Summary Environmental Impact Assessment of the Yunnan Dachaoshan Power Transmission Project in the People's Republic of China

Appendix 6

CURRENCY EQUIVALENTS
(as of 1 July 1998)

Currency Unit	=	Yuan (Y)
Y1.00	=	$0.1203
$1.00	=	Y8.3100

ABBREVIATIONS

ANR	-	Ailao Nature Reserve
BERI	-	Beijing Economic Research Institute
DHP	-	Dachaoshan Hydropower Plant
EIA	-	environmental impact assessment
EMO	-	Environmental Management Organization
GDP	-	gross domestic product
kV	-	kilovolt
MW	-	megawatt
NO_x	-	nitrogen oxides
PRC	-	People's Republic of China
SO_2	-	sulfur dioxide
SWEPDI	-	Southwest Electric Power Design Institute
TSP	-	total suspended particulates
YPDC	-	Yunnan Power Dispatch Center
YPEPC	-	Yunnan Provincial Electric Power Corporation

NOTES

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

I. Introduction

The Government of the People's Republic of China (PRC) has requested the Bank to provide loan assistance for the Yunnan Dachaoshan Power Transmission Project. This summary environmental impact assessment (SEIA) for the Project has been prepared to meet the requirements of the Bank. It is based on the Project EIA, the Project Resettlement Action Plan, a subsequent environmental assessment of the 220 kV and 110 kV transmission lines requested by the Bank, and related reports.

The EIA was commissioned in early 1996, and its results were approved by the Government in July 1997. The EIA was prepared by the Southwest Electric Power Design Institute (SWEPDI) with contributions from the Biology Institute of Yunnan University, the Yunnan Provincial Environmental Monitoring Central Station, and the Environmental Protection Office of the Yunnan Provincial Electric Power Corporation (YPEPC).

The Project will be connected to the partly constructed Dachaoshan hydropower plant (DHP). Although the DHP is not receiving assistance under the Project, its operations are intrinsically linked to Project construction and operation. Therefore, an evaluation of the DHP's proposed environmental and social impact mitigation measures was done as part of the Project preparation, and the findings are presented in this SEIA.

II. Description of the Project

The Project will be undertaken in Yunnan Province in southwestern PRC (Map 1). One of the Bank's strategic objectives in the PRC is to promote economic growth and thereby reduce poverty in the interior provinces. The Government's program to alleviate poverty depends partly on improving the infrastructure in rural areas and particularly in poverty counties.[7] Yunnan is a poor interior province with about 4.7 million people

[7] *"Poverty counties" are so designated for having per capita income below the standard set by the Central Government, from which they receive financial assistance for poverty reduction measures.*

Map
Yunnan Dachaoshan Power Transmission Project

living below the poverty line out of a total population of 40.9 million, and 73 of its 128 counties are designated as poverty counties. Nonetheless, the provincial gross domestic product (GDP) grew at an average of 11.5 percent annually during the past ten years, and it is forecast to grow at an average of 8.3 percent annually during the next five years. This rapid economic growth is creating demand for additional infrastructure, including the supply of electricity.

However, social and environmental issues related to infrastructure development need addressing in parallel to ensure sustainable economic growth. Kunming's air pollution levels are among the highest of major PRC cities. Among the more environmentally acceptable alternatives for meeting the growing demand for electricity would be to transmit hydropower to Kunming while also addressing demand-side efficiency issues. This would enable the closing of some old, polluting, coal-fired power plants and avoid the need to construct a new plant, thus improving air quality. The Project will help Yunnan Province to meet the demand for electricity in a way that does not cause further deterioration of air quality.

The specific Project objective is to promote sustainable economic growth in Yunnan Province. This will be achieved by (i) supporting sector and enterprise reforms in the power sector of Yunnan Province, (ii) augmenting power transmission capacity by establishing additional 500 kV transmission facilities, (iii) providing related 110 kV and 220 kV transmission facilities, (iv) modernizing the load dispatch and communications systems, (v) connecting about 115,000 people in rural parts of the Project area to the electricity grid, and (vi) closing three old and inefficient coal-fired power plants.

