

ASIAN DEVELOPMENT BANK

SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

OF THE

ZHEJIANG-SHANXI WATER CONSERVANCY PROJECT

IN THE

PEOPLE'S REPUBLIC OF CHINA

May 1997

CURRENCY EQUIVALENTS

(as of 30 April 1997)

Currency Unit	—	Yuan (Y)
Y1.00	=	\$0.1201
\$1.00	=	Y8.3249

The exchange rate of the renminbi yuan is determined under a floating exchange rate system. In this report, a rate of \$1.00=Y8.3, the rate prevailing at the time of appraisal of the project has been used.

ABBREVIATION

ECIDI	-	East China Investigation and Design Institute
EIA	-	Environmental Impact Assessment
EMO	-	Environmental Monitoring Office
ERAB	-	Environment and Resettlement Advisory Board
LTEP	-	Leading Team of Environmental Protection
PRC	-	People's Republic of China
SRAP	-	Summary of Resettlement Action Plan
SEDC	-	Shanxi Economic Development Corporation

WEIGHTS AND MEASURES

ha	-	hectare
km	-	kilometer
m	-	meter
mm	-	millimeter
m ³	-	cubic meter
m ³ /s	-	cubic meter per second
MW	-	megawatt
t/yr	-	ton per year
°C	-	degree Celsius

NOTES

- (i) The fiscal year (FY) of the Government ends on 31 December.
- (ii) In this Report, the symbol "\$" refers to US dollars.

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Zhejiang-Shanxi Water Conservancy Project

A. Introduction

1. This Summary Environmental Impact Assessment Report on the Zhejiang-Shanxi Water Conservancy Project has been prepared in accordance with the requirements of the Asian Development Bank and is based on the full Environmental Impact Assessment (EIA) Report prepared by the East China Investigation and Design Institute (ECIDI) in September 1996. Prior to preparation of the EIA for the Shanxi Economic Development Corporation (SEDC), the Executing Agency for the Project, an Environmental Impact Report was prepared and submitted to the provincial and State authorities as required by the People's Republic of China (PRC). Approval of this Report was issued by the National Environmental Protection Bureau on 30 August 1995, after which it was translated into English (Environmental Impact Report, February 1996), and submitted to the Bank for information.

2. A three-member Environment and Resettlement Advisory Board, (ERAB) comprised of an environmental policy advisor, a sociologist/resettlement advisor, and a socioeconomic impact advisor was established by the Bank to undertake a comprehensive review of the environmental and social aspects of the Project. The ERAB produced a final report in January 1997, which stated that the Project would have "relatively benign impacts on the physical and natural environment but rather more extensive potential impacts in the social area." The ERAB had no major suggestions for revision of the EIA Report but did make a number of recommendations for strengthening the Project's resettlement planning, which were addressed by the Project proponent and the Bank during Project processing.

B. Description of the Project

3. The Project area includes the Feiyunjiang River, Wenzhou Ruian and Pinyang cities, and Wencheng and Taishun counties—all part of Wenzhou Prefecture in Zhejiang Province (Map 1). The primary purpose of the Project is to provide raw water to meet the increasing needs for domestic and industrial water supply of the urban areas and for irrigation of the surrounding rural areas. It will also provide electricity generation and alleviate flooding in the lower reaches of the Feiyunjiang River.

4. The main objective of the Project is to provide urgently needed raw water supplies for the seven million people living in Wenzhou Prefecture's coastal plains. The raw water supplied by the Project will replace the existing polluted canal sources as well as meet the current water supply shortfall and the projected increase in demand through year 2010 and beyond. Secondary objectives are to (i) ameliorate flood/drought cycles by increasing flood protection and by providing water for irrigation; and (ii) provide 220 megawatts (MW) of hydroelectric power on a peaking basis and 30 MW of full-time electric power to the Wenzhou electric grid. A consequence of the Project is the resettlement of about 10,000 households (37,000 people) from the inundation area behind the dams to the coastal region. The construction period will be four years, with expected completion in late 2001. The total estimated cost is \$523.7 million equivalent.

5. The Project scope comprises four main elements (Map 2): (i) Shanxi dam and reservoir, (ii) Zhaoshandu barrage and reservoir, (iii) a water conveyance system, and (iv) resettlement. Shanxi dam site is situated about 1 kilometer (km) from Shanxi town and 70 km inland from the coast. Zhaoshandu dam site lies approximately 32 km upstream of Ruian, 35 km below the Shanxi site, and downstream of the confluence of the Sixi river. Shanxi and Zhaoshandu dams will form a cascade development of the Feiyunjiang River, capturing the

hydropower potential of the lower river and regulating the flow to ensure a secure water supply for the heavily populated coastal plains.

6. The conveyance system will conduct water from Zhaoshandu reservoir to the three cities and smaller towns of the coastal plains. The main channel will subdivide into two main branches, one serving the northern part of the coastal plains including the Wenzhou and Ruian, the other serving southern areas including Pinyang. The system will deliver water to pump stations supplying major treatment works or to the channel system, from which water will be abstracted by pumping for use by industry or agriculture. The system will be 68 km long, comprising 18 tunnels together with 10 concrete aqueducts. In addition, the conveyance system includes six closed conduits and nine inverted siphons. Aqueducts will be of reinforced concrete construction and will comprise elevated conduits of rectangular section mounted on piers.

C. Description of the Environment

1. Topography and Geology

7. The western and central parts of the Project area are mountainous, with peak elevations between 600 and 1,000 meters (m). The eastern part of the basin is characterized by river and coastal plains with elevations of less than 10 m, typically 3 m. The Shanxi dam site is confined by hills of massive volcanic rocks, predominantly rhyolite and tuff. Zhaoshandu diversion site is in a broad, shallow section of the Feiyunjiang River valley with deep alluvial gravels. The conveyance system will run through a hilly area, crossing small valleys by aqueducts, and will terminate in low-lying areas of the coastal plain. The main channel of the Feiyunjiang River is a valuable source of sand and gravel for construction. Hills in the coastal plain are quarried for building materials. No precious mineral resources or important minerals are known to occur in the inundated areas. The dam sites are remote from areas of significant earthquake activity.

2. Climate

8. The climate is subtropical monsoonal, with a mean yearly temperature range of 14-20°C. Mean annual rainfall varies from over 2,000 millimeters (mm) in the western and southern mountains to 1,450 mm over the coastal plain. The catchment has an annual average of 149 days of rainfall.

3. Hydrology

9. Drainage of the Project area is through the Feiyunjiang River system, on which the proposed Shanxi dam and Zhaoshandu diversion structures will be located. The drainage network discharges into the Feiyunjiang, Ao, and Ou Rivers (Map 2).

10. The Project area is situated in a temperate humid zone, where frequent torrential rainfall, steep topography, shallow soils, and relatively impermeable geology produce high runoff, typically 65 percent of rainfall. The catchment to the Shanxi dam site has an area of 1,529 square kilometers. Shanxi dam will regulate some 47 percent of the catchment. Mean annual runoff at the Shanxi dam site is estimated at 1,860 million cubic meters (m³), equivalent to a discharge of 59 cubic meters per second (m³/s). Mean annual runoff at the Zhaoshandu diversion site is estimated at 2,800 million m³ (89 m³/s). Maximum runoff occurs between May and September, and lowest

runoff during December and January. Typhoons between June and September often cause major floods. The estimated peak flood discharge for the Feiyunjiang River at the Shanxi site is 11,500 m³/s in the 100 year flood and 25,300 m³/s in the probable maximum flood. The maximum mean annual water temperature has been recorded in August (32.7°C) and the minimum in January (7.8°C).

