</td>
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<td></td>
<td>Flood diversion and drain influence area in bank and slope of lower reaches</td>
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<td>Subtotal</td>
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<td>Control responsibility range</td>
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<td>3387.58</td>
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</tr>
</tbody>
</table>

#### 10.3.3 Control measures for soil erosion

- **Junction project control area**

The slope protection measures and plants protection measures of the control area have been involved in the main part of the project design, which forms a temporary retaining wall close to the side of the reservoir, so as to prevent excavated and stacked earthwork entering into the water body. Temporary drainage ditch should be set in the construction area, and set up simple retaining wall or baffle around and cover with waterproof cloth when the excavated cover layer and stones stacking temporarily.

- **Protection works control area of reservoir**

The slope protection measures and plants protection measures of the control area have been
involved in the main part of the project design, the soil slope temporary coverage during the construction period has not been considered in the current design stage, which will be considered in the soil and water conservation scheme, stack (waste) soil in the construction area should be temporarily protected and covered.

- **Project management area**
  
  Greening and beautifying area provide a fine office and living environment.

- **Soil and rocks yard control area**
  
  During the construction period, do well the water damming and drainage work in the material yard, strip off temporary protection of surface soil, and reduce soil erosion during the construction period. After the completion of the construction, implement site regulation and covering soil greening. Most sand and pebble materials are located in the river shoal, which mainly explore underwater, waste sand treatment is required to back fill the pit the leveling. Drainage measures of borrow pit, plant protection measures and temporary protection measures will be increased in the soil and water conservation scheme.

- **Waste soil (slag) yard control area**
  
  Since storage and waste soil (slag) yard is a loose congeries, it has uneven sedimentation phenomenon; rainwater is easy to be infiltrated, which may become the source of landslide or debris flow with serious water erosion. However, combining with project measures and plant measures for this area, pay attention to the stability of slag yard. measures design has not be involved in the main body design for the waste soil (slag) yard, drainage facilities and waste slag obstructing design, plant protection measures, temporary protection measures and construction management measures have been increased in the soil and water conservation scheme.

- **Construction road control area**
  
  Construction roads include main trunk road in the site, secondary trunk road and branch roads. Plant roadside trees for greening along trunk road and secondary trunk permanent roads, for construction temporary branch roads, adopt planting measures after the completion of the construction. Protection of construction temporary road, drainage measures and vegetation recovery will be involved in the soil and water conservation scheme.

- **Construction productive and living control area**
  
  It includes mainly sandstone material processing and concrete mixing system, construction living base camp and land occupied by construction auxiliary enterprises. The main task is to pay attention to the drainage problem of peripheral area of the construction site, site stripping surface soil protection measures, after the completion of the construction and removal of temporary facilities, improve the occupied and pressed and damaged earth’s surface to resume the land use function.

- **Resettlement area**
  
  The local government will be responsible for the resettlement work. The water and soil conservation expenses of resettlement area are involved in the resettlement expenses, which
will be implemented by relevant personnel or unit of the local government. The water and soil conservation scheme is mainly greening the resettlement area (point), elevate the farmland and strip off protection of farming soil, raise the slope protection and etc.

See Table 10.3 for newly increased work volume of water and soil conservation scheme of the project. See Figure 42 for general layout of soil erosion control measures.

10.3.4 Schedule arrangement of soil erosion control measures

The working schedule of water and soil conservation is based on the construction progress of main part of the project. The water and soil conservation project will start in January 2008 and complete in June 2012 with a construction period of 54 months.

Protection of construction road and construction productive living area, as well as drainage works should be completed during the main part of the project “Three connections and one leveling”, drainage works should be completed before the borrow soil of borrow pit control area, and other protection works (vegetation protection) should be completed after the borrow soil as soon as possible. Waste soil (slag) yard control area should be completed before the completion of obstruction and drainage measures of waste slag, and carry out vegetation recovery and second ploughing after the completion of waste soil. Land regulation will be implemented first, plant measures can be arranged later. The corresponding water and soil conservation works should be completed basically at the completion of each bidding section of main part of the project; The rest work volume of water and soil conservation measures should be completed at the completion of the project.

10.3.5 Guarantee measures of scheme implementation

☐ Organization leading and management measures

The project management department will set up the implementation management organ for water and soil conservation scheme. Special personnel will be in charge of the organization, management and implementation of water and soil conservation work, and contact with the local water and soil conservation department, receive consciousness the supervision inspection of local water administration department. Coordinate the relations between water and soil conservation scheme and main part of the project, lead uniformly and regulate the construction. Establish scheme implementing target responsibility system, establish scheme implementation, check, acceptance method and requirements, establish scheme implementation self-inspection group, and organize the construction strictly according to the design requirements and standard. During the project tendering and bidding process, bring the water and soil conservation requirements into the tendering and bidding documents, indicate clearly the soil erosion control responsibility of the contractor and ensure various water and soil conservation facilities to satisfy the design standard and quality.
<table>
<thead>
<tr>
<th>No.</th>
<th>Unit works</th>
<th>Unit</th>
<th>Junction project area</th>
<th>Protection project area</th>
<th>Junction management area</th>
<th>Construction productive living area</th>
<th>Traffic road area</th>
<th>Soil and rocks material yard area</th>
<th>Waste soil yard</th>
<th>Total</th>
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<tr>
<td>I</td>
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<tr>
<td>1</td>
<td>Strip off surface soil ×10⁴m³</td>
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<td></td>
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<td>135.59</td>
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<td>0.075 0.85 0.93</td>
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### 10.0 Environment Protection Measures & Technoeconomic Analysis

To be continued Table 10.3—1  
Newly increased work volume of Shihutang water and soil conservation scheme

<table>
<thead>
<tr>
<th>No.</th>
<th>Unit works</th>
<th>Unit</th>
<th>Junction project area</th>
<th>Protection project area</th>
<th>Junction management area</th>
<th>Construction productive living area</th>
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<td></td>
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</tbody>
</table>
10.0 Environment Protection Measures & Techoeconomic Analysis

- Technical guarantee measures

As for water and soil conservation scheme, the design work of relative stage should be carried out. After the inspection of water and soil conservation scheme is passed, the Owner should implement seriously the design contents of water and soil conservation scheme approved by department of water administration in accordance with the current project design progress, entrust the engineering design contractor with qualification should start the construction drawing design work of water and soil conservation of the project as soon as possible. Ask the opinion of water administration department during the design examination, the approved water and soil conservation scheme report should be sent to the competent authorities for file. During the implementation of water and soil conservation scheme, if any larger changes in project position and project quantity, report for approval according to the regulations, and report to department of water administration for file.

10.4 Protective Measures of Ambient Air

The project impact to ambient air mainly occurs in construction period; Water power generation utilizes production process engineering of water power resources to generate energy sources, environment atmosphere pollutants discharged by the project operation itself is limited.

Control measures of environment atmosphere pollution during the construction period are:

- One water sprinkler will be used at the left and right bank of the dam site construction area and at the farmland elevating area respectively to regularly spray water to reduce dust every non-rainy day to reduce dust impact time and scope.

- At pump station and protection embankment, along the line of guide drainage canal; borrow pits, spoil sites; project field elevating area; concentrated resettlement point; construction temporary road and the existing roads to be used, regularly spray water to reduce dust every non-rainy day to reduce dust impact time and scope.

- In order to reduce the dust impact on the health of working personnel and construction personnel of construction site, transport of construction materials should adopt as possible the coverage and closed form.

- Implement individual protection to the construction personnel. The main objects affected by project atmosphere pollution are the construction personnel, individual protection should be adopted for the construction personnel, such as wearing anti-dust respirator and etc.

- Sandstone aggregate processing should adopt low dust technology, dedusting devices should be equipped in primary crushing, pre-screening, main screening, medium and fine crushing workshop in order to control dust pollution.

- Concrete will be produced within closed mixing building with dust collector to control concrete mixing dust.

- Follow strictly Discard Standard for Vehicles In-Use, execute compulsory update and discard system, update timely old vehicles that have more fuel consumption of engine with low efficiency and serious tail gas discharge.
Construction road repair, maintenance and cleanup team shall be established to timely cleanup road surface droppings and to keep road clean and in good condition.

**10.5 Protective measures for acoustic environment**

10.5.1 Protective measures for acoustic environment during the construction period
- Select low noise equipment and technology in order to reduce source intensity
- Strengthen maintenance of equipment, keep the machine lubricated in order to reduce operating noise.
- Mechanical equipment with large vibration should adopt vibration reduction machine base to reduce noise;
- Workshops, such as crusher, sand maker, screening building, mixing building, air compressor, refrigerating compressor and etc should adopt as many as possible porous sound absorbing material to set up noise barrier, acoustic enclosure and acoustic booth.
- Main affected object of the project construction noise is construction personnel in the site, individual protection measures should be adopted, such as earplug, ear protector, noise proof helmet and etc.
- Strictly organize and control construction time, avoid night construction of machines with high noise. The project construction time should be controlled as possible during 8:00~12:00 in the morning and 14:00~20:00 in the afternoon.
- Transport vehicle may cause noise standard-exceeding impact to residential area along two sides of transport line, restrict strictly vehicle speed and vehicle flow rate within unit time during the transport process, reduce the vehicle speed when vehicle passing through towns and cities and concentrated residential, in order to reduce disturbance to the residents in the city and no horn is allowed.
- Sign boards should be set on the road of villages near the dam site, such as Shihutang Village, Sangyuan Elementary School, Jiangjiazhou Village, Lingbei Village and Xiayinxia Village, indicate: speed per hour less than 20km/h, no horn. There are altogether 8 sign boards.
- Protection embankment, construction point of guide drain ditch should be within 100m from the concentrated residential point along the line, no night (22:00~6:00) construction is allowed.
- If there is concentrated residential point 30m along the construction road sides, avoid night (22:00~6:00) transport.

10.5.2 Protective measures for acoustic environment during the operating period
- According to Standard of Environmental Noise of Urban Area (GB3096-93), maximum value of night sudden noise should not exceed standard value 15dB, while the ship horn
instantaneous noise usually is over 100dB. “No horning” sign board should be set in the middle and lower reaches of the section of Taihe County Seat, approach channel upstream and downstream of ship lock at the dam separately, and altogether 4 sign boards.

Noise of slurry carrier is usually the serious noise pollution sources in the waterway. Relevant management department should strengthen management on the ships, ships with their noises that can not satisfy the requirements shall be prohibited to enter the waterway to carry out transport activities, so as to reduce as possible impacts from the ship traffic noise on the normal production and living of residents along the waterway.

10.6 Environmental protection plan for resettlement works in the reservoir area

10.6.1 Environmental protection plan for resettlement

According to existing main environment problems in the resettlement area, we put forward relative and practical environmental protective measures, so as to reduce unfavorable impacts to ecology and environment due to resettlement, and integrate organically resettlement and protection and regulation of ecology and environment, bring comprehensive benefit of the project into full plat in order to create favorable environment for migration resettlement, and enable the migration to reach the target of living and working in peace and contentment.

Domestic sewage treatment measures for rural resettler

New site for resettling area should be selected for immersed area of reservoir, there are many residents in these area and spread sporadically, domestic sewage generated must be treated to the standard on the basis of households, domestic sewage discharge of residents will adopt anaerobic pool for the treatment, and combining to develop methane, we decide primarily to set 1 about 4m³ anaerobic methane pool per household. For those inconvenient to develop methane, encourage them to build a septic tank for every household. And subsidy 1000 yuan will be paid per pool.

Human-animal sewage discharged by residential household will enter the anaerobic pool to carry out anaerobic ferment, methane generated can be taken as residential living fuel, waste slag and wastewater after ferment treatment will be clearer, waste slag generated can be as agricultural manure, while small amount of wastewater also can be discharged into farmland for irrigation. By this way, it avoids effectively the impact of domestic sewage in rural resettlement areas to the aquatic environment, and increased precious energy and manure for the rural resellers.

Treatment measures for solid waste

Every household must select well the rubbish stacking position to avoid pollution, at the same time, according to the rural rubbish components, rubbish should be burnt and waterlogged compost as possible.

Environmental protection of resettling public infrastructure

Migrants in the immersed area of reservoir will adopt moving arrangement at the back of
former address, or moving to another place, the construction of public infrastructure for migration residential area must combine with environmental protection, and adopt some measures to protect the environment.

- Migration residential area should be far from the industrial and mining enterprises, select areas that locate in the upper drift and upper reaches of the industrial and mining enterprises, so as to avoid impact by waste gas and wastewater.

- When arranging the migrants, utilize fully waste mountain and barren slope, and reduce as possible forest land or farmland for building of houses in principle, which should be arranged in hillside area with better geological conditions, do well the water and soil conservation, set drainage ditch on the upper part of excavation surface in order to reduce flushing and protect the safety of residents; Excavation waste soil should be backfilled as soon as possible and plant trees and grass in order to prevent soil erosion.

- Migration residential area shall be matched with new roads, drainage facilities and etc., reduce as possible damages to landforms and vegetation. After the completion of the project, excavation surface and bared land should plant trees and grass to restore the landscape.

- Pay special attention to animal houses in residential area, such as hogcage, bullpen and etc., wastewater and domestic sewage discharged should be concentrated in the pool for treatment, which should not flow at random in order to prevent environment pollution.

- House arrangement of residential point should be planned, which is favorable to reduce land use and natural lighting. Living and drinking water should adopt tap water method as possible for the convenience of migrants.

- Since some migrants in the reservoir area will move to another places, the resettlers will generate impact to the local residents. In order to do well the coordinating measures, reduce as possible impact of reconstruction of residential point to the local natural environment and social environment. To provide benefit from the reconstruction for the local residential point in the design should be considered, as well as improve their living environment and enable the resettling area to develop healthy and last stability and durable peace.

- Residential area should have greening plan, and increase the forest and grass coverage gradually to over 30%, plant trees around the house and village, promote ecological courtyard. Selection of tree species should be decided by the villagers; it should beautify the environment and increase income as the same time.

- Protective measures for public health

- During the resettlement of migration, strengthen the supervision on migration capitals, master the living situation of migration, and do well the water quality monitoring work on the living water of migrants.

- Hygiene and disease control measures

Strengthen patriotic health education, mobilize people to participate large scale of killing mouse and mosquito, level the ditches water accumulation belt, and eliminate disease infectious vector from the beginning.

Before the water storage of reservoir, clean thoroughly pollution sources of reservoir bottom,
pollutants, clear other sundries, prevent new disease sources due to water body spreading strictly in accordance with the requirements of Method on Reservoir Bottom Cleaning.

Do well the health care work in resettlement area. For migrants adopting moving arrangement at the back of former address, the residential houses must be planned uniformly, select places with fine ventilation and natural conditions, human and animal live apart, construct supporting public facilities, and carry out regular disinfection, do well the planned disinfection for drinking water sources and stop drinking unclear water sources. Make thorough physical examination for resettlers, as well as corresponding examination on people in the resettlement place, so as to prevent strictly infection of migrants by infectious disease sources.

Epidemic situation monitoring and management

Since the immersion involves a large scale, hygiene and disease control monitoring organization must be established, after the completion of reservoir, establish epidemic prevention division, which is subordinate to the project monitoring center, carry out sampling investigation on the health of people in the reservoir area, pay close attention to the dynamic health of people, cooperate closely with relative professional department, and prevent strictly the occurrence and spreading of communicable disease.

Fisherfolk compensation measures

According to the site interview result of this resettlement report of the project, there are 7 professional fishing boats in the river section between the Shihutang dam site and upstream Taihe Pivot (listed in the compensation scope of this project), in addition there are a small amount of non-professional fishing boats. Those affected fisherfolks will be compensated for resettlement as per the state latest compensation standard.

10.6.2 Water and soil conservation plan for resettlement

Soil erosion resulted in migrant relocation mainly includes two aspects, namely productive development and foundation implementing construction in the resettlement area.

10.6.2.1 Soil erosion impact analysis

The project migrant resettlement adopts moving arrangement at the back of former address and part concentrated arrangement, production arrangement mainly adopting farmland adjustment, and avoid large excavations, which is favorable for the water and soil conservation; however, the construction of residential building and construction of special facilities, such as field lift and so on, have changed the original land utilization method during the construction process, which has caused damage to the local vegetation, generate soil erosion, like surface erosion, gully erosion, gravity erosion and etc., corresponding protection measures and regulating measures must be adopted; otherwise, the generated soil erosion affects not only the ecological environment in the resettlement area, but also the peripheral agricultural production.

Soil Table 10.6—1 for detailed erosion impact analysis.
Table 10.6-1  Soil erosion impact analysis of resettlement area

<table>
<thead>
<tr>
<th>Single works</th>
<th>Soil erosion impact analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resettlement area (point)</td>
<td>Soil loss in the village, no drainage facilities both in and out of the village, surface runoff with mud and sand flows to the low area in the village in the rain, slope excavation in the arrangement area, it is easy to be flushed and form gulley erosion.</td>
</tr>
<tr>
<td></td>
<td>Drainage water way out of village, residential point set on the upper part of the slope, since there is no way out drainage channel, rainwater and mud and sand in the village flush to the farmland outside the village, which causes damage to agricultural crop, or flush to the nearby village, and cause unnecessary contradictions.</td>
</tr>
<tr>
<td></td>
<td>Rainwater flows into the courtyard, landform of some residential points are low; there is no drainage facilities in the village, rainwater in the heavy rain will flow into the courtyard.</td>
</tr>
<tr>
<td></td>
<td>Affected by drain from the upper reaches, residential point that constructed in the lower part of large area slope, rainwater from the upper part will flush into the in rainstorm, which will cause impact to the production and living conditions of the people.</td>
</tr>
<tr>
<td>Field elevating</td>
<td>Slope of excavation and fill exposed, excavated slope espoused, surface farmland is stripped off to stack, that is easy to be flushed and cause serious soil erosion.</td>
</tr>
</tbody>
</table>

10.6.2.2 Soil erosion control responsibility

The project soil erosion control responsibility includes requisition, permanent, temporary occupation and area. Soil erosion control responsibility in resettlement area includes rural resettlement area (point) 5.21hm2 and field lift 82.47hm2, altogether 87.68hm2.

10.6.2.3 Water and soil conservation measures

- **Water and soil conservation measures of rural resettlement area (point)**

Relative measures of main part of the project has controlled basically soil erosion, considering plant measures of new rural residential site, the measures will adopt plant measures for bare slope in front and back of the house and site, the area adopted control measures is 5.21hm2.

Soil erosion is most serious in the “Three connections and one leveling” stage of construction period of migration new village, the leveling of new site in the stage will damage the original surface, the surface is bare, rainfall may cause soil erosion.

When there is larger catchments area in resettlement area in the upper reaches, build flood control drainage ditch in resettlement area in the upper reaches in order to prevent flood flushing the bare surface during the construction period and safety of the resettlement area. Resettlement area will be arranged in the slope of upper reaches, build catch basin at the slope foot, so as to prevent mud and sand silting in the farmland furrows of lower reaches. Drainage direction inside and outside of the resettlement area will not affect the farmland furrows of lower reaches and flushing to the villages in lower reaches.

Utilize fully the land, according to the principle of “the most suitable tree for the most proper site”, combining with the local conditions, and considering the local economic benefit and ecological efficiency, we suggest to plant economic tree species: mandarin orange, broadcast
sowing pasture with better economic benefit.

Adopt slope protection measures of stone masonry and grass planting for excavation surface of the site slope in resettlement area (point). The slope protection area is 0.74hm². Slope protection work volume: work volume of cement laid stone masonry is 330m³, grass planting area in the gridiron is 0.37hm².

- **Field lift protection measures**

Field lift is 82.47hm², field lift by sections, and strip off agricultural soil, pay attention to strengthen the protection of agricultural soil.

Temporary protection measures for agricultural soil stacking: in order to protect and utilize fully the reproducible land resources, before the field lift, strip off the cultivated layer and stack at other site, so as to backfill and second ploughing after the completion of construction. Set corresponding surface soil temporary stacking area in every site with a height about 3m, stacking slope ratio will be controlled in about 1: 1.5, in order to avoid soil erosion during the surface soil stacking period, temporary breast wall built with polywoven bag with soil will be constructed around the slope foot of soil stack, soil texture drainage ditch will be set around, drainage ditch dimension: 0.3 (upper bottom) × 0.3 (lower bottom) × 0.6m (depth);

Cover waterproof cloth or grass on the stacked surface soil for temporary protection. After the completion of field lift, adopt stone masonry and lay turf for newly formed slope to control soil erosion.

Lay turf about 0.8hm², stone masonry 500m³, temporary breast wall about 346m³, waterproof cloth 6000m². Excavation of temporary drainage ditch earthwork 156m³.

10.6.3 Reservoir bottom cleaning

10.6.3.1 Reservoir bottom cleaning scope

Reservoir bottom cleaning consists of general cleaning and special cleaning. Scope and contents of general cleaning includes removal and cleaning of various buildings and structures under residential migration level; forest cut-down below reservoir normal water storage level, site cleaning and hygiene and disease control cleaning; residues (such as pile, stone tablet, pole) of large buildings and structures under 2m from normal water storage level to dead water level (including dead water level) and forest land cleaning and etc. scope of special cleaning is within the area of each department and special facilities of each unit, which will be cleaned according to the requirements of the departments.

10.6.3.2 Structures cleaning

- Houses and accessory structures within the cleaning scope should be removed, fences, walls and chimneys should be push down and levelled, wastes that cannot be utilized and easy to float will be transported outside the reservoir or burnt on the spot.

- Ground structures and its auxiliary facilities of road, power supply, telecom, industrial and
mining enterprises, water conservancy and power projects in inundation area, hampering reservoir operation and utilization, must be removed, equipment and old materials should be transported outside the reservoir; larger obstruction, such as pier, gate and dam must be blown down, and the residual height usually should not be 0.5m over the ground.

- Underground structures in reservoir drawdown area should adopt blocking, plugging or other treatment measures according to the geological situation and beneficial use requirements of the reservoir area.

10.6.3.3 Hygiene cleaning

- Pollution sources in reservoir area should be hygiene cleaned. For washroom, cesspit, pens for livestock, rubbish and etc, pollutants should be transported to outside the reservoir as possible, if it is difficult to transport to outside, adopt insolation disinfection treatment; and adopt disinfection treatment for pit with 0.5～1kg/m² quicklime; The sewage pit should be blocked with clean soil.

- Toxicant sites as industrial and mining enterprises, hospitals, veterinarian stations of severe pollution sources, and the places to bury dead persons and livestocks of communicable disease should be cleaned or treated under the guidance of environmental and hygiene departments.

- For tombs buried for over 15 years, decide whether to move outside the reservoir according to the local custom, however, tombs buried less than 15 years must be moved outside the reservoir or treated on the spot, and adopt disinfection treatment for every pit with 0.5～1kg bleaching powder.

10.6.3.4 Forest land cleaning

- Tree species with special and high value within the cleaning range, as well as young trees that can be transplanted should be transplanted outside the reservoir.

- Forest and sporadic trees that cannot be transplanted may be cut down at the level of ground and cleared outside the reservoir, residual stubs should not be over 0.3m on the ground.

- Drifters, such as tree folk cut down in the forest, dead wood, bushes and straw stalk, peat coal and etc., should be transported outside the reservoir or burnt on the spot before the water storage.

