SUMMARY ENVIRONMENTAL ASSESSMENT REPORT

YIXING PUMPED STORAGE POWER PROJECT

Prepared for:

The Government of Jiangsu Province

Prepared by:

Jiangsu Provincial Electric Power Company
East China Investigation and Design Institute

January 2002

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<th>Yixing Pumped Storage Project, P.R. China</th>
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<td><strong>Document:</strong></td>
<td>Summary EA Report (Final Draft)</td>
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Chapter 1

Introduction to the Project

1.1 Introduction

This section of the report provides an overview of the project and its objectives, and identifies the main benefits and adverse impacts that are expected to accrue if the project proceeds.

1.2 Background

The Jiangsu Government, in association with the Jiangsu Provincial Electric Power Company (JPEPC), proposes to implement the 1000 MW Yixing Pumped Storage Project (YPSP). The project will be located in the south of Jiangsu Province, just west of Tai Lake, near the borders of neighbouring Anhui and Zhejiang provinces (see Figure 1-1).

The YPSP is a water resources development project consisting of two small reservoirs (one lower; one upper), and an underground power generating/pumping station. As a pumped storage facility, the project will be designed to generate power during daily periods of peak electricity demand, when energy can be sold at a premium, by using the water stored in the upper reservoir. The water collected in the lower reservoir will then be pumped back up to the upper reservoir, during periods of the day when cheap energy can be bought from the east China power grid. A 6.3 km double circuit 500 kV transmission line will be constructed as part of the project for wheeling power out to the 500 kV Liyang Substation, which connects to the east China power grid, and to receive off-peak power with which to pump water back up to the upper reservoir. Two 35 kV transmission lines (5 km from Taodu Substation; 10 km from Yixing Thermal Power Plant Substation) will be constructed to bring power from the grid into the 35 kV YPSP Substation, which will be constructed near the lower reservoir. This power will be used initially for supplying electricity to the upper and lower reservoir construction areas and, later during operation, to provide electricity to the powerhouse facilities and auxiliary operations.

Jiangsu is one of the most economically developed provinces in China, and its power supply system is the most important part of the entire east China power grid. At present, the Jiangsu provincial power supply system is totally dependent on thermal generating plants for electricity generation. Because of their operating characteristics, thermal plants do not provide for good peak energy regulation. There is considerable concern that the current dispatching and operating system is unable to meet the increasing demand for peaking power, and that safe and stable operation of the system will soon be at risk. To solve the problem of regulating peak energy demand in Jiangsu Province and the east China power grid, the Government of Jiangsu Province has determined that it is necessary and feasible to build the Yixing
Figure 1-1 – Map Showing Location of Proposed Yixing Pumped Storage Project
Pumped Storage Power Project. The contribution that the YPSP will have on regulating peak demand in Jiangsu Province, once the project is fully operational (i.e., by 2010) is illustrated the diagram included as Appendix A.

1.3 Basis for Environmental Assessment

As a requirement of both the Government of China and the World Bank, an Environmental Impact Assessment (EIA) report must be prepared for the YPSP. The project has been assigned a Category ‘A’ rating under the World Bank’s environmental screening process. The following World Bank environmental and social safeguard policies have been triggered by the project:

- Environmental Assessment (OP 4.01, BP 4.01, GP 4.01);
- Involuntary Resettlement (OD 4.30); and
- Safety of Dams (OP 4.37, PB 4.37)

The Bank requires that the EIA be prepared in both the Chinese and English languages, and that the EIA meet both Chinese and World Bank EIA requirements. Where Bank funding is involved in any part of the project, the EIA must cover all project components, including transmission lines.

A draft EIA report (Chinese language version) was prepared by the East China Investigation and Design Institute (ECIDI) and State Power Corporation (SPC), as part of the feasibility studies, and submitted to the Jiangsu Environmental Protection Bureau (JEPB) for approval in January 2000. The JEPB convened a panel of experts, which met over a two day period (25 and 26 January 2000) to review the draft EIA. Formal approval of the draft EIA report was provided by the JEPB on 05 September 2000. Environmental specialists representing the World Bank subsequently reviewed the draft EIA (English language version), dated November 2000, in early December 2000, and provided detailed review comments. The draft EIA (English version) was revised and resubmitted to the Bank as a final draft EIA in May 2001. Further Bank review of this document produced additional comments, which were addressed by ECIDI and SPC in the final EIA dated September 2001, and submitted to the Bank in November 2001.

The EIA report takes into account the entire spectrum of potential project-related environmental effects on the bio-physical and socio-economic environments within the project setting. The EIA identifies the existing environmental and socio-economic conditions that could be affected adversely or beneficially by the project, identifies potentially significant impacts, and recommends measures for mitigating the more serious negative impacts. The EIA also suggests measures for enhancing beneficial impacts, where a small additional investment would yield environmental returns.
The following state and provincial policies, regulations and standards have been followed in preparing the EIA report:

- Environmental Protection Law of the People’s Republic of China (1989)
- Regulations of the People’s Republic of China Concerning Prevention of Environmental Noise Pollution (1996)
- Law of the People’s Republic of China on Prevention of Environmental Pollution by Solid Wastes
- Forestry Law of the People’s Republic of China
- Law of the People’s Republic of China on the Conservation of Water and Soil
- Law of the People’s Republic of China on the Protection of Wild Animals
- Regulations of Environmental Protection Management for Construction Projects [1998], Decree No.253 of the State Council of the People’s Republic of China
- Technical Guidelines of Environmental Impact Assessment HJ/T 2.1-2.3 – 93. HJ/T 2.4 – 95
- Specification of Environmental Impact Assessment for Water Conservancy and Hydropower Projects SDJ302 – 88 (Interim)

1.4 Scope of Environmental Impact Assessment

The scope of the EIA is the upper and lower reservoir areas, the reservoir peripheries, the affected downstream areas, water control works areas, the affected construction areas, resettlement host area, water conveyance system area, diversion area, makeup/balancing water supply area (Tuanjiu Lake – Huangtong River watershed), and the irrigated area served by the existing Huiwu reservoir.
1.5 EIA Methodology

1.5.1 Data Collection and Field Investigations

An environmental survey of the project area and its surroundings was initiated in April 1998. Yixing Environmental Monitoring Station was entrusted to provide water quality monitoring data for surface water sources and drinking water wells within the project affected area. A survey of terrestrial animals, plants and fishes inhabiting the project area was completed, and the local experts in these fields were consulted.

1.5.2 Methods of Analysis

Qualitative assessment methods were used to determine the extent of potential impacts on water quality downstream of the lower dam and within the diversion area, as well as for determining potential impacts of the project on the ecological environment within the project area and surrounding vicinity. Impacts were determined for both the construction period, as well as for the operations and maintenance period.

The impact on the reservoir water quality was predicted by quantitative analysis using a mathematical model.

The effects of release of chemicals (i.e., PAHs) into the water from the asphalt facing of the upper reservoir was determined by comparing the proposed project with similar analogous projects that have been constructed and are now operational.

1.5.3 Agency Input and Public Consultation and Disclosure

During preparation of the environmental impact assessment, the State Environmental Protection Agency and the environmental protection bureaus at different levels supervised the work according to the current relevant Chinese laws, statutes and regulations.

During the project site selection and design phase, the opinions of various government departments were solicited, and specialists from different fields (e.g., engineering, environmental, economics) were invited to evaluate and comment on the feasibility study report, and the design alternatives. The local project affected people (PAPs) and social groups were interviewed and meetings were held. Questionnaires were developed and used to obtain opinions from PAPs as part of the public consultation process. The project was publicized in the local newspapers, and radio and television programs. At the same time, the EIA Report for the project was made available for public review and comment in the offices of the local environmental protection authority. The availability of the report was advertised in the local newspaper, and people were invited to review and provide comments.
1.6 Project Impacts

1.6.1 Benefits of the Proposed Project

The primary benefit of the project is that it will improve the capability of the largely thermal-based electricity generating system to respond to peak load demands, by shifting 2000 MW of load to the off-peak (valley) load periods of the day. This will greatly alleviate peak regulation operation of Jiangsu’s thermal power plants, improve unstable frequency conditions in the system and, overall, improve the quality and reliability of the power supply system in the east China grid. This will result in spin-off socioeconomic and environmental benefits, including avoided emissions from additional thermal generation.

Localized benefits of the YPSP include employment opportunities that accrue from project construction, and operation, and creation of a local tourist attraction and the jobs that go with it.

1.6.2 Negative Impacts

The proposed YPSP is expected to generate the following negative impacts:

- **Resettlement and Losses from Reservoir Inundation** – A total of 757 people will be effected by the project. Of these, only 44 persons, from 19 households will be involuntarily resettled. The other 713 persons will lose some or all of their cultivated land or forestry land as a result of expansion of the lower reservoir, construction and inundation of the upper reservoir, construction of the power plant and substation facilities, and construction of the resettlement village needed to house the 44 displaced persons. An estimated 3,174 mu (211.6 ha) of forestry plantation, representing only 0.53% of plantation forest, will be removed from production at the Yixing Forestry Farm. Approximately 71.32 mu (4.75 ha) of tea farm and 23.59 mu (1.6 ha) of farmland will be permanently lost. Another 97.62 mu (6.5 ha) of tea farm will be temporarily occupied during the construction period.

Approximately 61 mu (4.1 ha) of fish aquaculture area (i.e., lower reservoir at Huiwu), will be removed from production. This facility currently only supports one retiree of the Yixing Forestry Farm (who will be compensated), and produces only 0.00075 to 00125% of the fishing output in Yixing.

- **Impacts During Pumped Storage Facilities Construction** – Construction zones will be established at the damsites for both the upper and lower reservoir, as well as at the power/pump house facilities and the main YPSP 500 kV substation. Vegetation (primarily cultivated coniferous forest plantation) will be cleared from these construction zones. Trees of merchantable quality will be sold. Otherwise the vegetation will be piled and burned. Soils will be removed and stockpiled for later site restoration. Sites will be leveled by clearing and blasting to make way for materials storage yards, equipment maintenance and fabrication
yards, rock quarries and aggregate processing facilities, concrete and asphalt batch plants, temporary construction camps and offices, transformer substation/switch yards. Waste rock and excess surficial material will be deposited in spoils dumps, which can present their own mass wasting and surface water course sedimentation problems if not properly designed and constructed. Construction debris will also be generated as a result of building the project.

Strong vibrations caused by excavation activities, particularly drilling and blasting have the potential to damage or disrupt service to the nearby Yixing TV Transmitting Station, and the Yixing 173 Microwave Station. Noise and dust generated by such activities as blasting and excavation, aggregate processing, and transporting materials may cause disturbance to the residents of Meiyuan village, located near the lower reservoir.

Exhaust gases from the asphalt batch plant have the potential to create localized air quality problems around the upper reservoir area. Although there are no residents in this area, workers and the local environment could be affected, if appropriate emissions controls are not incorporated in plant operation.

● Transmission Line Impacts – The two single circuit 35 kV transmission lines and one double circuit 500 kV transmission line will be constructed over forested mountainous terrain. The two 35 kV lines will have a total length of 17 km, and will require 91 steel lattice towers. A total of 0.58 ha of land will be required to accommodate the tower foundations. The 500 kV line will require 45 steel lattice towers that, in total, will occupy 0.27 ha of land. A total of 4,660 trees (approximately 200 trees/km) will be cut to provide space to construct the tower foundations, and provide safe line clearance distances along the rights-of-way for the 35 kV and 500 kV transmission lines. Electromagnetic interference of the TV and Microwave stations is not considered an issue, as both of these stations are located outside the zone of EMF disturbance.

● Impacts During Operations Period – Because both the operating levels of the upper and lower-reservoirs will vary considerably over the course of a given day, it will not be safe to use the reservoirs for swimming, fishing or boating. Therefore, the reservoirs will be closed to the public.

Makeup/balancing water will be piped approximately 7 km from Tuanjiu Lake, to make up for losses from seepage and evaporation from the two YPSP reservoirs, and to compensate for loss of the pre-project irrigation waters that were provided from Huiwu Reservoir (i.e., the lower reservoir). Although the water from Tuanjiu Lake is of slightly poorer quality than the waters of the existing lower reservoir, it is still meets the standards for irrigation use. The asphalt liner of the upper reservoir will prevent seepage losses that could affect wells located downstream from the upper reservoir. Initial releases of polycyclic aromatic hydrocarbons will occur during initial inundation of the upper asphalt-lined reservoir. However, due to the volume of water involved and the dilution effects, this transient impact is not considered to be significant. Drinking water wells,
located downstream of the lower reservoir are considered to be located far enough from the reservoir so as not to be affected by seepage from it.

1.7 Recommended Mitigation Measures

To reduce or eliminate negative impacts generated by the Yixing Pumped Storage Project, a total of 37.989 million RMB Yuan will be allocated for developing and implementing environmental protection and mitigation measures, carrying out environmental monitoring and providing environmental training to project staff. These costs are in addition to the costs of the resettlement program. Mitigation measures will include the following:

- **Relocation and Protection of TV and Microwave Stations** – The TV transmission tower will be relocated and the TV and microwave stations will both be strengthened to protect them from damage during the period of construction when drilling and blasting are carried out nearby.

- **Environmental Measures During Construction of the Project** – Environmental protection measures will be implemented for liquid and solid waste management from construction camps, aggregate, concrete and asphalt processing facilities, and materials storage, fabrication and equipment maintenance yards. Actions will be undertaken to ensure good housekeeping practices are followed during construction. Dust and emissions control measures will be implemented for activities generating these noxious substances, including siting certain operations away from human settlements or environmentally sensitive areas. Measures to control or minimize noise will be implemented, including restricting the hours of the day when particularly noisy activities are allowed.