11. Bedrock in the Project area comprises Jurassic volcanic rocks interspersed with intrusive and clastic rocks of the Cretaceous period. The water content of these rocks is low, and groundwater is concentrated in fracture zones. Aquifers occur in alluvial materials of river valleys and coastal plains. They are small and numerous in the coastal plains, and are affected by pollution and salinity.

12. The tidal limit of the Feiyunjiang River is located at Tanjiao, approximately 59 km from the river mouth and 8 km downstream of the Zhaoshandu site. The mean annual tidal range is 4.22 m.

4. Water Quality

13. The water quality of the Feiyunjiang River upstream of the tidal reach in terms of biological oxygen demand, chemical oxygen demand, and dissolved oxygen generally meets Grade II standards (on the PRC scale of I [best] to VI [worst]). The exception is at Shanxi dam site, where pH values and total nitrogen cause the quality to exceed Grade II in dry periods. The water quality of tidal reaches generally complies with Grade II.

14. The water quality of the coastal river network is typically slightly polluted (Grade II-III) along upstream reaches, accounting for about 45 percent of the river network area; moderately polluted (Grade IV) in channels either side of the main channels, accounting for 35 percent of the river network area; and heavily polluted (Grade V or VI) in population centers, which account for the remaining 20 percent of the network. The water quality has deteriorated in the last 10 years and is influenced by the amount of industrial effluent, size of catchment, amount of natural runoff, and level of water supply abstractions. Sluices from the coastal river network are opened when the water quality seriously deteriorates.

15. The Ou River is the major source of water for domestic and industrial use in Wenzhou. At present there are no facilities for treatment of wastewater in Wenzhou, Ruian or Pinyang Cities and the surrounding area. Wastewater from Wenzhou city is discharged into the Ou River from three discharge points. Plans have been prepared to close these discharge points and treat the wastewater at three new secondary treatment plants before release into the Ou estuary. The water quality in the vicinity of the Oujiang pumping station exceeds standards for mercury content.

16. The main existing industrial polluter upstream of the Shanxi dam site is the Siqian Paper Mill, located in Taishun County at the upper end of the proposed Shanxi reservoir. Other sources of pollution are small factories involving bamboo, timber, wineries, and ceramics. In Wencheng, the main sources of wastewater discharge are wineries, concrete works, and other small-scale factories. Wastewater at Wencheng is not treated, nor is treatment planned for the future, because it is calculated that the dilution capacity of Sixi tributary will be adequate to maintain water quality at Grade II until at least 2010. However, new buildings now are required to

use septic tanks, and all factories are required to provide on-site treatment to Grade III standards before discharge.

5. Sediment

17. Suspended sediment concentration in the estuary varies between 2 and 4 kilograms per cubic meter, 12-25 times the mean annual suspended sediment concentration of the Feiyunjiang River at Shanxi. The high turbidity results from the estuary being located in the coastal zone, which is experiencing marine deposition, with land being reclaimed along the coastline between the Feiyunjiang and Ou river estuaries. However, the sediment content in the river above the two dams is low and sedimentation will not reduce the storage volume behind the dams.

6. Terrestrial Flora and Fauna

18. Natural vegetation in the river catchment comprises mixed deciduous and coniferous forest. It is limited to high elevation areas outside of the dam inundation area, where access is difficult and special protection is provided, such as the Wuyangling Nature Reserve. In other areas natural vegetation has been replaced by secondary growth. The forest coverage of Taishun and Wencheng counties is 72 percent and 65 percent, respectively, and is increasing due to reforestation. Pines are the most common trees. Medicinal plants are widely distributed, but none were within the inundated area of Shanxi reservoir during the wildlife and habitat survey. Land in the coastal plain is intensively used for agriculture, settlements, and industries.

19. Vertebrate wildlife species known or considered to be present in and around the proposed Shanxi inundation area comprise 25 mammals, 82 birds, 5 amphibians, and 12 reptiles. All of the reported vertebrate species are widely distributed throughout Zhejiang Province. No Grade I (endemic/rare/threatened) protected animal or plant species are reported to exist in the Project area. Grade II protected species, whose numbers are declining or whose geographical distribution is becoming more restricted, include up to 15 animals, which are expected to be put under little or no additional stress due to the Project. These species are found predominantly at higher elevations above the inundation area. The only species occurring in the *International Union for Conservation of Nature Red List of Threatened Animals* (IUCN, 1993) is the Mandarin duck (*Aix galericulata*), which will not be adversely affected by the Project.

20. Zhejiang Province has 11 nature reserves—three national and eight provincial. Wuyanling National Nature Reserve, located in Taishun Country, is close to, but lies outside of, the Project area. Wuyanling has flora and fauna that are undisturbed and probably best illustrate natural conditions that existed in the Shanxi reservoir area before settlement, hundreds of years ago. Of the protected species reported to exist, or that probably exist, in the Shanxi reservoir area, many were observed at Wuyanling. There are no existing or proposed nature reserves or other protected areas within or adjacent to the Project reservoirs, dams, transmission lines, tunnel, or aqueduct alignment, so none will be adversely affected.

7. Aquatic Life

21. The Feiyunjiang River is gravel-bedded, swift flowing, and supports no emergent or surface water plants. Surveys of phytoplankton and zooplankton identified 42 species, with

diatoms being dominant, and the average biomass sampled was relatively low. The lack of pollution-resistant species indicates that the water quality in the upper reaches of the Feiyunjiang River is generally good.

22. Seventeen fish species have been identified in the Feiyunjiang River, which is a typical number for a river basin of its size. Current fish yields in the streams of the Feiyunjiang catchment are only between 10 and 20 tons per year (t/yr).

23. Two fish species migrate over long distances. The eel, *Anguilla japonica*, spawns in the brackish water of estuaries along the eastern coastline of the PRC but lives in freshwater rivers. Young eels migrate upstream into freshwater tributaries in March-April. They are capable of movement out of water over wet soil and vegetation, particularly after rain and flooding. The sweetfish, *Plecoglossus altivelis*, a migrant species with Grade II protection (under pressure) in the PRC, which is also found in Republic of Korea and Japan, used to be present in the Feiyunjiang River.

24. The sweetfish is a species in the order Salmoniformes. It migrates from the sea to freshwater to spawn, with some characteristics similar to the Atlantic salmon and the Atlantic sea trout. A review of the sweetfish in the PRC has been published by Li Si Zhong (1988). Adult fish are reported to move from the East China Sea upstream in coastal rivers during early summer at rates of more than 20 km/day and can pass large obstacles. They spawn in September in north PRC, but in November and December in Zhejiang Province. Spawning requirements are sand and gravel in middle reaches of clear (good water quality, low turbidity) rivers. Best spawning temperatures are reported to be 15-25°C. After spawning, most adult fish die. After hatching, young fish swim out to sea, where they mature before returning to freshwater river systems in spring or early summer.