10.6.3.5 Reservoir bottom cleaning substance quantity

According to the reservoir bottom cleaning scope, cleaning requirements, structures that may hamper the shipping in trunk stream of reservoir area or grade one branch, house waste that cannot be utilized and burnt, junction that may affect the power station, drifters and pollutants in the water quality of reservoir area had been investigated one by one. According to the statistics, cleaning structures in reservoir area of Shihutang navigation and power junction project, removed frame, bricks and concrete, bricks and wood, mud and wood, and other
structures houses are 45500m²; forest land cleaning is 2159mu calculating in accordance with immerged area; Hygiene cleaning is 744 persons calculating in accordance with designed annual relocation persons, and tomb treatment 221.

10.7 Measures to Reduce Unadvantageous Social Environmental Impact

10.7.1 Cultural relic impact reduction measures

Some culture relics are distributed in inundation area and reservoir area of Shihutang navigation and power junction project, such as Baikoucheng site of ancient city (site protected for historical and cultural value at state level), Gouzi Pagoda (site protected for historical and cultural value at county level), Ouyang ancestral hall (it applies now for provincial site protected for historical and cultural value), Huangkeng ancient ferry (it is not included in any site protected for historical and cultural value), site of ancient city (it is not included in any site protected for historical and cultural value), altogether 5 cultural relic points. The project construction and reservoir area immersion have no impact on 2 cultural relic points that have protective grade and 1 cultural relic point that applies now for provincial site protected for historical and cultural value; They have impact on 2 cultural relic points (Huangkeng Ancient Ferry and site of ancient city) that have no protective grade.

According to the Investigation Report of Cultural Relics in Jiangxi Province Kan River Shihutang Navigation and Power Junction Project and the Cultural Relics Protection Law of P. R. China, Jiangxi Provincial Institute of Cultural Relics and Archaeology will implement rescuing archaeological excavation on the Huangkeng Ancient Ferry (work area 600m²) and site of ancient city (work area 5000m²) so as to obtain related historic information. The cultural relics and relative historical information of 2 cultural relic points will be transferred to the site protected for historical and cultural value or museum. After the archaeological excavation work is completed, the two cultural relics points can be submerged, which will not affect the implementation of the project and be consistent with the regulations and requirements of the Cultural Relics Protection Law of P. R. China. The cost of archaeological excavation work has been listed in the project budget.

Except that the culture relics protection work of the above-mentioned 2 cultural relic points that may be affected by the project construction will be completed to obtain related historic information before the commencement of the project, it can be certain that the whole project inundation area is beyond the protection scope and construction control zone of county grade cultural relics protection units, and will not threathen the safety of cultural relics and be consistent with with the regulations and requirements of the Cultural Relics Protection Law of P. R. China.

Because of concealment and unpredictability of buried cultural relics, plus limited investigation and survey technical means of cultural relics department, possibility of futher finding cultural relics points during construction can not be ruled out. Once a cultural relics point is found during construction, the Owner and construction company shall timely report to Jiangxi Provincial Institute of Cultural Relics and Archaeology according to related cultural relics regulations, the construction work can be continued only after rescuing archaeological
10.0 Environment Protection Measures & Techoeconomic Analysis

excavation work is completed. After all the cultural relics protection work is finished, Jiangxi Provincial Institute of Cultural Relics and Archaeology will issue the final certificate of “Cultural Relics Protection Work Done”.

The Owner should communicate as soon as possible with Jiangxi Provincial Institute of Cultural Relics and Archaeology, so as to start the cultural relic protection work of 2 cultural relic points for Jiangxi Provincial Institute of Cultural Relics and Archaeology, guarantee the cultural relic protection work before the project construction and reservoir water storage, and avoid damage to cultural relic due to project construction and water storage or affect the construction period due to cultural relic protection.

10.7.2 Prevent impact to the normal study and living measures of residents due to construction transport

Located at 500m in the lower reaches from right bank of recommended dam site, Sangyuan Elementary School has 200 students, students must pass the highway from the school gate to go to the school and go back. During the project construction period, construction vehicles and construction material transport vehicles will utilize this highway as the construction roads, and vehicle flow rate of this highway will be great during the construction peak. In order not to affect the normal study of the students and the safety of the students, a sign board will be set at the road side of Sangyuan Elementary School during the construction period, indicate: speed per hour less than 20km/h, no horn, students in and out; Establish special construction road management team to command, manage and supervise the construction vehicles passing the school gate.

10.7.3 Protective measures for public health

In order to protect public health of residents and construction personnel, ensure various diseases, especially communicable disease and level will not have any abnormal changes due to the project construction, protective measures for people’s health should be implemented.

- Environment hygiene cleaning
  Harmful animals, such as mouse, mosquitoes, fly, cockroach and etc. should be killed regularly in construction living area every year. Mouse trap method and poison bait method should be adopted to kill mouse, and spray “kill them fast” to kill mosquito, fly and cockroach.

- Environment hygiene and food hygiene management
  Strengthen environment hygiene management of the drinking water sources of living area and office area of construction personnel and owner living area during the construction period, and public food and beverage site, rubbish stacking point, public washroom, carry out hygiene examination regularly, except daily cleaning, at least 2 concentrative cleanings should be carried out every month.

Persons engaged in food and beverage must obtain hygiene license, and carry out regular
physical examination, communicable disease carrier must leave his post.

Drinking water sources must be monitored regularly on all camps in order to ensure the water quality of drinking water.

Establish special cleaning team in charge of the cleaning work of construction area, office area, living community, set garbage can, garbage truck.

Public hygiene facilities should satisfy the state hygiene standard and requirements.

☐ Control measures for hygiene and disease

☐ File establishment and general investigation of epidemic situation

In order to control communicable disease epidemic in construction area, the construction contractors should carry out comprehensive health investigation for construction personnel and establish epidemic situation file before construction personnel entering the site, and only healthy personnel can enter the construction area.

Investigation and file contents mainly include age, sex, health situation, communicable disease history, native places and etc. the general investigation items are: tuberculosis, epidemic hepatitis, diarrhea and so on, outsourcing construction personnel should also check the origin of communicable disease.

Investigation and number of establishing file will be calculated according to 3900 person/day during the construction peak period.

☐ Selective examination of epidemic situation and control plan

During the construction period, carry out regular epidemic situation sampling quarantine on epidemic situation. Selective examination contents of epidemic situation are mainly alimentary canal communicable diseases of local susceptible hepatitis, diarrhea, respiratory diseases of tuberculosis and other common communicable diseases in the general investigation of epidemic situation, find patients condition and carry out therapy in time.

Quarantine will be carried out in autumn every year during the construction period, quarantine persons will be calculated according to 10% of 3900 persons during the construction peak period, namely 390 persons.

In order to control effectively epidemic disease in the site and improve the disease resistance ability of construction personnel, adopt some preventive measures for construction personnel regularly, such as take preventative medicine, vaccination and etc.

☐ Epidemic situation monitoring and emergency measures

All Owners should determine clearly person in charge of hygiene and disease control, and manage epidemic situation management system and report system regulated by the local hygiene department, and receive the supervision of the local hygiene department.

Epidemic situation monitoring station should be set during the construction period, prepare medicines and facilities for common communicable diseases at any time, such as diarrhea, hepatitis, tuberculosis and etc. in case of epidemic situation, adopt measures for infection source, like therapy, isolation, observation and etc, adopt preventive measures for susceptible
10.7.4 Protective measures for area public facilities

The project land occupation and reservoir area immersion will occupy 8 wells, pressure pumped well 161, water tower 1 set, Class IV Highway 2.21km, tractor road 10.71km, ferry and wharf 18, aerial optical cable 8.62km, underground optical cable 5.84km, cable TV line 2.48km, 10kV transmission line 5.03km, 0.4kV transmission line 7.55km, transformer 3 sets, small hydraulic power plant 1 (200kW), small scale electric lift irrigation facilities 15 points, water works for industrial use 1. since this will generate certain impact to normal production, life, work and travel of the local residents, protective measures should be adopted accordingly.

☐ Migrant residential point relocation plan established in the main part of the project will guarantee all migrants productive conditions, house building conditions, infrastructure of water, power and road conditions not lower than the before the building of reservoir. These measures can guarantee the living level of migrants is not lower than before the requisition and relocation, and even higher than before the implementation of the project.

☐ Special item rebuilding plan established in the main part of the project will rebuild all public facilities affected by the construction on the principle of resuming its function in accordance with original scale, original standard. These measures can guarantee the effective resume of area public facilities.

☐ Aforesaid measures should be implemented according to the principles of make-before-break, and those facilities shall be put into operation before the requisition and relocation and the water storage of reservoir area.

10.7.5 Protective measures for geological environment

10.7.5.1 Protective measures for geological environment during the construction period

Reservoir bank with poor stability is mainly distributed in Jiangjiazhou—Huwei on the east bank of Kan River in the dam site area, Weijia on the east bank of Kan River at the end of reservoir and both banksides section of Shushui River entering into Kan River with a total length about 24km. the project design has adopted proper works design measures for treatment according to the requirements of the regulations, specifications and relative documents.

Both banks of earth-rock dam section meet with F1, F3 fault with medium water penetration, in order to control the dam foundation penetration, the project design has adopted proper works design measures for anti-penetration treatment according to the requirements of the regulations, specifications and relative documents.

Absorption rate of rock body of ZK203, ZK206 holes of dam foundation at concrete dam section is between 10—100Lu, which has medium water penetration; in order to control the
10.0 Environment Protection Measures & Technoeconomic Analysis

dam foundation penetration, the project design has adopted proper works design measures for anti-penetration treatment according to the requirements of the regulations, specifications and relative documents.

Furthermore, adopt necessary project measures for reservoir protection that may occur leakage, such as grouting, bedspread, block, build retaining wall, membrane barrier wall and drain and pressure reduction measures; for bank slope that may occur serious bank slope damage (collapse, landslide), adopt measures for protection, such as slope protection, unloading load, regulation, reconstruction and necessary plant protection.

10.7.5.2 Protective measures for geological environment during the operation period

Carry out regular monitoring and maintenance on the stability of reservoir banks of the project protection area, and adopt emergency treatment for section in dangerous conditions.

10.7.6 Submergence impact prevention measures

To prevent and treat submergence impact of the reservoir area, the engineering contractor has designed and arranged five protection areas of Wanhe, Yanxi, Zhangtang, Yongchang and Taihe County Seat. The total length of fending groyne lines of the protection works is 38.38km, including 3.36km Taihe Fending Groyne, 8.12km Wanhe Fending Groyne, 0.80km Zhangtang Fending Groyne, 15.79km Yongchang Fending Groyne and 10.32km Yanxi Fending Groyne, the total length of guide support canal is 61.33km, including 17.18km long county seat guide support canal to be dredged and resumed as per the original section, 14.45km Yongchang Guide Support Canal to be refit as per the design standard, 29.70km Yanxi and Wanhe guide support (drainage) canals to be built; 11.85km diversion canal to be refit; 6 new pumping stations with total installed capacity of 5456kW and 2 new regulating sluices. The total farmland elevating area is 1237.05Mu.

Drainage design standard: There are village and town protection areas within the protection area, the drainage standard is to apply a once-in-a-five-year 3-day rainstorm and drain to the inundation resistant depth within 3 days; the drainage standard of the Taihe County seat is to apply a once-in-a-10-year 1-day storm and drain to the elevation of main buildings non-inundated within 1 day, indicated in the Preliminary Design Report of Flood Control Work of the Taihe County Seat by Ji’an City Water Conservancy and Hydropower Plan and Design Institute; The drainage standard of the guide support canal within the protection area is to apply the corresponding drainage reoccurrence period standard of the protection area, the foreign water guide support canal (river) within the protection area is based on the design flood standard of the fending groyne of the protection area.

In the engineering design of protection work of protection area, the embankment will be raised, consolidated or newly constructed, to develop into sealed protection ring. Vertical anti-seepage treatment will be done for permeable layer of embankment foundation; drain system at flat land of the region will be refit and dredged, with drain pumping stations and culverts and gates at outlet of inland inundation and waterlogging control; water from hillsides within
the area will be diversified. Farmland elevating measure will be taken for local area. It is suggested that in the engineering design of the next stage, as per raised water table depth after water impounding of protection areas and corresponding inundation standard, detailed inundation impact survey should be made at the protection areas, specific protection and treatment measures should be taken for the area possibly affected by inundation as per the survey results.

10.7.7 Other environmental protective measures

□ Project construction will cause the original navigation mark facilities arranged on the river section of dam site losing navigation function. This will cause some impact to the navigation during the construction period. The Owner should communicate closely with the navigation competent authorities during the construction period, and set necessary temporary navigation mark facilities in order to guarantee the safety of navigation.

□ Project operating period will generate certain amount of flush to the dam below, both banks of the dam below may cause collapse. The project design has implemented project protection measures for bank line of dam below that may generate collapse according to the requirements of the regulations, specifications and relative documents.

□ During construction of Phase II cofferdam, along with the gradual advance of berm, the original navigation river channel will be narrowed, which will loss the navigation function, while the permanent structures will usually start to use only after the water level reaches a certain degree, there is a gap between them, there is a shipping interruption time for a short or longer while.

In order to solve or relieve this contradiction, we suggest keeping close contact with maritime affair and navigation department, apply short term navigation blockage if necessary, and issue notice to mariners in advance in order to guarantee the navigation safety.

10.8 Handling Measures for Solid Waste

10.8.1 Handling measures for solid waste during the construction

Solid waste during the construction period mainly includes construction rubbish and domestic waste of construction personnel. Generating capacity of solid waste in construction period (domestic waste ) peak is 3900Kg/d; total construction rubbish quantity during the whole construction period is about 200~300t. Since the project has a longer construction cycle, various solid wastes generated in the construction camp during the project construction process should be treated properly, abandon at will is forbidden. Productive rubbish, such as abandoned concrete block, equipment packing and so on should be concentrated to stack, and then sent to the nearby refuse disposal plant of the town for landfill treatment. Set garbage can in construction living area and main office area, and transport periodically to the refuse disposal plant for landfill treatment.
10.8.2 Handling measures for solid waste during the operating period

Generating capacity of domestic waste generated by personnel of project management department of Shihu navigation and power junction is 193.5kg/d. Project management department will be equipped with 30 garbage cans to collect domestic waste of staffs, and transport periodically to the refuse disposal plant for landfill treatment.

Generating capacity of domestic waste of ships in waterway of reservoir area in 2020 is about 13.49t, and about 16.67t in 2030. Ship domestic waste should not be thrown into the river at will, ship lock shall be equipped with 20 garbage cans in order to collect domestic waste of the ship, and transport periodically to the refuse disposal plant for landfill treatment.

Taihe County Environment and Hygiene Management Office has the transport and treatment ability of domestic garbage during construction and operation of the project. Presently Taihe County Environment and Hygiene Management Office has committed to undertake paid transport and treatment of domestic garbage during construction and operation of the project (see Appendix 11).

10.9 Precautions and Emergency Plan for Environmental Risk

See Chapter 9.0 ENVIRONMENTAL RISK ANALYSIS for details of precautions and emergency plan for environmental risk.
11.0 ENVIRONMENT MONITORING AND ENVIRONMENT MANAGEMENT

11.1 Environment Monitoring Plan

11.1.1 Objective of environmental monitoring

Environmental monitoring plans include the Environmental Monitoring Plan during Construction and the Environmental Monitoring Plan during Operation, the purposes of monitoring are to investigate and understand the range and degree of influence on the environmental quality from the construction of the project during construction and during operation so as to provide authoritative prompt information and scientific basis for environmental management.

11.1.2 Environment Monitoring Plan during the Period of Construction

In order to monitoring the performance of various measures for environmental protection in construction period and understand the environmental influences from the project in operation period as well as to better understand the environmental quality in construction area and the discharging of the pollutants in different construction stages, it is necessary to carry out environmental monitoring in construction period.

The monitoring period shall include the whole construction period and the contents include water quality, air, noise, biological environment, public health, hydrological forecasting, soil erosion, resettlement and so on.

11.1.2.1 Water quality monitoring

- Monitoring of sewage port

  Monitoring item: pH value, suspended matters, oily matters, COD, BOD₅, ammonia and nitrogen.

  Monitoring point: including the discharging port of domestic sewage, discharging port of sewage of foundation pit, discharging port of the sewage from concrete blending system.

  Monitoring frequency: twice per year, once respectively in level period and dry season. The monitoring time shall be increased in the peak period of construction.

- Monitoring of water quality of Kan River at this section

  Monitoring item: pH value, water temperature, suspended solids, oils, index of permanganate, BOD₅, ammonian and total phosphorus.

  Monitoring section: one section shall be arranged respectively at the upper and lower reaches of Hanjiang River at construction area to collect the water sample of the surface layer.
Monitoring frequency: twice per year, once respectively in level period and dry season. The monitoring methods of water quality shall be carried out according to Monitoring and Analysis Method of Water and Waste Water (the second edition) issued by State Bureau of Environmental Protection.

11.1.2.2 Air monitoring
Monitoring item: TSP, SO$_2$ and NO$_2$

Monitoring frequency: twice per year, once respectively in summer and winter, 5 days continuously for each time.

Monitoring point: one monitoring point will be set respectively at the Shihutang Village, Jiangjiazhou Village, Lingbei Village, Xiayinxia Village, access road sides at the construction areas of the right and left banks of the site.

The monitoring and analysis methods will be based on the specifications in Monitoring and Analysis Method of Air and Waste Water (1990) issued by State Bureau of Environmental Protection.

11.1.2.3 Noise monitoring
Monitoring item: continuous equivalent sound level A.

Monitoring frequency: once per season, monitoring frequency will be properly increased at construction peak.

Monitoring point: one monitoring point will be set respectively at the Shihutang Village, Jiangjiazhou Village, Lingbei Village, Xiayinxia Village, access road sides at the construction areas of the right and left banks of the site.

Monitoring points during construction period are shown in DRAWING NO. 15.

11.1.2.4 Hydrologic regime monitoring and forecasting
Hydrologic information about water from upstream and rainfall will be collected during construction period, and hydrologic regime forecast plan of construction period will be prepared.

11.1.2.5 Water and Soil Erosion Monitoring
Water and soil conservation plan is to set 39 fixed monitoring points: one point at the borrow site, spoil site and construction site of the pivot work area separately; five points at the borrow site, spoil site, construction site and filled side slope of the fending groyne work area.
separately; four points at the borrow site, spoil site, construction site and filled (excavated) side slope of the fending groyne work area separately. Patrol inspection will be implemented in other construction sites.

Water and soil erosion monitoring plan is shown in Table 11.1 Water and soil erosion monitoring points of construction site are shown in DRAWING NO. 43.

11.1.2.6 Old trees monitoring
Construction supervisors shall supervise the construction site carefully, assuring the old trees protection measures implemented. The management personnel of the project environment protection dept. and construction contractors will carry out daily patrol inspection on the construction site, directly viewingly understanding the impacts on old trees by construction activities, and preventing construction activities from damaging old trees or contrived damages of old trees.

11.1.2.7 Aquatic ecology monitoring
It is to survey the situation, species and quantity of fishes passing through the river section of the dam site during construction period, and to analyze their reasons so as to take related countermeasures.

11.1.2.8 Monitoring of other construction sites
As for the construction situation of the reservoir, lower reaches, construction road, solid wastes, material stacking sites, borrow sites and waste dumping sites, cultural relic protection, resettlement area, reservoir area cleanup, Kan River navigational safety, construction site overviews, the supervising and the managerial staff of the environmental protection department of the project must make daily inspection of the sites, so as to have direct views of the general environmental quality, promptly discover environmental problems and analyze their developing tendency and to take countermeasures accordingly.

The environmental monitoring plan of the project in construction period is shown in Table 11.1-2.
## Table 11.1 — Water and soil conservation monitoring plan during construction

<table>
<thead>
<tr>
<th>Period</th>
<th>Item</th>
<th>Monitoring point</th>
<th>Content</th>
<th>Monitoring frequency &amp; method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction period</td>
<td>Dike slope</td>
<td>One point for each dike section.</td>
<td>Rainfall, Erosion loss</td>
<td>Once before and after rainy season of each year, once every month from June to September, once more after P12h·30mm rain, with site measuring method.</td>
</tr>
<tr>
<td></td>
<td>Fill slope of guide support canal</td>
<td>One point for each canal section.</td>
<td>Rainfall, Erosion loss</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Borrow site</td>
<td>One for pivot area, one for each of protection area of fending groyne work and drainage work</td>
<td>Disturbed ground area, erosion loss</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Construction site</td>
<td>One for pivot area, one for each of protection area of fending groyne work and drainage work</td>
<td>Disturbed ground area, erosion loss and density of cover</td>
<td>Once before and after rainy season of each year, once every month from June to September, twice more after P12h·30mm rain, with site measuring method.</td>
</tr>
<tr>
<td></td>
<td>Spoilt site</td>
<td>One for pivot area, one for each of protection area of fending groyne work and drainage work</td>
<td>Whether or not to dump at specified place, erosion loss and prevention</td>
<td>Once before and after rainy season of each year, once more after P12h·30mm rain, with site measuring method.</td>
</tr>
<tr>
<td>Woods and grass resumption period</td>
<td>Filled slope</td>
<td>Wanhe section, Yanxi section</td>
<td>Completeness of protection work — vegetation survival ratio, density of cover, soil erosion.</td>
<td>Once every May and October of each year, site survey, standard land method</td>
</tr>
<tr>
<td></td>
<td>Construction site</td>
<td>Pivot area, fending groyne area, drainage work area</td>
<td>Ditto</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Borrow site</td>
<td>Pivot area, fending groyne area, drainage work area</td>
<td>Ditto</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Spoil site</td>
<td>Pivot area, fending groyne area, drainage work area</td>
<td>Ditto</td>
<td>Ditto</td>
</tr>
</tbody>
</table>

Note: Site patrol inspection shall be done at other construction stages at rainy
prospects found shall be timely feedbacked to the Owner.
Table 11.1—2 Environment monitoring plan during construction