A plan has been developed for clearing and sanitizing the two reservoirs. The plan provides direction on vegetation removal, removal of human-built structures, and sanitizing pit latrines, pig sties, etc. Since the only human development currently within either of the two reservoir inundation zones is that of the Yixing Forestry Farm camp and offices located adjacent to the lower, Huiwu Reservoir, most of the reservoir clearing activities will involve removal of vegetation.

Upon completion of the construction phase of the project, contractors will demobilize by removing materials and equipment. The temporary work sites will then be cleaned of all debris, leveled, and restored by replacing soil and planting vegetation. All non-recyclable debris will be disposed of in the local Yixing landfill.

- **Environmental Measures During Project Operation** – To minimize the number of fish that could be damaged or killed when makeup water is pumped from the Huangtong River arm of Tuanjiu Lake into the lower YPSP reservoir, fish screens will be installed at the intake to the makeup water pumping station. To protect members of the public, the upper and lower YPSP reservoirs will be closed to swimming, angling and boating, and signs will be placed around the reservoirs.
warning of the dangers to personal safety.

- **Preparation of an Environmental Management Plan** – An EMP has been prepared which identifies the key impacts, how they will be minimized during construction and operation, the parties responsible for implementing the mitigation measures, monitoring activities and responsible monitoring authorities, reporting requirements, institutional requirements of the environmental program, budget for labour and equipment, and scheduling.
Chapter 2

Project Description

2.1 Introduction

This section of the report provides a brief description of the Yixing Pumped Storage Project and its various components.

2.2 Geographical Location of the Project

The Yixing Pumped Storage Project (YPSP) is located in the Tongguanshan mountains in the southwest corner of Yixing, southern Jiangsu province. The lower reservoir of the project is about 8.5km away from Yixing urban area. The geographical location of the power project is shown in Figure 1-1.

2.3 Primary Purpose of the Project

Upon its completion, the primary purpose of the Yixing Pumped Storage Power Project will be to provide for peak regulation, valley filling, spinning standby, frequency regulation and condenser operation in Jiangsu provincial power system, which makes up part of the east China power grid.

2.4 Project Composition

The Yixing Pumped Storage Project is composed of three main parts – (1) water storage/power generation/pumping facilities, (2) makeup/balancing water supply works, and (3) transmission lines. Table 2-1 provides a summary of the key features of the project. More detailed information is available in Appendix B, as well as in the feasibility report.

2.4.1 Power Generation/Pumping Facilities

The proposed YPSP will have an installed capacity of 1000 MW (4 x 250 MW), which makes it a large (Grade I) power project under the Chinese power project classification system. Its major structures are Grade I and secondary structures are Grade III.

The water storage/power generation/pumping facilities are comprised of the upper and lower reservoirs, underground penstock tunnels, powerhouse, switchyard/substations, and access roads inside and outside the project site.

The upper reservoir is located in a gully near the top of Tongguan Mountain on its north side. It consists of the main asphalt-faced rockfill dam, an auxiliary dam and the surrounding hills. A road presently runs around the proposed location of the upper reservoir.
<table>
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<td>Min. net head of generation</td>
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<td><strong>II Upper reservoir</strong></td>
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<td>Dam Crest Elevation (main dam; auxiliary dam)</td>
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<td><strong>III Lower reservoir</strong></td>
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<td>Catchment area</td>
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<td>Elevation at dam crest</td>
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<td><strong>IV Underground Penstock/Tailrace System</strong></td>
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<td>Length of diversion tunnel (main; branch)</td>
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<tr>
<td></td>
<td>Length of tailrace tunnel (main; branch)</td>
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<td><strong>V Underground Powerhouse and Switchyard</strong></td>
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</tr>
<tr>
<td></td>
<td>Type of powerhouse</td>
<td></td>
<td>Underground – located middle of tunnel system</td>
</tr>
</tbody>
</table>
The lower reservoir will be located at the foot of Tongguan Mountain on its northeast side, and will be constructed by expanding the existing Huiwu reservoir. This will be accomplished by increasing the height of the present dam and excavating the existing reservoir. A road presently runs to the Huiwu Reservoir.

The water conveyance system will consist of two parallel 1129.03 m long underground penstock tunnels, 6 m and 4.8 m in diameter, respectively arranged inside the mountains between the upper and lower reservoirs. These two penstock tunnels will divide to form four penstock tunnels, each 3.4 m in diameter, which will convey water to the powerhouse turbines. The underground power/pump house will be situated in a cavern located roughly midway between the upper and lower reservoirs, and approximately 320 m below ground. Water leaving the power house will be conveyed by four tailrace tunnels, each 183.33 m in length and 5 m in diameter, which will then combine to form two parallel 1453.56 m long, 7.2 m diameter tailrace tunnels. The ground switchyard will be located on relatively flat ground at the top-of-slope above the main transformer cavern.

Connecting to the project site will be 12.54 km of new permanent access highway. Another 6.96 km of roads will be constructed within the project area.

The general layout plan of the water storage/power generation/pumping facilities is shown in Figures 2-1 through 2-4.
2.4.2 Makeup/Balancing Water Supply Works

The makeup/balancing water supply works will be constructed to provide water throughout the construction period and for initial reservoir filling. Once the project is operational, the makeup/balancing water supply works will provide water daily to make up for water lost to seepage, evaporation, and irrigation. For construction, filling and operation, 0.18 m³/sec of makeup water will be required. Another 0.3 m³/sec of water will be required for irrigation purposes, to compensate for loss of Huiwu Reservoir as a source of irrigation water.

Primary and secondary makeup water pumping stations will be constructed along with steel pipelines for conveying the water. The Primary makeup water pumping station will be located on the east bank of Huangtong River, a slow moving arm of Tuanjiu Lake, on the south side of Donghe Road (Photo 2-1). The secondary pumping station will be located immediately below the downstream end of the lower YPSP reservoir. During operation, the primary makeup water pumping station will be used to pump water out of the Huangtong River, through 3,220 m of 500 mm diameter steel pipeline, to the discharge pond located just below the foot of the lower reservoir dam. The secondary pumping station will then be used to lift the water up into the lower reservoir. The layout plan of the makeup/balancing water supply works is shown in Figure 2-5. Water volume balance between the upper and lower reservoir, and makeup water requirements, are shown in Figure 2-6.

Photo 2-1 - Proposed Location for the Primary Makeup/Balancing Water Pumping Station on the Huangtong River
Note:
1. Elevation counted in meters, other sizes counted in centimeters.
Figure 2-3 - Cross Sections of Underground Works
Figure 2-4 - Upper Reservoir Cross Sections

Note:
1. Elevations marked in meters, other sizes marked in centimeters.
2. The drawing set is composed of 4 sheets: SHEET-06-01.02.03.04.
3. The average down stream slope of the main dam is 1:30.

说明:
1. 图中高程注高程,其余尺寸以毫米计,
2. 本图比例尺1:5000,图号SH1805-01.02.03.04.
3. 上下坝平均坡度为1:30.
4. 编制人：...
Figure 2-6 - Water Balance Between Upper and Lower Reservoirs, and Makeup/Water Balancing System

<table>
<thead>
<tr>
<th>Upper Reservoir</th>
<th>Down Reservoir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Area: 0.1649 km²</td>
<td>Basin Area: 1.87 km²</td>
</tr>
<tr>
<td>Annual Rainfall: 1521.8 mm</td>
<td>Annual Rainfall: 1241.2 mm</td>
</tr>
<tr>
<td>Annual Average Flow: 28.3 m³</td>
<td>Annual Average Flow: 104.5 m³</td>
</tr>
<tr>
<td>Annual Average Vapor Amount: 860.1 mm</td>
<td>Annual Average Vapor Amount: 879.1 mm</td>
</tr>
<tr>
<td>Normal Reservoir Level: 471.5 m</td>
<td>Normal Reservoir Level: 76.9 m</td>
</tr>
<tr>
<td>Total Reservoir Volume: 530.7 m³</td>
<td>Total Reservoir Volume: 572.8 m³</td>
</tr>
<tr>
<td>Annual Leakage: 98.4 m³</td>
<td>Annual Leakage: 38.4 m³</td>
</tr>
<tr>
<td>Average Annual Water Compensation: 52.25 m³</td>
<td>Average Annual Water Compensation: 52.23 m³</td>
</tr>
</tbody>
</table>
2.4.3 Transmission Lines

The YPSP will be served by two 35 kV circuits, which will require that two single-circuit 35 kV transmission lines (total length 17 km) be constructed. One line will connect a new 35 kV substation to the existing 220 kV Taodu Substation. The new 35 kV substation will be built near the existing Huiwu Reservoir (future lower YPSP reservoir). The 220 kV Taodu Substation is located approximately 5 km south southwest of the reservoir. The second line will connect the new 35 kV substation to the existing Yixing City Thermal Plant Substation, which is located approximately 10 km to the northwest. The two circuits will be inter-connected, to facilitate simultaneous switching, by 2 km of 35 kV transmission line that will run between a “T” Tap connector located just west of the new YPSP 35 kV Substation, to the 220 kV Taodu Substation. A total of 91 towers will be required for the two single circuit 35 kV lines. The proposed route of these transmission lines is shown in Figure 2-7.

The Yixing Pumped Storage Power Project will transmit power to the 500 kV Liyang Substation via a 6.3 km double circuit 500 kV transmission line. A total of 45 steel lattice towers will be constructed.

The 500 kV transmission line route will run from the YPSP Substation, which will be located northeast of the upper reservoir, westward toward Nanshanmen and Shanhualing, then north to Jinshanwu and west again toward Zhuposhan, and finally north over the Nanjing-Hangzhou Expressway and 220 kV Yitao I and II transmission lines to a point just west of Minnan Village of Xinjie Town, where the Yili Substation is located. The proposed route of the dual circuit 500 kV Transmission Line for the YPSP is shown in Figure 2-8.

2.5 Construction Program

2.5.1 Layout of Construction Works

Construction works will be divided into two main construction areas -- upper reservoir and lower reservoir construction zones. Other minor construction works will be undertaken outside these main construction zones. The upper reservoir construction area will be the site of an asphalt batch plant, concrete batch plant, and three fixed compressor stations. The lower reservoir construction area will contain a multipurpose fabrication yard, steel pipe assembly and fabrication yard, machine shop, truck maintenance shop, materials warehouse and storage yard, two fixed compressor stations, and a concrete batch plant. A construction camp will be built at the edge of the lower reservoir construction zone.

Approximately 13 km of temporary access road will be constructed to service the two construction zones. These will be decommissioned following project completion.
Figure 2-7 - Proposed 35 kV Transmission Lines
The length of the Power-storage Station Yixing-Liyang Transformer Substation:

500kV Yixing-Liyang Transformer Substation

500kV Yixing-Liyang Transformer Substation

The Airline Distance from the Power-source 500kV Yixing-Liyang Transformer Substation is 5.6km.

The length of the Power-storage Station Yixing-Liyang Transformer Substation is 9.3km.
2.5.2 Spoils Disposal Areas

Four spoils disposal sites (shown on Figure 2-9) will be established for the project – two in the upper reservoir area (3.84 ha, 2.121 million m$^3$ at the foot of the main dam; and 31 ha, 6.5872 million m$^3$ in Dahanjie Gully); and two in the lower reservoir area (26.4 ha, 2.714 million m$^3$; and 0.76 ha, 1.5845 million m$^3$).

2.5.3 Sources of Materials

Power will be provided to the upper and lower construction zones by 10 kV lines originating from the 35 kV substation, which will be constructed near the intersection of Highways #1 and #5.

Construction water will be obtained directly from the Huangtong River via a series of pumping stations and storage ponds. The water meets Grade III, which is suitable for industrial/agricultural use, but is not of high enough quality for use as potable water. Domestic potable water for the construction camp, offices and other ancillary facilities (on-site cafes/restaurants, etc.), will be obtained via a piped connection to the nearby Yixing Water Supply Works.

Approximately 1.1308 million tonnes of gravel, and 719,100 tonnes of sand will be required for the project. The gravel will be purchased directly from the Furongshi Quarry and trucked 14 km to the lower damsite. Sand will be purchased from Guangde, Anhui Province.

About 2.1404 million m$^3$ of rock will be required for the main embankment dams and 1.0595 million m$^3$ of rock will be required for the secondary embankment dams. The rock for the primary embankment of the reservoir main dam will be purchased directly from Nanba-Yushan Quarry, and trucked 25 km to the upper damsite. The rock for the secondary embankment of the upper reservoir main dam will be obtained on site from excavated material obtained from excavating the upper reservoir basin, the intake/outlet structures, underground tunnels, underground cavern, etc. Where necessary, the supply of this material will be supplemented by rock purchased from the Ximeiyuan Quarry. The rock required for the concrete faced-rockfill dam of the lower reservoir will be obtained from excavating the lower reservoir basin and underground power/pump-house and water conveyance caverns.

Approximately 196,100 m$^3$ of clay is required for the clay core for the lower reservoir dam. This material will be obtained from the Dongmeiyuan Borrow Area, which is located approximately 2 to 3 km from the lower reservoir.

About 400,000 tonnes of cement will be required for the project. Cement will be purchased directly from the Yixing Cement Factory and trucked 15 km to the job site. Steel, timber and fuel/lubricants will be purchased locally. Explosives will be purchased directly from state-designated manufacturers.
2.5.4 Construction Schedule and Workforce

Construction of the YPSP is estimated to take 6 years, including 12 months for the preparatory civil works (roads, 35 kV substation, etc.), 3 months for mobilization of the primary contractors, 4 years 9 months for construction of major structures, and 12 months for finishing construction and demobilization. The 1st generating/pumping unit will be commissioned in the 5th year following the start of construction. By the end of the 6th year, all four units will be in operation.