25. The sweetfish was at one time widely distributed along the coast of the PRC from the Biliu River in Liaoning Province in the north to the Longxi River in Fujian Province, but its numbers are declining. From discussions with local people, sweetfish traditionally used the Feiyunjiang River as far as Baizhangkou, over 20 km upstream of the Shanxi dam site. However, research undertaken during the Project's feasibility study, including trapping, villager interviews, and market surveys at six locations, failed to find evidence that the fish still occurs in the Feiyunjiang River. Its possible disappearance from the river is thought to be due to pollution and destructive fishing practices, such as dynamiting.

8. Social and Economic Conditions

26. The population in the Project area grew from 1.178 million in 1953 to 3.761 million in 1994 and is expected to grow to 5.732 million by 2030. The present population in the area of Wenzhou City to be supplied by the Project is 2.2 million, which is expected to rise to 2.9 million by 2010, placing increasing pressure on water resources. The population in inundation areas behind the two dams in 1995 was about 37,000, equivalent to a density of 926 persons per km². There is a small number of the ethnic minority She in the Project area, but since most have settled in the higher mountains, only about 17 households (55 persons) will be affected by the inundation.

27. Social services are generally poor in the remote mountain areas with scattered population and economically weak collective units that no longer provide free basic social

services. Government medical and educational services are poor in the inundation area. A general moratorium on new development has occurred in the catchment area since 1984 in anticipation of the Project. Rural towns have a small local power grid with basic power service, while major urban areas are linked to the provincial grid.

28. The area to be inundated is populated mainly by farmers living below the poverty level. In the narrow V-shaped river valleys, settlements are stretched along the river on higher banks, where agricultural land is scarce and scattered. Settlements located in wider valleys have a good agricultural resource base. The main source of income is subsistence farming. Other livelihoods include fruit, tea, tea oil, bamboo, noodle production, and some construction materials. Because of the prevailing poverty in the inundation area, the Government has begun implementing plans to relocate families to the coastal region, where there are greater opportunities for increasing household incomes and access to social services. The Wenzhou Municipal Government has formulated a policy whereby persons resettled to the coastal area can obtain land use rights through exchange with those existing residents who no longer wish to exercise their farm registration. The average annual per capita income in the resettlement and host villages is summarized in Table 1.

Table 1: Resettlement and Host Villages Annual Per Capital Income

Annual Income Range (Y)	Resettlement Villages (%)	Host Villages (%)
<1,000 (600-1000)	40	—
1,001-1,500	25	—
1,500-2,000	10	—
>2,000 plus	25	—
<4,000 (3,000-4,000)	—	50
4,000-5,000	—	20
5,001-6,000	—	10
>6,000	—	20

29. The cost of living in the host villages is correspondingly higher, and there is less informal economy/bartering.

30. The mountain regions of Wencheng and Taishun are forested and provide a variety of products for subsistence and cash. Most of the bamboo and timber in Wenzhou comes from this area, and the two counties also provide various forest products such as tea-oil and bamboo. Natural resources in mountainous regions are most plentiful in Taishun, where agriculture is highly diversified, including cash crops such as mushrooms and tea. Households practice a diversified land use system. On the contracted grain land they grow two seasons of rice, and wheat or potatoes as a winter crop. In addition, households cultivate vegetable plots for daily consumption and various fruit trees, timber, and bamboo. Wencheng and Taishun are the least industrialized counties in Wenzhou. Industrial production is much below the Wenzhou average and is sustained mostly by the construction industry. Until 1997, Wencheng and Taishun were both considered poverty counties. Most industry consists of oil and noodle processing industries serving local markets. Some enterprises specialize in the use of local resources, such as mountain spring water, wood, or bamboo. Other industries include brick making and paper making.

31. The coastal plains of Wenzhou, Pinyang, and Ruian consist mostly of rice fields, which produce two crops per year. Only a small proportion of land is undeveloped. Coastal areas have experienced rapid industrialization based on small private enterprises. They are engaged in the manufacture of consumer goods and are characterized by the specialization of entire villages on one type of product.

32. Land ownership is vested with the State, and land use rights are still administered by the former collectives. Agricultural land was allocated to the households in 1982, and farmers are free to produce for their own consumption or sale after fulfillment of taxes and grain quotas. Fines are imposed if arable land is not used. Village groups make regular reallocations of arable land on a per capita basis in order to adjust to changing demographic conditions.

33. The communicable diseases common in the Project area include hepatitis, measles, whooping cough, and bacterial dysentery. Morbidity rates for the Project area are considerably lower than national levels, and the health of local inhabitants is considered relatively good. Goiter is common in the reservoir area within Wencheng County; the rate of infection is 19 percent among school age children.

34. There are 14 historic relics in the proposed inundated area of Shanxi reservoir (5 cultural, 4 ancient kilns, 3 ancient timber buildings, 1 stone carving, and 1 stone memorial archway) having county conservation status. There is one historic relic with ordinary status located in the Zhaoshandu area of impoundment. These will be relocated to sites above the periphery of the reservoir.

D. Anticipated Environmental Impacts and Mitigation Measures

1. Impacts Associated with Project Design

35. The major impact that was modified during Project design was the possible flooding of Siqian town, located north of the reservoir. The normal water level in Shanxi (142 m) was chosen to limit backwater effects from the 20 year flood to a level below the town of Siqian, in accordance with the national flood regulations for towns of less than 200,000 population. Modeling has shown that water levels due to floods with return periods greater than 1 in 50 years will be raised following construction. Therefore, a flood warning system for settlements surrounding the Shanxi reservoir will be implemented as part of the Project.

2. Impacts Associated with the Construction Phase

a. Flora and Fauna

36. The construction of Shanxi and Zhaoshandu dams will have minor impact on flora and fauna. The area of land taken up by construction (excluding the inundation area) amounts to 263 ha. This land is close to existing settlements and agricultural areas and does not provide a significant habitat for wildlife.

b. Fisheries

37. Impacts on fisheries during construction will be minor. They include loss of habitat in the area of dam construction, flooding of habitat by short-term high water levels caused by the diversion of floods at Shanxi, and increased downstream turbidity. Fishing in the Feiyunjiang River has little economic importance, and overall productivity is low. These impacts will be localized over the duration of construction and are unlikely to be of significance in terms of overall fish stocks and yield. Diversion tunnels will probably act as a barrier to migration, because fish are generally unwilling to enter dark areas to continue their upstream passage. Impacts on the sweetfish, and mitigation measures are further discussed in the section below on operational phase impacts (paras. 74-76).

c. Quarries, Borrow Areas, Excavation, and Spoil Disposal

38. Construction materials for the Shanxi dam will be derived from the dam site or from the river channel downstream. The excavated volume will be approximately 4,000,000 m³, of which 60 percent will be derived from rock excavation at the spillway, 25 percent from alluvial gravel deposits, and the remainder from other excavations for the dam foundations, power station site, and tunnels. A quarry will be established to provide additional material to meet the demands of construction at peak times. Almost the entire amount of excavated materials will be used in dam construction. The remainder will be disposed of at spoil areas located upstream, at the dam toe, and at a spoil dump 1 km downstream of Shanxi town.

39. Excavations for Zhaoshandu dam will total approximately 1,800,000 m³. Spoil dumps for about 1,500,000 m³ will be located on the left and right banks at the dam site, and the remaining spoil will be disposed upstream of the dam site in areas to be inundated following construction. Attention will be given to minimizing erosion and downstream turbidity, but it is expected that most of the spoil material will be used for construction and therefore will not present long-term turbidity problems.