<table>
<thead>
<tr>
<th>Monitoring factor</th>
<th>Monitoring point (section)</th>
<th>Content</th>
<th>Monitoring frequency</th>
<th>Monitoring organs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water quality</strong></td>
<td>1# domestic sewage discharge at right bank, taking mixed water sample.</td>
<td>pH, COD, BOD₅, NH₃-N.</td>
<td>Twice per year, once per dry and level season. Monitoring times shall be properly increased at construction peak.</td>
<td>Ji’an City Environment Monitoring Station</td>
</tr>
<tr>
<td></td>
<td>2# domestic sewage discharge at left bank, taking mixed water sample.</td>
<td>pH, SS, oils.</td>
<td>Twin per year, once per dry and level season.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3# foundation pit waste water discharge, taking mixed water sample.</td>
<td>pH, water temperature, SS, oils, COD₅, BOD₅, BOD₅, NH₃-N &amp; total P.</td>
<td>Twin per year, once per dry and level season.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4# waste water discharge of concrete blending system at left bank, taking mixed water sample.</td>
<td>pH, SS, oils.</td>
<td>Twin per year, once per dry and level season.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5# waste water discharge of concrete blending system at right bank, taking mixed water sample.</td>
<td>pH, SS, oils.</td>
<td>Twin per year, once per dry and level season.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6# 1km upstream of the dam site, taking mixed water sample of left, middle and right.</td>
<td>pH, water temperature, SS, oils, COD₅, BOD₅, BOD₅, NH₃-N &amp; total P.</td>
<td>Twin per year, once per dry and level season.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7# 1km downstream of the dam site, taking mixed water sample of left, middle and right.</td>
<td>pH, water temperature, SS, oils, COD₅, BOD₅, BOD₅, NH₃-N &amp; total P.</td>
<td>Twin per year, once per dry and level season.</td>
<td></td>
</tr>
<tr>
<td><strong>Air</strong></td>
<td>1# Shihutang Village</td>
<td>TSP, SO₂, NO₂.</td>
<td>Twin per year, continuous 5 days per time</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>2# Jiangjiazhou Village</td>
<td>TSP, SO₂, NO₂.</td>
<td>Twin per year, continuous 5 days per time</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>3# Beiling Village</td>
<td>TSP, SO₂, NO₂.</td>
<td>Twin per year, continuous 5 days per time</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>4# Xiayinxia Village</td>
<td>TSP, SO₂, NO₂.</td>
<td>Twin per year, continuous 5 days per time</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>5# side of access road of pivot construction area at the left bank</td>
<td>TSP, SO₂, NO₂.</td>
<td>Twin per year, continuous 5 days per time</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>6# side of access road of pivot construction area at the left bank</td>
<td>TSP, SO₂, NO₂.</td>
<td>Twin per year, continuous 5 days per time</td>
<td>Ditto</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>1# Shihutang Village</td>
<td>Equivalent continuous A sound level</td>
<td>Once per season, once at day and at night per time</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>2# Jiangjiazhou Village</td>
<td>Equivalent continuous A sound level</td>
<td>Once per season, once at day and at night per time</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>3# Beiling Village</td>
<td>Equivalent continuous A sound level</td>
<td>Once per season, once at day and at night per time</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>4# Xiayinxia Village</td>
<td>Equivalent continuous A sound level</td>
<td>Once per season, once at day and at night per time</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>5# side of access road of pivot construction area at the right bank</td>
<td>Equivalent continuous A sound level</td>
<td>Once per season, once at day and at night per time</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>6# side of access road of pivot construction area at the left bank</td>
<td>Equivalent continuous A sound level</td>
<td>Once per season, once at day and at night per time</td>
<td>Ditto</td>
</tr>
<tr>
<td><strong>Regime forecasting</strong></td>
<td>Hydrologic information about water from upstream and rainfall will be collected during construction period, and hydrologic regime forecast plan of construction period will be prepared.</td>
<td>Hydrologic information about water from upstream and rainfall will be collected during construction period, and hydrologic regime forecast plan of construction period will be prepared.</td>
<td>Real time monitoring</td>
<td>The Owner &amp; construction contractor</td>
</tr>
<tr>
<td><strong>Old trees</strong></td>
<td>Assuring the old trees protection measures implemented, understanding the impacts on old trees by construction activities, and preventing construction activities from damaging old trees or contrived damages of old trees.</td>
<td>Assuring the old trees protection measures implemented, understanding the impacts on old trees by construction activities, and preventing construction activities from damaging old trees or contrived damages of old trees.</td>
<td>Daily</td>
<td>The Owner &amp; construction contractor &amp; supervision contractor</td>
</tr>
<tr>
<td><strong>Aquatic ecology</strong></td>
<td>Understanding activities of fishes.</td>
<td>Understanding activities of fishes.</td>
<td>Daily</td>
<td>Project Environment Protection Dept. &amp; construction supervision contractor</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>Observing environment quality during construction</td>
<td>Observing environment quality during construction</td>
<td>Daily</td>
<td>Project Environment Protection Dept. &amp; construction supervision contractor</td>
</tr>
<tr>
<td></td>
<td>Reservoir &amp; its downstream</td>
<td>Observing environment quality during construction</td>
<td>Daily</td>
<td>Project Environment Protection Dept. &amp; construction supervision contractor</td>
</tr>
<tr>
<td></td>
<td>Construction road</td>
<td>Observing environment quality during construction</td>
<td>Daily</td>
<td>Project Environment Protection Dept. &amp; construction supervision contractor</td>
</tr>
<tr>
<td></td>
<td>Material storage yard</td>
<td>Observing environment quality during construction</td>
<td>Daily</td>
<td>Project Environment Protection Dept. &amp; construction supervision contractor</td>
</tr>
<tr>
<td></td>
<td>Solid wastes</td>
<td>Observing environment quality during construction</td>
<td>Daily</td>
<td>Project Environment Protection Dept. &amp; construction supervision contractor</td>
</tr>
<tr>
<td></td>
<td>Borrow sites and spoil sites</td>
<td>Observing environment quality during construction</td>
<td>Daily</td>
<td>Project Environment Protection Dept. &amp; construction supervision contractor</td>
</tr>
<tr>
<td></td>
<td>Resettlement area</td>
<td>Observing environment quality during construction</td>
<td>Daily</td>
<td>Project Environment Protection Dept. &amp; construction supervision contractor</td>
</tr>
</tbody>
</table>
11.1.3 Environment Monitoring Plan during the Operating Period

11.1.3.1 Monitoring of Water Quality

The change of the water quality at the inlet of the reservoir, in the reservoir and at the outlet of the reservoir after the reservoir is built must be monitored. If the result shows that pollution is aggravated or over the limit, timely report to the environment protection administration must be made in order to adopt the relevant measures for controlling the pollution sources and to guarantee the water quality to reach the function standard as regulated.

Layout of the Sections for Monitoring: the principle of the layout is to control the quality of the water source from the upper reach of the river, and that of the water in the reservoir and that at the outlet of the reservoir. Seven sections are to be laid out for monitoring.

Monitoring Frequency: continuously monitoring for five years, once during low flow period, level period and high-water period respectively; two successive days each time for sampling at sections of the right, middle and the left.

Monitoring items: totally 15 items, including water temperature, pH, SS, DO, CODmn, BOD5, oils, NH3-N, Hg, phenols, total P, total N, Cr\(^{+6}\), coliform bacteria and chlorophyll a.

11.1.3.2 Monitoring of Water Temperature

After the Project is completed, the water temperature will show its firm layered structure. At that time monitoring of the vertical layered structure of the water temperature must be performed and the temperature of the flow or drain must be validated in order to adopt measures to reduce the influence on water for industrial and agricultural uses at the lower reaches of the river.

Monitoring of the water temperature structure is to be done within the five vertical observation lines distributing in the left, middle, right zones of the dam and in the reservoir and at the tail of the reservoir.

Monitoring frequency: the observation period is 5 years and the time for the same term observation is the fifth day, 15\(^{th}\) day and 25\(^{th}\) day of each month at 8:00.

Monitoring items: the water temperature and the runoff at the outlet of the power station, the vertical water temperature of the reservoir, the water temperature and runoff at the inlet, the air temperature in front of the dam, water level, etc.

11.1.3.3 Monitoring of noise
Monitoring point: one monitoring point will be set respectively at the Shihutang Village, Jiangjiazhou Village, Lingbei Village and Xiayinxia Village.

Monitoring Frequency: continuously monitoring for three years, once per season.

Time and Method for Monitoring: as per the relevant requirements in *Methods for Measuring of Environmental Noises in Urban Area* (GB/T14623-93).

11.1.3.4 Hydrologic regime monitoring and forecasting
After the reservoir impounds water, the hydrologic regime will be observed for 20 years, Hydrologic information about coming water and rainfall of the area will be collected, and hydrologic regime forecast plan will be prepared.

11.1.3.5 Monitoring of reservoir bank stability
After the reservoir impounds water, the reservoir bank stability will be monitored for 5 years.

11.1.3.6 Soil submersion monitoring
After the reservoir impounds water, the submerged soil will be monitored for 5 years.

11.1.3.7 Monitoring of water and soil erosion
Monitoring period of water and soil erosion is ten years, the first monitoring of water and soil erosion will be done in the first year of operation period, thereafter, it will be monitored once every two years.

11.1.3.8 Monitoring of old trees
After the reservoir impounds water, the old trees will continuously be observed and maintained for 5 years.

11.1.3.9 Monitoring of terrestrial ecosystem and land resource
Monitoring of terrestrial ecosystem and land resource is to understand the impacts on terrestrial ecosystem and land resource application due to the reservoir inundation and resettlement development work after operation of the reservoir.

Irregular survey will be made on density of cover, terrestrial organism species change, and diversity change, especially the backwater section of the reservoir will be observed; irregular observation and survey shall be made on change of the land application method and benefit of the reservoir area and resettlement area, water and soil erosion and soil fertility; irregular
observation shall be made on soil gleying and secondary salinization at the surrounding of reservoir and its downstream.

11.1.3.10 Monitoring of aquatic ecosystem

- Monitoring and survey on population type, quantity, biomass, fish flora, population, dominant species, distribution and change of aquatic higher plants, plankton and zoobenthos;
- One aquatic ecosystem monitoring point will be set respectively at the Taihe Spawning Site, the Yanxidu Spawning Site, and at 2km downstream the dam (Specific locations are shown in DRAWING NO. 42), monitoring and surveying the spawns, fry quantity, fish species, quantity, population dynamics, and habitat condition;
- Survey on the effect of fish proliferation and fry laying;
- Survey on situation, species and quantity of fishes passing through the fish pass, analysis on their tendency so as to take relevant countermeasures;
- Since the first year after the reservoir impounds water, three aquatic ecological environment monitoring will be made respectively in April, July and December of each year, for continuous five years. Fish passing situation of the fish pass will be surveyed once a season, survey frequency will be properly increased during spawning and migration peak period.

11.1.3.11 Other monitoring during operation

As for the construction situation of the reservoir, lower reaches, resumption overviews of material stacking sites, borrow sites and waste dumping sites, resettlement area, increase and reduction of discharge ports, the supervising and the managerial staff of the environmental protection department of the project must make inspection of the sites, so as to have direct views of the general environmental quality, promptly discover possible environmental problems and analyze their developing tendency and to take countermeasures accordingly.

Environment monitoring plan during operation is shown in Table 11.1—3. Environment monitoring points during operation of the project are shown in DRAWING NO. 15.
### Table 11.1—3  Environment monitoring plan during operation

<table>
<thead>
<tr>
<th>Factor</th>
<th>Monitoring point (section)</th>
<th>Content</th>
<th>Monitoring frequency</th>
<th>Monitoring organs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality</td>
<td>1# at 100m upstream at backwater end of the reservoir, taking mixed water samples of left, middle and right side.</td>
<td>Water temperature, pH, SS, DO, COD$_{mn}$, BOD$_5$, oils, NH$_3$N, Hg, volatile phenol, total P, total N, Cr$^{6+}$, coliform and chlorophyll a etc.</td>
<td>Once per dry, level and rich season of each year, two days each time.</td>
<td>Ji’an City Environment Monitoring Station</td>
</tr>
<tr>
<td></td>
<td>2# Taihe County Seat discharge, taking mixed water samples.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3# 100m upstream of Gouzinao Water Intake, taking mixed water samples of left, middle and right side.</td>
<td>Flowrate, flow and ecological base flow added for 6# section.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4# Yanxi discharge, taking mixed water samples.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5# 200m upstream of the dam site, taking mixed water samples of left, middle and right side.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6# 1km downstream of the dam site, taking mixed water samples of left, middle and right side.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7# 100m downstream of Wanhe Drainage Gate, taking mixed water samples of left, middle and right side.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water temp.</td>
<td>1 # Vertical survey line at the left side of the dam site</td>
<td>Water temperature, flow, atmospheric temperature, water level</td>
<td>Survey period is five years, survey time is 8:00 a.m. of the 5th, 15th, and 25th of each month</td>
<td>Ji’an City Environment Hydrological Station</td>
</tr>
<tr>
<td></td>
<td>2 # Vertical survey line at the middle of the dam site</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 # Vertical survey line at the right side of the dam site</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 # Reservoir middle vertical survey line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 # Reservoir tail vertical survey line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>1# Shihutang Village</td>
<td>Equivalent continuous A sound level</td>
<td>Once a season, once at day and at night each time.</td>
<td>Ji’an City Environment Monitoring Station</td>
</tr>
<tr>
<td></td>
<td>2# Jiangjiazhou Village</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3# Lingbei Village</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4# Xiayinxia Village</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regime forecast</td>
<td>Collection of hydrological information and preparation of regime forecasting plan</td>
<td></td>
<td>For continuous 20 years.</td>
<td>The Owner</td>
</tr>
<tr>
<td>Reservoir bank stability</td>
<td>All the protection areas</td>
<td></td>
<td>For continuous 5 years once a year.</td>
<td>Geological Dept.</td>
</tr>
<tr>
<td>Soil submersio n</td>
<td>All the protection areas</td>
<td></td>
<td>Ditto</td>
<td>Ditto</td>
</tr>
<tr>
<td>Water &amp; soil erosion</td>
<td>Reservoir area</td>
<td>Intensity and loss of water and soil erosion</td>
<td>Monitoring period is 10 years (once every two years)</td>
<td>Water conservancy dept.</td>
</tr>
<tr>
<td></td>
<td>Resettlement point</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old trees</td>
<td>Within the project area</td>
<td>Survey on the growth and habitat conditions of old trees within the project area, especially the affected old trees.</td>
<td>For continuous 5 years after operation of the reservoir</td>
<td>Forestry dept.</td>
</tr>
</tbody>
</table>

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Irregular observation on density of cover, terrestrial organism species change, diversity change, change of the land application method and benefit of the reservoir area and resettlement area. For continuous 5 years once a year.

### Table 11.1—3 Environment monitoring plan during operation (Cont’d)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Monitoring point (section)</th>
<th>Content</th>
<th>Monitoring frequency</th>
<th>Monitoring organs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial ecosystem</td>
<td>Within the project area</td>
<td>Irregular observation on density of cover, terrestrial organism species change, diversity change, change of the land application method and benefit of the reservoir area and resettlement area.</td>
<td>For continuous 5 years once a year.</td>
<td>Forestry dept. &amp; land administration dept.</td>
</tr>
<tr>
<td>Aquatic ecosystem</td>
<td>1# Taihe Spawning Site</td>
<td>Monitoring and survey on population type, biomass, fish flora, population, dominant species, distribution and change of aquatic higher plants, plankton and zoobenthos; Monitoring and surveying the spawns, fry quantity, fish species, quantity, population dynamics, and habitat condition; Survey on the effect of fish proliferation and fry laying; Survey on situation, species and quantity of fishes passing through the fish pass</td>
<td>Since the first year after the reservoir impounds water, three aquatic ecological environment monitoring will be made respectively in April, July and December of each year, for continuous five years. Fish passing situation of the fish pass will be surveyed once a season, survey frequency will be properly increased during spawning and migration peak period.</td>
<td>Fishery and aquatic product dept.</td>
</tr>
<tr>
<td></td>
<td>2# Yanxidu Spawning Site</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3# Place 2km downstream of the dam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>Reservoir and its downstream</td>
<td>Understand the general environmental quality change, promptly discover environmental problems and analyze their developing tendency and to take countermeasures accordingly.</td>
<td>Once a season</td>
<td>Project environment protection dept.</td>
</tr>
<tr>
<td></td>
<td>Construction road</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Material storage yard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increase and decrease of discharge quantity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Borrow site and spoil site</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resettlement area</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11.1.4 Environment monitoring institutions

Environmental monitoring and management during the construction period is to be done by the joint monitoring group consisting of local qualified environmental monitoring unit entrusted by the project, local quarantine service and local environmental geological department.
After the completion of the reservoir, it is suggested that the environmental monitoring during the operation period is to be performed by the local environmental monitoring unit entrusted. The local quarantine service can be entrusted for the monitoring of public health within the reservoir area. The monitoring of stability of reservoir bank is to be undertaken by local environmental geological department entrusted. Monitoring of terrestrial ecological system shall be done by local forestry department, while the monitoring of aquatic ecological system shall be done by local fishery and aquatic products department.

All methods for monitoring and analyzing will adopt the existing national or industrial standards and codes.

11.1.5 Submission of Environmental Monitoring Report

After completion of each phase of monitoring during construction period, the monitoring institution is required to submit in duplicate *Environmental Monitoring Report during Construction Period of the Project* to the Environment Protection Department of the Project Construction Office of Shihutang Shipping and Hydropower Pivotal Project of NAA (hereafter referred as to the Project Office).

From the first year of construction commencement, the Project Office is required to submit semi-annual report respectively to NAA of Jiangxi Communications Bureau, Jiangxi Environment Protection Bureau and Ji’an Environmental Protection Bureau till completion of the project.

11.1.6 Estimated Cost of Environmental Monitoring

(1) Cost of Environmental Monitoring during the Construction Period

Construction period: 5 years; environmental monitoring cost: RMB 1,076 million yuan/a; monitoring cost of water and soil erosion: RMB 620,000 yuan/a.

(2) Cost of Environmental Monitoring during the Operation Period and other environment protection cost:

Environment monitoring cost: RMB 1,528 million yuan/a; monitoring cost of water and soil erosion: RMB 120,000 yuan/a

The estimated environmental monitoring charges are shown in Table 11.1.
11.0 Environment Monitoring & Environment Management

Table 11.1—4 Estimated environmental monitoring charges

<table>
<thead>
<tr>
<th>Phase</th>
<th>Monitoring items</th>
<th>Monitoring period(year)</th>
<th>Estimated cost (RMB10,000/a.)</th>
<th>Total (RMB10,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Water quality</td>
<td>5</td>
<td>3.0</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>Air</td>
<td>5</td>
<td>0.4</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
<td>5</td>
<td>0.12</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Aquatic ecology</td>
<td>5</td>
<td>8.0</td>
<td>40.0</td>
</tr>
<tr>
<td></td>
<td>Regime forecasting</td>
<td>5</td>
<td>4.0</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Old trees</td>
<td>5</td>
<td>6.0</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>107.6</strong></td>
</tr>
<tr>
<td>Operation</td>
<td>Water quality</td>
<td>5</td>
<td>2.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>Water temperature</td>
<td>5</td>
<td>2.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
<td>3</td>
<td>0.8</td>
<td>1.8</td>
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<tr>
<td></td>
<td>Public health</td>
<td>10</td>
<td>1.0</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>Regime forecasting</td>
<td>20</td>
<td>2.0</td>
<td>40.0</td>
</tr>
<tr>
<td></td>
<td>Bank stability</td>
<td>5</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>Soil immersion</td>
<td>5</td>
<td>3.0</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>Terrestrial ecosystem</td>
<td>5</td>
<td>3.0</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>Aquatic ecosystem</td>
<td>5</td>
<td>10.0</td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>152.8</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Grand total</strong></td>
<td></td>
<td></td>
<td><strong>260.4</strong></td>
</tr>
</tbody>
</table>

11.2 Environment Management Plan

11.2.1 Environment Management Organs and Responsibilities

Environment management is also an important guarantee that can control the negative impacts of the project and exert the long-run benefits. Environmental management must be available throughout the construction and operational periods whereby there will emerge many factors that will have impacts on the environment. Therefore, the project shall establish professional administrative institutions that have good professional basis and administrative competence. It should be equipped with necessary environmental protection personnel, being merged into the established integrative and professional environmental protection system to be responsible for, carrying out and supervising the work of environmental protection of the project.

Environment management procedure during construction of the Project is given in Drawing No.11.2-1. Environment management procedure during operation of the Project is given in Drawing No.11.2-2.
The environmental management for the project shall be conducted by the Project Office, under which, the Environmental Protection Section (EPS) of the Project shall be established and charged by specially-assigned persons.

During construction, the EPS has 1~2 full-time personnel with the following responsibilities:

The EPS is administratively under the leadership of the Project Office and professionally under the supervision and guidance of the provincial and prefectural (municipal) environmental protection bureaus, forestry bureaus, water conservancy bureaus and fishery bureaus, being responsible for submitting the monthly report on environmental management and for compiling the reports of environmental monitoring during construction.

Entrust qualified environment monitoring company to execute environment monitoring during construction, assist to well do environment monitoring work during construction.

Assure to include the environment management plan into tender document or contracting contract. Supervise construction contractor to implement pollution prevention and treatment measures, immediately issue an unconformity notice to the construction team and report to the Project Office if the contractors are found to violate environmental protection regulations or fail to effectively implement the pollution preventive measures. Assist to deal
with the environment pollution accidents in case a pollution accident occurs.

- Assure to include the environment management plan into tender document or supervision contracting contract. Supervise and participate in environment supervision of the Project. Assist to deal with the environment pollution accidents in case a pollution accident occurs.

- Employ an environment protection consultation organ to provide technical support for environment protection work of the Project during construction and to provide contractor with technical supervision of environment protection work and to assist to well carry out on-the-job environment protection training of project management personnel, supervision personnel and contractors.

- During operation, the EPS has 1~2 full-time personnel with the following responsibilities:

  - The EPS is administratively under the leadership of the Shihutang Pivot Management Department and professionally under the supervision and guidance of the provincial and prefectural (municipal) environmental protection bureaus, forestry bureaus, water conservancy bureaus and fishery bureaus, being responsible for submitting the annual report on environmental management and for compiling the reports of environmental monitoring during operation.
  - Entrust qualified environment monitoring company to execute environment monitoring during operation, assist to well do environment monitoring work during operation.
  - Supervise and assure normal operation of all the environment protection facilities. Assist to deal with the environment pollution accidents in case a pollution accident occurs.
  - Employ an environment protection consultation organ to provide follow-up study and technical support for environment protection work of the Project during operation and to assist to well carry out on-the-job environment protection training of management personnel and operators.

- Main responsibilities of environment monitoring organ:

  Main responsibilities of environment monitoring organ are to complete environment monitoring work during construction and during operation as per the entrustment of the EPS of the Project Office (Shihutang Pivot Management Department) and the environment monitoring plan given in this EIA.

- Main responsibilities of environment protection consultation organ:

  Main responsibilities of environment protection consultation organ are to provide technical support for the environment protection work of the Project and to provide technical supervision for contractors during construction as per the entrustment of the EPS of the Project Office (Shihutang Pivot Management Department), this EIA and the environment protection design document and to well carry out environment protection training work during construction; and to provide technical support for the environment protection work of the Project during operation and to well carry out environment protection training work during operation as per the entrustment of the EPS of the Project Office (Shihutang Pivot Management Department) and this EIA.

- Main responsibilities of contractor:
Main responsibilities of contractor are to perform environment protection work during construction according to the tender document, contract, this EIA and environment protection design document etc. under instruction and supervision of the environment management personnel and environment supervision engineers of the EPS of the Project Office and governmental relative functional departments and under technical support of environment protection consultation organ.

Responsibilities of environment supervisor:
The responsibilities of the environmental supervisor are, based on routine site observation, to coordinate the environmental protection section of the Project Office to deal with the identified environmental problems.

11.2.2 Environment supervision

The environmental protection supervisor can be assumed by construction supervision engineer who can learn to supervise environmental works after being trained.

11.2.2.1 Determination of environment supervision plan of the project

Environment supervision includes two parts of environment quality supervision and environment engineering supervision. Before environment supervision, supervisor shall prepare the supervision plan of the project according to the environment protection codes and standards related with the project, the engineering design document, design specification and other design documents, project construction contract, tendering and bidding documents, environment supervision contract and tendering and bidding document etc. The supervision plan shall include the followings:

Scope, stage and duration of environment supervision

Environment supervision scope: the area where the project is located and the affected area.