At the height of construction, 4,470 persons will be working on the project. The average number of workers on site at any time is estimated to be 3,250.

2.6 Project Cost

The project has a total static investment cost of 4.19308 billion RMB Yuan, with static investment per kW of 4,193.08 RMB Yuan, and a total dynamic investment cost of 4.77684 billion RMB Yuan, with an investment per kW of 4,776.84 RMB Yuan.
Chapter 4

Assessment of Impacts and Recommended Mitigation Measures

4.1 Introduction

This chapter identifies the major potential environmental and socioeconomic impacts that are expected to result from the Yixing Pumped Storage Project, and presents recommendations for mitigating these impacts.

4.2 Construction Related Environmental Impacts and Mitigation

4.2.1 Upper and Lower Damsites, and Underground Works

Site Preparation and Excavation

Site preparation work will involve clearing of vegetation, grubbing out roots, removal and stockpiling of soils, and removal and disposal of overburden at spoils sites. No quarry or borrow areas will be developed for the project, since rock excavated to create the underground penstock and tailrace tunnels, power/pump house, and switchyards will provide rock for processing into suitably sized aggregate. Additional materials for use in constructing the project (e.g., sand, gravel, cement, bitumen, etc.) will be imported from existing from nearby sources.

Terrestrial Ecosystem – As noted in Chapter 3, the vegetation within the project area is cultivated vegetation consistent with forestry and tea plantations. All vegetation will be removed from the site of the proposed upper reservoir, and from the margins of the existing lower reservoir to facilitate its expansion. In addition, all vegetation will be removed from areas within the construction zone in which ancillary facilities (concrete and asphalt batch plants, works yards, offices, construction camp, aggregate processing facilities, etc.) will be temporarily established. All vegetation will also be cleared from areas designated for use as spoils dumps.

As an area that is presently managed for commercial timber and tea production, there is frequent human activity and human presence within and around the proposed project setting. Native species of plants have largely been supplanted by plantation varieties, an action that has lead to a reduction in the level of plant biodiversity in the area. Lack of rich and varied wildlife habitat, combined with human presence (including hunting pressure), has contributed to diminished wildlife populations over the years.

The loss of small portions of forestry (0.78% of the Yixing Forestry Farm) and tea plantations will not have a significant effect on remaining wildlife numbers. The relatively small footprint of this project, combined with the varied topography of the
area, which will tend to isolate much of the construction activity from adjacent forested lands, will help to mitigate impacts on local wildlife. To further protect remaining wildlife populations, prohibitions against hunting any local wildlife will be strictly enforced within the construction workforce. Upon completion of the project, areas no longer required for use by the various contractors, will be restored by planting with grass, shrubs and trees.

**Soil Erosion and Sedimentation of Watercourses** – Clearing and grubbing of the construction site, and subsequent excavation of surface areas will expose erodible surficial materials, especially those on steep slopes, to the actions of surface water erosion. Of particular concern are the slopes of spoils dumps that, if heavily saturated by monsoon rains, can become destabilized and fail through a process of mass wasting. In addition to carrying fine sediments, runoff waters from the project site may also carry oil residues introduced from heavy equipment, and explosives residues, introduced by the blasting program.

During rainstorm events, sediment and residue laden water from the excavated upper reservoir project site will enter Dahanjie gully, which extends downslope from the base of the upper reservoir dam. Introduction of these construction affected runoff waters into the gully will reduce the quality of water in this ephemeral watercourse, and will also reduce the quality of water in the wells that are located adjacent to it, and from which the Jingle Water Company and others obtain their water. It may be necessary to provide alternate sources of water for the users of these wells, if monitoring results show that the wells are being negatively affected. Measures will be employed to minimize the release of contaminated or sediment laden waters into the gullies located downstream of the upper reservoir construction zone.

To prevent soil and water loss from spoils dumps, the spoils materials will be contained within rock retaining walls. Masonry drain ditches will also be constructed around the spoils areas to intercept and divert water away from these sites. The material itself will be deposited with angles of repose appropriate for the type of material, to further minimize the chances of slope failure. As part of the process of expanding the existing Huiwu Reservoir to become the YPSP lower reservoir, the fine sediments that have accumulated over the years will be removed and placed atop the spoils disposal sites as cover material. Spoils dumps will then be vegetated with grass, shrubs or trees towards the end of the project, or sooner, if these sites are not required as works yards for contractors.

For sections of roads that are constructed through areas that provide poor geological conditions, measures will be taken to minimize the chance of soil erosion or slope failure. Measures may include bridges over gullies, anchors, masonry walls, etc. Drainage ditches will be built along both sides of any project roads.
**Existing Structures** – Site preparation and excavation in the vicinity of the upper reservoir will affect both the TV transmission station and the microwave station. The TV transmission tower is located atop Tonguang Mountain, at the base of a steep slope, near what will be the upper extent of excavation in the upper reservoir. The process of excavation may affect the stability of the tower base. Therefore, to ensure continued service for the TV station, and eliminate the risk that upper reservoir excavation could lead to collapse of the TV transmission tower, the YPSP will construct a replacement tower at a suitable nearby location.

Excavation in the upper reservoir area will also affect the lightning/earth ground system of the TV transmission station and the earth-grounding system of the microwave station. Both earth-grounding systems run through the area where the upper reservoir will be constructed. Therefore, the YPSP will install two new earth ground systems for each station, and install a new lightning rod on the relocated TV transmission tower.

Because a significant amount of blasting will be required to construct the upper reservoir, there is some concern that the TV station and microwave station buildings, particularly their windows and roofs, may be damaged by flying rock. Therefore, the YPSP will install steel mesh screens over the windows and place straw mats on the roofs of these structures to protect them. Additional protection will be provided for the TV transmission station building in the form of a retaining wall, which will be constructed along the north side of the building.

During blasting events, increased construction supervision will be put in place. Management and operations staff of the TV transmission and microwave stations will be informed in advance regarding when explosives are to be detonated, so as to afford the staff an opportunity to seek safe quarters and to protect their valuable equipment. The YPSP contractors will provide blast warning and all clear signals, in accordance with accepted Chinese and international practice.

In addition to damage that can be caused by flying projectiles from a detonation, damage can also be caused to sensitive TV and microwave station electronic equipment by blast induced vibrations. Therefore, as part of the blasting program, YPSP blasting contractors will adopt measures that control the way the blasting is carried out, thereby reducing the vibration (i.e., ground force acceleration) that could damage sensitive equipment. This may include minimizing the size and orientation of the explosive charges, using shaped charges, pre-split blasting and/or differential initiation of charges, and covering charges with blast mats. Additional measures will be suggested to the operators of the TV and microwave stations, including isolating equipment from significant blast vibration by placing vibration dampening pads under important equipment, reinforcing structures, and monitoring equipment during blasting operations.
4.2.2 Protecting Air Quality

Controlling Fugitive Dust

During construction, dust will be generated as a result of excavation activities, movement of vehicles and equipment, stockpiling of soils and spoils disposal, blasting, aggregate processing, and concrete manufacturing. Fugitive dust is primarily a concern in the dry season, when lack of rainfall and humidity contributes to the formation of dust within and adjacent to the construction zone. The main concerns regarding fugitive dust related to: dust accumulation on crops or ecologically important varieties of vegetation, which can reduce the ability of the plants to photosynthesize (i.e., plant productivity is diminished); inhalation of dust by workers or area residents, which can impair breathing and lead to chronic respiratory disease; and accumulation of dust in camps, residences and offices, which is a nuisance to clean up and can damage electronic equipment (i.e., office computers).

There are no food crops or critically important native vegetation species of concern within or adjacent to the proposed YPSP construction zone. The only residents currently residing in the area, who could be affected by fugitive dust, will be relocated prior to any construction. Construction workers are the group with the greatest potential to be exposed to fugitive dust. Dust control measures will be adopted for the construction site, particularly in the dry season, and will include such things as spraying water onto dirt roads to minimize generation of dust; spraying water onto gravel crushing/sorting equipment to reduce dust; requiring truck drivers to cover their loads of soil, spoils or other loose material with tarps before transporting material from one location to another; ensuring that the workers who may be exposed to dusty conditions are equipped with dust masks or respirators; and mixing concrete in enclosed silos so as to avoid introducing cement dust into the air.

Emissions from Mobile and Non-Mobile Construction Equipment

Stationary and mobile heavy equipment will release gaseous emissions into the atmosphere during operation. The pollutants are mainly nitrogen oxides (NOx), carbon monoxide (CO) and hydrocarbons (HC), for gasoline-powered engines, and these same substances plus suspended particulates, for diesel-powered engines. The effects of these emissions will be short term and transient, and will occur in a rural setting away from any major population center. Therefore, the impacts are not considered to be significant.

Other Sources of Emissions

In addition to emissions released during operation of equipment powered by internal combustion engines, atmospheric pollutants will also be released in the form of smoke, when vegetation that has been cleared from the site, is burned, and from gases released from explosive charges during blasting operations. Given that the area to be
cleared of vegetation is quite small, the atmospheric pollutants contributed by burning
this material is not considered to be significant.

The total amount of explosives required for the project is estimated at 4,930 tonnes. Surface
blasting will be carried out primarily in the vicinity of the upper reservoir near the top of Tongguang Mountain, an area where there are no residences, livestock or critical natural habitat, and where gases are expected to quickly dissipate. The environmental effects of the blasting program are, therefore, anticipated to be negligible.

The underground blasting program will generate toxic gases in a confined space. To
ensure that workers are not exposed to these toxic substances, a high volume
ventilation system will be installed as part of the advancing underground excavation works.

4.2.3 Treating Construction Process and Domestic Wastewaters

The construction phase of the YPSP will generate process wastewater from drilling
operations (surface and underground), aggregate washing operations, and concrete and ashpalt batch plant operations. Most of the process wastewater will contain fine sediment in suspension (e.g., silt and clay sized particles), but may also contain oil residues introduced from equipment used in construction processes. It is estimated that approximately 363.6 m$^3$/h (about 0.101 m$^3$/s) of process wastewater will be produced at the peak of construction.

Domestic wastewater in the form of sewage and gray water, will be produced from
construction camps, office facilities and other ancillary operations. The peak total discharge amount of the domestic wastewater is estimated to be 132.4 m$^3$/h (about 0.37 m$^3$/s).

In the dry season, the upper drainage of Huangtong River (i.e., Huangtong Creek
downstream of the lower reservoir) can become dewatered. During construction of the lower reservoir works, the main component of stream flow in Huangtong Creek during the dry season will consist of construction process wastewater and treated domestic wastewater. The total combined process and domestic wastewater input is estimated to be 0.0893 m$^3$/s. The primary contaminants and their respective concentrations are estimated to be COD$_{Cr}$ (29.9 mg/L) and BOD$_5$ (6.17 mg/L). If this wastewater is not treated before it reaches Huantong Creek, the quality of the water in this stream course will be significantly diminished.

During construction of the upper reservoir works, the quality of water in Dahanjie Gully, which runs down the north side of Tongguang Mountain, may be negatively affected if untreated wastewater is discharged from the asphalt and concrete batch plants. This would affect water quality in drinking water wells used by the Yixing Dhanshan Drinking Water Company, and the few local inhabitants that depend on this source of potable water.
Construction process wastewater will be treated using settling basins to remove the fine suspended sediments. The treated process wastewater will be released well away from any surface watercourses. Domestic sewage and gray water will be collected and piped to septic tanks for treatment. Treated effluent will be discharged to the Huangtong River. All wastewater (construction process and domestic) will be treated so that upon release to the receiving environment, the treated water meets the Grade I specification defined by The Integrated Wastewater Discharge Standard (GB8978-96). The characteristics, treatment capacity and treatment method of process wastewater and sewage produced during construction are summarized in Table 4-1. The location of the water treatment stations is shown in Figure 3-9.

Table 4-1 - Summary of Wastewater Treatment Requirements

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Discharge point</th>
<th>Main characteristics of sewage and wastewater</th>
<th>Capacity (m³/h)</th>
<th>Treatment method</th>
<th>Primary planned position of the facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.1 treatment facilities</td>
<td>Main dam of upper reservoir</td>
<td>SS</td>
<td>163.3</td>
<td>Settlement</td>
<td>Spoils yard downstream of the main dam of the upper reservoir</td>
</tr>
<tr>
<td></td>
<td>Minor dam of upper reservoir</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upper reservoir basin</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.2 treatment facilities</td>
<td>Concrete batch plant for upper reservoir</td>
<td>SS, PAHs and hydrocarbon</td>
<td>11.1</td>
<td>Settlement treatment, Oil separating settlement, gas floating treatment</td>
<td>Level site near the batch plants</td>
</tr>
<tr>
<td></td>
<td>Asphalt batch plant for upper reservoir</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.3 treatment facilities</td>
<td>Water conveyance system, underground powerhouses, dam and basin of lower reservoir</td>
<td>SS</td>
<td>180</td>
<td>Settlement</td>
<td>Level site downstream of the lower reservoir dam</td>
</tr>
<tr>
<td>No.4 treatment facilities</td>
<td>Lower reservoir concrete batch plant</td>
<td>SS</td>
<td>9.2</td>
<td>Settlement</td>
<td>Flat belt near the system</td>
</tr>
<tr>
<td>No.5 treatment facilities</td>
<td>Temporary living area and auxiliary enterprises during construction</td>
<td>COD₅₇, BOD₅, Oils</td>
<td>132.4</td>
<td>Oil-separation biochemical treatment</td>
<td>Near temporary living area during construction</td>
</tr>
</tbody>
</table>

The following additional specific mitigation measures will be implemented to protect local water sources:
- Procedures for safe fuel and lubricant transport, storage and handling, and emergency spill response;

- Equipment maintenance procedures will be developed to ensure good housekeeping practices are carried out when repairing and maintaining equipment, including acceptable methods for replacing lubricants and filters, and disposing of waste materials;

- Effective site supervision and monitoring procedures to enforce water treatment protocols;

- Soil erosion and water conservation design measures are implemented, especially in areas such as the spoils dumps, road cuts, etc., where sedimentation of water courses damage drinking water sources;

- Timely collection and disposal of solid construction and domestic wastes at the Yixing Landfill will be carried out; and

- Batch plant facilities will be inspected and approved for operation by local environmental authorities.