40. Spoil dumps for the water conveyance system will be located in gullies and depressions at tunnel and siphon outlets to accommodate 1,700,000 m³ of tunnel material. Spoil from the tunneling will be used for construction purposes, where possible, including preparation of housing sites for resettlement. Due to the steep terrain and the potential for turbidity problems in nearby streams, masonry bank protection will be provided to restrict spoil dumps and prevent sediment discharge.

41. Following completion of construction, some dumps will be used as a source of rocks, reducing the need for quarrying. Others will be used for industrial purposes, and the remainder will be revegetated and landscaped.

d. Access Roads

42. The Project requires only 12 km of road construction, 10 km of which comprises local realignment of the Rui'an-Shanxi rural highway around the Zhaoshandu inundation area. The roads will not traverse mature forests or other environmentally sensitive areas. The main potential environmental impacts will include soil erosion, land slippage, and unsightly areas. To address these impacts, the exposed slopes along the roads will be revegetated with soil-binding grasses, shrubs, and trees. Catch drains will be installed on the upper portion of the excavated soil face. Stabilization measures will be implemented where ground conditions are unfavorable. Creation of

dust will be addressed through regular spraying of road surfaces during dry periods. A minimal area of agricultural land will be required, and compensation will be paid under the resettlement plan.

e. Flooding

43. An initial cofferdam will be erected at the Shanxi dam site by September 1998, followed by construction of the main cofferdam, which will form an integral part of the dam by June 1999. The initial cofferdam has been designed to allow passage of the 1-in-10 year dry season flows through diversion tunnel No.1. The main cofferdam has been designed to allow the passage of the 1-in-100 year flood. In the event of floods of these magnitudes, the area upstream of the Shanxi dam would be flooded to elevations of 62.1 m and elevation 100.8 m, respectively. To ensure that people in this area are not adversely affected, the resettlement schedule has been arranged so that those households at risk will be resettled at an early stage.

f. Agriculture

44. The amount of land lost due to construction activities related to the Shanxi dam, Zhaoshandu dam, conveyance system, access roads, and transmission lines will be approximately 223 ha, of which 50 percent will be temporarily occupied and will be returned to agricultural use following completion. Early notice of agricultural land required for construction will be provided to villagers affected to avoid wasted farming effort. Compensation measures are included in the resettlement plan.

g. Labor and Contractor's Camps

45. At the peak of the five-year construction period, about 10,460 workers will be employed on the Project: 3,500 at Shanxi dam, and 6,960 at Zhaoshandu dam and on the conveyance system. Living quarters will be constructed at Shanxi, Zhaoshandu, and approximately 18 locations along the conveyance system.

46. Water supply during construction will be provided by abstraction from the Feiyunjiang River at Shanxi and Zhaoshandu, and from the coastal channel network. Water will be treated by filtration and disinfection. The schemes will ensure that the Project's water requirements are met without adversely affecting the needs of local inhabitants. At the Shanxi and Zhaoshandu sites, the sewage will be conducted to septic tanks. The tanks will be periodically cleared and the solids sterilized before disposal to landfills. Solid waste will be collected at regular intervals from offices and living quarters. Suitable biodegradable waste will be used as fertilizer. The remaining waste will be disposed of in landfills.

47. Worker's quarters will include social amenities. A clinic will be provided to treat minor injuries and common diseases. Serious medical cases will be referred to nearby hospitals in Rui'an and Wenzhou. Because of the proximity of the sites to existing settlements at Shanxi and other towns and villages, there will be a risk of disease transmission to the local population. This will be minimized by proper health care and education. There also may be a risk of some escalation in local prices for consumer goods because of the injection of money into the local economy and demands from the labor force. The provision of shops at the site construction camp will help minimize this risk.

48. The greatest risk of construction-related injuries will arise from site traffic, use of construction equipment, and movement of materials. Provisions for good working practices will be included in the tender documents and contracts, and adherence to these provisions will be monitored.

h. Transmission Lines and Substations

49. The main transmission line, running 55 km from Shanxi to Chuiyang, will operate at 220 kilovolts. The line will run parallel to the Chuiyang-Huanxi highway, and so is expected to have minimal impacts. It will avoid Mount South Yandang National Scenic Zone and other sensitive areas. Where the line passes through settled areas, national minimum clearance regulations will be enforced. Because of continuous cropping, it will not be possible to completely avoid disturbance to agricultural activities, and compensation to farmers will be provided. The small work crews will not adversely affect local social conditions.

3. Impacts Associated with the Operational Phase

a. Reservoir Conditions

50. Seasonal variation in Shanxi's reservoir level will be significant, typically 10 m and a maximum of 25 m. Diurnal variation in reservoir level will not be significant. Reservoir operating rules have been drawn up to ensure that the spillway will be operated efficiently, and it is normal practice in the PRC to test the operation of all gates prior to the flood season. The risk of flooding at Siqian as a result of error or malfunction is therefore considered small. The operating range of levels in Zhaoshandu reservoir is small (less than 1 m), and is not expected to cause significant disruption to local inhabitants. Backwater from Zhaoshandu will affect Yingqian town, which will therefore be protected by an embankment against the 20-year flood.

51. Water quality in the Shanxi reservoir will be oligotrophic, and a program of vegetation clearance and removal of sources of water pollution will be carried out before impoundment to minimize adverse impacts on water quality. Possible adverse impacts from wastewater discharge from the Siqian Paper Mill, located upstream of the Shanxi dam, will be removed following its relocation outside the Project area. The mean annual sediment load at the Shanxi dam site is insignificant in terms of reliability of water supply yield and power generation, and sedimentation in the Shanxi reservoir is not a major issue, utilizing less than 1 percent of the reservoir's volume after 50 years.

b. Environmental Geology

52. The mountains surrounding the Shanxi reservoir comprise hard compact volcanic lava and clastic rocks. Mountain springs are located mainly above the normal water levels of both reservoirs, and there are no great fault structures in Shanxi or Zhaoshandu reservoir basins to create a permanent passageway for water. The banks surrounding both reservoirs comprise hard, compact volcanic rock or clastic rock, and no large-scale bank stability problems have been encountered.

53. Both reservoirs are located in a region of low earthquake intensity and frequency.

The designs incorporate safety measure to ensure that earthquake events will not pose a threat to the dam, and it is not expected that the banks will collapse if earthquakes occur. The selection of tunnel and aqueduct alignments has considered many factors, including avoidance of intercepting groundwater. Tunnels are not expected to drain or lower groundwater levels, and thus impacts on spring flows and seepage are not expected to occur.

c. Resettlement

54. The greatest impact of the Project is the flooding of land and settlements, principally in the Shanxi reservoir, and to a lesser extent in the Zhaoshandu reservoir. The greatest Project mitigation measure required is satisfactory resettlement of approximately 37,000 people. The resettlement plan incorporates development economic opportunities for people from a relatively poor area. Current planning is addressing the complexity of the socioeconomic conditions, and the time and preparation required to implement this strategy. Details of the resettlement plan are provided in the separate "Summary Resettlement Action Plan." The main features of the proposed resettlement strategy are described below. (Where numbers of affected people are presented, they have been rounded to the nearest hundred or thousand.)