Scope of work: construction site, camp building, auxiliary facilities and etc. and the area in which construction may cause environment pollution and ecological damage of the said scope.

Stage of work: environment supervision at construction preparation stage, construction stage, and guarantee stage.

Term of supervision service: from construction preparation stage till expiration of guarantee period of the project, term of service during guarantee period is one year after completion of construction. The environment supervision of the project is divided into three stages of construction preparation, construction and defects liability period.

Work objectives

Environment supervision work objectives: In accordance with the national and industrial laws, rules, policies, the rules, codes and technical standards of the World Bank, and the approved design documents, bidding documents, supervision contract and construction contract signed lawfully, as per the scope and content of environment supervision service,
perform the environment supervision obligations, independently, justly, scientifically and effectively serve the project, implement an overall environment supervision, make the project to reach the environment protection requirements in the aspects of engineering design, construction and operation, implement the environment supervision as per the measures in the environment management plan of this report.

☐ Supervise the water and soil erosion caused by the main project and temporary works, check whether or not all the water and soil conservation facilities reach the design requirements, borrowing and spoiling are in accordance with specified procedures and locations; especially supervise construction spoils not to dump to mountain slopes to avoid damaging landscape; build temporary settling tank during construction; use straw cushion or plastic film to cover the ground breaking points or other places vulnerable to soil erosion before rainstorms for protection; keep the rivers, canals and drainage system unblocked with good conditions.

☐ Environment supervision on productive wastewater and residence sewage treatment measures: Supervise the sources, discharge quantities and water quality of productive wastewater and residence sewage, and construction process and treatment effect of treatment facilities of productive and domestic wastewater, check and monitor whether or not they reach the approved discharge requirements.

☐ Environment supervision of air pollution prevention measures: air pollution at the construction area comes mainly from waste gases and dust produced during construction and production. Pollution sources are required to discharge after meeting the discharge standard, construction area and its affected area shall reach the specified environment quality standard.

☐ Environment supervision of noise control measures: To avoid noise harm, strong noise or vibrating pollution sources shall be prevented as per the design requirement, especially blasting operation, it is required to assure the noise environment quality of construction area and its affected area to reach the related standard.

☐ Environment supervision of solid wastes treatment measures: Solid wastes treatment includes treatment of productive and domestic garbage and productive waste slags, reaching the requirement of cleanliness and tidiness of the construction site.

☐ Environment supervision of wildlife and aquatic ecological measures: To avoid impacts of water and soil erosion, manage the construction contractors, especially fulfill the measures of protection, relocation and isolated protection of old trees as per vegetation protection requirements.

☐ Environment supervision of public health measures: to guarantee domestic water and drinking water safe and reliable, prevent infective diseases, provide necessary welfare and sanitary conditions etc.

☐ Environment monitoring supervision: Supervise performance of the environment monitoring work as per the monitoring content of this report.

☐ Construction and installation supervision of environment protection facilities: supervise construction of wastewater treatment facility, noise barriers, environment greening etc.
Work system
Including work record system, training system, report system, correspondence system, regular environment meeting system: An environment protection supervision meeting will be held each month. During the regular environment meeting, contractor shall make a review summarization on the environment protection work of the recent stage, environment supervision engineer will make an overall assessment on the environment protection work of that month, affirming the achievement of the environment protection work and lodging existing problems and improvement requirements. A MOM will be formed at each meeting.

Plan and preparation of personnel and equipment in and out of the site
Preparing environment supervision work plan, submitting the composition of environment supervision organ and name list of environment supervision engineers to the Owner before entering the construction site; defining the duty responsibilities, posts and work time of environment supervision engineers; establishing complete and stringent supervision rules and regulations and organizing all the environment supervision engineers to be familiar with contract terms and related technical codes; carrying out site surveys, mastering the site landform, geographical objects, hydrogeology and environment overview.

On the basis of environment supervision plan, according to detailed engineering design, providing environment supervision work plan and preparing environment supervision work detailed rules for implementation before environment supervision engineers enter the site.

Environment supervision work plan and environment supervision work detailed rules for implementation will be prepared by environment supervision engineer, reported to the Owner for approval.

Quality control

Quality control principle
Implementing an overall-process and omnibearing check, supervision and management on construction. Stressing on precontrol, timely preventing and curbing varied disadvantageous factors which may cause environment impacts, stifling in the cradle; stringently implementing midcontrol, eliminating all the hidden troubles which may cause environment impacts at any time; completing post-control, making the project to be handed over by the contractor consistent with all the environment protection requirements specified in design documents, technical codes and contract.

Main methods and measures of quality control
Establishing a complete quality control system with chief supervisory engineer in charge of environment supervision work, executing an omnibearing supervision and check on the construction methods and processes of contractor.

Organization and coordination, information summarization, transmission and management
Coordination and management work will be well done mainly in the form of environment
supervision meeting.

As for information summarization, filing and management, according to the Owner’s requirements, with reference to related national, local and WB regulations and the project features, information will be sorted, classified, tabulated and filed, and special meeting will often be held, checking and supervising and urging contractor to timely sort contract document and technical documents, assuring engineering document and file classification clear & complete, technical files and drawings simultaneous with physical goods.

11.2.2.2 Content of environment supervision work

- Environment supervision at the early stage of construction

Review of pollution prevention plan: As per the process design of specific project, review wastes discharge links of construction process, main discharge pollutants, and review whether or not treatment measures applied in the design advanced or feasible. Plan for final pollutant disposal method and destination shall be made at the early stage of the project as per related rules and treatment requirements, and fulfilled after being reported to environment protection authority.

Review of special environment protection terms in construction contract: Construction contract must follow the environment protection requirements and embody in construction contract in the form of special terms, hereby strengthen supervision and management, check, monitoring during construction, reducing environment impacts during construction, meantime, civilized construction quality and construction environment management level of construction contractor will also be reviewed.

- Environment supervision during construction period

- Supervise and check whether water and soil conservation measures are consistent with requirements of environment protection countermeasures, measure fulfillment and effects;

- Supervise and check whether different machinery and equipment are consistent with noise pollution control requirement during construction or not;

- Supervise and check whether the domestic sewage and garbage at construction site are properly disposed as specified;

- Supervise and check the daily collection, classified storage and disposal of construction and domestic garbage;

- Productive wastewater must be discharged after treating and meeting the discharge standard;

- Supervise and check whether the construction roads are unblocked or drainage system in good application condition, the construction site has retained water;
Well train constructors in the aspect of environment protection, train them to have consciousness of cherishing environment and preventing pollution;

Well do the environment monitoring, check and inspection work for pollutants discharge during construction;

Participate in investigating and handling environment pollution accidents and environment disputes during construction period.

Environment resumption supervision after completion of the project

Supervise and manage the fulfillment of environment resumption monitoring and plan and the operation of the environment protection facilities.

Supervise preparation of as-built documents;

Organize initial acceptance;

Assist the Owner in organizing as-built acceptance;

Prepare the environment supervision sum-up report of the project;

Sort out environment supervision as-built documents.

Site supervision

Environment supervision engineers shall wholly patrol the environment protection construction and links possibly causing pollution, be present at the main pollution construction process to supervise and check all the links. The main work contents are:

Coordinate environment supervision work of site construction, stress on patrolling construction site, master site pollution dynamics, supervise and urge both contractor and supervisor to jointly implement environment supervision detailed rules well, timely find and handle important pollution problems;

Supervision engineers shall be present at construction site for supervision of the whole construction process and for site monitoring and checking contractor’s construction records.

Content of site monitoring and check: Check whether construction is in accordance with environment protection terms, or any changes without authorization; Check through monitoring whether the construction process is consistent with the environment protection requirements; check whether construction is consistent with the environment protection codes, or the environment protection design requirements; Check whether all the environment protection measures to assure the environment protection requirements have been implemented or not during construction.

Supervision personnel shall record daily site monitoring and check results and report to environment supervision engineer, the environment supervision engineer shall supervise and check the work of supervision personnel and timely find and treat the existing problems.
11.2.3 Environmental Protection Training

All personnel of the Project Office Environment Protection Section and construction workers have to receive environmental protection training at least one time before commencement of construction. Key environmental administrative and monitoring personnel must go through the technical training for a period of 1~3 months.

11.2.3.1 Environmental protection technology and technical training

1. On-duty training for environmental monitoring managerial personnel

The targets to provide with on-duty training for the environmental monitoring and management personnel are to enhance the work of environmental monitoring and management during construction and operational periods, thus to ensure the quality of environmental monitoring and effective environmental management and to wholly improve the quality of the project. Through the training, the trainees will know how to distinguish the key environmental problems during construction period and acquire more about the existing problems and deficiencies so that they can make prompt reports to the environmental protection department to take necessary preventive measures as soon as possible. During the process of construction, the Project Office Environment Protection Section will invite experts of environmental protection or experienced administrative staff to lecture on the possible environmental problems and correspondent solutions.

2. Training for persons in-charge and construction workers

Before commencement of the project, the persons in-charge and construction workers of the contractor must receive systematic training of environmental protection knowledge, so that they can avoid the damages to the environment due to mal-operation during the process of construction. The target of training person in-charge of contractor is to clarify the responsibilities of environmental protection for the contractor. The aim of training construction workers is to emphasize the correct operating methods for construction works during construction period, so that mal-operation can be avoided. The training of person in-charge and construction workers shall be charged by the assigned persons of the environmental protection department of the Project Office, of which, the main tasks are to make clear the possible damages to the environment by project construction, necessary environmental protection measures and the handling methods for any problems. Through training, the person in-charge may know the obligations that he should shoulder and the possible consequences if the environment is damaged. At the same time, construction workers may be more directly knowing about the degrees and methods of environmental protection for the sensitive points. According to the actuality of the project, the training period for the person in-charge and construction workers shall last for one week.

3. During operation period, Project Owner shall regularly provide environmental protection training for the staff, hence to make them clear about possible environmental problems and take necessary measures. Each personnel shall have the awareness to protect the environment.
11.2.3.2 Training method and training charges

Training method includes:
(1) Experts, or leaders from environmental protection competent department give lectures. Training budget is RMB 30000.

(2) Visit of environmental protection site of similar projects. This is to organize visits to the environmental administrative departments of representative inland river waterway development projects under construction or operation to learn experienced environmental administrative method through site demonstration. Training budget: RMB60000.

(3) Non-scheduled long-term (1 to 2 years) or short-term (1 to 3 months) training sponsored by domestic universities and scientific research units. Estimated cost for training is RMB 100,000.

(4) Abroad study and training. Twelve persons divided into two groups will be sent abroad to the places, which have similar experiences (especially the World Bank loaned projects) to learn foreign advanced management. It is to formulate provisions for environmental administration according to the actuality of the project. The training period shall be one month. Training budget: RMB600000.

The total budget of the above training will be RMB790000.

11.2.4 Implementation of Environmental Protection Measures

The Implementation plan of project environmental protection measures is shown in Table 11.2-1.
Table 11.2—1 Implementation plan of project environmental protection measures

<table>
<thead>
<tr>
<th>Key environmental problems</th>
<th>Mitigating measures</th>
<th>Implementation institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Design period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Flood control and reservoir inundation</td>
<td>Dam site, dam line, dam pattern, flood discharge mode, normal impounding level should be rational, hence to reduce the loss caused by inundation and avoid adverse impacts on anti-flood in reservoir area.</td>
<td>Engineering contractor</td>
</tr>
</tbody>
</table>
| 2. Safety of reservoir bank and dam. | - Adopt measures to prevent the risk from eroding bank, seepage and dam breaking.  
- Establish Dam Safety Team.                                                                                                                           | Engineering contractor, local government    |
| 3. Impacts of increasing water level on flood dam and irrigation and drainage facilities. | Raise anti-flood standard, repair and maintain flood release gate, flood release channel and drainage and irrigation facilities as well as implement compensation and relocation plan for water conservancy and electricity facilities. | Engineering contractor, Owner, local government |
| 4. Protection of cultural relics. | Survey if there are cultural relics hence to protect culture relics from being damaged.                                                                                                                               | EIA contractor                              |
| 5. Nature reserve          | -Environment alternatives comparison & selection for fending groyne line orientation, put forward environmental alternative scheme if necessary.                                                                         | Engineering contractor, Owner, EIA contractor |
| 6. Protection of old trees | -Adjust fending groyne line orientation as per the specific distribution of old trees.                                                                                                                               | Ditto                                       |
| 7. Aquatic ecology         | -Design fish pass and fish proliferation & fry laying station.                                                                                                                                                       | Engineering contractor, EIA contractor       |
| 8. Terrestrial ecology     | -Well do water and soil conservation and vegetable resumption plan.                                                                                                                                                 | Engineering contractor, water & soil conservation contractor, EIA contractor |
| 9. Land acquisition & resettlement | -Well prepare the RAP.                                                                                                                                                                                             | RAP contractor, EIA contractor               |
| II. Construction period    |                                                                                                                                                                                                                      |                                             |
| 1. Waste water pollution  | Waste water are mainly from the waste discharges from sand and stone materials, concrete blending & foundation pits. The pollutants can be settled for discharge after reaching the standard through treatment in sedimentation tanks and depositing tanks and oil isolation pond.  
It is discharged after reaching the discharge standard by adopting integrative sewage treatment device for domestic sewage.  
Bilge oil-contained water is discharged after meeting the discharge standard by using oil/water separator equipment in ship. | Contractor & subcontractor                  |
| 2. Dust pollution          | Water sprayer will be used to regularly spray water to reduce dust with the spraying frequency to be decided as per local soil property during construction period, regular cleaning shall be done.  
The material stack & material storage site must be covered or water sprayed to prevent from dust pollution. Trucks carrying materials shall be covered to reduce material dropping.  
Concrete blender shall be well sealed.                                                                                                           | Ditto                                       |
| 3. Noise pollution         | Choose low-noise construction machine. Strong-noise machine shall be arranged to work in daytime. Construction time limit shall be implemented in sensitive spots.                                                                 | Ditto                                       |
Build stone retaining wall, protection slope and water drainage in which water and soil erosion easily occur. Prompt refilling, tamping is necessary where it is excavated. Vegetation must be promptly recovered in borrow pits and spoil sites. | Ditto                                       |
<p>| 5. Environmental monitoring | In construction period, regular monitoring must be implemented as per environment monitoring plan.                                                                                                                      | Local environment                           |</p>
<table>
<thead>
<tr>
<th></th>
<th>monitoring station</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Protection of cultural relics</td>
<td>Relocation protection</td>
</tr>
</tbody>
</table>
Table 11.2—1 Implementation plan of project environmental protection measures

(Cont’d)

<table>
<thead>
<tr>
<th>Key environmental problems</th>
<th>Mitigating measures</th>
<th>Implementation institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Nature reserve &amp; old trees</td>
<td>∙ To implement the old trees protection plan; ∙ To Build cement laid stone slope protection at the river bank of Xinzhou 30m long. ∙ To Build a 1040m long cement laid stone slope protection at the river bank of the nature reserve.</td>
<td>Contractor &amp; subcontractor, forestry dept.</td>
</tr>
<tr>
<td>8. Aquatic ecology</td>
<td>∙ To build fish pass; ∙ To construct fish proliferation and fry laying station; ∙ To plant reeds etc. to form artificial fish nest; ∙ To observe and understand fishes activity.</td>
<td>Contractor &amp; subcontractor, fishery dept., the owner</td>
</tr>
<tr>
<td>III. Operation period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Industrial &amp; domestic waste water</td>
<td>No waste water shall be discharged by the Pivot proper. It is discharged after reaching the discharge standard by adopting integrative sewage treatment device for domestic sewage. Enterprises within reservoir area can discharge waste water into the Kan River after reaching the standard through treated by the city wastewater treatment plant. Projects of discharge nature surrounding the reservoir area shall be strictly controlled to avoid new pollution sources. Ship bilge oil-contained waste water, sewage and garbage shall not be discharged into water body but into acceptance facilities in the port.</td>
<td>Local government, Navigation administration</td>
</tr>
<tr>
<td>2. Noise of vessels</td>
<td>Strengthen the management of passing ships and vessels. Those which noise is beyond the limited standard are not allowed to run.</td>
<td>Navigation supervising administration</td>
</tr>
<tr>
<td>3. Accident risk</td>
<td>Regional flood control plan and the Ji’an City Emergency Plan to Handle Water Emergencies shall be implemented.</td>
<td>Local government, Transportation administrative department, navigation supervising administration</td>
</tr>
<tr>
<td>4. Environmental monitoring</td>
<td>Environmental monitoring must be implemented according to monitoring plan.</td>
<td>Ji’an environment monitoring station</td>
</tr>
<tr>
<td>5. Nature reserve and protection of old trees</td>
<td>∙ Old trees protection plan shall be executed.</td>
<td>Forestry dept. Contractor &amp; subcontractor</td>
</tr>
<tr>
<td>6. Aquatic ecology</td>
<td>∙ Vegetation coverage percentage, terrestrial animal and plant population change, reservoir area and resettlement area shall be irregularly observed.</td>
<td>The owner</td>
</tr>
<tr>
<td>7. Terrestrial ecology</td>
<td>∙ To survey aquatic higher plants, planktons, zoobenthos population type, biomass, and artificial fish nest etc. ∙ To observe spawn, fry quantity, fishes species, quantity, population dynamics, habitat condition and etc.</td>
<td>The owner</td>
</tr>
<tr>
<td>·To execute fish proliferation and fry laying and to survey its effect.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>·To survey the fish passing situation, passed fish species and quantity through fish pass.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
12.0 ENVIRONMENT PROTECTION INVESTMENT ESTIMATE AND ENVIRONMENTAL GAIN & LOSS ANALYSIS

12.1 Environment Protection Investment Estimate

12.1.1 Preparation principles and basis

- The principle of “one shall treat the pollution which he causes, one shall protect the environment in which he develops” shall be followed. The investment required by measures of environment protection, monitoring and management taken for lessening or eliminating disadvantageous impacts on the environment by construction project, not only protecting the environment but also serving the main project, shall be included in the environment protection investment of the project, among which the investment of environmental protection nature of the project investment and resettlement investment and water and soil conservation investment will be listed separately, the others are the environment protection investment.

- “Giving prominence to the key point” principle shall be abided by. The environment factors having great impact by the project, causing public attentions and having higher protection grades shall be specially protected with environment protection investment priority.

- “Function resumption” principle. The compensation measures taken for disadvantageous impacts on the environment by the project shall be based on the principle of resuming the original functions. The investment increased due to standard raising or scale increase of relocation and revamping project shall be borne by local government or competent authorities or equity ownership.

- “Compensation just in one time” principle. Substitute compensation or reasonable compensation in one time as per specified standard shall be paid for the environment losses by the project which can not be resumed.

- Environment protection is one of the important items of the project whose cost composition, investment estimate basis and price level are consistent with those of the main project.


12.1.2 Investment item classification

Article 62 of “Environment Protection Design Specification of Construction Project” specifies that units, equipment and monitoring means and engineering facilities required by pollution treatment and environment protection all belong to environment protection facilities and that construction project with environment protection facilities shall list out the investment estimate of environment protection facilities.

As per the regulations of “Environment Protection Design Estimate Preparation Specification for Water Resources and Hydropower Project”, together with environment protection work content of water resources and hydropower project, investment items are classified into five
12.0 Environment Protection Investment Estimate and Environmental Gain & Loss Analysis

parts: environment protection measures (including environment protection measures and environment monitoring measures), water and soil conservation measures, environment protection measures for resettlement, water and soil conservation measures for resettlement and reservoir area cleanup etc.

12.1.3 Environment protection investment estimate

The static environment protection investment of this project is estimated as per the price level of the first season of 2007.

12.1.3.1 Investment estimate of the environment protection measures of the project

Investment of water environment protection measures is estimated as 7.19 million yuan. Details are shown in Table 12.1-1.

Table 12.1-1   Investment estimate summary of water environment protection measures

<table>
<thead>
<tr>
<th>Stage</th>
<th>Item</th>
<th>Civil construction cost (10^4 yuan)</th>
<th>Equipment cost (10^4 yuan)</th>
<th>Operating cost (10^4 yuan)</th>
<th>Environment protection investment (10^4 yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction period</td>
<td>Sand &amp; stone aggregate flushing waste water treatment system at the pivotal left bank</td>
<td>20.0</td>
<td>60.0</td>
<td>50</td>
<td>130.0</td>
</tr>
<tr>
<td></td>
<td>Sand &amp; stone aggregate flushing waste water treatment system at the pivotal right bank</td>
<td>20.0</td>
<td>60.0</td>
<td>50</td>
<td>130.0</td>
</tr>
<tr>
<td></td>
<td>Concrete blending flushing waste water treatment system at the pivotal left bank</td>
<td>0.5</td>
<td>1.5</td>
<td>2.5</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>Concrete blending flushing waste water treatment system at the pivotal right bank</td>
<td>0.5</td>
<td>1.5</td>
<td>2.5</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>Foundation pit drainage treatment measure</td>
<td></td>
<td></td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Maintenance system oil-contained waste water treatment system at pivotal left bank</td>
<td>1.0</td>
<td>3.0</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>Maintenance system oil-contained waste water treatment system at pivotal right bank</td>
<td>1.0</td>
<td>3.0</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>Domestic sewage treatment system at pivotal left bank</td>
<td>5.0</td>
<td>25.0</td>
<td>35.0</td>
<td>65.0</td>
</tr>
<tr>
<td></td>
<td>Domestic sewage treatment system at pivotal right bank</td>
<td>5.0</td>
<td>25.0</td>
<td>35.0</td>
<td>65.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>409.5</td>
</tr>
<tr>
<td>Operation period</td>
<td>Domestic sewage collection &amp; treatment system</td>
<td>6.0</td>
<td>33.6</td>
<td></td>
<td>39.6</td>
</tr>
<tr>
<td></td>
<td>Oil contained wastewater treatment system</td>
<td>3.5</td>
<td>12.0</td>
<td></td>
<td>15.5</td>
</tr>
<tr>
<td></td>
<td>Workboat jetty</td>
<td>20.0</td>
<td></td>
<td></td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Workboat</td>
<td></td>
<td>150.0</td>
<td></td>
<td>150.0</td>
</tr>
<tr>
<td></td>
<td>Caution board</td>
<td></td>
<td></td>
<td></td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>800m oil boom, float, anchor, &amp; anchor rope etc.</td>
<td></td>
<td></td>
<td></td>
<td>50.0</td>
</tr>
<tr>
<td></td>
<td>2t Oil absorption felt and 1 oil absorber</td>
<td></td>
<td></td>
<td></td>
<td>30.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>309.5</td>
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<tr>
<td>Environment protection investment estimate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>719.0</td>
</tr>
</tbody>
</table>
Investment estimate of ambient air protection measures
Investment estimate of ambient air protection measures: 1.05 million yuan. Details are shown in Table 12.1—2.