The drinking water wells located near the gully leading downstream from the upper reservoir dam, and adjacent to Dahanjie Gully, will be monitored during the construction phase to ensure that construction process and domestic wastewaters are not degrading water quality. If it is determined that the quality of the well-water is being adversely affected, then measures will be implemented to ensure the drinking water companies and local residents that rely on these sources of water, continue to have access to clean drinking water. Measures could include supplying water treatment devices to pre-treat the drinking water for the downstream affected water companies, establishing new wells outside the zone of influence, financial compensation, etc. The project budget includes an allowance for providing secure and safe drinking water to these water users.

4.2.4 Disposing of Construction Wastes

Aside from earth spoils material and vegetation cleared from the site, construction wastes will include waste concrete, wooden formwork, scrap steel, broken brick, packing crates, waste oil and oil filters, spent lubricating tubes, broken heavy equipment batteries, broken steel cables, rubber hoses, and a myriad of other forms of debris. As noted earlier, earth spoils will be disposed of in engineered spoils dumps. Vegetation cleared from the site will be sold as merchantable timber or used for firewood. Otherwise, it will be piled and burned. Scrap wood (from forms and packing crates) will be recycled or used by local area residents for fuel wood. Scrap steel, heavy equipment batteries and broken equipment will be recycled, as will waste oil. Non-recyclable, combustible material will be burned. While, other non-
recyclable, non-toxic materials, non-combustible materials, such as broken roofing panels and tiles, broken concrete or broken bricks, will be disposed of in the local Yixing municipal landfill.

Domestic solid wastes will be produced from the temporary construction camp, and will include such things as kitchen scraps, plastic bags, bottles, and ash from coal cooking stoves. Kitchen scraps will be collected by local farmers for use as pig feed, while bottles and other recyclable items will be sold. Other non-recyclable wastes will be disposed of at the local Yixing municipal landfill.

4.2.5 Controlling Noise Disturbance

The only residential areas presently within the YPSP site are the Yixing Forestry Farm village, which is located immediately adjacent to the lower reservoir, and another ten households located along the main road leading to the reservoir. The forestry farm village and its forty-four residents will be relocated prior to construction commencing. Therefore, construction related noise disturbance will not be an issue for these people. However, construction related noise, including noise generated by heavy trucks moving up and down the road, will be a potential source of disturbance for residents of the ten households located along the road, as well as the construction workers who will reside in the temporary construction camp. Construction activities will not significantly impact the construction crews and local inhabitants during the daytime period, when these groups are going about their daily work routines. To ensure there is no disturbance to these groups at night, no construction work or other tasks that create noise that would disturb people at rest, will be permitted between 2200 and 0700 hours.

Noise generated by construction activities will primarily affect the upper reservoir area, where the Yixing TV Transmitting Station and 173 Microwave Station are located. To meet the noise requirement of indoor working environment, a 3m high acoustic isolation wall, which also acts as a wall to protect from projectiles during blasting operations, will be built outside the main equipment building of the TV transmission station. In addition, all windows of the building will be replaced with double glazed windows.

Given that the project area is a commercial forestry and tea plantation operation and, therefore, does not provide significant natural habitat for important species of wildlife, the construction related noise impacts on wildlife are not considered to be significant.

4.2.6 Protecting Worker Health and Safety

According to the construction plan, the peak number of laborers that will be employed on the project is 4,470. To ensure that diseases are not imported into the project area by the influx of such a large workforce, the YPSP will require that all laborers undergo a medical health inspection. Those persons deemed to have an
infectious disease, will not be allowed to work on the project until such time as they can demonstrate they are healthy.

The construction camp dining room and kitchens will be regularly inspected and be required to maintain a health certificate. Construction workers will be given health and personal hygiene training to strengthen their self-protection knowledge. A hygiene supervision system will be established for the construction zone, and the hygiene conditions will be regularly inspected. Operators of restaurants and snack bars located near the construction zone will also receive training on health, hygiene and safety matters by appropriate authorities.

Workers will be equipped with appropriate personal protective equipment needed to perform their jobs, in accordance with Chinese State and Jiangsu provincial regulations. This includes the use of hard hats, protective eyewear, hearing protection, dust masks or respirators, safety harnesses, steel-toed safety boots, etc., as may be required by the specific tasks being performed.

4.2.7 Transmission Line Construction Impacts

35 kV Transmission Lines

The two single-circuit 35kV transmission lines (total length 17 km) will require a total of 91 towers, for which the foundations will occupy 0.58 ha of land. The lines will be routed over forested hilly land, and through some residential areas, which will require relocation of residents. A resettlement action plan has been developed as part of the overall process of dealing with the issue of involuntary resettlement for the YPSP.

Compensation will be paid according to national specifications for forestry land permanently removed to provide for the tower foundations. The tower design chosen requires only a small foundation footprint, which will cause minimal disturbance to vegetation and nominal excavation during construction. Land temporarily occupied for construction purposes will be restored to its original state as the last step in the construction process.

The 35 kV lines will also cross the Xin-Chang railway and Ning-Hang expressway. According to the State Environment Protection Administrative (SEPA) Laws for Electromagnetic Radiation, the electromagnetic field produced by a 35 kV transmission line is well within the acceptable range for human exposure. Therefore, no EMF impacts are expected to accrue to any residents who may reside within close proximity to one of the two proposed single-circuit 35 kV transmission lines. Nor will there be any radio interference. Using accepted construction procedures for stringing conductor wire, there will be no disruption to rail or expressway traffic.
500 kV Transmission Line
The 6.3 km dual circuit 500kV transmission line, which will connect the YPSP Substation to the existing Liyang 500 kV substation, will require 45 towers that together occupy a total of 0.27 ha of land. The transmission line will be routed over mountainous and hilly terrain that is presently covered by plantation forest. The transmission line route and tower designs have been selected to take maximum advantage of terrain features and geologic conditions, such that the extent of excavation and tree harvesting can be kept to a minimum.

The transmission line will be sited between 1 km and 1.3 km from the Yixing TV Transmission Station and Yixing 173 Microwave, which is twice the separation distance required to ensure that there is no interference to telecommunications systems, as specified in The Design Specifications of High-voltage Transmission Line Impact on Radio Station (DL/T5040-95). The transmission line will not run parallel to, or cross any major communications lines, and will not be within 2 km of any radio broadcasting station. The routing of the line has also been chosen to avoid any villages or built up areas, which could otherwise be affected by electromagnetic fields generated by the line. Therefore, the 500 kV line will have no effect on telecommunications systems or local residents.

4.3 Operational Impacts and Mitigation

4.3.1 Reservoir Water Quality
The natural springs and ephemeral streams that presently flow from the very small catchment area (0.2106 km²) into the lower reservoir, and which will flow into the upper reservoir (once completed), meet the Grade I water quality standard. However, initial reservoir filling, and replenishment during project operation (makeup/balancing) will require that water be pumped from the Huangtong River arm of Tuanjiu Lake into the lower reservoir, from where it will be pumped/released between the two reservoirs as part of normal operation.

During normal operation of the power station, runoff water entering the reservoirs from their catchment areas, as well as makeup/balancing water pumped into the lower reservoir from the Huangtong River arm of Tuanjiu River, will introduce small quantities of suspended sediment (i.e., fine silt). It is estimated that 0.76 g of sediment per m³ of water will be introduced on average, and that by the end of the thirtieth year of operation, the sediment accumulation in the reservoirs will not exceed 42.07 g of sediment per m³ of reservoir volume.

The upper reservoir will be surrounded by a paved road, with interception/drainage ditches located on both sides of the road. Road embankments will be stabilized to prevent banks from slumping and control surface soil erosion. Road runoff, and water from adjacent upslope roadside embankments will be collected in the
interception/drainage ditches and diverted to vegetated surface depressions down-slope of the upper reservoir, where the drainage waters will be allowed to dissipate.

In addition, an eddy-control beam, concrete apron and sand trap will be constructed at the water inlets and outlets of the reservoirs to eliminate any possible increase in turbidity of reservoir water from the operation of the power station.

The combined effects of naturally low sediment input, and engineering measures to stabilize slopes and minimize re-suspension of accumulated deposits, will result in negligible impacts on the normal operation of the reservoirs or the hydraulic turbines as a result of reservoir sedimentation.

The entire upper reservoir basin will be covered with an asphalt lining to prevent loss of water by seepage. It is expected that there will be an initial release of polycyclic aromatic hydrocarbons (PAHs) into the waters of the upper reservoir from the asphalt lining, when it initially makes contact with the reservoir waters. However, the extremely low residual amounts of these PAHs, combined with the dilution factor resulting from the large volume of water, will result in negligible effects of PAHs on water quality. Monitoring results of similar projects, such as the asphalt lined upper reservoir and dam at the Tianhuangping Pumped Storage Power Project, show that PAHs are non-detectable once the reservoir is filled. The same can be expected for the YPSP upper reservoir.

During initial reservoir filling, 70% of the water for both reservoirs will come from Tuanju Lake if filling is carried out in the rainy season, as opposed to 95% if the filling is undertaken in the dry season. The rest of the water will come from the lower and upper reservoir catchment areas. During normal project operation, water loss from the reservoirs from evaporation and seepage will be higher than water inflow from the upper and lower reservoir catchment areas for much of the year (61.8% of the time). The mean annual requirement for makeup/balancing water from Tuanju Lake is 522,000 m$^3$, which corresponds to 8.76% of the total storage of the upper and lower reservoir.

Because the reservoirs will be filled initially using water from Tuanju Lake, then regularly topped up using this same source, the quality of water in both reservoirs will primarily be a function of the makeup water that is pumped into the lower reservoir from the lake. The quality of the reservoir waters will, however, be ameliorated by normal biochemical processes, along with the introduction of rainwater and water flowing in from the catchment areas.

The water quality of Tuanju Lake basically conforms to the Grade III water quality standard (Environmental Quality Standard for Surface Water [GHZB 1-1999]). Water quality modeling for the system indicates that COD$_{Mn}$ and BOD$_5$ levels for the lower and upper reservoirs will be higher, initially, than the present levels encountered in the existing Huiwu (future lower reservoir). However, these levels
will become gradually reduced and will stabilize with time (600 to 800 days), as non-persistent pollutants degrade through biochemical processes, and water inputs from rainfall and natural inflow from the catchment areas mediates the effects of the water introduced from Tuanjiu Lake. Modeling indicates that there will not be any significant accumulation of persistent chemicals that could otherwise contribute to deterioration of reservoir water quality. Overall, it is calculated that the water in the lower and upper reservoirs, at the end of the stabilization period, will conform to the Grade I water quality standards (Environmental Quality Standard for Surface Water [(GHZB 1-1999].

4.3.2 Downstream Water Quality

The power station will be staffed by 242 persons, many of whom will also reside in staff residences. Sewage and gray water will be produced at an estimated rate of 54.5 m$^3$/day. This domestic wastewater will be treated using septic tank systems, before the treated effluent is released to the Huangtong River via surface drainage courses. As noted in Section 3.7.5, some residents located downstream of the Huiwu Reservoir, but upstream of the Huangtong River obtain their drinking water from wells. During operation of the project when the dry season flows in Huangtong Creek are primarily composed of treated sewage effluent from the project offices and residences, there is the potential for wells located within 30 m of the watercourse to be adversely affected by these discharges. Therefore, YPSP will undertake a program of well-water monitoring to determine if the quality of water in any of these wells is being effected. If it is found that water quality is being degraded, then the YPSP will provide alternate sources of clean water, including, if necessary, connections to the Yixing Water Supply Works.

At present, the surface runoff from what will be the upper reservoir catchment area, flows downslope through a number of shallow gullies, which are bounded by wells. Once the upper reservoir is completed and is operational, water that would normally have flowed beyond the upper damsite, will now be intercepted by the upper reservoir. Because the catchment is so small (0.2106 km$^2$) the effects on the quantity of water available to wells located downslope of the upper reservoir will be negligible. Although the waters of the upper reservoir will be of lower quality during the period of initial filling and initial operation, due to the large percentage of Grade III quality water introduced from Tuanjiu Lake, there will be no water quality impacts on wells located adjacent to the gullies down-slope from the upper reservoir, since there will be no water releases from the upper reservoir, directly or by seepage, during operation.

4.3.3 Water Removal for Makeup/Balancing

The maximum diversion inflow during the construction of the power station, initial storage and normal operation replenishment is about 0.18 m$^3$/s. Together with the
additional 0.3 m$^3$/sec of water required to compensate for loss of the Huiwu Reservoir as a source of irrigation water, the maximum diversion inflow is calculated to be 0.48 m$^3$/sec, which is 1.17% of the mean inflow and 2.59% of the mean flow of the three jius (lakes) in a low flow year. Removal of 0.48 m$^3$/sec of water for construction, initial reservoir filling, makeup/balancing during operations and for irrigation use is estimated to lower the level of Tuanjiu Lake by only 1.94 mm. This will have no obvious or significant impacts on environmental conditions or on other users of this body of water.