The Project will have the following components:

(i) Two parallel single-circuit 500 kV transmission lines of about 260 kilometers [km] each from DHP in western Yunnan Province to Baofeng substations southwest of Kunming, and one single-circuit, 59-km long 500 kV transmission line from Baofeng substation to Chaopu substation west of Kunming.

(ii) One new 500 kV substation at Baofeng, and expansion of the existing 500 kV Chaopu substation.[8]

(iii) Two single-circuit 220 kV transmission lines south of Kunming connecting Jin Cheng with Baofeng (25 km) and Maan Shan (20 km), and Chen Xi with Puji (14 km).

(iv) Two new 220/110 kV substations at Jin Cheng and Cheng Xi.

(v) Three twin-circuit 110 kV cables within Kunming (underground) for a total of 12 km.

(vi) Three new 110/10 kV substations at Pan Jia Wan, Cha Jie, and Xi Ba.

(vii) Three communication systems linking Baofeng with the Yunnan Power Dispatch Center (YPDC) in Kunming, DHP and other power plants and substations in southern Yunnan with the YPDC, and DHP with the Baofeng and Chaopu substations.

(viii) New load dispatch and high-voltage metering equipment for the YPDC.

(ix) Closure of three old and inefficient coal-fired power generating plants at Xuanwei (200 megawatts [MW]), Kaiyuan (70 MW), and Penshuidong (12 MW).

(x) About 1,675 km of rural electrification lines at 35 kV and 5,560 km at 10 kV, and associated substations.

(xi) Software and hardware to improve the YPEPC's financial management systems.

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[8] *The Chaopu 500 kV substation serves the two single-circuit 500 kV transmission lines evacuating power from the existing Manwan hydropower plant.*

(xii) Consulting services for Project implementation supervision.

The Project is expected to be completed in December 2002. The total Project cost is estimated at $315.8 million equivalent, of which the Bank will provide 33 percent. The remaining Project costs will be financed by the State Development Bank; YPEPC; the Yunnan Provincial Water Conservation and Hydropower Bureau; and by the central, provincial, and local governments.

The 1,350 MW DHP was developed as an independent project by the Beijing Hydroelectric Investigation and Design Institute. Construction began in 1991, and DHP is expected to start producing energy in 2001. Construction will be finished in 2003. The DHP will be the second dam on the Lancang (Mekong) River. It is located 90 km downstream of the Manwan dam, which started operation in 1993 and has been recently completed. The reservoir that will form behind the 118-meter-high DHP dam will have a surface of only 26.3 square km (km^2); it is about 90 km long, but very narrow due to the topography of the area. Reservoir capacity is very small in comparison with the annual flow of the river. Total storage is 2 percent of annual flow, and live storage is only 0.9 percent.

III. Description of the Environment

The climate in the Project area is tropical to subtropical monsoon with hot summers and generally mild winters. Annual precipitation is in the range of 900 to 1,200 millimeters. There is a distinct dry season from October to April (winter) and a wet season from May to September (summer). Frost and occasional snowfall occurs at the highest elevations. The area under the transmission line corridors is seismically rather stable. However, there are several faults in the area that, combined with erodable metamorphic and volcanic soil formations, lead to occasional landslides.

The Project area between Dachaoshan and Baofeng is predominantly mountainous and characterized by parallel, north-south running mountain chains and rivers. The direction of the transmission corridors is west-east, crossing several mountain ranges and rivers. Maximum elevation range

from 1,500 meters [m] to 2,800 m above mean sea level, and the highest point reached by the transmission line corridors is 2,600 m above mean sea level.

The Project area has been inhabited and intensively used for generations. Consequently, only relict evergreen and semideciduous broad-leaved forests remain. Less than 7 percent of vegetation within the transmission line corridors and adjacent land is natural forest. The area has been extensively planted, primarily with commercial species of pine (e.g., *Pinus yunnanensis* and *P. armandi*) and agricultural trees such as tea and mulberry. The pine forests generally present a low density of trees with little or no undergrowth.