Table 12.1-2 Investment estimate summary of air environment protection measures

<table>
<thead>
<tr>
<th>Period</th>
<th>Item</th>
<th>Unit</th>
<th>Qty</th>
<th>Unit price (10^4 yuan)</th>
<th>Environment protection investment (10^6 yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Sprinkler</td>
<td>Piece</td>
<td>3</td>
<td>20.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Operating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>105.0</td>
</tr>
</tbody>
</table>

Investment estimate of acoustic environment protection measures
Investment estimate of acoustic environment protection measures: 108,000 yuan. Details are shown in Table 12.1—3.

Table 12.1-3 Investment estimate summary of acoustic environment protection measures

<table>
<thead>
<tr>
<th>Period</th>
<th>Item</th>
<th>Unit</th>
<th>Qty</th>
<th>Unit price (10^4 yuan)</th>
<th>Environment protection investment (10^6 yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Noise reduction barrier</td>
<td>m</td>
<td>100</td>
<td>1000 yuan/m</td>
<td>10.0</td>
</tr>
<tr>
<td>Warning sign</td>
<td></td>
<td>Piece</td>
<td>8</td>
<td>1000 yuan/piece</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>10.8</td>
</tr>
</tbody>
</table>

Public health investment estimate
Public health investment estimate: 50,700 yuan. Details are given in Table 12.1—4.

Table 12.1-4 Public health investment estimate summary

<table>
<thead>
<tr>
<th>Period</th>
<th>Item</th>
<th>Unit</th>
<th>Qty</th>
<th>Unit price (10^4 yuan)</th>
<th>Environment protection investment (10^6 yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Public health quarantine</td>
<td>Person</td>
<td>390</td>
<td>50 yuan/person</td>
<td>1.95</td>
</tr>
<tr>
<td></td>
<td>Public vaccination</td>
<td>Mantime</td>
<td>390</td>
<td>30 yuan/mantime</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>Deratization, mosquitoes</td>
<td>Mantime</td>
<td>3900</td>
<td>5 yuan/mantime</td>
<td>1.95</td>
</tr>
<tr>
<td></td>
<td>extirpation etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>5.07</td>
</tr>
</tbody>
</table>
Solid waste treatment investment estimate

Solid waste treatment investment estimate: 112,000 yuan. Details are shown in Table 12.1—5.

Table 12.1-5  Solid waste treatment investment estimate summary

<table>
<thead>
<tr>
<th>Period</th>
<th>Item</th>
<th>Unit</th>
<th>Qty</th>
<th>Unit price</th>
<th>Environment protection investment $10^8$ yuan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction period</td>
<td>Solid waste collection &amp; disposal</td>
<td>Month</td>
<td>51</td>
<td>2000 yuan/m</td>
<td>10.2</td>
</tr>
<tr>
<td>Operation period</td>
<td>Solid waste collection &amp; disposal (garbage bins)</td>
<td>Piece</td>
<td>50</td>
<td>200 yuan/piece</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>11.1</strong></td>
</tr>
</tbody>
</table>

Investment estimate of ecological environment protection measures

Investment estimate of ecological environment protection measures: 19.362 million yuan. Details are shown in Table 12.1—6.

Table 12.1-6  Investment estimate summary of ecological environment protection measures

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Qty</th>
<th>Unit price</th>
<th>Environment protection investment $10^8$ yuan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Old tree protection cost</td>
<td>Item</td>
<td>1</td>
<td>655.06</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Fish passing device (Fish pass)</td>
<td>Item</td>
<td>1</td>
<td>716.14</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Fish proliferation and fry laying station</td>
<td>Item</td>
<td>1</td>
<td>500.00</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Artificial fish nest</td>
<td>Mu</td>
<td>2100</td>
<td>0.03</td>
<td>63.0</td>
</tr>
<tr>
<td>5</td>
<td>Ecological environment protection propaganda during construction</td>
<td></td>
<td></td>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>1936.2</td>
</tr>
</tbody>
</table>

12.1.3.2 Investment estimate of water and soil erosion prevention and treatment measures of the project

Investment estimate of water and soil erosion work of the project is 14.8113 million yuan, including 5.5933 million yuan for engineering measures, 1.5921 million yuan for plant measures, 1.8928 million yuan for temporary work of construction, 2.0415 million yuan for separate cost, 667,200 yuan as basic contingency fee and 3.0244 million yuan as compensation fee of water and soil conservation devices.

12.1.3.3 Investment estimate of resettlement environment protection measures

Investment estimate of resettlement environment protection measures: 411,600 yuan. Details are shown in Table 12.1—7.
### Table 12.1 — 7 Investment estimate of resettlement environment protection measures

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
<th>Qty</th>
<th>Unit price</th>
<th>Total (10^4 yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I. Environment protection measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Domestic sewage treatment</td>
<td>Biogas generating pit (septic tank)</td>
<td>Piece</td>
<td>196</td>
<td>0.10</td>
<td>19.60</td>
</tr>
<tr>
<td>2</td>
<td>Public health</td>
<td>Once quarantine, 80 yuan/mantime</td>
<td>Mantime</td>
<td>356</td>
<td>0.01</td>
<td>3.56</td>
</tr>
<tr>
<td>3</td>
<td>Sanitary treatment</td>
<td>Disinfection, garbage disposal etc.</td>
<td>hm²</td>
<td>4.46</td>
<td>1.00</td>
<td>4.46</td>
</tr>
<tr>
<td></td>
<td>II. Separate cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Environment management fee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.00</td>
</tr>
<tr>
<td>2</td>
<td>Environment supervision fee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.00</td>
</tr>
<tr>
<td>3</td>
<td>Investigation and design fee</td>
<td>8% of total of Parts I ~ II.</td>
<td></td>
<td></td>
<td></td>
<td>2.21</td>
</tr>
<tr>
<td>4</td>
<td>Public health monitoring fee of reservoir area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>III. Basic contingency fee</td>
<td>6% of total of Parts I ~ III.</td>
<td></td>
<td></td>
<td></td>
<td>2.33</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>41.16</td>
</tr>
</tbody>
</table>
12.1.3.4 Investment estimate of resettlement water and soil conservation measures

Investment estimate of water and soil conservation measures of resettlement area: 379,400 yuan. Details are shown in Table 12.1—8.

Table 12.1—8 Investment estimate of water and soil conservation measures at resettlement area

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Qty</th>
<th>Unit price (yuan)</th>
<th>Total (10^4 yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Engineering measure cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Field elevating</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Slope with mortar laid stone for protection</td>
<td>m³</td>
<td>500</td>
<td>120</td>
<td>6.00</td>
</tr>
<tr>
<td></td>
<td>Ditch excavation</td>
<td>m³</td>
<td>156</td>
<td>14.43</td>
<td>0.23</td>
</tr>
<tr>
<td>2</td>
<td>Resettlement area (point)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Slope with mortar laid stone for protection</td>
<td>m³</td>
<td>330</td>
<td>120</td>
<td>3.96</td>
</tr>
<tr>
<td>II</td>
<td>Plant measure cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Field elevating area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grass revetment</td>
<td>m²</td>
<td>8000</td>
<td>4.00</td>
<td>3.20</td>
</tr>
<tr>
<td>2</td>
<td>Resettlement area (point)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bamboo</td>
<td>Piece</td>
<td>784</td>
<td>16.00</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>Mandarin orange</td>
<td>Piece</td>
<td>1372</td>
<td>24.00</td>
<td>3.29</td>
</tr>
<tr>
<td></td>
<td>Slope grass planting</td>
<td>hm²</td>
<td>0.37</td>
<td>40000</td>
<td>1.48</td>
</tr>
<tr>
<td>III</td>
<td>Temporary measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temporary block</td>
<td>m³</td>
<td>346</td>
<td>65.40</td>
<td>2.27</td>
</tr>
<tr>
<td></td>
<td>Waterproof cloth</td>
<td>m²</td>
<td>6000</td>
<td>1.00</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>Other temporary measure</td>
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<td></td>
<td></td>
<td>0.07</td>
</tr>
<tr>
<td>IV</td>
<td>Separate cost</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction supervision fee</td>
<td></td>
<td></td>
<td></td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>Water &amp; soil conservation monitoring fee</td>
<td></td>
<td></td>
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<td>2.00</td>
</tr>
<tr>
<td></td>
<td>Investigation &amp; design fee</td>
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<td>2.00</td>
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<tr>
<td></td>
<td>Construction management fee</td>
<td></td>
<td></td>
<td></td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>Engineering quality supervision fee</td>
<td></td>
<td></td>
<td></td>
<td>3.00</td>
</tr>
<tr>
<td>V</td>
<td>Contingency fee</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6% of total of Part I-IV.</td>
<td></td>
<td></td>
<td></td>
<td>2.15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>37.94</td>
</tr>
</tbody>
</table>
12.1.3.5 Investment estimate of reservoir bed cleanup
Investment estimate of reservoir bed cleanup is 170,600 yuan in total.

12.1.3.6 Total environment protection investment
The total investment of the project is 2.2268932 billion yuan, static environment protection investment is 71.1983 million yuan in total, including environment protection investment of 55.4254 million yuan, investment of water and soil erosion work of 14.8113 million yuan, resettlement environment protection investment of 411,600 yuan, investment for water and soil conservation measures at resettlement area of 379,400 yuan, and reservoir bed cleanup investment of 170,600 yuan. Environment protection investment accounts for 3.20% of the total investment of the project.

Total environment protection investment estimate of the project is shown in Table 12.1—9.
### Table 12.1-9  Investment estimate summary of environment protection measures

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Qty</th>
<th>Unit price ($10^4$ yuan)</th>
<th>Total ($10^4$ yuan)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Part□: Environment protection measure of the project</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Incl. special cost of environment protection of 6.8737 million yuan.</td>
</tr>
<tr>
<td></td>
<td>Water environment protection cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>719</strong> Incl. special cost of environment protection of 2.895 million yuan.</td>
</tr>
<tr>
<td>i</td>
<td>Water environment protection cost during construction period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>409.5</td>
</tr>
<tr>
<td></td>
<td>Aggregate processing system flushing waste water system</td>
<td>Item</td>
<td>2</td>
<td>130.0</td>
<td>260.0</td>
<td>Included in the cost of main project.</td>
</tr>
<tr>
<td></td>
<td>Flushing waste water treatment system</td>
<td>Item</td>
<td>2</td>
<td>4.5</td>
<td>9.0</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Foundation pit drainage treatment measures</td>
<td>Item</td>
<td>1</td>
<td>0.5</td>
<td></td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Maintenance system oil-contained waste water treatment system</td>
<td>Item</td>
<td>2</td>
<td>5.0</td>
<td>10</td>
<td>Special cost for environment protection</td>
</tr>
<tr>
<td></td>
<td>Domestic sewage treatment system</td>
<td>Item</td>
<td>2</td>
<td>65.0</td>
<td>130.0</td>
<td>Ditto</td>
</tr>
<tr>
<td>2</td>
<td>Water environment protection fee during operation period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>309.5</td>
</tr>
<tr>
<td></td>
<td>Domestic sewage collection &amp; treatment system</td>
<td>Item</td>
<td>1</td>
<td>39.6</td>
<td>39.6</td>
<td>Special cost for environment protection</td>
</tr>
<tr>
<td></td>
<td>Oil contained wastewater collection &amp; treatment system</td>
<td>Item</td>
<td>1</td>
<td>15.5</td>
<td>15.5</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Workboat jetty</td>
<td>Item</td>
<td>1</td>
<td>20.0</td>
<td>20.0</td>
<td>Included in the cost of main project.</td>
</tr>
<tr>
<td></td>
<td>Workboat</td>
<td>Set</td>
<td>1</td>
<td>150.0</td>
<td>150.0</td>
<td>Special cost for environment protection</td>
</tr>
<tr>
<td></td>
<td>Caution board</td>
<td>Item</td>
<td>22</td>
<td>0.2</td>
<td>4.4</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Oil boom, anchor, &amp; anchor rope etc.</td>
<td>Item</td>
<td>1</td>
<td>50.0</td>
<td></td>
<td>Ditto</td>
</tr>
<tr>
<td>ii</td>
<td>Air environment protection cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>105.00</strong> Incl. special cost for environment protection 144,000 yuan.</td>
</tr>
<tr>
<td></td>
<td>Sprinkler</td>
<td>Piece</td>
<td>3</td>
<td>20.0</td>
<td>60.0</td>
<td>Included in the cost of main project.</td>
</tr>
<tr>
<td></td>
<td>Operating cost</td>
<td></td>
<td></td>
<td></td>
<td>45.0</td>
<td>Incl. special cost for environment protection 144,000 yuan.</td>
</tr>
<tr>
<td>iii</td>
<td>Acoustic environment</td>
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<td></td>
<td></td>
<td><strong>10.80</strong></td>
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</tr>
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<td>Total (10^4 yuan)</td>
<td>Remarks</td>
</tr>
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<tr>
<td></td>
<td>protection cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>environment protection 100,000 yuan.</td>
</tr>
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<td></td>
<td>Noise reduction barrier</td>
<td>m</td>
<td>100</td>
<td>0.1</td>
<td>10.0</td>
<td>Special cost for environment protection</td>
</tr>
<tr>
<td></td>
<td>Warning sign</td>
<td>Piece</td>
<td>8</td>
<td>0.1</td>
<td>0.8</td>
<td>Included in the cost of main project.</td>
</tr>
<tr>
<td>iv</td>
<td>Cultural relic protection cost</td>
<td>Item</td>
<td>1</td>
<td></td>
<td>50.00</td>
<td>Preliminarily considered cost</td>
</tr>
<tr>
<td>v</td>
<td>Public health cost</td>
<td>Item</td>
<td>1</td>
<td></td>
<td>5.07</td>
<td>Construction period: Special environment protection item</td>
</tr>
<tr>
<td>vi</td>
<td>Solid waste collection &amp; disposal cost</td>
<td>Item</td>
<td></td>
<td></td>
<td>11.2</td>
<td>Special cost for environment protection</td>
</tr>
<tr>
<td></td>
<td>Solid waste collection &amp; disposal during construction</td>
<td></td>
<td></td>
<td></td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solid waste collection &amp; disposal during operation (garbage bins)</td>
<td>Piece</td>
<td>50</td>
<td>0.02</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>vii</td>
<td>Ecological environment protection cost</td>
<td></td>
<td></td>
<td></td>
<td>1936.2</td>
<td>Incl. special cost for environment protection 3.572 million yuan.</td>
</tr>
<tr>
<td></td>
<td>Old tree protection fee</td>
<td>Item</td>
<td>1</td>
<td></td>
<td>655.06</td>
<td>Incl. special cost for environment protection 3.552 million yuan.</td>
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<tr>
<td></td>
<td>Fish passing devices (Fish pass)</td>
<td>Item</td>
<td>1</td>
<td></td>
<td>716.14</td>
<td>Included in the cost of main project.</td>
</tr>
<tr>
<td></td>
<td>Fish proliferation and fry laying station</td>
<td>Item</td>
<td>1</td>
<td></td>
<td>500.00</td>
<td>Included in the basic contingency of main project</td>
</tr>
<tr>
<td></td>
<td>Artificial fish nest</td>
<td>Mu</td>
<td>210</td>
<td>0.03</td>
<td>63.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ecological environment protection propaganda during construction</td>
<td>Item</td>
<td>1</td>
<td></td>
<td>2.0</td>
<td>Special cost for environment protection</td>
</tr>
<tr>
<td>viii</td>
<td>Risk prevention cost</td>
<td></td>
<td></td>
<td></td>
<td>367.50</td>
<td>Included in the cost of main project.</td>
</tr>
<tr>
<td></td>
<td>Automatic regime monitoring and reporting system during operation</td>
<td>Item</td>
<td>1</td>
<td></td>
<td>367.5</td>
<td>Included in the cost of main project.</td>
</tr>
<tr>
<td>Part II: Environment monitoring cost during construction period</td>
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<td></td>
<td></td>
<td></td>
<td>107.6</td>
<td>Incl. special cost for environment protection 576,000 yuan.</td>
</tr>
<tr>
<td></td>
<td>Water quality</td>
<td>Year</td>
<td>5</td>
<td>3.0</td>
<td>15.0</td>
<td>Special cost for environment protection</td>
</tr>
<tr>
<td></td>
<td>Air</td>
<td>Year</td>
<td>5</td>
<td>0.4</td>
<td>2</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
<td>Year</td>
<td>5</td>
<td>0.12</td>
<td>0.6</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Aquatic ecology (fishes)</td>
<td>Year</td>
<td>5</td>
<td>8.0</td>
<td>40.0</td>
<td>Ditto</td>
</tr>
<tr>
<td></td>
<td>Regime forecasting</td>
<td>Year</td>
<td>5</td>
<td>4.0</td>
<td>20.0</td>
<td>Included in the cost of main project.</td>
</tr>
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</table>
### Environment Protection Investment Estimate and Environmental Gain & Loss Analysis

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Qty</th>
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<th>Total (10^4 yuan)</th>
<th>Remarks</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td>Old trees</td>
<td>Year</td>
<td>5</td>
<td>6.0</td>
<td>30.0</td>
<td>Ditto</td>
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<tr>
<td></td>
<td>Total of Part</td>
<td></td>
<td></td>
<td></td>
<td>3312.37</td>
<td>Incl. special cost for environment protection 7.4497 million yuan.</td>
</tr>
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</table>

Incl. special cost for environment protection 7.4497 million yuan.
Table 12.1-9  Investment estimate summary of environment protection measures  (Cont’d)

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
<th>Qty</th>
<th>Unit price (10^4 yuan)</th>
<th>Total (10^4 yuan)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Part  □  Separate cost</td>
<td></td>
<td></td>
<td></td>
<td>659.08</td>
<td>Incl. special cost for environment protection 1.5498 million yuan.</td>
</tr>
<tr>
<td>i</td>
<td>Environment management cost</td>
<td></td>
<td></td>
<td></td>
<td>52.9</td>
<td>71% of sum of Part I–II; Calculated as special cost for environment protection.</td>
</tr>
<tr>
<td>ii</td>
<td>Environment protection consultation fee</td>
<td></td>
<td></td>
<td></td>
<td>328.0</td>
<td>Incl. special cost for environment protection 754,000 yuan.</td>
</tr>
<tr>
<td>1</td>
<td>EIA cost</td>
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<td></td>
<td></td>
<td>88.0</td>
<td>Incl. in cost of preparation stage of the project</td>
</tr>
<tr>
<td>2</td>
<td>EIA review fees</td>
<td></td>
<td></td>
<td></td>
<td>30.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Consultation fee of fish pass and fish proliferation station</td>
<td>Item</td>
<td></td>
<td></td>
<td>30.0</td>
<td>Incl. in total engineering design fee of the project</td>
</tr>
<tr>
<td>4</td>
<td>Fish pass physical model test fee</td>
<td>Item</td>
<td></td>
<td></td>
<td>60.0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Design fee of fish pass and fish proliferation station</td>
<td>Item</td>
<td></td>
<td></td>
<td>120.0</td>
<td></td>
</tr>
<tr>
<td>iii</td>
<td>Environment protection training fee</td>
<td></td>
<td></td>
<td></td>
<td>79.0</td>
<td>Incl. in total training cost of the project.</td>
</tr>
<tr>
<td>iv</td>
<td>Environment supervision fee</td>
<td>Manyear</td>
<td>24</td>
<td>6.0</td>
<td>196.5</td>
<td>Incl. special cost for environment protection 240,000 yuan.</td>
</tr>
<tr>
<td>v</td>
<td>Engineering quality supervision fee</td>
<td></td>
<td></td>
<td></td>
<td>2.68</td>
<td>0.36% of sum of Part □□□ as special environment protection cost.</td>
</tr>
<tr>
<td></td>
<td>Total of Part □□□</td>
<td></td>
<td></td>
<td></td>
<td>3971.45</td>
<td>Incl. special cost for environment protection 8,9995 million yuan.</td>
</tr>
<tr>
<td></td>
<td>Part □ Basic contingency fee</td>
<td></td>
<td></td>
<td></td>
<td>238.29</td>
<td>6% of sum of Part □□□; including special cost for environment protection 540,000 yuan.</td>
</tr>
<tr>
<td></td>
<td>Part □: Environment monitoring &amp; protection cost during operation period</td>
<td></td>
<td></td>
<td></td>
<td>1332.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water quality</td>
<td>Year</td>
<td>5</td>
<td>2.0</td>
<td>10.0</td>
<td>Special cost for environment protection</td>
</tr>
<tr>
<td>2</td>
<td>Water temperature</td>
<td>Year</td>
<td>5</td>
<td>2.0</td>
<td>10.0</td>
<td>Ditto</td>
</tr>
<tr>
<td>3</td>
<td>Noise</td>
<td>Year</td>
<td>3</td>
<td>0.8</td>
<td>1.8</td>
<td>Ditto</td>
</tr>
<tr>
<td>4</td>
<td>Public health</td>
<td>Year</td>
<td>10</td>
<td>1.0</td>
<td>6.0</td>
<td>Ditto</td>
</tr>
<tr>
<td>5</td>
<td>Regime forecasting</td>
<td>Year</td>
<td>20</td>
<td>2.0</td>
<td>40.0</td>
<td>Included in the project operating cost</td>
</tr>
<tr>
<td>6</td>
<td>Reservoir bank stabilization</td>
<td>Year</td>
<td>5</td>
<td>1.0</td>
<td>5.0</td>
<td>Ditto</td>
</tr>
</tbody>
</table>
### 12.0 Environment Protection Investment Estimate and Environmental Gain & Loss Analysis

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Unit</th>
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<th>Total (10^4 yuan)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Soil submersion</td>
<td>Year</td>
<td>5</td>
<td>3.0</td>
<td>15.0</td>
<td>Ditto</td>
</tr>
<tr>
<td>8</td>
<td>Old tree maintenance</td>
<td>Year</td>
<td>5</td>
<td>30.0</td>
<td>150.0</td>
<td>Ditto</td>
</tr>
<tr>
<td>9</td>
<td>Contingency fee for old tree emergent protection</td>
<td>Year</td>
<td>5</td>
<td>150.0</td>
<td></td>
<td>Incl. in the basic contingency fee of the main project during construction; Included in the project operating cost during operation.</td>
</tr>
<tr>
<td>10</td>
<td>Terrestrial ecological system</td>
<td>Year</td>
<td>5</td>
<td>3.0</td>
<td>15.0</td>
<td>Special cost for environment protection</td>
</tr>
<tr>
<td>11</td>
<td>Fish proliferation and fry pouring station</td>
<td>Year</td>
<td>20</td>
<td>44.0</td>
<td>880.0</td>
<td>Executing long-term fry pouring for 20 years; Included in the project operating cost during operation.</td>
</tr>
<tr>
<td>12</td>
<td>Aquatic ecological system</td>
<td>Year</td>
<td>5</td>
<td>10.0</td>
<td>50.0</td>
<td>Included in the project operating cost</td>
</tr>
</tbody>
</table>

1. Environment protection investment of the project: 5542.54
2. Investment of water & soil erosion prevention and treatment measure: 1481.13
3. Resettlement environment protection investment: 41.16
4. Water and soil conservation measure investment for resettlement area: 37.94
5. Reservoir bed cleanup investment: 17.06

### 12.2 Environment Economic Benefit Analysis

The Project is a comprehensive application project mainly featured as shipping one and compromised to generate hydropower and to control flood, having total installed capacity of 117MW, and annual average generating capacity of 4.8×10^8 kW·h.