4.3.4 Aquatic Ecology

The makeup/balancing water intake located on the Huangtong River arm of Tuanjiu Lake, has the potential to negatively affect resident fish populations. Fish entrained in the pumped water can be damaged or killed as they pass through the pumps. Any fish surviving to enter the lower reservoir, would likewise be at risk to being damaged or killed if they were entrained in the waters that passed through the pumps en route to the upper reservoir, or the reverse, entrained in waters that flowed back down through the turbines. Therefore, to protect fish and ensure the safety of the pumps within the makeup/balancing works, a trash rack and fish screens will be installed at the Huangtong River intake structure. The trash rack and fish screens will be maintained to ensure they continue to function as designed.

To facilitate the passage of water to the intake structure, a short section of the Huangtong River arm of Tuanjiu Lake will be dredged. As noted in a previous section, most species of fish located in this complex of lakes and canals are common varieties used in fish aquaculture. There are no rare or unique species of fish or other aquatic organisms encountered in the affected area. Therefore, dredging of the channel will not have any significant effects on local fish populations.

4.3.5 Safety of the Dams and Related Facilities

Project Layout and Design – Report by the Special Board of Consultants

A Special Board of Consultants (SBC), comprising relevant technical specialists\(^1\) (international and national), was engaged by the Jiangsu Provincial Electric Power Company (JPEPC) to review key technical aspects of the YPSP, including engineering geology and geotechnical conditions, upper and lower dam design and stability, underground waterway and power/pump-house complex, and downstream conduits. The SBC submitted its first report on 27 May 2001.

In its report, the SBC indicated that the general layout of the YPSP is well adapted to the topography and geology of the project setting. The SBC commented that the

\(^1\) Jiazheng Pan (Chairman), Fabio Villegas (Vice Chairman), Shaoji Luo, Jingyi Tan, Keming Cao, Arthur Stukey and Laurie Richards
shape of the main upper reservoir dam is very peculiar, owing to the high fill slope that will form the downstream face of the dam. The SBC noted that, although the design is theoretically feasible, differential settlement of the dam would likely occur, causing face-slab cracking and subsequent escaping of water from the reservoir. The SBC recommended that for the sake of design improvements, ease of construction and reduction of hazard, one of two alternative designs should be considered: (1) a reinforced-concrete faced rockfill dam with reservoir blanket, which would reduce the height of the downstream fill; or (2) a hardfill dam consisting of a roller- compacted low-paste material, with a watertight slab covering the upstream face, which would provide adequate safety factor against sliding. For whichever design is chosen, the SBC also recommended that adequate compaction and settlement needed to be achieved as the dam is constructed.

Regarding the lower reservoir dam, the SBC noted that it is of modest height and a conventional design and, therefore, should not present any technical constraints. The SBC agreed with the designs developed by the YPSP, but recommended that the clay or weathered material which will be used for the core of the dam be excavated from within the reservoir area, rather than from downstream, so as to minimize loss of tea plantation and lessen environmental impacts.

The SBC concluded that the present layout design for the underground waterway and power/pump-house complex is feasible and adaptable to the geological conditions, and noted that the power/pump-house cavern and transformer vault can be safely supported with rockbolts, mesh-shotcrete, or fibrecrete, provided these areas are properly excavated.

Regarding the proposed use of steel liners for the upstream pressure conduits and shafts, the SBC expressed the opinion that this design is overly conservative, and suggested that only the lower vertical shaft and adjoining lower horizontal tunnel are likely to require steel liners. Otherwise, the rest of the headrace conduits/shafts can be safely lined with reinforced concrete or fibrecrete, supplemented with consolidation grouting. The SBC concluded that the layout design of the downstream (tailrace) conduits has been well conceived, and agree that it is necessary to line the tailrace branch tunnel with steel, and the tailrace bifurcation and tunnel with reinforced concrete.

**Slope Stability**

The slopes around the proposed upper reservoir are stable, showing no signs of mass wasting. To prevent seepage losses from the upper reservoir during operation, an asphalt lining will be installed as part of the construction process. This lining will further contribute to the already stable conditions of this site.
The slopes surrounding the existing Huiwu Reservoir, which will be expanded to form the YPSP lower reservoir, are moderately steep, but stable. It is expected that the slopes will remain stable once the lower reservoir is raised and is in operation.

For both upper and lower reservoirs, energy dissipating devices (i.e., eddy beams, concrete aprons, etc.) will be installed to reduce turbulence and the potential for undermining and destabilizing reservoir shorelines.

Reservoir Seepage

According to the geological information, there is a 0.5 m - 5 m wide rupture bed and smaller 0.1 m - 0.2 m wide rupture bed and cracked zone located within the proposed area of the upper reservoir. The scale of rupture bedding at the lower reservoir is relatively small and the cracked zone is less than 1 m in width. The primary issue associated with these ruptures/cracks is reservoir seepage.

As noted above, the upper reservoir will be lined with a layer of asphalt to prevent seepage losses. Three sides of the lower reservoir are surrounded by hills. Based on geological investigations, seepage losses are not expected through the underlying strata. However, there is the potential for leakage around the dam abutments and along the base of the dam. Therefore, seepage protection will be incorporated as part of the dam design.

Induced Seismicity

The proposed YPSP is located 50 - 60 km northwest of the Maoshan rupture, an area of earthquake intensity VI on the Modified Mercalli Scale. Owing to the distance from this fault, naturally occurring earthquake activity in Yixing is relatively weak.

Both the upper and lower reservoirs will be small holding basins. The difference in surface loading before and after reservoir filling is relatively small, so small that it is considered highly unlikely that structure or stability of the existing geological strata will be affected. Therefore, there is virtually no risk of reservoir-induced seismicity. The risk of earthquake-induced failure of the lower or upper reservoir dams is also considered extremely small due to there being no major fault zones in the YPSP area.

4.3.6 Electromagnetic Field (EMF) Impacts

The 500 kV switchyard for the YPSP will be located at 310 masl, on the north side of the ridge, which sits atop the underground powerhouse. The edge of the switchyard will be situated approximately 1000 m from the TV transmission station, and 850 m from the microwave station. This is less than the 1800 m separation protection distance specified by the national standard (GBJ143-90). However, the ground elevation of the switchyard is 60m below the top of the ridge, which separates the switchyard from the TV and microwave stations. The geological strata and mass of the ridge serves as a natural magnetic barrier between the switchyard and the two
stations. The GIS mode used inside the switchyard has a good shielding effect, which will eliminate the electromagnetic wave interference on the TV transmission and microwave stations.

The linear distance between the outgoing line of the switchyard and the TV transmission station and microwave station is much more than the protection distance of 500 m specified by national standard (GBJ143-90). Since the ridge is a natural barrier, signal receiving and transmitting of the TV transmission station and microwave station will not be affected.

4.4 Social Impacts and Mitigation

4.4.1 Resettlement Program

A total of 757 people will be affected by the project. Among them, 713 people will be affected when land used primarily for commercial forestry and tea plantation, is requisitioned for the project. Another 44 persons, mainly staff (and their families) from the Yixing Forestry Farm, will be involuntarily resettled. A Resettlement Action Plan (RAP) for the project has been completed. The project construction will cause little impact on the migrants’ living condition and the environment of their host site. The existing village from which the Yixing Forestry Farm workers will be relocated is shown in Photo 3-3.

4.4.2 Agricultural Land Use and Irrigation

The YPSP will permanently alienate a total of 348.1 mu (22.8 ha) of agricultural land, including 308.12 mu (20.1 ha) of tea plantation and 39.98 mu (2.7 ha) of farmland. Of the agricultural land that will be affected, most is within Meiyuan Village (328.62 mu (21.9 ha) total, including 298.94 mu (19.9 ha) of tea plantation and 29.68 mu (2 ha) of farmland. Another 204.63 mu (13.6 ha) of tea farm belonging to Meiyuan Village, will be temporarily occupied for construction works during project construction. The people of Meiyuan Village will receive compensation for lost agricultural productivity in accordance with relevant Chinese regulations. In addition, lands used for temporary construction works will be reclaimed and rehabilitated for tea plantation.

At present, the existing Huiwu Reservoir provides 0.24 m$^3$/sec of irrigation water to the Meidong irrigation area. This will be increased to 0.3m$^3$/s by the YPSP, a measure that will increase the dependability of the irrigation system beyond its present capacity. It is expected that the construction of the project will not have any measurable impact on the agricultural potential of the Meidong irrigation area.
4.4.3 Commercial Forestry

The project (reservoirs and permanent facilities) will occupy 2,171.68 mu (144.76 ha) of land presently used as commercial forestry plantation, including 1,480.68 mu (98.7 ha) from Nanyuesi Forestry Branch, and 691 mu (46.1 ha) of the Dahanjie Forestry Branch. This accounts for 14.08% and 7.53% of the total area of these two branches of the Yixing Forest Farm, respectively. Within the entire Yixing Forest Farm the removal of forestry production from these two branches of the operation accounts for only 0.78% for the land area of the entire Yixing Forest Farm. Therefore, alienation of this land will have little effect on local forest ecology. Generally speaking, the loss of < 1% of the forestry farm’s productive lands, will not have a significant effect on the operation of either of the two affected branches. However, In accordance with Chinese regulations, YPSP will compensate the Yixing Forest Farm for loss of these lands.

4.4.4 Commercial Fisheries

The fishery area of the existing Huiwu Reservoir is 16 mu (1.1 ha). A single reservoir keeper carries out all fishery work. Varieties of fish propagated in the reservoir include grass carp, pien fish, crucian carp, silver carp and black carp. Juvenile fish are introduced into the reservoir from local seed sources every 2 to 3 years, when the previous stock of fish is harvested. The reservoir produces approximately 1,000 kg of fish every 2 to 3 years, yielding a profit of 6,000 RMB Yuan. The reservoir keeper is the sole beneficiary of this revenue. Upon completion of YPSP, the lower reservoir will be owned by the power station, and fishing operations will no longer be permitted in the reservoir. The reservoir keeper will be compensated for loss of revenue by the YPSP, which has purchased a lump-sum annuity for him.

Loss of the fish production from the Huiwu Reservoir will represent only 0.00075% to 0.00125% of the total fish aquaculture output of Yixing. Therefore, the impact on local fisheries production is not considered significant.

4.5 Other Impacts

4.5.1 Visual Aesthetics and Tourism

Areas that are disturbed during construction will be rehabilitated as the last step in the construction process. Spoils disposal sites, works yards and other temporary sites will be leveled and landscaped with trees, shrubs and flowers. Although no recreation will be allowed on the two reservoirs, construction of the paved service road into the upper reservoir area will improve accessibility to the area. The combination of improved access and the scenic vistas offered from the top of Tongguang Mountain may stimulate development of a small local tourism enterprise.
Chapter 5

Assessment of Project Alternatives

5.1 Introduction

This section of the Summary EA Report compares two viable alternatives against the proposed Yixing Pumped Storage Project as follows: 1) do not proceed with the project (the “No Action Alternative”); and 2) construct a single coal-fired thermal generation station, with the same installed capacity and power output as the proposed YPSP, to provide power to the provincial grid.

5.2 Other Alternative Energy Generation Alternatives Not Considered

Nuclear power generation was not considered an option within the project area, primarily for economic and technical reasons. Neither was solar or wind power generation considered, primarily because of the inability of these energy sources to satisfy the primary objective of regulating peak demand.

5.3 The ‘No Action’ Alternative

If the proposed project is not constructed, the provincial power authority will look to other sources of generation to satisfy peak power demand. The region is facing increased power demand, which cannot be satisfied by traditional hydropower sources, given the nature of the local geography and river morphology and flows. The only viable alternative aside from the proposed project is thermal power, which does not facilitate peak regulation.

The following environmental and socioeconomic impacts would likely arise if a decision is made not to proceed with the YPSP:

Environmental

- **Negative** -- if the YPSP is not constructed, then the only viable alternative is to build an additional 1000 MW of thermal power generation somewhere within the east China power grid area. The only viable fuel source for this is coal, which when burned, can cause significant negative environmental effects.

- **Positive** -- not proceeding with the proposed YPSP will save 2,171.68 mu (144.76 ha) of plantation forestry land (< 1% of the available forested land in Yixing) that provides some limited habitat to indigenous species of wildlife.
Socioeconomic

- **Negative** -- if the YPSP is not constructed, then public health within the region could be placed at risk, as the only viable alternative to meeting the current energy demands during peak periods would be to construct and operate a 1000 MW thermal generating station, whose environmental pollutants would affect a wide area of this heavily populated region of eastern China.

- **Positive** -- if the YPSP is not constructed, then 44 persons will not have to be relocated, and the livelihoods of another 713 persons, a portion of whose lands would be requisitioned, would not be affected.

5.4 Economic Comparison of the YPSP and Thermal Alternatives

On a least cost basis using net present value, the YPSP is estimated to cost 7.36111 billion RMB Yuan, while the cost of an equivalent capacity coal-fired thermal project would cost 7.97504 billion RMB Yuan. Based on this comparison, the YPSP is the more attractive of the two alternatives.