The most important natural forests are those in the Wuliang and Ailao mountain ranges. Both of these forests have been declared nature reserves. The transmission line corridors have been realigned to avoid Wuliang Nature Reserve, but the transmission line will pass through Ailao Nature Reserve (ANR). ANR protects a narrow band of forest, 3.5 to 10 km wide and 110 km long, running in a north-northwest to south-southeast direction. The total area is 500 km^2 of which about 71 percent is forested. The transmission line crosses ANR at its narrowest point, where it is estimated that half of the land is covered by secondary forest and bamboo.

ANR is important for the conservation of the relict evergreen and semideciduous forests remaining in this part of Yunnan Province. Two tree species found in ANR have protected status in the PRC—*Tetracentra sinense* and *Manglietia insignis*. ANR also is important for wildlife conservation. Biodiversity studies have recorded 96 bird species, 23 mammal species, and numerous amphibian and reptile species. Included in this number are eight mammal and eight bird species having special protected status in the PRC. The most important from an international conservation perspective is the endangered black gibbon (*Hylobates concolor*). The black gibbon is found in small numbers in Yunnan Province, Lao PDR, and Viet Nam. The total population in ANR has been estimated at 50, while the population in Wuliang Nature Reserve (which will not be affected directly or indirectly by the Project) has been estimated at 2,000. Of most concern among bird species is the green peafowl (*Pavo muticus imperator*), which is an internationally vulnerable species.

The seven counties in the Project area have a total population of about 1.75 million. The population density varies from the sparsely settled Shuangbai County at 37 persons per km^2, to the urban counties of Anning and Jinning at 190 persons and 202 persons per km^2, respectively. However, the population density at the township level, where the transmission line corridors actually pass, tends to be lower: between 25 and 80 persons per km^2, reflecting the rural character of the Project area. Overall, about one third of the population is composed of ethnic minorities. The Yi are predominant, and there are significant communities of Hani, Hui, Dai, and Bai.

The per capita GDP of Yunnan Province was Y3,715 in 1996, 33 percent lower than the national average of Y5,518. Similarly, the rural income per capita was about 34 percent lower than the national average. In 1997, about 12 percent of the provincial population were under the official poverty line.[9]

In the seven Project counties, the labor force is predominantly engaged in agriculture. With the exception of Anning County, about 80-95 percent of the population are farmers. Main subsistence crops are rice, wheat, and beans. Main cash crops are tobacco, sugar cane, oil seed, and fruits. Agro-industrial activities include the processing of grains, fruits, nuts, tea, coffee, and sugar; the manufacturing of food products based on these crops, such as bread, noodles, and beverages; and tobacco curing. Forests of primarily pine trees have a good commercial value and are exploited by individuals and township and county enterprises. In the eastern counties, higher proportions of the labor force are employed in township and county enterprises, as well as in a growing service sector.

In the mountainous regions, the high potential of streams and rivers has been exploited through the development of many small hydropower stations of about 1-2 MW each. However, the electricity produced by these schemes is not reliable, particularly in the dry season. In the western sections of the province, wood is the primary fuel for cooking, heating, and other energy needs.

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[9] *The poverty line in the PRC is defined to reflect a subsistence level of living. It is equivalent to about $0.76 per day, considerably below the poverty line of $1.00 a day commonly used internationally.*

The available data for the seven counties indicate highly variable levels of education and literacy, with the level of education generally higher in the eastern counties. The literacy rate is generally much lower than the provincial average. In general, medical clinics and services are available in the administrative towns through the Project area.

The two counties that share the DHP project area among them are rather mountainous. There is only a small amount of natural vegetation of subtropical evergreen and semideciduous broad-leaved forest remaining in the area. The largest parts of the area are covered in pine forest plantations (44 percent) and agricultural land (34 percent). Due to the restricted habitat and high hunting pressure, populations of major wildlife species are either small or absent. Twenty-nine species of fish are reported in the area around the dam, but are mainly of low or no economic value.

These two counties are among the poorest in Yunnan Province. The total population is about 791,000 (1996 census). Both counties have a high proportion of ethnic minorities, as does the area around the DHP reservoir.