According to the with and without principle analysis, the national economic benefit of the project embodies mainly in shipping benefit, hydropower benefit, flood control benefit, replanting benefit of unapplied land etc.

□ Shipping benefit

Shipping benefit embodies mainly in saving of freight due to change of transport methods and reduction of transport cost due to application of large ships.

After completion of the project, with the improvement of channel conditions, part of goods is transferred to water transport from road transport, the transfer volume of freight is calculated on 20% of forecasted volume of freight, average road transport distance is considered as
30km, road transport unit price is based on the current Jiangxi road transport unit price of 0.5 yuan /tkm; water transport distance is considered as 38km, water transport unit price is based on the current Jiangxi water transport unit price of 0.15 yuan /tkm.

Benefit of national economy due to application of large ships after operation of the project is divided into near-future benefit and far-future benefit, the near future benefit is the saved channel regulation cost and maintenance fee, the far-future benefit is the benefit of national economy due to reduction of transport cost after application of large ships.

After the project is implemented, it can channelize 38km Kan River channel upstream the dam site (backwater to Taihe Pivot), by 2020 the upstream and downstream planned steps will have been completed, the channel of the Kan River from Ganzhou to Nanchang will reach Grade III channel standard, navigable to 1000 DWT ships all the year around. If this project is not implemented, with reference to similar channel regulation projects of the Kan River, the channel regulation cost is considered as 2.60 million yuan/km, meantime, since then, channel need to maintain each year, on the basis of maintenance fee of 50000 yuan/km, the channel regulation cost and channel maintenance fee are the near-future benefit of national economy of the project.

In the far-future to 2020, the channel of the Kan River from Ganzhou to Nanchang will reach Grade III channel standard, the Kan River shipping must be developing to application of large ships. Application of large ships is a gradual process, therefore, in the calculation with the project, average ship DWT is based on 500DWT, average ship DWT without the project is based on 80DWT. Because minerals and building materials among freight volume mostly belong to regional short-distance transport, therefore, the average transport distance with the project is considered as 35km. Through calculation of ship/day cost, the transport costs of 500DWT ship and 80DWT ship are respectively 0.03893 yuan/t·km and 0.09109 yuan/t·km, saved unit transport cost is about 0.05215yuan/t·km.

- **Hydropower benefit**

  The project has a total installed capacity of 117MW, and annual average generating capacity of $4.8 \times 10^8$ kW·h, the annual hydropower benefit is 136.417 million yuan as per the annual cost of substituting thermal power station.

- **Flood control benefit**

  Flood control benefit is divided into direct benefit and indirect benefit. Both banks at the Kan River of the reservoir area is flat with rich land. Terrace at both banks of the Kan River trunk is normally 600～1400m wide, with ground elevation between 48～60m, population and farmland concentrated. The existing fending groynes along the Kan River are of low flood control standard with serious flood & waterlogging disaster. To minimize impacts of the reservoir inundation on local national economy and ecological environment, and to minimize land inundation, protection work measures are taken by the project in temporary inundation area or shallow inundation area or partly deep inundation area with protection work condition and with concentrated population and concentrated land. After implementation of the project, the flood control standard will be totally raised up to control a once-in-a-10-year flood and to protect farmland and population at both banks. Flood losses include losses of agriculture,
forestry, engineering facilities, communication and transport, individual, collective and national properties etc. Because flood losses of forestry and engineering facilities are hard to quantitatively calculate, so only flood losses of agriculture and population due to inundation are calculated and included. Annual average flood control benefit is the annual average loss before implementation of flood control works, i.e. direct benefit is 19.025 million yuan. The indirect benefit is the loss caused by flood loss, which can not be quantized, such as disease spreading, rising prices, loss of work time etc. Indirect benefit is calculated on basis of 20% of direct benefit.

After the project is implemented, the annual average flood control benefit is 22.831 million yuan.

Replanting benefit of unapplied land

At present, there are altogether 12695 Mu unapplied land below a once-in-a-10-year flood without benefit. After implementation of the project, these lands can be used for planting grain crops and for developing mixed farming, which will bring considerable economic benefit and social benefit.

12.3 Analysis of Loss due to Environmental Impacts

The construction of the project without adopting relevant protection measures may cause environmental loss, which includes mainly the discharge of pollutants during the construction period, the uprise of incidence of diseases among the construction workers, the interference of the growing environment of animals and plants, the obstruction of the dam, the serious damage to the growing environment of fishes and flooding historical cultural sites due to the water flow from the dam and the malaria spreading etc.

Disadvantageous impacts on environment can be avoided or lessened through adopting measures. The environmental loss is about equal to the total sum of the cost of protection measures for disadvantageous influence and the relevant cost of environmental protection management and control.

The total investment of the project is 2.2268932 billion yuan, the static investment on environmental protection is 71.1983 million yuan, which amounts to 3.20% of the total project investment.

12.3.1 Analysis of Environmental Economic Loss

Environmental economic loss includes the necessary investment for avoiding or reducing the environmental loss, totaling 71.1983 million yuan. The average annual value of loss is 3.5599 million yuan during 20 years’ operation.

12.3.2 Analysis of Environmental Economic Benefit
Water power is to be used as the clean energy source, which can greatly reduce the discharges of the wastes, and its environmental benefits can be calculated based on the equivalent environmental investment of thermal power plant on the coequal scale, which can be saved if water power is used.

The total investment of thermal power plant of coequal scale is about 600 million yuan, to satisfy the national environment protection requirement, its environment protection investment normally accounts for 12% of the total investment, i.e. 72 million yuan; As per the requirement of SEPA, thermal power plant is allowed to discharge 0.9g SO2/kWh, 512.2t SO2/a, it is roughly calculated that SO2 discharge fee to be levied each year is 308,000 yuan on the basis of 0.6 yuan/kg SO2. Therefore, the annual investment for E.P. will be RMB4.8 million if the E.P. establishments can be used for 15 years. The operating cost of environmental protection facilities is RMB 200 thousand each year.

So it can be calculated that annual average environment loss by thermal power plant RMB 5.3008 million can be saved each year after operation of the project.

12.3.3 Analysis of Loss and Benefit of Environmental Economy

Ratio of Loss and Benefit  = value of annual environmental loss / value of annual environmental benefit

The annual average environmental loss is RMB 3.5599 million and the annual average environmental benefit is RMB 5.3008 million, so the ratio being 1:1.49. Therefore, the economic benefits brought by the environmental investment is larger than the environmental loss.

This project can bring remarkable social benefits, economic and environmental benefits as well.
13.0 PUBLIC CONSULTATION

Public participation and consultation is an important part of the work of estimating the environmental influences of the project construction as well as a kind of bi-directional exchange between the owner, EIA unit and the public. Through public participation and consultation, the environmental problems cared by the public can be really understood so as to assist the related authorities with preparing practical and reliable environmental protection measures so that the environmental estimation of the project to be constructed can be more open to the public and the conclusion is more practical just to ensure the project can realize its expected social and economic benefit.

The Project construction is to indirectly and directly influence the economic and cultural lives of the residents around the project site in many aspects, especially, for example the problems such as relocation and resettlement and land acquisition and so on that are involved in the immediate interests of the public. Therefore, it is very necessary to carry out public participation and consultation.

13.1 Objectives of Public Participation

☐ To make the public understand the objective and scale of the construction of the project and construction place as well as the influences on the areas around the project in related aspects after it is built and the countermeasures and measures to be adopted, and to let the public express their opinions so as to get understanding, support and cooperation of the public;

☐ Through the local residents’ consultation results about the personal experience in the inhabited and living environment, it can help analyze the characteristics of the polluted environment in this area and the existing quality level of the environmental factors so as to reflect the objective degree of the environmental estimation and protect the immediate interest of the affected people;

☐ The public are similar with the resources such as natural ecology, economic development, values of consumer goods involved in EIA, through public participation, they are invited to participate in confirming the measures of protecting resources and environment; in this way, their requirements can be understood; as a result, various environmental protection measures put forward in this project will be more practical and effective;

☐ To make the public have chance to participate in discussing the construction feasibility of the project.

13.2 Performance of Public Participation and Poll

13.2.1 Scope of public poll

Public poll covers the area of Taihe County where the project is situated (Both banks of the Kan River), the surrounding area of the reservoir area, all the affected villages with land acquired etc. basically all the possibly affected areas.
13.2.2 Respondents
To assure the public poll results abroad representative, the respondents can be classified as follows:

(1). Affected residents, enterprises and institutions, and relocated households;
(2). NGO: township government, village committee, civil organizations and social groups.
(3). Government departments: local environment protection bureau, water conservancy departments, forestry departments, communications departments, cultural bureaus, etc.

13.2.3 Investigation method
The following forms for public participation and poll are applied:

Public symposia, to be held in the township government, village committee and affected villagers’ homes which may be attended even by the illiterate people;
Public opinion survey, using a pre-prepared questionnaire;
Official notice (Open to the public): Information open to the public via the Internet.
   Put the EIA of the Shihutang Shipping and Hydropower Pivotal Project at the Shihutang Project Office at the second floor of Taihe County Government Building for public reference. Put the Concise EIA of the Shihutang Shipping and Hydropower Pivotal Project at the governments of Wanhe Township, Tangzhou Township, Yanxi Township, Chengjiang Township and Mashi Township, and Wushan Reclamation Farm Office for public reference.

13.2.4 Investigation content
Investigation content: Explain to the affected people the scope and content of the Project, investigate the understanding of the respondents on the Project, their attitudes on environment pollution impacts and the most concerned issue on the Project.

13.2.5 Investigation process
Public symposium of the first round
After accepting the EIA work entrustment of the Project by the Owner, the EIA contractor – SHCC consulted and held symposiums with 132 people in October 2006, including the affected households, affected people, affected village committees, township governments, and related functional departments of the environment protection, water conservancy, forestry and communications of Taihe County.
Public participation and investigation of the first round

After accepting the EIA work entrustment of the Project by the Owner, the EIA contractor – SHCC organized public poll in the form of distributing questionnaires in October 2006. Detailed are presented in Table 19. After the questionnaires were distributed to the respondents, those questionnaires were signed by the respondents proper, filled with the work unit, sex, age, nationality, education, professional title, post, address, and contact method etc., finally SHCC sorted out, summarized and analyzed the collected questionnaires.

Official placard in the Internet of the first round

After accepting the EIA work entrustment of the Project by the Owner and having prepared the EIA Outlines, on April 10, 2007 SHCC posted the following contents on the Jiangxi Navigational Affair Information Website (www.jxhw.gov.cn): Brief introduction to the Project; main environment problems which may be caused during and after implementation of the Project; the Owner and their contact methods; EIA contractor and their contact methods; public comments feedback methods etc., provided the public inquiry, consultation and disambiguation services.
A public consultation was held by the EIA contractor – SHCC and held symposiums with 156 people in May 2005, including the affected households, affected people, affected village committees, township governments, and related functional departments of the environment protection, water conservancy, forestry and communications of Taihe County.

Public participation and investigation of the second round

After having prepared the draft of the EIA of the Project, the EIA contractor – SHCC organized public poll in the form of distributing questionnaires in May 2007. After the questionnaires were distributed to the respondents, those questionnaires were signed by the respondents proper, filled with the work unit, sex, age, nationality, education, professional title, post, address, and contact method etc., finally SHCC sorted out, summarized and analyzed the collected questionnaires.

Official placard in the Internet of the second round

After having prepared the draft of the EIA of the Project, on April 10, 2007 SHCC posted the following contents on the Jiangxi Navigational Affair Information Website (www.jxhw.gov.cn): Simplified EIA of the Project, the Owner and their contact methods; EIA contractor and their contact methods; public comments feedback methods etc., provided the public inquiry, consultation and disambiguation services.
13.0 Public Consultation

Environment impact placard at Shihutang Village

Environment impact symposium at Shihutang Village

Environment impact placard at Caoping Village

Environment impact symposium at Pingshang Village

Official placard in the Internet of the second round
13.3 Public Poll Results

13.3.1 Public poll results of the first round
104 questionnaires are released for public participation in this survey, of which 102 are returned effectively and the rate of return is 98.1%.

The sex proportion, age structure, education background, and profession distribution of the persons participating in the survey are described as below:

- Sex proportion: 83.3% male, 16.7% female;
- Age structure: 15.7% younger than 30, 51.0% between 30 and 50, 32.3% older than 50;
- Education background: 36.3% junior college and higher, 27.59% high school, 29.4% junior high school and 6.8% primary school.
- Profession distribution: 29.4% cadres, 36.3% farmers, 30.3% workers and 4% others.

The following collected public opinions and suggestions are summarized in Table 13.3-1. According to the survey results, the following collected opinions and suggestions are obtained:

- The degree of understanding this project

Among the persons surveyed, as to the question that do you know the construction of the project related to yourself? The ones who understand the information account for 92.6%, the ones who do not understand the information about the project so much account for 6.9%, in addition, the ones accounting for 0.5% are not clear about the project; Through public symposia, 100% of the public express to support construction of the project.

- The opinions to the land acquisition, relocation and resettlement

Among the surveyed persons, as to the question that do you know the policy of compensation for relocation, the ones who know this policy account for 40.2%, the ones who does not know the policy accounts for 59.8%; when asked the question whether they obey relocation, 7 households disobey the relocation, the other households affected express to obey relocation. Those seven households all are the villagers of Caoping Village of Xinzhou, the main reason they are not willing to relocate is that they can earn higher incomes from crops planted in Xinzhou and they are worrying about future incomes of crops planted in the newly allocated land not as high as present ones.

- The influences on the environment from the construction of the project and the countermeasures
After the workers answer some questions, most of the public (accounting for 81.4%) think the influence on the water environment from the construction of the project is the largest, 29.4% of them think the construction of the project will have great influences on the agricultural production, 23.5% think the construction of the project will have influences on ecological environment. As to the measures that shall be taken to slow down the influences on the environment, 79.4% think the measure of improving it in limited period is a very good measure; 6.8% require to strengthen management or to take other measures.

13.3.2 Suggestions of the respondents of public symposium and questionnaire survey of the first round
The main suggestions of the respondents are as follows: to employ local labors as many as possible during construction; to build a new bridge and fending groyne at Xinzhou; To minimize to occupy farmland and woodland; to build the project simultaneously with ecological work; to assure relocation and resettlement fund paid to the affected people; to commence the project construction as soon as possible and to benefit local people; to simultaneously well build water conservancy and flood control facilities; to completely solve the waterlogging problem; to earnestly protect the ecological environment at the surrounding of the reservoir area and to well resettle the relocated people; to protect farmland from being occupied, and improve farming condition at the surrounding of the reservoir area; to recommend to the dam open to traffic etc.
<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Comments</th>
<th>Proportion(%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do you support the construction of the project?</td>
<td>Yes</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Do you know the construction of the project related to yourself?</td>
<td>Clear</td>
<td>92.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not too clear</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No clear</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Degree of satisfaction on the current environment of the area in which the project is involved.</td>
<td>Satisfactory</td>
<td>92.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>So-so</td>
<td>7.8</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Dissatisfactory</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>What are the main environment problems of the area where the project is involved?</td>
<td>Atmosphere</td>
<td>2.9</td>
<td>Majority select answers of 2 or more.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water</td>
<td>72.5</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Noise</td>
<td>9.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ecology</td>
<td>23.5</td>
<td></td>
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<td></td>
<td></td>
<td>Others</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non</td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>What are the environment issues which shall draw emphatical attention?</td>
<td>Atmosphere</td>
<td>3.9</td>
<td>Majority select answers of 2 or more.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ecology</td>
<td>23.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Noise</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water</td>
<td>81.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drink water source</td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agricultural production</td>
<td>29.4</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Town landscape</td>
<td>12.7</td>
<td></td>
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<td></td>
<td></td>
<td>Others</td>
<td>/</td>
<td></td>
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<td></td>
<td></td>
<td>Non</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Impacts of the project construction on the living quality of surrounding residents?</td>
<td>Increased</td>
<td>90.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decreased</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not apparent</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Whether the project is advantageous or not to regional economic development and water transport development?</td>
<td>Advantageous</td>
<td>98.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not apparent</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disadvantageous</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>What measures shall be taken to mitigate pollution?</td>
<td>EP measures by the project</td>
<td>79.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>To build the project in another place</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>To strengthen management</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Do you know the policy of compensation for relocation?</td>
<td>Yes</td>
<td>40.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>59.8</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>The place you want to be resettled?</td>
<td>Same village &amp; town</td>
<td>97.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other village</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Do you obey the decision of relocation and resettlement?</td>
<td>Yes</td>
<td>39.2</td>
<td>54.0% are not involved in relocation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>6.8</td>
<td></td>
</tr>
</tbody>
</table>
13.3.3 Result of information of the first round open to the public via the Internet
During the period of the information of the first round open to the public via the Internet from April 10 to 30, 2007, the open information click rate reaches 93 mantimes, no comments or suggestions of units or individuals have been received up to now.

13.3.4 Public poll results of the second round
190 questionnaires are released for public participation in this survey, of which 190 are returned effectively and the rate of return is 100%.

The sex proportion, age structure, education background, and profession distribution of the persons participating in the survey are described as below:

- Sex proportion: 88.2% male, 11.8% female;
- Age structure: 9.4% younger than 30, 60.0% between 30~50, 30.6% older than 50;
- Education background: 15.3% junior college and higher, 21.2% high school & technical secondary school, 55.3% junior high school and 8.2% primary school.

The following collected public opinions and suggestions are summarized in Table 13.3-2. According to the survey results, the following collected opinions and suggestions are obtained:

- The degree of understanding this project
  With the progress of the earlier work of the project, more and more people understood the project. Among the persons surveyed, as to the question that do you know the construction of the project related to yourself? The ones who understand the information account for 94.1%, the ones who do not understand the information about the project so much account for 5.9%. Through public symposia, 100% of the public express to support construction of the project.

- The opinions to the land acquisition, relocation and resettlement
  Among the surveyed persons, as to the question that do you know the policy of compensation for relocation, the ones who know this policy account for 50.3%, the ones who does not know the policy accounts for 7.1%; when asked the question whether they obey relocation, 34.1% have not answered, the others affected express to obey relocation.

- The influences on the environment from the construction of the project and the countermeasures
  After the workers answer some questions, most of the public (accounting for 85.9%) think the influence on the water environment from the construction of the project is the largest, 20% of them think the construction of the project will have influences on the agricultural production,
10.6% think the construction of the project will have influences on ecological environment. As to the measures that shall be taken to slow down the influences on the environment, 82.4% think the measure of improving it in limited period is a very good measure; 60% require to strengthen management.

13.3.5 Suggestions of the respondents of public symposium and questionnaire survey of the second round

The main suggestions of the respondents are as follows: to employ local labors as many as possible during construction; to well protect the ancestral temple of the village during relocation of Pingshang Village; to assure the project quality during construction; to assure relocation and resettlement fund paid to the affected people; to commence the project construction as soon as possible and to benefit local people; to simultaneously well build water conservancy and flood control facilities; to earnestly protect the ecological environment at the surrounding of the reservoir area and to well resettle the relocated people; to protect farmland from being occupied, and improve farming condition at the surrounding of the reservoir area; to recommend to the dam open to traffic etc.
## Table 13.3-2 Summary of questionnaire survey with the participation of the public

<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Comments</th>
<th>Proportion(%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do you support the construction of the project?</td>
<td>Yes</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Do you know the construction of the project related to yourself?</td>
<td>Clear</td>
<td>94.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not too clear</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No clear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Degree of satisfaction on the current environment of the area in which the project is involved.</td>
<td>Satisfactory</td>
<td>96.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>So-so</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissatisfactory</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>What are the main environment problems of the area where the project is involved?</td>
<td>Atmosphere</td>
<td>5.9</td>
<td>Majority select answers of 2 or more.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water</td>
<td>87.1</td>
<td></td>
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<td></td>
<td></td>
<td>Noise</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ecology</td>
<td>15.3</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Others</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>What are the environment issues which shall draw emphatical attention?</td>
<td>Atmosphere</td>
<td>4.7</td>
<td>Majority select answers of 2 or more.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ecology</td>
<td>10.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Noise</td>
<td>3.5</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Water</td>
<td>85.9</td>
<td></td>
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<td></td>
<td></td>
<td>Drink water source</td>
<td>2.4</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Agricultural production</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Town landscape</td>
<td>8.2</td>
<td></td>
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<td></td>
<td></td>
<td>Others</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>Non</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Impacts of the project construction on the living quality of surrounding residents?</td>
<td>Increased</td>
<td>95.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decreased</td>
<td>4.7</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Not apparent</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Whether the project is advantageous or not to regional economic development and water transport development?</td>
<td>Advantageous</td>
<td>100.0</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Not apparent</td>
<td>/</td>
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<tr>
<td></td>
<td></td>
<td>Disadvantageous</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>What measures shall be taken to mitigate pollution?</td>
<td>EP measures by the project</td>
<td>82.4</td>
<td>Majority select answers of 2 or more.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To build the project in another place</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>To strengthen management</td>
<td>60.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Do you know the policy of compensation for relocation?</td>
<td>Yes</td>
<td>50.3</td>
<td>42.6% have not answered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>The place you want to be resettled?</td>
<td>Same village &amp; town</td>
<td>64.7</td>
<td>35.6% have not answered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other village</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Do you obey the decision of relocation and resettlement?</td>
<td>Yes</td>
<td>65.9</td>
<td>34.1% have not answered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
13.3.6 Result of information of the second round open to the public via the Internet
During the period of the information of the second round open to the public via the Internet from June, 2007, the open information click rate reaches 128 mantimes, no comments or suggestions of units or individuals have been received up to now.

13.3.7 Official notice on newspaper
After the EIA is prepared, it will be placed at the third floor of Taihe County Government Building for public reference. Put the Concise EIA of the Shihutang Shipping and Hydropower Pivotal Project at the governments of Wanhe Township, Tangzhou Township, Yanxi Township, Chengjiang Township and Mashi Township, and Wushan Reclamation Farm Office for public reference. In October 2007, official notice was posted on the Jinggangshan Newspaper (No.1 newspaper at the location of the Project) for public reference. Up to now no comments or suggestions of individuals or units have been received.

13.4 Acceptance of Public Comments
Seven households are worrying about future incomes of crops planted in the newly allocated land not as high as present ones. SHCC has feedbacked this information to the Owner. The Owner answers that the latest national and local compensation standards will be implemented by the Project (the compensation sum will be greatly raised than before) and the compensation standards have been included into the Feasibility Study Report and RAP of the
13.0 Public Consultation

Project, which will be under supervision of the World Bank during implementation. Item 6.6 Resettlement of Chapter 6.0 – Environment Impact Assessment and Chapter 10.0 Environment Protection Measures of this Report analyzes their concern.

☐ As for the suggestion that local labors should be employed as many as possible during construction of the project, SHCC has feedbacked this information to the Owner. The Owner answers that local labors are surely to be employed during construction of the project; During construction bidding of the project, construction contractor is required to employ local labors as many as possible under the premise of guaranteeing quality, schedule of the project and same labor cost.

☐ As for the suggestion that a new bridge and fending groyne be built at Xinzhou Islet, SHCC has feedbacked this information to the Owner and Taihe County People’s Government. According to the introduction of the Owner and Taihe County People’s Government, this suggestion will not be considered through integrated consideration of the project investment, overall county development plan, flood control safety and convenient traffic of the residents on Xinzhou Islet, future tourism development plan, aquatic ecological environment protection and convenient environment management.