5.5 Environmental Comparison of YPSP and Thermal Alternatives

5.5.1 Air Quality Impacts

The YPSP will use electrical energy produced by existing thermal power plants, during off peak hours, to pump water to the upper reservoir. The annual equivalent coal consumption to produce this “pumping” energy is 145,700 tonnes per year. A new 1000 MW coal-fired plant, that would be required in place of the YPSP to satisfy energy demand during peak periods, would burn an estimated 285,200 tonnes of coal/year. The respective pollutant discharge amounts for the proposed YPSP and its thermal alternative is shown in Table 5-1.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Pollutant discharge coefficient (kg/tonne)</th>
<th>Supply Pumping Energy for YPSP ((10^4 \text{ kg}))</th>
<th>1000 MW Thermal Alternative ((10^4 \text{ kg}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon monoxide (CO)</td>
<td>0.23</td>
<td>3.35</td>
<td>6.56</td>
</tr>
<tr>
<td>Hydrocarbon (CnHm)</td>
<td>0.091</td>
<td>1.33</td>
<td>2.60</td>
</tr>
<tr>
<td>Nitrogen oxide (\text{NO}_x)</td>
<td>9.08</td>
<td>132.29</td>
<td>258.96</td>
</tr>
<tr>
<td>Sulfur dioxide (\text{SO}_2)</td>
<td>18.26</td>
<td>265.9</td>
<td>520.4</td>
</tr>
<tr>
<td>Soot</td>
<td>362.54</td>
<td>5279</td>
<td>10332</td>
</tr>
</tbody>
</table>
It is obvious that the volume of air pollutants discharged by existing thermal plants to produce “pumping” energy during off-peak hours, is roughly half that of a new coal-fired thermal plant of the same capacity as YPSP. Therefore, the YPSP will have less of an impact on regional air quality.

5.5.2 Regional Water Quality Impacts

The ‘pumping’ energy for the YPSP will come from redundant power in the grid during lower load (off-peak) periods of the day. Therefore, there will be no increase in the amount of waste discharge water from the existing thermal plants connected to the grid, from which the YPSP will draw energy, since no additional power will need to be generated by the existing thermal plants. The only incremental discharge in wastewater from the YPSP will be that which is produced during construction and operation, primarily process waters from batch plants and aggregate production (construction phase) and sewage/gray water (construction and operations phases).

By comparison, a new 1000 MW thermal plant will introduce large volumes of waste water as new wastewater discharges to the environment during operation. It will also release wastewater during the construction phase. The YPSP will, therefore, have considerably lower impact on regional water quality than a new thermal plant alternative.

5.5.3 Acoustic Environmental Impacts

During the construction phase, the YPSP will create noise disturbance in a localized area, primarily as a result of drilling and blasting, and heavy equipment operation on the surface. Underground construction activities will not create any noise disturbance above ground. During operation most of the equipment that is capable of generating high noise levels, will be located below ground and, therefore, there will be virtually no noise disturbance from the project. The only exception is the above ground 500 kV substation, with its actuators, shunt reactors and static “crackle” of high voltage lines. However, based on current designs for substations in China, which require the use of quiet equipment and/or installation of noise baffles, the noise disturbance from the substation will be well within acceptable limits at the boundaries of the substation.

By comparison, the noise generated by a new thermal generating station will be considerable. Noise from the generators, boilers venting, coal mills, draught fans, ventilating fans, transfer stations for delivering coal, and cooling water towers, etc., will affect the local acoustical environment over a much wider area than the proposed YPSP.

5.5.4 Regional Ecological Environment

In general, the amount of land occupied by a thermal plant with the same peak regulation capacity as the YPSP, will be less than that of the YPSP. A new coal-fired thermal plant would likely be situated on level ground adjacent to a river from which
process and cooling water could be extracted. Assuming that the land on which the thermal plant would be sited is part of a larger industrial estate, the plant would likely have fewer impacts on the terrestrial ecological environment than that of the YPSP, which will be located in more varied forested mountain terrain, and require inundation of some forested land.

However, during operation, the YPSP will produce orders of magnitude less wastewater, solid wastes and atmospheric emissions than an equivalent capacity thermal plant. Therefore, the impacts of the YPSP on the ecological environment will, over the long term, be considerably less than for a thermal plant alternative.

5.5.5 Solid Waste Impacts

During construction, the YPSP will generate spoils from excavation works, as well as construction debris, most of which will be reused or recycled. Once operational, the YPSP will produce virtually no solid waste, with the exception of sanitary wastes produced from offices and residences on site. No incremental increase in solid wastes will be produced by the existing thermal plants whose off-peak energy will be used as "pumping" energy for the YPSP.

A new 1000 MW thermal plant will generate roughly the same amount of construction debris during its construction, as that of the YPSP. However, during operations, a thermal plant will produce significant quantities of ash. For a 1000 MW coal-fired thermal plant, this would amount to 41,900 tonnes/year that must be disposed of in a land disposal site large enough to contain the ash that will be accumulated over the life of the facility. The coal ash contains heavy metals that can affect the surface and groundwater, if not properly contained. The YPSP will, therefore, have considerably lower impact on regional solid waste generation than a new thermal plant alternative.

5.6 Comparison of YPSP and Thermal Plant Peak Regulation Capacity

The YPSP will have twice as much peak regulating capacity as a single cycle gas turbine thermal power plant, or a double shift startup/shutdown thermal station generator, either of which would have to be used 100% of the for regulating peak demand. The YPSP will have about four times the peak regulating capacity than that of coal-fired thermal generator, in which 50% of the units are designated for peak regulation.

5.7 Comparison of YPSP and Thermal Plant Dynamics

With respect to electricity production, pumped storage projects allow for rapid changing from no-load to full load conditions and back again. Generally, the time required to go from full-load pumping to full-load generating is less than 400 seconds
(6.7 min), and less than 220 seconds (3.4 min) in an emergency. By comparison, the speed with which generator load can be increased for various coal-fired thermal plant generators operating within the Jiangsu power system is 1% - 2% output/min. The time required to go from generator start to its full-load operation is several hours, longer in the case of a cold start. For gas turbine generators, the time from start to full-load operation is 7 to 8 minutes. It is clear that the YPSP will afford much greater flexibility to address peak demand and emergency power needs than a coal-fired thermal plant of equivalent capacity.

5.8 Conclusions

Based on the above comparisons of economics, environmental impacts, peak-regulating capacity, and dynamic response capability of different power stations, the proposed Yixing Pumped Storage Project is the best of the viable alternatives considered.
Chapter 6
Environmental Assessment
Economic Benefit and Loss Analysis

6.1 Introduction

This section of the report summarizes the social, economic and environmental benefits and losses that are expected to accrue as a result of the Yixing Pumped Storage Project.

6.2 Benefits

6.2.1 Economic and Social Benefits

Comparative Investment Cost - YPSP versus Thermal

The YPSP is estimated to cost 4,228 RMB Yuan/kW to construct. When compared against an equivalent size thermal project, the YPSP is estimated to cost approximately 494.86 million RMB Yuan less to construct than its thermal power equivalent.

Reduced Operating Costs and Improved Power System Regulating Capacity and Reliability

By the end of 1998, all of Jiangsu Province’s electricity was generated by thermal plants, which provide only limited peak regulating capacity. Thermal power generation is ideal for providing electricity for base load conditions, but does not have the ability to quickly adjust to peak load conditions (i.e., peak regulation). During times of the day when demand falls below base load, thermal plants must continue to burn fossil fuels to keep the boilers at operating pressure.

Economic losses accrue from having to burn fuel when electricity demands are low, and to maintain equipment. Economic losses also accrue as a result of problems created by unstable frequency of the electricity provided to the system during off-peak periods. This is particularly the case for equipment that can be damaged or disrupted by varying frequency, such as sensitive electronic equipment, integrated assembly lines, and heavy-load electric motors.

Operating the YPSP will off-set the need to burn 0.13945 million tonnes of coal per year. Based on a price of 350 RMB Yuan/tonne of coal, the YPSP will result in a savings of 48.80 million RMB Yuan/year in the cost of fuel. A comparison of the operating costs of the YPSP and an equivalent size thermal plant indicates that the
YPSP will cost 130.17 million RMB Yuan/year less to operate than an equivalent thermal generating station.

Once operational, the YPSP will supply 1000 MW of electricity to the system during peak-load periods, thereby greatly reducing the peak-regulating burden of thermal power plants. The YPSP will correct the unstable frequency of the system to a certain extent. Thus, it can play a role in phase modulation, spinning reserve and emergency reserve of the system, eliminate the impact of frequency fault within the system, and improve the quality and reliability of the power supply system.

**Economic Payback**

The YPSP will use cheaper electricity produced by the thermal plants during that part of the day when the demand for power is low, to pump water to the upper reservoir, and produce electricity during the peak demand period of the day, when electricity can be sold for a higher price. The difference between the price of electricity bought from the grid during off-peak hours to pump water, and the price of electricity sold back into the grid during the peak demand hours is a tangible economic benefit of the YPSP.

The YPSP will generate 1.491-billion kW·h of electricity, all of which will be supplied during the peak demand period of the day. After deducting the cost of purchasing power to pump water to the upper reservoir, and power lost as transmission line loss, the annual quantity of power supplied to the power supply system is estimated to be 1.461 billion kW·h per year. Based on a peak demand rate of 0.832 RMB Yuan/kW·h (inferred on the basis of loan payback conditions), the annual income earned from selling power from the YPSP is estimated to be 1.21531 billion RMB Yuan.

**Optimizing Industrial Output**

The inability of a thermal generation-based power system, such as that of Jiangsu Province, to adjust to changes in electricity demand, and the problems caused by varying output frequency, has required that industries adjust their mode of operation in an effort to change the demand curve. Rather than operate one, or perhaps two, production shifts per day, industry has had to go to a three-shift system. The result is that the lifestyle and quality of life for many workers has been negatively affected. Triple shift production has also resulted in increased production costs, and other negative social impacts.

It is expected that, once operational, the improved peak load regulation and improved quality and reliability of electricity supply (i.e., through improved frequency control) provided by the YPSP, will enable some factories to reduce the number of shifts. These factories will now be able to operate without disruptions that are presently caused by power interruptions, brown-outs, varying frequency, and other reliability problems. Reducing operations to one or two shifts per day, will contribute to
improved lifestyle and quality of life for some workers, have a positive impact on
taxation, and result in a saving in costs associated with night-shift production.

**Potential Tourism Spin-offs**

Improved road access to the top of Tongguang Mountain, combined with the presence
of the two reservoirs and their associated landscaped surroundings, may attract local
tourists who are interested to avail themselves of the scenic vistas offered by this
location. Spin-off benefits may also accrue in the form of economic opportunities
that come from providing transportation, accommodation, food services, etc., to
tourists interested in visiting the area.

### 6.2.2 Environmental Benefits

When compared against a coal-fired thermal generating plant, the operation of the
YPSP will offset the need to mine another 0.13945 million tonnes of coal per year.
Accordingly, operation of the YPSP will offset the discharge of waste gasses (e.g.,
carbon monoxide, hydrocarbons, nitrogen oxide, and sulfur dioxide), as well as the
slag-ash. Contamination, which would result from transportation and storage of coal,
and transportation and disposal of ash, will be greatly reduced. In addition, operation
of the YPSP will also off-set the long-term negative impacts on the regional water
environment and aquatic ecological environment that would result from discharging
warm waste-water, etc., from an equivalent size thermal plant. Noise impacts that
accrue from operation of thermal plants, would also be off-set by operating the YPSP.

### 6.3 Losses

The only losses expected to accrue from the project are environmental loses.
Creation of the YPSP upper reservoir, and expansion of the existing Huiwu Reservoir
to create the lower YPSP reservoir, will inundate a small fraction of the Yixing
Forestry Farm, thereby permanently removing an area of commercial forestry
plantation from production. A small area of tea farm will also be lost. Compensation
will be provided in the amount of 30.3532 million RMB Yuan, for the land removed
from production, and to resettle those persons affected by the project.

During construction, the project will generate minor impacts upon the local
environment. To minimize these impacts, and ensure environmental protection and
monitoring measures are implemented effectively, 37.9899 million RMB Yuan will
be provided by the YPSP. This amount can be considered as an environmental loss.
6.4 Conclusions

The above analysis of social, economic and environmental benefits and losses associated with the YPSP indicates that the environmental, social and economic benefits of this project exceed the environmental economic losses.
Chapter 7

Environmental Management Plan

7.1 Introduction

This section of the report summarizes information on the environmental management plan (EMP), including the monitoring program, and institutional structure required to implement the EMP and carry out environmental monitoring.

7.2 EMP Purpose and Objectives

Chinese environmental laws and World Bank policies require that a program of environmental monitoring be carried out during construction and operation periods to identify potential environmental issues as early as possible, and undertake measures to prevent or mitigate harm to the environment or local residents.

An EMP has been developed for the YPSP in accordance with the World Bank’s operational policy on Environmental Assessment (OP4.01). The purpose of the EMP is to provide guidance on environmental management and monitoring activities to the owner, contractors, operators and environmental protection and management authorities involved in designing, constructing and operating the project. The EMP delineates environmental and monitoring requirements, identifies organizations and institutions responsible for implementing various activities identified within the EMP, defines a budget for EMP activities, training and equipment costs, and provides a schedule for carrying out the program.