- (i) Nearly 92 percent of affected people will be resettled in the coastal region at 80 sites in eight counties. The remaining affected people will be resettled along the reservoir periphery, either in newly developed townships or at higher elevations in their villages of origin.
- (ii) Of the 34,000 people to be relocated in the coastal area, 31,000 will be provided with paddy land at the rate of 0.02-0.04 ha per person. The farmland required for their resettlement will be made available by allowing about 35,000 host area people voluntarily to change their resident registration (*hukou*) to nonrural status in exchange for return of their farmland, enabling these people to relocate in urban areas near their work.
- (iii) Of the 3,000 people to be resettled in the reservoir periphery, 1,500 will be resettled on agricultural land and the remainder on non-agricultural land.
- (iv) The primary means of non-agricultural resettlement is to allow people to change their resident registration to nonrural status, thus freeing them from the legal obligation of fulfilling grain production quotas. They will be provided with a house plot in one of the fast developing townships, where they can start enterprises or business ventures. Of the 4,500 people to be resettled under non-agricultural means, 1,800 are those who already have nonrural registration, who are employed in Government offices or State enterprises, and therefore do not require economic rehabilitation.
- (v) The resettlement program will begin in 1997 and continue until 1999. Approximately 3,300 persons were scheduled to be relocated between August and December 1996.
- (vi) The resettlement program is estimated to cost about Y1,079 million, roughly 25 percent of the total Project cost.

55. Land resources that will become available for resettlement in the coastal plain comprise 2,400 ha of cultivated land. Standards of new infrastructure to be provided under the resettlement plan will be equivalent to existing local infrastructure. Additional roads will be constructed within resettlement areas. Power transmission lines will be routed along roads, and all resettlement sites will have access to electricity. Water supplies will be extended from the existing

system, which are all able to accommodate the increased demand.

56. Of the resettlers to the coastal plain area, more than 90 percent will be engaged in agriculture on land that is currently cultivated. No significant environmental impacts on resettlement during the Project operational period are expected in relation to land use. The potential incremental pollution loading of the river network by resettlers is insignificant compared with the loads of the existing population and industry.

d. Flora and Fauna

57. The Project will be located in an area dominated by secondary vegetation. The forestry bureaus in Taishun and Wencheng counties have succeeded in afforesting most land that is unsuitable for agriculture, and are continuing programs to plant the few remaining areas of "wasteland." No specific proposal is therefore considered necessary to replace lost areas of timber and other resources, apart from spoil heap and site reclamation activities. Timber occurring within inundated areas will be salvaged prior to impoundment under the supervision of the Department of Forestry.

58. There are 124 wildlife species reported or thought to exist in the Project area, according to the wildlife and wildlife habitat survey in August 1996. All of these are widely distributed throughout Zhejiang Province. The survey concluded that the Project area does not contain a nationally or internationally significant population of any wildlife species. Wuyanling National Nature Reserve, located 20 km from the western end of the proposed Shanxi reservoir, will not be affected by the Project. No serious losses of wildlife are expected by construction activities and reservoir impoundment.

e. Downstream River Conditions—Shanxi Dam

59. The hydrological impacts of the Project relate to an increased range of diurnal flows, reduction in flood discharge, possible localized scouring, and lowering of river temperature and dissolved oxygen. The Shanxi dam will operate as a peaking station for 11-13 hours per day. Daily flows past the dam will be substantial, and no compensation flow is proposed. Flow releases may be up to 223 m³/s for as many as 5 hours, and zero for up to 17 hours per day, which will be detrimental to aquatic life in the stretch between the dam and the Zhaoshandu reservoir. As explained earlier, however, fish species that will be affected by this fluctuation are widespread in the province and the country, and local residents are not dependent on fish for their livelihood, income, or protein. Furthermore, it is expected that the Shanxi reservoir will produce wild reservoir fish (without stocking or aquaculture) of about 300 t/yr, which is more than 10 times the estimated existing fish catch for the entire Feiyun river system.

60. Flood control storage in the Shanxi dam will reduce flood peaks by approximately 25-40 percent, increasing present flood protection to 1 in 20 years.

61. Water releases will lower the river temperature below that required for rice growth using current rice strains. Without mitigation, this is expected to decrease production of early rice crops by 3-7 percent, but the Project is also expected to increase rice crops in July and August by 4-5 percent. This will affect approximately 200 ha of paddy fields. Mitigation through the use of alternative rice strains, transplanting, additional fertilizer, and shallower water depths will reduce

these impacts.

62. The primary source of pollution will continue to be domestic sewage, which will increase proportionally with population. However, the basic pollution load will remain the same, even though the Project will cause incremental volumes of wastewater. It is expected that the reservoir will reduce both annual and seasonal variations in water quality of the Feiyunjiang River between Shanxi and Zhaoshandu. Releases will be rapidly aerated when flowing over gravel downstream, and dissolved oxygen levels are expected to be restored to high levels at Zhaoshandu.

f. Downstream River Conditions—Zhaoshandu

63. The reservoir storage is small, sufficient only to regulate diurnal discharges from Shanxi, and to regulate low flows received from the intervening catchment area, principally from the Sixi River. Flows that are surplus to the requirements of water supply diversion will enter the power station intake, subject to its maximum design discharge of 228 m³/s. The balance, flows, water supply diversion and power generation, will pass through spillway gates. The design maximum diversion for water supply is 36 m³/s, or 17 percent of the long-term mean annual runoff. Engineering measures will be adopted to safeguard the quality of water conveyed through the tunnels and aqueducts of the water conveyance system. These measures will preclude pollution of the water supply during the long conveyance, and will ensure that the grade of delivered water remains the same as at the Zhaoshandu source—Grade II or better.

64. Hydrological and water quality impacts on the Feiyunjiang River downstream of Zhaoshandu will be similar to those described for the reach downstream of the Shanxi dam. However, runoff from Sixi tributary will reduce these impacts. The Zhaoshandu reservoir will not have flood control storage and thus no significant impact on floods. Sediment transport is not expected to have significant adverse impacts on the operation of the Zhaoshandu reservoir or on gravel extraction downstream. Model predictions show that water temperature will recover to a normal level at the Zhaoshandu reservoir. No adverse impacts on rice and other crops are expected.

65. Owing to wastewater inflows from the rapidly growing towns of Shanxi, Wencheng, and elsewhere, there is need for further consideration to be given to establishing more "water protection zones" (as is the case upstream of the Wencheng water supply) and to treating wastewater discharges adequately. This will be the responsibility of the Leading Team of Environmental Protection (LTEP).

66. The impact of Zhaoshandu diversions on water quality in the Feiyunjiang River downstream will be evident only upstream of the tidal reach near Tutou. The deterioration in water quality caused by the diversions will be small compared with the impact of future increases in wastewater discharge, for which pollution control measures are planned.

g. Estuary

67. Estimates of future wastewater discharge into the Feiyunjiang estuary have been based upon projections of industrial output and population growth, and show a dramatic increase over existing levels. The existing dilution capacity of the Feiyun river is weak upstream of the strong tidal influence (at Tutou), and the river will not be able to cope with additional untreated wastewater discharges.

68. Plans have been prepared to improve water quality by one grade, or at least to maintain water quality at current levels. Water quality modeling of the Feiyunjiang estuary has shown that water quality objectives can be met provided the measures for pollution control and effluent treatment are implemented.