☐ As for the suggestion that farmland be minimized to occupy by the project, SHCC has feedbacked this information to the Owner. The Owner answers that, in order to meet the requirements of realm and resource department and environment protection department and in order to reduce the project investment, occupation of farmland by the Project will be minimized, the quantity of farmland to be occupied by the Project has been reduced from more than 6000Mu at Prefeasibility Study Stage to the current 2977.3Mu. Item 6.2 Ecological Environment and Item 6.3 Water and Soil Conservation of Chapter 6.0 – Environment Impact Assessment and Chapter 10.0 Environment Protection Measures of this Report analyzes their concern.

☐ As for the suggestion that the project should be constructed simultaneously with ecological work, SHCC has feedbacked this information to the Owner. The Owner answers that the environment protection work and water and soil conservancy work shall be implemented simultaneously with the main Project. Item 6.2 Ecological Environment and Item 6.3 Water and Soil Conservation of Chapter 6.0 – Environment Impact Assessment and Chapter 10.0 Environment Protection Measures of this Report analyzes their concern.

☐ As for the request to assure relocation and resettlement fund paid to the affected people, SHCC has feedbacked this information to the Owner, the Owner promised to assure relocation and resettlement fund paid to the affected people in time as per the specified sum. Item 6.6 Resettlement of Chapter 6.0 – Environment Impact Assessment and Chapter 10.0 Environment Protection Measures of this Report analyze and answers their concern.

☐ As for the suggestion to commence the project construction as soon as possible and to benefit local people, SHCC has feedbacked this information to the Owner, the Owner
expressed to stringently execute national approval procedure of construction project and to seize the time to try to commence the project construction as soon as possible.

- As for the suggestion to simultaneously well build water conservancy and flood control facilities and to completely solve the waterlogging problem, the project is to construct five protection areas (including fending groynes and drainage pumping stations) of Taihe County seat, Wanhe, Yongchang, Yanxi and Zhangtang. The present flood control standard for once-every-2~5-year flood of both banks of the Kan River will be upgraded into flood control standard for once-every-20-year flood. Chapter 2.0 Project Overview, Item 6.6 Resettlement of Chapter 6.0 – Environment Impact Assessment and Chapter 10.0 Environment Protection Measures of this Report analyze and answers their concern.

- As for the suggestion to protect farmland from being occupied, and improve farming condition at the surrounding of the reservoir area, the plans of farmland elevating and five protection areas are raised in the engineering design, which are advantageous to protecting farmland and to improving farming conditions at the surrounding of the reservoir area.

- The suggestion that the dam should be open to traffic, which has been accepted in the engineering design.

- As for the suggestion that the ancestral temple of the village should be well protected during relocation of Pingshang Village, SHCC has feedbacked this information to the Owner, the Owner expressed to keep it in the fending groyne line arrangement of the next stage.
14.0 ACCUMULATED IMPACT ANALYSIS

The approved Jiangxi Kan River Drainage Area Planning Report recommends two trunk stream cascade development plans I and V through analysis on antiflood, hydropower generation, shipping, water resource application, construction condition, investment, cost and benefit etc. Plan I is an eight-step development plan, from upstream to downstream is Xiashan, Maodian, Wan'an, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan. Plan V is a ten-step development plan, from upstream to downstream is Bai'e, Baikoutang, Xiashan, Maodian, Wan'an, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan. The two plans are the same just at the river section downstream Ganzhou, i.e. six steps of Wan'an, Taihe, Shihutang, Xiajiang, Yongtai and Longtoushan are arranged.

At present, among the planned 6 steps of the Kan River downstream Ganzhou, the Wan’an step was put into operation in 1993, because the two downstream steps of Yongtai and Longtoushan are situated at the flat country of lower reaches of the Kan River, having great impacts of reservoir area inundation, higher investments, poor step economic figures, they are difficult to implement in the near future. In addition, among the three steps, the preparation work of the Taihe step between Wan’an and Shihutang Steps has been organized to do by power department; The Xiajiang step downstream the Shihutang step is the flood control project of the Kan River. The project proposal has been prepared by water conservancy department, the project is to commence to build within the Eleventh-Five-Year Plan; The Shihutang Project has been listed into the Eleventh-Five-Year Plan of the Ministry of Communications and into an important project of Eleventh-Five-Year Plan by the Jiangxi Provincial People’s Government; The State Development and Reform Commission will list this project into 2007~2009 alternative projects to use the World Bank loan, and has approved to establish this project in the document No. [2007]717 “Official Reply of the State Development and Reform Commission to the Proposal of the Shihutang Shipping and Hydropower Pivotal Project at the Kan River”, it is planned to commence construction of the project in 2008 and to put into operation in 2012.

Step construction is short-term behavior, in views of individual construction, the impacts would be small. However, with the time passes, some impacts will turn serious due to the cumulative effects. Because these projects are similar, the impacts on the environment are also similar. Such impacts will have cumulative effects. The cumulative effects of the proposed project and the step construction of the Kan River drainage area are shown in Table 14.0-1.

14.1 Analysis of Impacts of River Hydrology and Sediment

With the gradual construction of the planned steps, the existing river will be divided into different sections, each of which will become a river-type reservoir. The water flow is slowered, water amplitude becomes less and the flow also undergoes obvious changes. Especially in low water period, the river can keep at a designed flow that will be higher than that in the natural river channel. In view of the prediction of each individual junction, it can be seen that, even water is released in flood period and most sand are carried away by flood,
14.0 Accumulated Impact Analysis

there are still some quantity of sand sediment in the reservoir. After completion of the multiple steps, even with flood releasing, due to the blocking gate in the floodway, flood releasing will be somewhat hampered and so some sand sediment shall be intercepted and silted in the reservoir.

Because the Shihutang Project is of runoff type development mode, and the beneficial reservoir capacity of the reservoir is very small, hardly having control performance on runoff, it can realize daily regulation of the Jiangxi power consumption peak only after it runs synchronously with the Wan’an Hydropower Station, i.e. the beneficial operating mode of the Shihutang Hydropower Station is basically to apply the release flow of the Wan’an Hydropower Station plus sectional flow as power generating flow of the Shihutang Hydropower Station. The annual, monthly and daily average flows and levels at the downstream of the Shihutang dam at design representative year are the same with the current runoffs and levels at the downstream of the Shihutang dam at design representative year. Therefore, construction of the Shihutang Project will cause very tiny impacts on the annual, monthly and daily average flows and levels at the downstream of the Shihutang dam at design representative year. Because upstream two steps have stronger regulating performance on runoff, so majority of cumulative impacts on the downstream of the Shihutang dam are impacts caused by the upstream two steps.
### Table 14.0-1  Matrix Table for Cumulative effects of the Project

<table>
<thead>
<tr>
<th>Project</th>
<th>Cumulative effects</th>
<th>Characteristics of Impacts</th>
<th>Degree of Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shihutang Project</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecological environment</td>
<td>Terrestrial &amp; aquatic organisms &amp; local ecological system</td>
<td>Serious</td>
<td></td>
</tr>
<tr>
<td>Social environment</td>
<td>Promotion of regional economic development</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Surface water environment</td>
<td>Water quality</td>
<td>Light</td>
<td></td>
</tr>
<tr>
<td>Ambient air</td>
<td>Fuel waste gas of ships</td>
<td>Light</td>
<td></td>
</tr>
<tr>
<td>Acoustic environment</td>
<td>Noise</td>
<td>Light</td>
<td></td>
</tr>
<tr>
<td>River hydrology</td>
<td>Change of river flow pattern and sand sediment</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Natural landscape</td>
<td>Natural landscape</td>
<td>Light</td>
<td></td>
</tr>
<tr>
<td>Local climate</td>
<td>Climate factors of temperature, humidity</td>
<td>Very Light</td>
<td></td>
</tr>
<tr>
<td>Public health</td>
<td>Health</td>
<td>Light</td>
<td></td>
</tr>
<tr>
<td><strong>Kan River Drainage Area Development</strong></td>
<td></td>
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</tr>
<tr>
<td>Ecological environment</td>
<td>Terrestrial &amp; aquatic organisms &amp; local ecological system</td>
<td>Serious</td>
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<td>Public health</td>
<td>Health</td>
<td>Light</td>
<td></td>
</tr>
</tbody>
</table>
14.2 Analysis of Cumulative Impacts on the Surface Water Environment

Construction of the Kan River steps will lower the water velocity in each reaches of the channel, degrade the degradation capacity of the river water and further deteriorate the water quality. Prediction of the single pivot also reflects the same point. Discharge equal quantities of pollutants into two kinds of river water, one is water before construction of the pivot and the other after. As a result, water quality of the former is better than the latter. After completion of multiple steps, quality of water from the upper step is already contaminated, and water quality of steps in the lower reaches will be accumulated to be worse and worse, so construction of Kan River steps will cause obvious cumulative impacts on water quality in the lower reaches, especially in case of short reaches of the channel.

14.3 Analysis of Cumulative Impacts on the Ecological Environment

- **Terrestrial organism**

Cascade development of the Kan River will inundate an abroad area, greatly damage the existent habitat of terrestrial organism, force the existent space of terrestrial organism to migrate to high level or zone far away from the reservoir area, result in reduction of the existent space of terrestrial animals and disappearance of terrestrial plans of a large area due to abrupt change of water and land environment. From the angle of organism species, no animals and plants in severe danger are found within the scope of the reservoir area, population quantities of terrestrial animals and plants will not be reduced.

- **Aquatic organism**

Generally speaking, cascade development of the Kan River will cause a certain impacts on aquatic animals. As for migratory fishes, steps will obstruct their migrating passage, cause them impossible to migrate. When a single dam is built, these fishes can find the environment downstream which suit to live for them, while construction of several steps is involved in longer channel, the upmost step and downmost step have a too far distance, their environment difference will be great, many fishes may be hard to exist because of great difference, causing their quantity gradually reduced.

Obstruction of the dam will cause impacts only on two fishes, one is migratory fish, the other is the fish with a large activity space. For algae fonding of deep water and slow flow, after cascade construction, it will slow down the flows of different river sections, increase the water depths and width, it will promote growth of the algae of that species. Meantime, due to decline of degradation capacity of the reservoir area on organic matters, plankton will have more sufficient foods and thus increase their reproductive force, quantity and species of plankton will be in the tendency of increase.
14.4 Analysis of Cumulative Impacts on the Social Environment

With gradual construction of the planned multiple steps in the Kan River, the navigating capacity of the Kan River will be improved, which will promote the exploitation of rich mineral resources in Jiangxi province, and drive the economic construction and development in the middle and lower reaches of Kan River, especially Ji’an City and Taihe County, thus drive the regional economic development, increase more job opportunities, and improve the regional economic situation.

14.5 Cumulative Impacts on Ambient Air

Construction of the Kan River steps will not produce air pollutants itself. However, step construction will increase the navigating capacities of the Kan River. This means that there will be more ships waiting for passing the cascade ship lock, which will discharge more waste gas. Therefore, the nearby air environmental quality will be affected by the waste gas discharged by the passing ships. After completion of the whole steps in the planning of the Kan River, the transporting capacity and volume of freight will be bigger and there will be more and more ships. So the neighboring ambient air quality will gradually deteriorate along with the completion of the steps. However, according to the estimated number of ships, even by 2020, waste gas of ships will not make the air quality nearby the ship lock lower than the corresponding standard.

14.6 Analysis of Impacts on Acoustic Environment

With gradual construction of the planned multiple steps in the Kan River, the navigating capacity of the Kan River will be improved. The passing ships will increase and the waiting ships for passing the ship lock will also increase. Therefore, the mechanical noises produced by ships will also worsen some impacts on the neighboring environment in the scope and degree of impact.

14.7 Analysis of Impacts on Natural Landscape

With the gradual construction of the planned steps, the natural channel of the Kan River will be divided into 9 (or 11) sections, 8 (or 10) of which are river-type reservoirs, and this will wholly change the landscape along Kan River. Although it imposes little impact on the value of sight enjoyment, it destroys to a certain extent the continuity and completeness of natural landscape along Kan River.

14.8 Analysis of Impacts on Local Climate

The Project belongs to a river-type reservoir that will have a very small scope of impacts on the climate, which shall be limited to the range of 2km from riversides in a limited degree. After completion of the multiple steps, the river sections shall remain the previous river
channels, and the impacts on climate are only limited to the neighboring areas of the river sections. The superpositional impacts shall be very much limited. Therefore, the construction of multiple steps will not have cumulative effects on the climate.

14.9 Analysis of Impacts on Public Health

According to the prediction of the Project, completion of the project will not have obvious impacts on the health of the neighboring residents. Due to the construction of the multiple steps, the water in the Kan River will be deeper than that in the previous natural river channel. All reservoirs belong to river-type reservoirs. In flood time, the flood will be released to the lower reservoirs. Even though with different water quality and the upper reservoirs will somewhat affect the lower reservoirs, due to the limited influence from upper reservoirs, the degree of cumulative effects will be limited.

From the above analysis, it can be seen that, construction of multiple steps will have cumulative effects on the social environment, especially on the aquatic organism followed by on the social environment and surface water environment. Therefore, during the process of construction, it is required to enhance the protective measures for negative impacts, thoroughly exert the positive effects, thus to make it serve the human being while minimize the impacts on the environment.

14.10 Conclusion of Cumulative Effects

From the analysis of cumulative effects of the Project and multiple-step construction, it can be seen that the cumulative effects of individual step construction will be limited while the construction of multiple steps will have obvious cumulative effects due to accumulation of time and identical impacts. The negative impacts are mainly on aquatic life, especially on the migratory fishes, semi-migratory fishes and spawning sites. Multiple-step construction will make floating and semi-floating spawns to flow into static waters too early during drifting and hatching process, thus affecting their growth.

The positive impacts of the construction of the project are to promote the economic development of the Kan River drainage area, especially the revolutionary old regions of Ji’an and Jinggang Mountains. Therefore, during construction of individual project, it is required to take into consideration of the integrative influences of multiple projects so that the advantages can be exerted and the disadvantages may be avoided, thus to minimize the negative impacts on the environment.
15.0 EIA CONCLUSIONS AND SUGGESTIONS

15.1 EIA Conclusions of Environment Actuality

- The Project is located between Ji’an urban area and Taihe County seat at the middle reaches of the Kan River, the dam site is situated nearby Shihutang Village, 26km downstream the Taihe County Seat Road Bridge.

- It is a multipurpose project, which takes shipping as the main, gives consideration to power generation and flood control. The project belongs to second-class large (2) type project, with normal impounding level of 56.50m, total reservoir capacity of about 632 million m³, the reservoir area at normal level of 29.2km², backwater length of 38km, 6 water turbine power generating sets, installed capacity of 117MW, annual average power generating capacity of 4.8×10⁸kW·h, water retaining height of 9.8m, belonging to low head building, the total investment is 2.223 billion yuan.

- According to the survey result of 6 water quality monitoring sections, the present quality of water environment of the Kan River section where the project is located meets the requirements of Category I to III water quality standard, and it is good in general.

- According to the survey result of 3 air monitoring points, the present quality of ambient air of the area the project is located meet Grade II of Ambient Air Quality Standard (Revision) (GB3095-1996), the regional ambient air quality is good.

- According to the survey result of 3 noise monitoring points, the noise values of the project area can Category 1 of City Area Ambient Noise Standard (GB3096—93) without standard-exceeding phenomena, the present regional acoustic environment is good.

- There are no national grade protected wild plants and famous trees within the EIA area. There are 11 species of provincial grade protected plants within the EIA area. More old trees are distributed along both banks within the EIA area, mostly cinnamonum camphora and schima superba, which have formed old tree population in some unique areas. Shihutang Project district is mainly of plains and low hillock plain distributed in six administrative townships, there is no native vegetation whatsoever. Instead, secondary plant and artificial vegetation makes up the majority. Density of cover from natural vegetation reaches 56%.

- Amphibians are classified into 1 order, 4 families and 8 genera, with no species under state protection. Investigation indicates that there are numerous Bufo gargarizana. There are 3 orders, 5 families and 9 genera of reptiles, with no species under state protection. Zoaecys dhumnades are large in quantity. There are 26 species of birds, classified into 8 families and 17 genera. Passerine are the largest in quantity, totaling 9 species, or 34.62% of all. There is no bird under state protection. There are 7 orders, 7 families and 7 genera of beasts in Shihutang Project district. There is no beard under state protection. Rodents are the largest in numbers and species in this area. Of all terrestrial vertebrates, there is no species under state protection. There are 20 species under province-level protection in Jiangxi Province, widely scattered in quantity in Shihutang Project district. Of plankton in the region the diatom plays the major role, followed by chlorella and Cryptomonadales. In biomass diatom makes up the majority. All together the investigation collected 21 species of zoobenthos, classified into 2
15.0 EIA Conclusions and Suggestions

Phyla, 3 classes and 9 families. Of them most are of mollusk, totaling 19 species, making up 90.48% of zoobenthos.

15.2 EIA Conclusions

15.2.1 Water environment

- During the construction period, water pollution source mainly comes from productive wastewater and domestic sewage, in general, smaller in discharge but higher in pollution concentration, after corresponding treatment measures are taken to make the discharge satisfy Grade 1 of the Standard for Integrated Sewage Discharge (GB8978-1996), it will cause smaller impacts upon water quality of treated wastewater reception water body during construction.

- The catchment area controlled by the Project is 43770km². The maximum annual average flow is 1940m³/s (in 1975), the minimum annual average flow is 405m³/s (in 1963), annual average flow is 1150m³/s, annual average runoff is 362.9×10⁸m³, annual average depth of runoff is 828.9mm, annual average runoff modulus is 26.27L/km²/s, the annual average total sediment runoff of the Shihutang dam site is 428×10⁴t.

The flood management and operation mode of the Project is decided as per the upstream incoming flow. When the incoming flow at upstream is smaller than critical flow for opening gates, it will switch into beneficial flood management and operation mode of shipping and hydropower generation. The design critical flow at the Shihutang dam site is 4700m³/s, and the critical flow at the Guanyuan River discharge section is 70m³/s.

To meet the shipping requirement of the dam downstream, the release flow of the reservoir shall not be smaller than 187m³/s, accounting for 16.3% of annual average flow. That release flow can also meet the navigational requirement of the downstream channel, and productive, domestic and ecological water consumption requirement of the dam downstream.

The silting sand in Shihutang reservoir is expected to become a small silting delta, the silting sand at the end of the reservoir and before the dam is relatively little.

- Water body in the reservoir is of mixed pattern, thus there is no big difference in water temperature in the discharged water and natural water, to produce no impact upon downstream eco-environment.

- Under the hydrological condition of monthly average flow of the driest month at 95% of assurance rate, after completion of the dam, in scope of the nearshore waters lasting 2050m long and 23m wide close to Chengjiang Sewage Outlet in the near future, the pollutant concentration goes beyond Grade II of water quality standard; at 2461m downstream the outlet (1000m in the upstream, 5m to the bank) NH3-N concentration ≤0.5 mg/L, BOD≤3 mg/L and COD≤15 mg/L. Still, water meets the requirement of water intaking of the Chengjiang Water Plant, 3461m downstream.

Under the hydrological condition of monthly average flow of the driest month at 95% of assurance rate, after completion of the dam, in scope of the nearshore waters lasting 2350m long and 15m wide close to Chengjiang Sewage Outlet in the far future, the pollutant...
concentration goes beyond Grade II of water quality standard; at 2461m downstream the outlet (1000m in the upstream, 5m to the bank) NH3-N concentration $\geq 0.5$ mg/L, BOD $\leq 3$ mg/L and COD $\leq 15$ mg/L. Still, water meets the requirement of water intaking of the Chengjiang Water Plant, 3461m downstream.

In case of the sewage treatment plants under normal discharge, under the conditions with and without the Shihutang Project and of short-term and long-term impacts, the quality of water at 1000m upstream of the water intake can satisfy Grade II of water quality standard; if under emergency discharge, the quality of water can not satisfy Grade II.

Under the hydrological condition of monthly average flow of the driest month at 90% of assurance rate, after completion of the dam, within the scope of 2000m long and 22m wide nearshore waters downstream of Chengjiang Wastewater Outlet, the quality of water will exceed Grade II in the near future; within the scope of 4480m long and 31m wide nearshore waters from Wentian Wastewater Outlet to Yanxi Wastewater Outlet, the pollutant concentration will exceed the Grade II of the water quality standard.

Under the hydrological condition of monthly average flow of the driest month at 90% of assurance rate, after completion of the dam, within the scope of 2250m long and 15m wide nearshore waters downstream of Chengjiang Wastewater Outlet, the pollutant concentration will exceed Grade II in the far future; within the scope of 1800m long and 31m wide nearshore waters downstream of Wentian Wastewater Outlet, the COD concentration will exceed the Grade II of the water quality standard in the far future; within the scope of 700m long and 12m wide nearshore waters downstream of Yanxi Wastewater Outlet, the COD concentration will exceed the Grade II of the water quality standard in the far future.

□ Annual mean phosphorus nutritive element in Shihutang reservoir will be $< 0.016$ mg/l, phosphorus concentration is at the lower limit of mesotrophic level, therefore there will be no eutrophication in the reservoir in general.

□ Water environmental capacity of NH3-N at Chengjiang Wastewater Outlet is 155.9 t/a; BOD$_5$ 695.2 t/a, and COD 3506.6 t/a.

In the near future annual NH3-N discharge at Chengjiang Wastewater Outlet is expected to be 137.87 t/a, BOD$_5$ 432.03 t/a, and COD 973.6 t/a; in the long run annual NH3-N discharge at Chengjiang Wastewater Outlet will reach 146.0 t/a, BOD$_5$ 365.0 t/a and COD 1095.0 t/a, all are below the environmental capacity of the river section.

□ Under normal operation, in the reservoir area upstream of the dam in the near future, COD concentration is expected to be 4.49 mg/l, and in the long run 4.28 mg/l; After water is discharged, the water flow rate will increase so that reoxygenation capacity will be improved and water quality will get better, thus the quality of water downstream of the dam site will not have a big change compared with that before construction of the dam.

□ After the reservoir is impounded, water levels of different river sections will be raised than before to different extents. The normal water level is higher than natural water level by 9.43m (Minimum flow as observed on Feb. to Oct. 2006 reached 274$m^3$/s, with
corresponding water level in the upper reach of the dam averaged 47.07 m, and water levels for 10-year and 20-year recurrence floods were raised by 0.08 m and 0.14 m respectively. Now water feeding balance to the underground water at the front edge of the first terrace and second terrace will be resumed in this case until new dynamic balance more beneficial to underground water is established. Lowering of the underground water level will be under effective control, so that underground water reserve will remain stable and steady, to provide sufficient water sources for domestic and industrial water consumption in Taihe County Town.

15.2.2 Ecological environment

The Project will permanently acquire 42525.1 Mu, including 2977.3 Mu farmland (incl. 198.27 Mu basic farmland). The Project will temporarily occupy 6895.65 Mu (incl. 1237.05 Mu by farmland elevating, 78.15 Mu by resettlement area), including 2748.6 Mu farmland. After completion of the Project, arable land per capita will reduce by 2.7%, from 1.42 Mu per capita to 1.38 Mu. There is little impact from such land acquisition to local residents. The major species of vegetation include Form Pinus massoniana, Form Pinus elliottii, shrub and meadow and artificial gardens. Except for permanent acquisition of land, the other land all can be resumed with their vegetation.