7.2.1 Institutional Roles and Responsibilities

The proposed institutional framework for environmental management for the project is illustrated in Figure 7-1. The roles and responsibilities of the various parties involved in implementing the EMP are as follows:

Owner

The owner of the YPSP, in association with the construction contractors, local environmental protection and management authorities and environmental institutions within the Yixing area, will establish the YPSP Environmental Management Office (EMO) for the project. The YPSP EMO will report to the Environmental Manager of the Jiangsu Province Electric Power Company, the parent company responsible for the YPSP.
Two full-time environmental specialists will be responsible for coordinating the environmental protection management activities during project construction and operation. Specifically, their work will involve the following:

- Ensuring that the environmental protection and monitoring/inspection and quality assurance and control (QA/QC) that make up the core of the EMP, are implemented effectively;

Figure 7-1 - Environmental Management/Monitoring Institutional Framework for YPSP
• Ensuring that applicable state and provincial environmental laws and regulations, and World Bank environmental and social safeguard policies are met;

• Coordinating with relevant departments that will be dealing with specific environmental issues

• Reviewing and approving contractor environmental mitigation plans, then monitoring and inspecting the works to ensure satisfactory performance;

• Approving payments to contractors for constructing, installing or undertaking environment protection measures;

• Strengthening the data collection procedures, including setting up an environment databank;

• Identifying environmental training needs for project owners, supervision contractors, construction contractors, and monitors, and facilitating training programs;

• Supporting environmental awareness and education for local members of the public; and

• Preparing the annual work plan, summarizing monitoring data, and preparing and submitting environmental activity and status reports to the Jiangsu Provincial Electric Power Company (JPEPC).

Regulatory Authority

The Jiangsu Provincial Environmental Supervision Bureau will be responsible for ensuring that the YPS is constructed and operated as per State and provincial environmental regulations, standards and norms.

Monitoring Authority

Environmental, resettlement, and public health monitoring will be carried out during the construction phase of the YPSP by local government monitoring agencies, which will provide these services under contract to the YPSP EMO. The Yixing Sanitation and Epidemic Prevention Station will be contracted to carry out public health monitoring and monitoring of solid waste management during construction. The Yixing Soil and Water Conservation Office will implement the soil and water conservation plan, and the Yixing Environment Monitoring Station will monitor water quality, air quality and noise levels.

Once the project becomes operational, environmental monitoring (primarily water quality monitoring) will become the responsibility of the Power Station Operator.
Contractor

Each of the main contractors (civil, underground, electrical, etc.) will assign at least one person to perform the role of environmental supervisor for their respective companies. These environmental supervisors will be part of the YPSP EMO, and will report to the EMO’s Senior Environmental Specialist on matters relating to environment. Individually, the contractors’ environmental supervisors will be responsible for ensuring their respective companies implement environmental protection measures specified in the bid documents or the detailed design drawings, and address any environmental problems that occur during construction.

7.3 Environmental Management and Supervision

7.3.1 Construction Phase

During the construction phase of the YPSP, environmental management will include the activities shown in Table 7-1.

Table 7-1 - Construction Phase Environmental Management Program Activities

<table>
<thead>
<tr>
<th>Environmental Issue</th>
<th>Environmental Management Actions</th>
<th>Responsible Authority</th>
<th>Supervising Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protect/relocate TV station and microwave station</td>
<td>Removal, consolidation and protection of buildings</td>
<td>Project owner</td>
<td>Competent higher-level authorities of Yixing Environment Protection Bureau, TV Station and Microwave Station</td>
</tr>
<tr>
<td>Protect remaining wildlife and plants</td>
<td>Enforce no hunting, and no cutting regulations</td>
<td>Project owner, Contractor</td>
<td>Contractor’s Environmental Supervisor; and Yixing Forestry Bureau</td>
</tr>
<tr>
<td>Mitigate Noise Impacts</td>
<td>Prevention of noise and control of noise sources at night</td>
<td>Contractor</td>
<td>Contractor’s Environmental Supervisor; and Yixing Environment Protection Bureau</td>
</tr>
<tr>
<td>Control Fugitive Dust</td>
<td>Regular sprinkling on working faces</td>
<td>Contractor</td>
<td>Contractor’s Environmental Supervisor; and Yixing Environment Protection Bureau</td>
</tr>
<tr>
<td>Environmental Issue</td>
<td>Environmental Management Actions</td>
<td>Responsible Authority</td>
<td>Supervising Authority</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Protect surface and ground water by controlling sewage and process wastewater</td>
<td>Treating production wastewater by using settlement basins and oil-water separators; separating domestic sewage, treating fecal sewage by septic tanks, and treating sewage from dinning room by oil-water separators and stage-2 biochemical treatment.</td>
<td>Contractor</td>
<td>Contractor’s Environmental Supervisor; and Yixing Environment Protection Bureau</td>
</tr>
<tr>
<td>Compensate for fish and fishery impacts</td>
<td>Purchasing sum-lump endowment insurance for managerial personnel, installing fish at the makeup/balancing water intake.</td>
<td>Yixing Environmental Protection Science and Technology Zone, Project owner</td>
<td>Yixing fishery departments</td>
</tr>
<tr>
<td>Public health protection</td>
<td>Regular health inspection, sterilizing drinking water, collecting and disposing of domestic refuse and construction debris</td>
<td>Project owner, Contractor</td>
<td>Yixing Sanitation and Antiepidemic Station</td>
</tr>
<tr>
<td>Ensure irrigation water supply for agricultural production</td>
<td>Build new irrigation supply pipeline and connect with makeup/balancing water pumping system</td>
<td>Project owner</td>
<td>Yixing agricultural departments</td>
</tr>
<tr>
<td>Protect surface waters from sedimentation and prevent soil loss</td>
<td>Implement engineering measures for stabilizing slopes of spoil disposal sites, reservoir banks, and other cut and fill slopes; install slope drains to divert water from erodible soils; carry out timely re-vegetation, and restoration of temporarily occupied-lands; install concrete aprons in reservoir intake/discharge areas</td>
<td>Project owner, Contractor</td>
<td>Contractor’s Environmental Supervisor; Provincial and municipal soil and water conservancy office; and Yixing Environment Protection Bureau</td>
</tr>
</tbody>
</table>
### Environmental Issue | Environmental Management Actions | Responsible Authority | Supervising Authority
--- | --- | --- | ---
Resettlement | Construct replacement housing with sewage collection/treatment systems and potable water systems; landscape area; implement soil and water conservation measures | Project owner, Yixing Environment Protection Bureau |  
Training YPSP environmental staff (owners and contractors) | Train managerial personnel of project owner on environment management, provide environmental awareness training for constructors, including training on environmental protection laws and regulations | Project owner, Contractor, Yixing Environment Protection Bureau |  
Environmental monitoring | Carry out monitoring of surface water, and domestic potable water (primarily from springs and wells); noise; air quality | YPSP EMO; Yixing Environment Monitoring Station; Yixing Sanitation and Anti-epidemic Station; Yixing Water and Soil Conservation Station | Yixing Environment Protection Bureau |  

#### 7.3.2 Operations Phase

In preparation for operating the YPSP, the YPSP EMO will post signs along the roads and adjacent to the reservoirs warning of the hazards associated with pumped storage reservoirs, and notifying the public that the reservoirs are closed to public access or use. The primary hazard for which the public must be made aware is the potential for rapid draw-down and raising of reservoir water levels, and the risk that persons could be drawn into intakes or discharge waters. In addition to signs that warn the public not to venture near to the edge of the upper or lower reservoirs, the YPSP EMO will also develop and deliver a program aimed at educating local inhabitants of the risks of venturing within the closed boundaries of the reservoirs.

Environmental management activities for the operation and maintenance phase of the YPSP are shown in **Table 7-2**.
### Table 7-2 - Operation and Maintenance Phase Environmental Management Program Activities

<table>
<thead>
<tr>
<th>Environmental Issue</th>
<th>Environmental Management Actions</th>
<th>Responsible Authority</th>
<th>Supervising Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement reservoir area safety program</td>
<td>Conducting public education program; installing warning signs; installing guard rails around reservoirs</td>
<td>Power station Operator</td>
<td>Yixing Environment Protection Bureau</td>
</tr>
<tr>
<td>Training Power Station Operator’s environmental monitoring personnel</td>
<td>Training managerial personnel of power station on environment management, conducting education on environmental protection and safety for inhabitants</td>
<td>Power station Operator</td>
<td>Yixing Environment Protection Bureau</td>
</tr>
<tr>
<td>Environment monitoring</td>
<td>Monitor reservoir waters and spring/well waters downstream of reservoirs</td>
<td>Power station Operator</td>
<td>Yixing Environment Protection Bureau, Yixing Environment Monitor Station,</td>
</tr>
</tbody>
</table>

#### 7.4 Environmental Monitoring

The environmental monitoring program will include provisions for monitoring surface water quality, spring and well water quality, noise, air quality, slope stability, worker health and safety, and health of inhabitants living adjacent to the project, during the construction phase. This includes monitoring of the construction works associated with construction of the reservoirs, underground works, roads, transformer substation, and ancillary works in the core project area, as well as construction works associated with the 35 kV and 500 kV transmission lines. Once the project moves into the operations/maintenance phase, environmental monitoring activities will be reduced to include only surface and spring/well water quality monitoring.

#### 7.4.1 Construction Phase Monitoring

**Water Quality Monitoring**

In total, eleven water quality monitoring stations will be sampled during the construction phase of the project. Five of the eleven water quality monitoring stations will be established to monitor treated effluent discharged from each of five wastewater treatment systems. Another five water quality monitoring stations will be established to monitor water quality in the surface water courses, springs and wells located downstream of the upper reservoir dam, including the following:
- 100 m upstream of the Jingle Active Drinking Water Company's well;
- Jingle Active Drinking Company's well;
- Tonguan Mountain Spring Company's well;
- In the Dhanjie Gully, 100 m upstream of the Yixing Dahanshan Drinking Company's well; and
- Yixing Dahansan Drinking Company's well

A single water quality monitoring station will be established at the makeup/balancing water pumping station intake, on the Huangtong River.

Water quality monitoring will be carried out over a period of six years, from commencement of preparatory civil works, to completion of all construction activities. Monitoring will be conducted four times per year, with samples being collected during the wet season, dry season, and intervening (moderately wet/dry season), respectively, and an additional set of samples being collected during the peak construction period, in whatever season that may fall. An additional set of samples will be collected from each of the five surface and spring/well water stations the day following a heavy rain event, to determine the impacts of construction related runoff on spring/well water.

Samples obtained from sites where treated wastewater effluent has been discharged, and from the Huangtong River, will be analyzed as per the guidelines identified in Tables 1, 2 and 4 of the Surface Water Environmental Quality Standard (GHZB1-1999). Water samples collected from the surface water courses, springs and wells located downstream of the upper reservoir will be analyzed as per the guidelines identified in Water Quality Standard for Living Drinking Water Source (CJ3020-93). For potable water samples, parameters to be tested for will include pH, suspended sediment, COD, BODs, petroleum, permanganate index, total nitrogen, total phosphorous, fecal coliform bacteria, and TNT residue (from blasting).

Slope Stability Monitoring

During construction, soil erosion and water-borne sediment transport will be monitored by qualitative means on the exposed cut and fill slopes, including those along road rights-of-way, spoils disposal areas, borrow areas, and reservoir banks. This monitoring will be done on a regular routine basis, particularly during the rainy season, as site inspections are carried out. As part of this monitoring, operation of soil and water conservation facilities and their running status will be evaluated.
Air Quality Monitoring

Two air quality monitoring stations will be established for the YPSP, one at the lower reservoir construction camp, the other between the Yixing TV Transmission Station and Yixing 173 Microwave Station in the vicinity of the upper reservoir. The parameters to be evaluated will include SO$_2$, NO$_2$, CO and Total Suspended Particulates. Routine meteorological observations will be recorded when air quality monitoring is being carried out. Monitoring will be undertaken over a period of six consecutive days, four times per year, roughly once in each quarter.

Noise Monitoring

Ten noise monitoring stations will be established within the YPSP project area. These will be located in the following strategic locations:

- At points along the main access road, including within villages situated on the road;
- Construction camps;
- Yixing TV Transmission Station;
- Yixing 173 Microwave Station; and
- The concrete and asphalt batch plants.

Monitoring will be conducted as 24 hour continuous monitoring, and will be undertaken once during execution of preparatory works, then twice per year during the construction phase, with at least one of the two annual noise monitoring events being carried out during the period of peak construction activity. Noise monitoring will be carried out in accordance with the Technical Specifications of Environmental Monitoring (Noise) [SEPA].

Health Monitoring

To protect the health of fellow workers, and to ensure that workers coming to the YPSP from outside areas do not bring with them diseases that could adversely affect the health of the rest of the work force, and the local population, each worker will be required to undergo a health examination prior to starting work on the YPSP. Periodic follow-up health examinations will be carried out to ensure the workforce remains healthy. Medicine and inoculations aimed at preventing the spread of disease will be provided to the work force by qualified medical practitioners.

In addition, public health screening will be carried out on project affected people by local public health and epidemiological staff as part of the resettlement program. Appropriate measures will be implemented to protect local inhabitants.
7.4.2 Operations Phase Monitoring

Once the YPSP is fully commissioned, the environmental monitoring program will be scaled back to include only water quality monitoring. Water samples will be collected and analyzed from monitoring stations in the two reservoirs, gullies located downstream of the upper reservoir, drinking water wells located adjacent to these gullies, and from the Huangtong River makeup/balancing water pumping station intake. Samples will be collected six times per year, twice during each of the high water, mean and low water seasons. Surface water samples will be monitored in accordance with guidelines set out in the Surface Water Environmental Quality Standard (GHZB1-1999). Water samples collected from springs and wells located downstream of the upper reservoir will be analyzed as per the guidelines identified in Water Quality Standard for Living Drinking Water Source (CJ3020-93). Water quality parameters monitored during the operations period will be the same as those analyzed for during the operations phase, with one exception. During the initial period of impoundment, water samples will be analyzed for polycyclic aromatic hydrocarbons (PAHs), a component of bitumen that is used to make asphalt. If no PAHs are detected for six consecutive sampling events, then this parameter will be dropped from the list of items for which water samples will be analyzed.