69. Because of the growing importance of the expanding port at Ruian in the regional economy, and the known problems of Feiyunjiang estuary siltation, initial EIA scoping studies identified morphological changes in the estuary as a major issue of the proposed project. Results of studies to forecast morphological changes in the estuary indicate that the proposed Zhaoshandu diversion should not cause problems. Mitigation measures are available to combat siltation at Ruian and to safeguard navigation in both harbors. Recommendations arising from these studies are that hydrographic surveys and related velocity monitoring should be carried out before Project construction and at intervals during the operational phase. Survey results may then lead to improved and adjusted models, and to detailed proposals for mitigation works, if required. These monitoring and research activities are included in the Environmental Management Plan.

70. Salinity modeling of the estuary with varying hydrological and river bed conditions demonstrated that the impact of the Zhaoshandu dam would be small. Salinity near the estuary mouth, between Ruian and Shangwang, is predicted to remain unchanged following the commencement of water diversion. Salinity at Panshan in the upper tidal reach currently varies between 100 and 200 milligrams per liter, and is predicted to increase by about 10 percent.

h. Coastal Waters and Coastal River Network

71. No reports have been received of adverse impacts on seaweeds and invertebrates due to existing pollution loads in the coastal waters off Wenzhou. Similarly, no reports have been received of reduced prawn, langouste, or fish catches in the Wentai fishing ground because of pollution in the estuaries. The biological impacts of future pollution loads in these estuaries have not been studied in detail, but it is believed that the capacities of the vast tidal volumes/flows in both estuaries will be sufficient to meet water quality objectives in the future, and that estuary/marine life will continue to be supported.

72. Water quality objectives can be met during the early years of Project implementation by making substantial discharges of Grade II water from the north and south branches of the Project's water conveyance system, and simultaneously and progressively controlling major pollution sources according to the master plan. In later years, comprehensive measures will be required to control urban pollution at the source, collect and treat wastewaters, and discharge them by sewers to below low tide levels of estuaries. Water transfers from Zhaoshandu will continue to be needed for meeting water supply demands and for meeting water quality objectives (by dilution) in the river networks.

73. Existing groundwater levels in the coastal plain exceed water levels in the river network, and the Project is therefore not expected to have a significant impact on hydrogeology.

i. Migratory Fish

74. The Shanxi dam will be a barrier to upstream and downstream movement of eel, *Anguila japonica*. However, because eels are capable of movement out of water, over wet soil and vegetation, particularly after rain and flooding, some may pass the much lower Zhaoshandu

structure when moving upstream, giving access to the Feiyun river as far as the Shanxi dam, Sixi River, and other tributaries. Downstream movement is not expected to be prevented, because eels are expected to pass through the spillway gates. *Anguila japonica* is not a protected species and has wide distribution along the eastern PRC coastline. No mitigation is proposed.

75. The sweetfish is a migrant species whose population is thought to be under considerable pressure throughout the PRC, and it has therefore been given Classification II protection. The survival of this favored species in the Feiyunjiang River will be jeopardized by barriers to its migration at Shanxi and Zhaoshandu. Possible mitigation measures include installation of fish passes and/or artificial breeding and production. In the case of the Shanxi dam, a fish pass is not considered to be feasible because of the dam's height. Even if it were feasible, almost all of the gravel reaches upstream of Shanxi will be inundated and useless for spawning. Further inundation at Zhaoshandu will leave only some 19 km along the Feiyun river, and the lower reaches of the Sixi River and other tributaries as potential spawning areas. A fish pass is not recommended at Zhaoshandu because the new hydrological conditions are expected to be incompatible with spawning requirements. Artificial breeding and culture have been developed in Japan for 70 years, and production is reported to be 15,000 t/yr. Initially successful attempts to breed sweetfish in Zhejiang Province using wild stock were reportedly abandoned in the mid-1990s due to the difficulty in finding wild specimens.

76. The fish surveys did not conclusively demonstrate that sweetfish still occur in the Feiyunjiang River. However, it is recognized that only a major, time-consuming, and costly survey would conclusively verify the species' presence.¹ Because the sweetfish is a Classification II protected species that is under threat throughout the PRC, and because the Project will almost certainly lead to its disappearance from the Feiyun river should it still occur there, technical assistance will be provided by the Bank for research into developing a captive breeding program that draws on successful efforts in Japan.²

j. Transmission Lines

77. The operational impacts of transmission lines primarily concern potential safety hazards. A minimum clearance in accordance with international safety standards will be maintained between conductors and any inhabited buildings. Warning signs will be placed on towers close to settlements. The standard design of tower is such that they cannot ordinarily be climbed. Nevertheless, anticlimbing guards will be placed on towers close to settlements. The operation of substations, one of which is existing, will have minor impacts on noise levels. Oil leaking from transformers will be trapped in pits provided with oil/water separators, which are included in the Project design. Any trapped oil will be disposed of following standard practice, such as high temperature incineration. Any further potential impacts, and related mitigation measures will be identified during detailed design.

k. Public Health and Safety

¹ A fish species believed to have been extinct in the United States for over 100 years provides a good example of the difficulty in determining the status of rare fish. The species was rediscovered by chance in early 1997 during a routine Government survey.

² This mitigation measure is not included in the EIA report, which stated that mitigation could not be justified. However, the technical assistance was prepared following the findings of the Bank's Fact-finding Mission for the Project.

78. The Shanxi and Zhaoshandu reservoirs will provide habitats for vectors of water-related diseases, particularly mosquitoes. County health care agencies will monitor mosquito populations near the reservoirs to ensure that any needed control, protection, and treatments are provided.

79. Analysis of public health indexes in the reservoir region shows that disease types and morbidity rates are less than in the main coastal host resettlement communities. Therefore, resettlers are not expected to bring new communicable disease to the host areas. Sanitary and medical services in the host areas are superior to those in the inundated areas.

80. Warning signs will be placed at main access points along river banks to advise people of the risk of reservoir releases and of the warning procedures. A siren will be sounded in advance of gate operation to give adequate warning to people along, and on, the river who may be at risk. Warning signs will be placed along the shoreline close to the spillways and floating booms installed to keep craft at a safe distance.

81. Tunnels and aqueducts will be made inaccessible to the public during construction by installation of physical barriers, supported by regular patrols of security staff, to prevent access. Signboards will inform local inhabitants of the dangers associated with the water conveyance structure and the possibility of occasional operation of spill sluices. The LTEP will consider the need for flood warnings in the backwater affected areas of the reservoirs and, if required, will make arrangements for monitoring and warning devices to be installed, in line with Wenzhou Prefecture's flood disaster warning procedures.

I. Other potential impacts

82. Fourteen cultural relics will be affected by impoundment and construction. Local authorities have extensive experience with preservation and conservation techniques, and will undertake appropriate mitigation measures during the construction period and before reservoir impoundment.

E. Alternatives

1. General

83. The available freshwater sources in the Wenzhou coastal plains area have already been fully developed. As water demand has grown, the cities have been forced to pump water from the local canals and streams. However, these are now running out of water during the dry season, especially in dry years. In addition, the water quality is poor—Grade V or worse, much below the Class III normally considered to be minimum for municipal use. The rivers in the area, the Oujiang and Feiyunjiang, are both impacted by the 6-m tide and are therefore saline and cannot be used for municipal industrial, or irrigation purposes. The only feasible option for good quality, raw water is the Project. Other options that are technically available include a similar project on the Oujiang River, desalination of the saline river water, or sophisticated tertiary treatment of the canal water. These options would require sophisticated treatment processes with higher capital costs and higher power consumption. The combined capital and operating costs of these options would be in the range of Y8-10/m³ as compared with 2/m³ for the Project. In addition, the Project will bring flood relief for the lower Feiyunjiang Valley and irrigation water at low/affordable cost.