There are 11 species of plants under province-level protection, including podocarpus macrophyllus, Osmanthus fragrans, camellia, mastic tree, Chinese holly, Ilex rotunda, Bischofia tyifliata, Gentiana scabra Bunge, Planchonella spp., Sapindus mukorossi Gaerth and Asnaragus cochinchinensis. These species are mainly distributed in the herbages of shrub and underwood and in the broad-leaved forest close to villages. There is no such mentioned species in the project site, except for Gentiana scabra Bunge, Planchonella spp., Chinese holly, Asnaragus cochinchinensis occasionally in borrow earth pits. Anyway they are limited in number, with no large trees or historical trees, all of which are dispersed species. The project will in no way threaten their survival or reproduction, and its impacts are slight.

Impacts during construction on terrestrial animals are smaller. Benthos loss will be about 63.57 t during construction.

During operation there will be at least 187 m$^3$/s of basic discharge flow to satisfy the need for navigation. The ship lock will maintain a discharge flow of 11.24 m$^3$/s in the near future and 15.31 m$^3$/s in the long run. The guaranteed minimum flow will reach 198.24 m$^3$/s in the near future and 202.31 m$^3$/s in the long run. During operation of the Project, the basic ecological water consumption requirement of the downstream river section and normal water intaking requirement of water consumers downstream of the dam can be satisfied.

15.2.3 Water and soil erosion

Earth excavation and earth-rock fill will severely threaten the stability of soil stratum, to aggravate water and soil erosion.

During the construction period, original topography will be under severe perturbation, with topsoil and vegetation under serious damage, which will greatly reduces soil resistance to corrosion. The project will involve such areas as residents’ settlement, land for farming and rivers and streams. Any neglect of temporary control of water and soil erosion will result in
desirable increase in runoff sedimentation in rainy seasons, which will deposit to block the
dam or channel to produce negative impact upon flooding or water transmission. In dry
season such neglect will produce a lot of dust to be unfavorable to people’s production or
living, unfavorable to vegetation growth only to worsen ecological environment.

15.2.4 Ambient air
Impact of the Project on ambient air happens mainly during construction period. Dust caused
by construction will cause a certain pollution impact on the surrounding residential areas.
Impact upon ambient air will not last long. Completion of the Project will mean an end to
such pollution.

15.2.5 Acoustic environment
Construction noise at daytime basically has no standard-exceeding impacts on the
surrounding residential areas, but construction noise at nighttime will cause a certain impacts
on the nearer surrounding residential areas.

Noises within 10m of the temporary roads and existing roads basically has no standard-
exceeding impacts and fall within Grade IV at daytime, with no standard-exceeding impact
upon objects over 30m away from the roadside at night. In a word, during the construction
period noise standard-exceeding pollution impacts on scattered residential areas by roadside
of the temporary roads and existing roads is limited.

The hydropower generation of the Project will produce noise effect only within the battery
limits of the pivot area, which is over 400m away from the concentrated residential areas at
both banks. Operation of the hydropower station basically will not cause noise pollution
impacts on them.

During the operation period noise from the ships basically creates no noise standard-
exceeding effect upon the residents along the channel.

15.2.6 Resettlement
After the fending groynes and farmland elevating measures, the reservoir inundation and the
bury of protection works will need to permanently occupy 2829.8Mu farmland (including
701.85Mu paddy field, 2127.9Mu dry land, among which there are 198.27Mu basic
farmland), 104.4Mu garden plot, 3130.9Mu other types of land, 32588.6Mu water area; It is
involved in relocation of 711 people, impacts of 8 enterprises and institutions, house
relocation of $4.56 \times 10^4 \text{m}^2$ and some other facilities.

After completion of the embankment protection works and works concerning lifting the field,
there will be land acquisition in form of belt, so that arable land per capita will reduce by
2.7%, from 1.42mu per capita to 1.38mu. There is little impact from such land acquisition to
local residents. Meanwhile resettlement is distributed in 44 villages, so they will benefit from
low-yield land improvement. Therefore complete fulfillment of RAP can minimize the
negative impacts on social environment due to resettlement.
15.2.7 Cultural relics protection

Five spots of culture relics are distributed in inundation area and reservoir area of Shihutang navigation and power junction project. The project construction and reservoir area immersion have no impact on 2 cultural relic points that have protective grade and 1 cultural relic point that applies now for provincial site protected for historical and cultural value; They have impact on 2 cultural relic points that have no protective grade. Jiangxi Provincial Institute of Cultural Relics and Archaeology will carry out the culture relics protection work for 2 cultural relic points that may be affected by the project construction before the commencement of the project, in order to obtain historical information, after the cultural relic protection work is finished, the project construction and reservoir area impounding will not cause damage and impact to cultural relics.

15.2.8 Bury and coverage of mineral resources

Within the reservoir inundation area and the project area, no important mineral resources will be directly buried and covered, without need to let by.

15.2.9 Social environment

☐ During the construction period, the engineering vehicles and material carrier vehicles will use the existing roads and village roads, which will cause a certain negative impact upon local traffic and normal living and traffic of local people too.

☐ At present in Wanhe and Yanxi some farmlands often suffer from flood inundation in Kan River, with poor annual yield. Completion of Shihutang Project will bring such five protection areas as Taihe County Town, Wanhe, Yongchang, Yanxi, and Zhangtang, so as to improve the current flood prevention standard from 2-to-5-year-recurrence to 10-to-20-year recurrence. As a result, there will be 74.8km2 area under protection, among which farmland totals 65000 Mu and population 53000 persons. By improvement of embankment in left-bank shallow inundation area of Kan River’s tributary Yunting River and by farmland elevating measure for basic farmland of Mashi Township (tail of reservoir), there will be 1200 Mu of farmland under protection. All of these will be beneficial for perfection of municipal infrastructure in Taihe, for protection of people’s lives and wealth and for improvement of farmland yield.

15.2.10 Geological environment

The landform unit within the project area is mainly of low hilly areas of tectonic denudation and plain of accumulation by fluvial erosion. Without artificial underground caves or goaf of mines to be exploited, therefore there is no possibility of surface collapse from karst or from goaf. The reservoir bank is composed of primary and secondary terraces, with partial low topography, lower than normal water level, and partial low hills of slow slopes. After the reservoir is impounded there is little chance of permanent seepage.

At the dam site the total annual discharge of sediment reaches 428×10^4t, with fine silt (0.054mm). Due to low elevation of the sluice gate bottom, most of sediment from the upper reach will be discharged out of the reservoir. Sediment accumulation in the reservoir is
estimated to develop into a small-scaled delta, with little sediment accumulation in the reservoir head and in front of the dam, which will produce little impact upon works operation. The basic earthquake intensity of the reservoir area is smaller than 7 degrees. After operation the reservoir will not raise water head by much, which will produces little change in terrestrial stress, therefore there is little possibility to induce earthquake.

15.3 Assessment Conclusions of Impacts on Old Trees and Large Trees

According to this investigation, vegetations in the project inundation area and around the reservoir are mainly secondary forest and artificial forest, such as protective forest of protection embankment, village amenity forest and poplar young growth of returning land for farming to forestry and etc. plants in inundation area are mostly common species distributed at low elevation.

Famous trees and wild national key protected wild plants have not been discovered in the project area.

After field investigation, there are altogether 215 old trees in the project area (according to the filed appraisal of experts of Forestation Commission of Jiangxi Province Forestry Department, all old trees belong to Class III protective old trees), including 211 Cinnamomum camphora, 2 Cupressus funebris, 1 Sabina chinensis and 1 Castanopsis sclerophylla. The old trees are mainly distributed in old forest of Jintan, Huanghangpengxia, Xinzhou, Shihutang, Jiangjiazhou, Xiabian Village, Yinxiajiang, Taipan, Zhangjia, Laohukeng and etc. Old trees form an old trees community in nature protection area of Jintan, and others are irregularly growing in the village or beside the village sporadically.

There are 215 old trees distributed in the project area, including 6 old trees in the planned protection embankment, 14 old trees within protection embankment, 7 beside the road of Shihutang Village on the edge of the junction project area, 7 old trees in the inundation area outside the protection embankment, 181 old trees in the non-inundation area outside the protection embankment (most of them is located in the Jintan Nature Protection Area at County Level). Moreover, there are 74 Cinnamomum camphora (potential old trees) with breast diameter of 80~100cm in the project area, including 9 in the inundation area, 4 on the embankment, 60 outside the embankment and 1 inside the embankment.

After the project impounds water, it will cause a certain impacts on the trees within the project area. The project will adopt protective measures for 21 old trees and 27 big trees, including transplanting protective measures for 3 old trees and 3 big trees; adopting concrete diaphragm wall protective measures for 9 old trees and 13 big trees; masonry breast wall protective measures for 7 old trees and 11 big trees; Embankment line avoiding protective measures for 2 old trees and no big trees. Cement laid stone masonry slope protection will be adopted for river bank of Xinzhou (30m long) in order to prevent river erosion.

This country grade nature reserve is at the Kan Riverside at Zhujia Village of Tangzhou Township, with an area of 330Mu including 225Mu core area and 105Mu buffer area. There are 161 old trees more than 100 years old among Jintan old trees. In addition, there are 39 Cinnamomum camphora with breast diameter 80~100cm, these old trees or big trees are located in the non-inundation area outside the embankment.
Embankment line direction of engineering design of Yongchang Protection area Protection Embankment of the project will pass the core area and buffer zone of this reserve. The arrangement plan of embankment line put forward by the engineering design contractor doesn’t comply with relative laws, rules and regulations of Regulation on Nature Reserves of the People’s Republic of China. The EIA contractor has put forward alternative scheme (recommended scheme) of environmental protection from environmental protection angle aiming at design of embankment line arrangement scheme of this section, embankment line of alternative scheme of environmental protection of this assessment is located outside the core area and buffer zone of the reserve zone. After communication with the Owner and engineering design contractor, they have agreed in principle to adopt the alternative scheme of environmental protection.

In order to reduce the environment impact of project construction to Tangzhou Town Zhujia Village County Level Small Natural Reserve (Jintan old trees) to an acceptable degree, implement cement laid stone masonry slope protection (with a length 1040m) for riverbank of core area of reserve zone in order to prevent river bank collapse due to river erosion. The riverbank slope protection work is located in the border of the reserve zone (within the reserve zone). Taihe County government agrees to implement the riverbank slope protection work at the border of the reserve zone put forward by this assessment and issued a document titled Reply on Adjustment of Core Area and Buffer Zone of Zhujia Village Cinnamomum Camphora Forest County Level Nature Reserve, Tangzhou Township, Taihe County (March 25, 2007).

### 15.4 Assessment Conclusions of Impacts on Fishes and Spawning Sites

According to the site interview result of the resettlement report of the project, there are 7 professional fishing boats in the river section between the Shihutang dam site and upstream Taihe Pivot, in addition there are a small amount of non-professional fishing boats. The gross annual catch totals 83 tons.

Historic literature and the document provided by fishery department show that the Project is involved in two spawning sites as Taihe (Chengjiang) Spawning Site and the Yanxidu Spawning Site. The main spawning fishes of these two sites are mandarin fish, grass carp, snail carp, silver xenocypris, Elopichthys bambusa, bream fish, Xenocypris argentea, H. maculatus Bleeker and etc. During the spawning period of 2007 (April to June), the project team has executed site survey on the two spawning sites. The total collected spawns are 2.3569 million grains, only accounting for 1.18% of historic spawning quantity. Meanwhile, fishes accumulating phenomenum is not found in the said two sites, and the river section is severely sand dredged and flows moderately and has sparse aquatic plants. It is told by the local fisherfolks that no large fishes spawning in these two sites have been found, which indicates that these two spawning sites have been severely degraded.

In accordance with the literature, fishes in the Kan River total 118 species, classified into 11 orders, 22 families and 74 genera, of which the Cyprinidae makes up the majority about 58.5% in total, followed by Bagridae, 9.3%; Of Cyprinidae in the Kan River, Gobioninae and
Anabarilius grahami each averages 23.2%. There are altogether 41 species of recorded fishes through investigation of the assessed river section, classified into 3 orders and 7 families, of which the Cyprinidae makes up the majority about 73.17% in total. These species are all common fresh water fishes without special species, among which there are key economic fishes as silver xenocypris, hemibarbus maculates, bream, red-eye trout, mandarin fish, pelteobagrus fulvidraco, shining pelteobagrus fulvidraco, etc. and migration fishes as “four major Chinese carps”. This investigation has not recorded some valuable and rare migration fishes (as Acipenser dabriganus Dumeril, Psephurus gladius(Martens), Myxocyprinus asiaticus (Bleeker), Anquilama japonica J.et.s, Coilia ectenes J.et.s and hilsa herring etc.).

Construction impact on fish mostly appears as “dissipation effect”, impact on protection of fish species resource will be limited. Construction diversion will not affect obvious obstruction impacts on fishes.

Over-water construction of this Project will be concentrated on the pivotal region. There are two spawning sites in the upper reach of the dam site with long distances (Taihe Spawning Site is about 21.4km away from the dam site, the Yanxidu Spawning Site is about 13.9km). Despite negative impact upon water quality, plankton and benthonic organism from such underwater construction as cofferdam, foundation pit excavation and cofferdam removal the construction site is far away from the spawning sites and there will be no water flow interception, thus there is no severe impact upon spawning sites during construction period.

After the project is put into operation, the levels of different sections of the river will be raised to different extents than before. Meantime, rising of water level will bring some water grass under inundation, to produce negative impacts upon fishes whose eggs are attached to the grass. This will cause great impacts on fishes laying adhesive spawns. The completion of the dam will reduce flow velocity and water level of the dam downstream river section to severely threaten the spawning and breeding of such fishes as enjoy flowing water.

After completion of the Project, the dam will block the migration passage of migration fishes. Some migration and semi-migration fishes can not swim back to the upstream for raising up seeds. Because the upstream spawning site nearer to the reservoir area is of short flow stream, floating and semi-floating spawns flow into static water of the reservoir area too early during drifting incubation, with growth affected. Some spawns or fries flow down with the water flow, and can not bear impact of enormous energy and can not survive, even if they can survive, they can not swim back to upstream for making up group resource.

As per literature, the Kan River hilsa herring spawing sites (Xiajiang~Xingan) are located at more than 90km long river section upstream of Xinganshikou and downstream of Ji’an, among which the main spawning sites are located at 30km long river section of upstream and
downstream of Xiajiang County seat. Xiajiang-Xingan hilsa herring spawning sites are located at about 90km~120km downstream of this dam.

The main spawning time of hilsa herring is concentrated in June and July each year. This site survey has not recorded hilsa herring. At the same time, the fisherfolks feedback that no hilsa herring has been caught in recent more than ten years. And in the investigation of fishes at lake intake in recent years, no adult hilsa herring has been found to enter the lake or fries found to go out of the lake.

Xiajiang hilsa herring (Xiajiang-Xingan) spawning site is over 90km away from Shihutang dam, such a long distance can basically resume the physical properties of water as water temperature etc. to be changed by the dam. And Shihutang Pivot belongs to low head dam, runoff type development mode, and hardly runoff control performance. The operation mode of the Shihutang hydropower station will utilize the power generating drain flow of the Wan’an hydropower station plus sectional flow as its power generating flow. The annual average, monthly average and daily average flows and levels of downstream of the Shihutang dam in the design representative year all will be the same with the runoff and level of the Shihutang dam under current condition in the design representative year. Therefore, the main negative impacts on the Xiajiang hilsa herring spawning site by the Kan River hydropower development will not come from the Shihutang Project.

Considering the hydropower development actuality of the drainage area and the special features of this project, the size, habit and operation management conditions of fishes at the Taihe section of the Kan River, this EIA applies protection measures of fishes and spawning sites for this project to build fishpass, to construct fish proliferation and fry releasing station, to construct substitute fish habitat, to execute monitoring and study, to strengthen fishery administration etc.

15.5 Plan Harmony Analysis & Environment Alternatives Comparison

15.5.1 Assessment conclusions of plan harmony

Construction of the Project is consistent with the national industrial policies, and with the Kan River Drainage Area Plan of Jiangxi Province in general, and with the Taihe County Seat Master Plan (1999—2020) and meets the requirements of the Taihe County Seat Environment Protection Plan (1999—2020) and the Taihe County Environment Function Delimitation.

15.5.2 Environment comparison conclusions of engineering alternatives

Environment comparison on the Fangzhou Dam Site Plan and the Shihutang Dam Site Plan lodged by the engineering design contractor is done, the Shihutang Dam Site Plan is recommended from the angle of environment protection in the EIA, which is just the same with the recommended plan by the engineering design contractor.

Two plans of Upper Dam Line Plan and Down Dam Line Plan are addressed by the engineering design contractor, the Upper Dam Line Plan is recommended from the angle of environment protection in the EIA, which is just the same with the recommended plan by the
15.0 EIA Conclusions and Suggestions

engineering design contractor.

Environment comparison on the normal impounded level plans of the Shihutang Project lodged by the engineering design contractor is done, the 56.5m normal impounded level plan is recommended from the angle of environment protection in the EIA, which is just the same with the recommended plan by the engineering design contractor.

Environment comparison on the Layout Plan 1 (right ship lock and left powerhouse plan) and Layout Plan 2 (right ship lock and right powerhouse plan) of the Shihutang Project lodged by the engineering design contractor is done, Layout Plan 1 (right ship lock and left powerhouse plan) is recommended from the angle of environment protection in the EIA, which is just the same with the recommended plan by the engineering design contractor.

Environment comparison on the normal impounded level plans of the Shihutang Project lodged by the engineering design contractor is done, the 56.5m normal impounded level plan is recommended from the angle of environment protection in the EIA, which is just the same with the recommended plan by the engineering design contractor.

Environment comparison on the Layout Plan 1 (right ship lock and left powerhouse plan) and Layout Plan 2 (right ship lock and right powerhouse plan) of the Shihutang Project lodged by the engineering design contractor is done, Layout Plan 1 (right ship lock and left powerhouse plan) is recommended from the angle of environment protection in the EIA, which is just the same with the recommended plan by the engineering design contractor.

In terms of environmental protection, three ship lock dimension schemes are compared, Scheme I (180×23×3.5m) is recommended, the same conclusion as out of engineering design.

A comparison is made of the three schemes, namely Scheme I (15m), Scheme II (20m) and Scheme III (22m) concerning gate hole clear width, on the viewpoint of environment protection, Scheme II is recommended, identical to conclusion out of engineering design.

Out of comparison of two schemes involving flood control or inundation of five protection areas, this report recommends Scheme I (flood control plan), the same conclusion as out of engineering design.

Of the two schemes of Wanhe guide drainage canal axial line in engineering design, this Report recommends Scheme II in terms of environmental protection after comparison, the same conclusion as out of engineering design.

15.6 Environment Risk Assessment Conclusions

The main environment risks of the shipping pivot are dam breach and earthquake etc.; The accident types in the water way operation include collision accident, hull stranding, boat fire and shipwreck accident and ship pollutant emergency discharge etc.

The maximum risk possibility of ship oil overflow accident in channel is 0.03～0.08 time/a. A perfect regional accident risk control management system has been set up by the Ji’An City government and relevant functional departments, as well as a permanent accident risk emergency reaction center. Once a risk accident occurs, accident emergency measures can be adopted promptly.

15.7 Environment Protection Measures and Cost Estimate

To control pollution impacts during construction and operation of the project on the environment within an endurable extent, corresponding environment protection measures have been framed according to the pollution impact characteristics of the project.

The total investment of the project is 2.2268932 billion yuan, static environment protection
investment is 71.1983 million yuan in total, including environment protection investment of 55.4254 million yuan, investment of water and soil erosion work of 14.8113 million yuan, resettlement environment protection investment of 411,600 yuan, investment for water and soil conservation measures at resettlement area of 379,400 yuan, and reservoir bed cleanup investment of 170,600 yuan. Environment protection investment accounts for 3.20% of the total investment of the project.

15.8 General Conclusions

The Shihutang Project is a multipurpose project, which takes shipping as the main, gives consideration to power generation and flood control. Construction of this project will promote construction of the Kan River backbone channel network and will raise hydropower proportion in the whole Jiangxi power grid, and will be beneficial to perfecting the municipal infrastructure of Taihe County and to protecting the safety of lives and properties of Taihe County’s people and to raising agricultural unit output within the protection area.

Completion of the project will tinnily change flood and runoff of the Kan River trunk, release base flow $187m^3/s$ will not affect all the existing water consumption functions of the dam downstream, and meantime it can also meet the ecological water consumption requirement of the downstream river section of the dam; It will have a certain function to control shipping at dry season, beneficial to navigation.

Measures of old trees protection, fish pass, fish proliferation and fry laying, and artificial fish nest lodged in this report will greatly lessen impacts on the ecological environment due to construction of the dam.

The Owner shall reinforce the work of environmental management during construction period, intensify environmental protection education of the construction team, make close supervision, and advocate civilized construction. The contractor shall make specific provisions in the contract and promise the above pollution control measures during construction period, as well as draw up rigorous punishment for breach of the contract.

According to the relevant environmental protection specification and standards, design drawings, design specifications and other design documents, construction contract and bid document and tender document, contract for construction environment supervision and bidding document, the construction supervision contractor shall draw up the environment supervision plan, and strictly abide by it.

Strengthen the work of environmental monitoring during construction period, and carry out regular or irregular environmental monitoring plans.

Before impounding of the project, Taihe County Government shall construct city sewage collector network and sewage treatment plant strictly according to the Taihe County City Overall Plan, collecting all the city sewage and industrial wastewater, discharge the treated water after satisfying the discharge standard; Taihe County Government shall prohibit to develop pollutive enterprises at the surrounding of the reservoir, and stringently control the new, revamping and expansion projects with discharge nature at the surrounding of the
reservoir, strictly forbid to set different pollution sources or night soil of human and domestic animals and garbage directly discharged into the river. This is the premise of the project feasible in the aspect of environment.

After fulfilling the environment protection plans decided in the engineering design and all the environment protection countermeasures and suggestions given in this report, the Project will be feasible in the angle of environment protection.

15.9 Suggestions

□ It is suggested to construct and complete the regional sewage collector system and treatment facilities and domestic garbage disposal facility as soon as possible, reducing and avoiding pollution impacts of wastewater and garbage discharge on water quality of the reservoir area.

□ Whereas the flow of ships in the reservoir area channel will greatly increase during operation period, it is suggested that the related governmental authority properly increase overwater emergency facilities of local departments according to the development situation of water transport industry of the reservoir area channel, so as to reduce accident probability and loss caused by accidental pollution.

□ With improvement of navigational conditions and increase of transport ships, it is suggested that governmental authority complete regional salvage and rescue organ and equip related equipment and facilities, so as to effectively aid the accidents.

□ After the dam is completed, the supervision and management work load of fishery department on fish passing device, fish resources, aquatic ecological environment, fish proliferation and fry pouring work will be greatly increased. It is suggested that related government authority increase financial input on local fishery department so that the daily supervision and management work of fishery department can be effectively fulfilled.