7.5 Data Management and Reporting

The YPSP EMO will establish a data management and filing system to receive and compile all documents relating to the environmental management program. Authorities contracted to carry out the monitoring and supervision activities will be required to submit a monitoring report in a timely manner following each monitoring event (generally within 30 days). The YPSP EMO will be responsible for compiling these data into a consolidated project monitoring reports that will be submitted to the environmental department of the JPEPC, following each monitoring event. On the basis of the environmental reports prepared by the YPSP EMO, the JPEPC will prepare an annual environmental management and monitoring report, which will be submitted to the World Bank for review.

7.6 Proposed EMP Budget

Table 7-3 provides a breakdown of the EMP budget during construction and operations/maintenance phases of the proposed YPSP.
### Table 7-3 Proposed EMP Budget (RMB Yuan)

<table>
<thead>
<tr>
<th>Environmental Management, Protection and Monitoring Measures</th>
<th>Cost (RMB Yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Phase</strong></td>
<td></td>
</tr>
<tr>
<td>Environmental Protection Measures for Yixing TV Transmission Station</td>
<td>3,124,700</td>
</tr>
<tr>
<td>Environmental Protection Measures for Yixing 173 Microwave Station</td>
<td>995,000</td>
</tr>
<tr>
<td>Fish Screens at Makeup/Balancing Water Pumping Station Intake</td>
<td>50,000</td>
</tr>
<tr>
<td>Soil and Water Conservation</td>
<td>20,461,700</td>
</tr>
<tr>
<td>Process Wastewater and Sewage Treatment Facilities</td>
<td>8,319,000</td>
</tr>
<tr>
<td>Worker Health and Safety; Public Health Protection</td>
<td>600,000</td>
</tr>
<tr>
<td>Potable Water Supply for Water Users Located Downstream of Upper Reservoir</td>
<td>549,500</td>
</tr>
<tr>
<td>Air Quality Protection/Control</td>
<td>490,000</td>
</tr>
<tr>
<td>Noise Mitigation</td>
<td>100,000</td>
</tr>
<tr>
<td>Environment Monitoring</td>
<td>1,080,000</td>
</tr>
<tr>
<td>Establishing YPSP Environmental Management Office (including civil works, office facilities, staff wages, training and daily operating costs)</td>
<td>800,000</td>
</tr>
<tr>
<td>Management and Training</td>
<td>920,000</td>
</tr>
<tr>
<td><strong>Operations/Maintenance Phase</strong></td>
<td></td>
</tr>
<tr>
<td>Operation of Sewage and Wastewater Treatment Systems</td>
<td>400,000</td>
</tr>
<tr>
<td>Public Safety</td>
<td>100,000</td>
</tr>
<tr>
<td>Environmental Monitoring (to come out of Operating Budget)</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL EMP BUDGET (RMB Yuan)</strong></td>
<td><strong>37,989,900</strong></td>
</tr>
</tbody>
</table>

Note: Equipment costs are included – see the full EIA Report for a more complete breakdown.

#### 7.7 Proposed EMP Schedule

The YPSP is estimated to require six years to construct. Preparatory civil works to build roads, a temporary construction camp, and ancillary service facilities will commence approximately three months following award of the civil works contract(s), and will take one year to complete. The major construction program is estimated to require four years nine months, with an additional one year required to complete the finish construction work. The first generating/pumping unit will be commissioned in the fifth year following start of construction, with all four generating/pumping units in operation by the end of year six.

Implementation of the environmental management and monitoring program will commence just prior to just prior to award of the first construction contracts (i.e., for preparatory civil works), and will initially involve pre-construction monitoring.
Regular environmental monitoring and supervision will be undertaken throughout the construction period, until all generating/pumping units have been installed, and contractors have demobilized from their respective work sites. Once the project sites have been cleaned up and restored, post-construction monitoring will be carried out to confirm the work has been satisfactorily completed. A scaled down program of monitoring, involving only water quality monitoring, will commence once the plant is YPSP is fully commissioned.
Chapter 8
Public Consultation and Disclosure

8.1 Introduction

This section of the report documents the program of public consultation and public disclosure that was undertaken for the YPSP.

8.2 Consultation of Technical Experts and Political Entities During Site Selection and Design

The technical and political consultation activities undertaken as part of the site selection and design process for the YPSP are summarized in Table 8-1.

Table 8-1 - Summary of Site Selection and Design Phase Consultation Activities

<table>
<thead>
<tr>
<th>Date</th>
<th>Purpose of Meeting</th>
<th>Participants</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 12-15, 1997</td>
<td>Approval meeting for selecting an appropriate site for a large-scale pumped storage station in Sunan. Eight potential sites were reviewed.</td>
<td>About 60 experts and professors from the Ministry of Power, East China Power Bureau and scientific research institutes.</td>
<td>The Yixing site was identified as the best possible site.</td>
</tr>
<tr>
<td>June 6-9, 1998</td>
<td>Approval meeting for the Yixing Pre-Feasibility Study. Issues discussed included project components, design aspects, construction, resettlement, environmental impacts, etc.</td>
<td>About 100 experts and professors from State Power Corporation, Jiangsu Environmental Protection Bureau, East China Power Industry Management Bureau and scientific research institutes.</td>
<td>Project feasibility was demonstrated, including suitability of the Yixing site, ability of the project to enhance load regulation and energy peaking within the East China Power Grid, satisfy technical and economic indices, and mitigate environmental impacts.</td>
</tr>
<tr>
<td>Feb. 8, 1999</td>
<td>Consultation meeting to select appropriate type of dam for the YPSP Upper reservoir</td>
<td>Various engineering specialists/experts and engineering professors.</td>
<td>Specific technical comments were provided by the various experts.</td>
</tr>
<tr>
<td>April 8, 1999</td>
<td>Site visit to acquaint key political decision makers with the location of the proposed YPSP, and how it will integrate into the setting.</td>
<td>Leaders from Yixing People's Politic Consultative Conference</td>
<td>Recognition that the YPSP would contribute to economic and social development of Yixing city.</td>
</tr>
<tr>
<td>Date</td>
<td>Purpose of Meeting</td>
<td>Participants</td>
<td>Comments</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>July 17, 1999</td>
<td>Integrated planning meeting.</td>
<td>Officers from Yixing City Government and staff from the project working group</td>
<td>City Government officials agreed to cooperate by ensuring adequate road and power connections are provided to the project site.</td>
</tr>
<tr>
<td>Nov.18-21, 1999</td>
<td>Power engineering assessment meeting.</td>
<td>About 10 experts and professors from relative authorities of the State Power Corporation, and General Hydropower Institute</td>
<td>Technical recommendations were provided on the proposed project.</td>
</tr>
<tr>
<td>Jan. 7, 2000</td>
<td>Meeting to approve the Feasibility Study of the Yixing Pumped Storage Project</td>
<td>About 100 experts and professors from relative authorities of the State Power Corporation, State Environment Protection Agency (SEPA), Jiangsu Environmental Protection Bureau, and General Hydropower Institute.</td>
<td>Provided comments on technical design and construction.</td>
</tr>
</tbody>
</table>

### 8.3 Public Consultation

#### 8.3.1 Survey of Local Government Agencies, Businesses, and Organized Social Groups

Meetings were held, and surveys conducted, with various local government agencies, business enterprises, and social groups in January 1999 and February 2001. The following groups provided input during these meetings and surveys:

- Yixing City Government
- City Planning Bureau
- Forestry and Sideline Bureau
- General Labor Union
- Women’s Federation
- Chinese People’s Political Consultative Committee
- Standing Committee Office of National People’s Congress
- Consultative Service Center of Science and Technology
- Yixing Forestry Farm
- Yixing Economical Development Zone
- Yixing Environmental Protection Science and Technology Zone
- Yixing Silkworm Mulberry Guidance Station
- Aquatic Guidance Station
All of these organizations indicated that they were aware of the proposed YPSP, having learned about the project from Television broadcasts, newspapers, and other media. Most organizations indicated that they support the YPSP, believing that it will contribute to development of the local economy. Moreover, most persons interviewed from these organizations believed that negative environmental affects can be mitigated using appropriate construction techniques and operating regimes.

**8.3.2 Survey of Resettlees and Other Local Project Affected Peoples**

The World Bank policy on environmental assessment (OP 4.01) requires that persons who may be adversely affected by a project be consulted during preparation of the EIA, to identify issues that may be of concern to them.

In January 1999, May 2000, and February 2001, the project-affected persons (PAPs) were surveyed. Staff and family that will be involuntarily resettled from the Nanyuesi Branch of the Yixing Forestry Farm, residents of Meiyan and Jiangli villages (from Highway 104 to the lower reservoir), and some citizens of downtown Yixing City were interviewed using a standardized questionnaire.

The survey results indicated that all those who were interviewed are familiar with the proposed YPSP, consider it to be a project which will be benefit development of the local economy and tourism, and consider it necessary to meet growing power demands for the province. Most (i.e., 93.6%) of those who will be involuntarily resettled (i.e., those residing in the staff quarters at Nanyuesi Branch of Yixing Forestry Farm) indicated their willingness to change employment, and most (i.e., 97.9%) are willing to relocate to a nearby location. The majority of the prospective settlees are of the opinion that the YPSP will not have a significant negative influence on forestry or agriculture production, or on their lifestyle. The respondents also expressed the opinion that any significant negative environmental impacts can be mitigated.

**8.2 Public Disclosure**

Information on the YPSP has been disclosed to the public via numerous public information events presented in Television and radio broadcasts, and newspaper articles. In addition to being provided with information on the project, the public
has been given details on how it can provide its comments and recommendations to the project authorities.

As a requirement of the World Bank’s operational policy on environmental assessments (OP 4.01), the Environmental Assessment report for the YPSP must be disclosed to the public, and the public given the opportunity to provide comments. In order to solicit opinions and comments of the public on the Environmental Impact Assessment Report of Yixing Pumped Storage Power Project (Chinese version), an announcement was issued on the front page of the Yixing Daily Newspaper on 06 March 2001, inviting the public to review the report at the Yixing Environmental Protection Station offices, and provide comments and/or recommendations on the EIA report.

Over the period 20 March 2001 to 04 April 2001, a total of fourteen members of the public reviewed the report. The following comments were provided by these lay reviewers:

- The environmental assessment is based on sound data and covers the full scope of impacts;

- Suitable environmental protection standards have been adopted for the project;

- The environmental impacts are not so significant as to unduly threaten the ecological and social environments, and the recommended mitigation measures seem adequate for controlling any impacts;

- Emphasis should be placed on environmental protection during project construction;

- The management of the local environmental protection department should be strengthened so as to guarantee effective implementation of the EMP.
Chapter 9
Summary and Conclusions

9.1 Introduction

This section of the report briefly summarizes the key findings of the Summary EA Report, which is itself a consolidation of findings, conclusions and recommendations of the Yixing Environmental Impact Assessment Report.

9.2 Project Impacts and Actions to Mitigate Them

The Yixing Pumped Storage Project (YPSP) will decrease the load difference in Jiangsu Province Power Grid by 2000 MW, by reducing the peak load and filling the valley load, thereby greatly alleviating the burden of thermal power plants in regulating peak load. In addition to improving the quality and reliability of the Jiangsu Provincial Power Grid, the project will generate sound economic returns, and pay for itself in a relatively short period of time. The YPSP will also improve the unstable power frequency conditions and improve the power supply quality and reliability within the overall power grid. The YPSP will also contribute, albeit in a minor way, to enhanced tourism opportunities within the Yixing area, by facilitating improved access to the upper elevations of Tuangtong Mountain, an area offering scenic vistas of the region.

A total of 757 people will be affected by the project. Of these, only 44 persons (19 families) will be involuntarily resettled. The majority (713) of the project affected people, although they will not have to relocate will, nonetheless, be affected economically as a result of losing a portion of their farmland or woodland enterprise when land is taken over by the project. A Resettlement Action Plan (RAP) has been completed, and all project affected people will be compensated in keeping with present state and provincial policies.

The project area is predominantly commercial forestry plantation and tea plantation and, therefore, does not provide critical natural habitat. The forest land that will be affected by the YPSP represents only 0.78% of the Yixing Forestry Farm and, therefore, the project will have virtually no impact on local remaining wildlife resources. There are no rare or endangered plant or animal species that could be affected by the YPSP. Likewise, there are no parks or nature preserves that could be affected by the YPSP.

The key project impacts are related to the effects of construction on surface, spring and well water, and sensitive communications structures like the Yixing TV Transmission Station and the Yixing 173 Microwave Station, both of which are located in the vicinity of the proposed upper reservoir. The lower reservoir will be
created by expanding the existing Huiwu Reservoir, a small artificial body of water created to provide irrigation water to a nearby farming enterprise.

An Environmental Management Plan (EMP) has been developed for the YPSP, and includes measures for mitigating environmental impacts and protecting the environment. A monitoring program will be undertaken as part of the EMP, and an Environmental Management Office will be established for the project. Assuming that the EMP is implemented effectively, the YPSP will not generate any significant adverse environmental impacts. To facilitate the implementation of the EMP, a satisfactory budget for managing the environmental aspects of the project has been defined by the proponent, which will be included in the Government/Bank Loan Agreement.
Appendix A

Diagram of Daily Operating Regime for the Jiangsu Provincial Power Grid in Year 2010
Diagram of Daily Operating Regime for the Jiangsu Provincial Power Grid in Year 2010 with Yixing Pumped Storage Project in Operation
Appendix B

Key Engineering Technical Features
For the Yixing Pumped Storage Project
## Appendix B – Key Engineering Technical Features of the YPSP

<table>
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<tr>
<th>No.</th>
<th>Item</th>
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