84. Sources of pollution downstream of Zhaoshandu are concentrated between Mayu and Xiangjiang in the towns of Changuan and Feiyun. Thirty-two major enterprises contribute 60-80 percent of all industrial wastewater discharges in this area. The greatest sources of pollution are tanneries, wineries, dairy processing, and paper-making factories. Domestic wastewater volumes generated downstream of Zhaoshandu have been estimated at 15.3 million t/yr, of which 80 percent is discharged into the Feiyunjiang River and the remainder into the coastal river network. Total wastewater discharge by industry into the Feiyunjiang River is estimated at 16.2-17.5 million t/yr.

85. Current wastewater discharge to the Ou estuary is estimated to be 73 million t/yr. This is approximately four times the current discharge into the Feiyunjiang River downstream of Zhaoshandu. Plans have been prepared for the construction, during the Tenth Five-Year Plan (2001-2005), of three major (secondary) treatment works for wastewater discharges to the Ou River.

86. Existing flood control works on the right bank at Shanxi town and on the left bank of the Feiyunjiang River give protection against a 20-year flood to settlements a few kilometers downstream of Shanxi town. Existing flood defense works downstream of Zhaoshandu offer protection to farmland and villages between Zhaoshandu and Mayu against 5-year floods. Estimates of the areas inundated by floods range from 7,900 hectares in 5-year floods to 9,900 hectares in 20-year floods.

2. Alternative Options in the Preferred Project Design

87. A range of alternative options were considered for the Shanxi reservoir, including maximum operation levels ranging from 140-144 m and minimum operating levels between 114-120 m with resultant Flood Control Storage between 212 and 128 million m³.

88. In considering the various options, emphasis was given to the reservoir's impact on surrounding settlements, and to flood control and protection of settlements in the downstream areas. The proposed full supply level of elevation 142 m was selected after confirmation that the town of Siqian would not be inundated in a 20 year flood. The minimum operating level of elevation 117 m was selected to provide sufficient live storage to allow for effective future regulation of river flows.

89. The height of the Zhaoshandu dam was determined by hydraulic requirements for gravity flow in the conveyance system. Topographic and geological conditions at the site and operational constraints are such that no major alternatives are possible.

90. Three design flows (36, 39, and 42 m³/s) were considered for the conveyance system. A flow of 36 m³/s was selected in consideration of capital cost and security of supply.

91. Consideration of alternative alignments for transmission lines primarily involved selection criteria rather than alternative alignments *per se*. These criteria included (i) least cost, (ii) avoidance of settlements and protected areas, and (iii) ease of access for construction and maintenance. Further consideration of adjustments to the provisional alignment will be made during detailed design.

F. Cost Benefit Analysis

92. The estimated total cost of the Zhejiang-Shanxi Water Conservancy Project is \$523.7 million equivalent, as shown in Table 2.

Table 2: Project Cost Summary
(\$ million)

Item	Foreign Exchange	Local Currency	Total Cost
A. Base Costs			
1. Equipment and Materials	67.3	34.8	102.1
2. Civil Works	0.0	139.2	139.2
3. Resettlement	16.6	100.9	117.5
4. Survey, Design, Consulting	4.1	22.5	26.6
5. Taxes and Duties	0.0	25.8	25.8
6. Miscellaneous	0.0	4.2	4.2
Subtotal (A)	88.0	327.4	415.4
B. Contingencies			
1. Physical	5.6	30.4	36.0
2. Price	4.3	44.2	48.5
Subtotal (B)	9.9	74.6	84.5
C. Interest & Other Charges During Construction	16.9	6.9	23.8
Total	114.8	408.9	523.7

93. The Project budget includes costs associated with environmental mitigation (\$1.506 million equivalent), as described in the EIA report, and resettlement (\$129 million equivalent), as described in the Summary of the Resettlement Action Plan (SRAP). The detailed estimated environmental mitigation costs are as shown in Table 3. Detailed resettlement costs are provided in the resettlement plan.

Table 3: Detailed Estimated Cost of Environmental Mitigation Measures

Item	Amount	
	Y (,000)	\$
A. Shanxi Dam		
1. Pollution Treatment During Construction	660	79,518
2. Tree Planting Within Construction Area	604	72,771
3. Env. Monitoring During Construction	196	23,614
4. Env. Supervision During Construction	361	43,494
5. Env. Monitoring for Resettlement	1,082	130,361
6. Water & Soil Conservation	319	38,433
7. Facilities for Monitoring Agency	99	11,927
8. Training & Expenses for Personnel	174	20,963
9. Equipment for Monitoring	539	64,939
10. Studies	232	27,951
11. Art Deco for Project Area	309	37,228
12. Tree Planting Within Project Area	721	86,867
Subtotal (A)	5,296	638,066
B. Zhaoshandu Dam		
1. Debris Monitoring	124	14,939
2. Ecological Recovery & Afforestation	247	29,759
3. Water Quality Monitoring	21	2,530
4. Dust Monitoring	10	1,204
5. Noise Monitoring	5	602
6. Monitoring Apparatus & Equipment	103	12,409
7. Technical Personnel Training	5	602
Subtotal (B)	515	62,045
C. Water Conveyance System		
1. Debris Treatment	1,750	210,843
2. Ecological Recovery & Afforestation	2,146	258,554
3. Water Quality Monitoring	51	6,144
4. Dust Monitoring	36	4,337
5. Noise Monitoring	10	1,204
6. Monitoring Apparatus & Equipment	463	55,783
7. Technical Personnel Training	21	2,530
8. Environmental Research	154	18,554
9. Estuarine Sediment Supervision & Research	1,544	186,024
10. Water Resource Protection Rule, Research & Control	515	62,048
Subtotal (C)	6,690	806,021
Total	Y12,501	\$1,506,132

94. The Project's expected financial internal rate of return is 8.6 percent, and the economic internal rate of return is 16.3 percent. The main benefits arising from the Shanxi Water Conservancy project comprise domestic and industrial water supply, power generation, flood alleviation, and irrigation.

G. Institutional Requirement and Environmental Monitoring Program

95. Environmental protection and monitoring functions will be managed by two related agencies especially established for the Project. The LTEP under the direction of the Shanxi Water Conservancy Project Management Bureau, will be located in Wenzhou and will consist of 3-5 staff. This office will be established as soon as the Project is approved. The LTEP director will be responsible to the directors of the Zhejiang Water Conservancy Project Management Bureau. It is expected that some experienced staff of the Wenzhou Prefecture Environmental Protection Bureau will be given special responsibilities with regard to the Project (along with other existing duties), and will be part of the LTEP team.

96. An Environmental Monitoring Office (EMO) and laboratory will be located at the construction site, at either Shanxi or Zhaoshandu, and will function throughout the operational phase. The EMO will consist of eight staff and will be established as soon as construction begins. The EMO chief will be responsible to the director of LTEP in Wenzhou, but for any emergency activities in the construction phase will consult directly with the resident chief engineers at Shanxi and Zhaoshandu.

97. There are existing agencies with environmental responsibilities in the counties comprising the Project's water source, water distribution, and resettlement areas, and also at the city and provincial levels. LTEP and the EMO will liaise with these agencies so that monitoring and management are coordinated. The combined number of LTEP and EMO staff is considered to be sufficient in view of the existing strength of the Wenzhou Prefecture Environmental Protection Bureau (234 staff, 8 laboratories, and 7 vehicles), and the need to avoid duplication. The main tasks of LTEP will be to (i) prepare annual programs of environmental monitoring and scientific studies, and a long-term environmental protection program; (ii) prepare and control an annual environmental monitoring and protection program; (iii) address major problems of environmental monitoring and protection; (iv) guide and inspect implementation of the monitoring program; (v) execute the laws and regulations for environmental protection issued by national and local governments and relevant departments; (vi) prepare regulations for protecting water resources; (vii) liaise with other environmental agencies; and (viii) make arrangements with the Zhejiang Provincial Institute of Estuarine and Coastal Engineering Research for specialized surveys and research in relation to water quality and pollution and estuary siltation.

98. The EMO will be directly responsible for monitoring Project construction impacts during the five-year construction period, and operational impacts following impoundment and first delivery of water supplies. During construction, EMO duties will include ensuring that contractors abide by regulations in respect of transport, storage, and use of flammable materials and explosives; noise and dust; waste disposal; road construction; reservoir clearance; and salvage of cultural relics. In addition, the EMO will monitor the impacts of resettlement sites, liaise with county health departments concerning health monitoring of the workforce and of the host and resettlement populations and liaise with the wildlife management units of the Forestry Bureau.

99. In the operational phase, EMO responsibilities will include public liaison (responding to unforeseen environmental problems, and promotion of public awareness of the project and of environmental issues); monitoring new infrastructure and resettlement impacts; liaison with county health departments concerning health monitoring of host and resettlement populations; monitoring public safety and warning devices downstream of the Shanxi and Zhaoshandu tailrace discharges; monitoring reservoir bank stability in suspect areas; monitoring

reservoir water quality; and liaison with county/city environmental monitoring stations concerning water quality monitoring of the coastal plain's river network. Other duties will include monitoring meteorology, sedimentation, and backwaters; ensuring that vegetation on reclaimed spoil heaps is maintained; and checking that areas are replanted where necessary.

100. Most staff of LTEP and the EMO are expected to be experienced personnel, already trained in environmental protection policies, monitoring, and mitigation. LTEP and EMO staff will be recruited or seconded from the Wenzhou Prefecture Environmental Protection Bureau or its environmental monitoring stations, or recruited from elsewhere. Use may be made of training courses provided by the Zhejiang Provincial Environment Protection Bureau, which include refresher courses.

101. During Project construction and operation, annual environmental reports will be produced by LTEP/EMO. These will include progress made on mitigation measures and monitoring, problems encountered, data collated, and any research results. These annual reports will be distributed to the Wenzhou Prefecture Environmental Protection Bureau and the environmental monitoring stations in Taishun, Wencheng, Ruian, and Pingyang counties and in Wenzhou city's three districts. The annual reports will also be distributed to other agencies, including the Bank.

H. Public Participation

102. The principal direct public involvement in the Project has been related to surveys of land and households in the inundated and host areas in preparation for the resettlement plan. During the course of resettlement planning, close cooperation has been maintained between the People's Government of Wenzhou City, SEDC, and local government in the affected areas, including local villages committees.

103. In 1994, the Project designers, East China Investigation and Design Institute, carried out an overall survey of the inundation area and an investigation of inundation losses with support and cooperation from the authorities in Ruian City, Wencheng County, and Taishun County. The survey included land and buildings, and marking of the planned reservoir level by colorful banners. The survey was carried out village by village and household by household. The survey team, together with cadres from the respective counties, townships, and villages, investigated on the spot the subsistence and production conditions of the population. Sample surveys were carried out among the potentially displaced population to assess holdings of fruit trees and ancillary houses. The group also investigated conditions within households of the "Five Guarantees" (childless and infirm old persons). Informal meetings were held at relocation sites and in inundation areas. Full details of the survey are presented in the Inhabitant Resettlement Planning Report, August 1996.

104. Guoxi county in Ou Hai Area was taken as a trial county for the resettlement program. The leaders of the Party Committee and the People's Government in the county and the County People's Congress have paid close attention to the trial. They set up the Leading Group for the Resettlement Program in Guoxi County, gathered leaders from all counties and villages, and determined the cooperative work for the resettlement program. About 30 representatives from the County People's Congress and 150 villager leaders participated in the planning work. Thousands of villagers were visited, and about 2,600 villagers indicated that they are willing to change their resident registration and have a town residence instead of the land usage right, thus releasing 2,400 ha of land for resettlers, and they welcome resettled inhabitants into the area.

105. In September 1996, a field survey was undertaken of 300 households in 20 villages. The villages selected are located within the areas to be resettled at an early stage of Project construction. This will be followed in early 1997 with surveys of the remaining areas. Questionnaires have been prepared for use in the survey and training given to interviewers. Further surveys are planned during 1997 covering 8 percent of households of the displaced population in order to determine their opinions and preferences, and to obtain further baseline data for use in the finalization of the resettlement plan and in the monitoring and evaluation of the resettlement program. In addition, the Bank's ERAB, resettlement staff consultants, project preparatory technical assistance consultants, and missions made numerous site visits and interviews for social assessments.

106. To determine the concerns of other stakeholders, a number of organizations were approached for information and advice. These included Wetlands International, World Conservation Union, Zhejiang Provincial Institute for Estuarine and Coastal Engineering Research, Fisheries Department of Ningbo University, Beijing Freshwater Aquaculture Research Institute, Institute of Zoology of the Chinese Academy of Sciences, Institute of Environmental Studies of Beijing Normal University, and Biology Department of Hangzhou University.

I. Conclusions

107. The Project will reliably meet the rapidly increasing water supply demands of Wenzhou Ruian, and Pingyang cities and other peripheral coastal areas for at least 25 years, directly benefiting 3 million people. It will solve existing problems of water shortages of public water supply, industry, and irrigation, and thereby improve conditions for attracting investment and stimulating the economy, including the creation of job opportunities. Project water supplies to the river network for irrigation will also improve water quality in the network, potentially raising existing water quality classifications by at least one grade. The Project will contribute to flood control of settlements and agricultural land along the Feiyunjiang River, directly benefiting 250,000 people. The project will also provide power for meeting future electricity demands. Road improvements to the highway from Ruian to Shanxi, necessary for Project construction, will have a wider benefit for Wencheng and Taishun counties. Project construction over five years will provide employment for over 10,000 workers, stimulating the local economy.

108. The Project's greatest adverse environmental impact involves resettlement of approximately 37,000 people. Comprehensive resettlement procedures have been prepared that conform with the Bank's policy on involuntary resettlement, as detailed in the SRAP.

109. The proposed environmental measures included in the Project costs are considered appropriate and will adequately mitigate adverse impacts. Although the sweetfish population in the Feiyun river is low at best, and perhaps absent, support will be provided for preparation of a breeding program. LTEP has been established, and will direct the work of an Environmental Monitoring Station, based at Shanxi or Zhaoshandu. The LTEP and WMO will coordinate and carry out environmental protection measures and monitoring in the Project construction and operational areas.

110. Given that adverse impacts can be adequately mitigated, and considering the Project's strong socioeconomic justification, the Project is justifiable on environmental grounds provided there is implementation of the recommended mitigation and monitoring programs.