IV. Anticipated Environmental Impacts and Mitigation Measures

The anticipated environmental impacts of the Project are those usually associated with extra high-voltage transmission lines. The study area for the transmission line was defined as a corridor 200 m wide. Within ANR, this corridor was widened to 1 km.

A. Climate, Air, and Water Quality

Climatic conditions, especially wind and the risk of frost in the higher elevations, will have some impact on the transmission lines. Appropriate design measures have been included in the Project to minimize climate-induced disruptions. Limited air contamination will be caused by vehicles and dust during construction. No specific mitigation measures are required except to maintain vehicles in proper running

order, to cover trucks carrying excavation material, and to water the road at a few sites to prevent dust.

B. Ambient Noise Levels

Most construction and operation activities are not expected to create significant noise problems due to the low level of human habitation in the vicinity of the transmission line and the Baofeng substation, where the nearest houses are several hundred meters away and protected by a ridge. The exceptions are the 220 kV and 110 kV lines and substations located in or near Kunming. To minimize noise nuisances, construction activities that create significant levels of noise and vibration will be limited to daylight hours. Mufflers and other noise reduction devices will be used and maintained. Noise generated during operation of the substations will be mitigated by providing walls composed of sound insulation material and by installing low-noise fans. The noise levels at 1 m distance from the 110 kV and 220 kV substations will be less than 50 decibels, which will meet standards for noise at the boundary of industrial enterprises.

C. Soils and Waterways

The transmission line and the Baofeng substation have been designed to take into account seismic conditions prevalent in the Project area. The local geological conditions, especially the risk of unstable slopes, have been taken into account during site selection. Where possible, the design places transmission towers on top of hills, thereby minimizing the risk of land slippage. Work areas around the towers will be leveled after construction for easy vegetation recovery. Transmission lines will be strung from hill to hill, keeping the need for access roads and associated erosion risks minimal. Where access roads are required, due consideration will be given to siting the roads away from erosion-prone land and following contours. Excavation and spoil disposal will be a consideration primarily at the Baofeng substation, for which appropriate spoil sites have been identified. Land not required by the substations but disturbed during construction will be rehabilitated.

Rivers will be crossed with long spans. There will be no towers or construction sites in or immediately adjacent to rivers. Wastewater generated by the Baofeng substation and the smaller substations during construction and operation will be treated before it is released. Septic tanks will be used to treat domestic wastewater (8 cubic meters [m^3] per day at Baofeng), and oil-contaminated water will be sent through a special oil-water separating tank before discharge. Oil confinement basins will be constructed at all oil-containing structures.

Sufficient ground water of good quality is present in the area of the Baofeng substation. The smaller substations will rely on Kunming's domestic water supply. Sedimentation ponds for substations will be established at construction sites. Oil containment structures for emergency spillage will be established during construction. Oil-water separators will be provided and good practices will be followed in terms of vehicle maintenance and other oil-related activities.

D. Health and Safety

A recent evaluation by the Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems, convened by the National Research Council of the United States, failed to find conclusive and consistent evidence showing that exposure to residential electric and magnetic fields produces cancer, adverse neurobehavioral effects, or reproductive and development effects.[10] Nonetheless, PRC national standards dictate a maximum allowable field intensity of 5 kV/m for living quarters, with exposure to higher fields allowed for lesser periods. These standards will be followed under the Project.

Fields of less than 5 kV/m will be maintained outside all substations. Inside the Baofeng substation, field intensity less than 5 kV/m will be maintained in about 50 percent of the area and less than 8 kV/m within about 95 percent of the area. Field intensity may reach more than 10 kV/

[10] *Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems, et al., 1996, Possible Health Effects of Exposure to Residential Electric and Magnetic Fields, Washington, D.C.: National Academy Press.*

m within less than 1 percent of the area. Working hours will be adjusted for staff so that their presence in areas of electric fields greater than 5 kV/m are minimized. During the selection of the transmission line corridors, special attention was given to avoiding schools, hospitals, and densely populated residential areas. Residences will not be allowed under the 500 kV lines, because fields there exceed 5 kV/m. Some houses will need to be moved, for which owners will be entitled to full compensation. The audible corona noise level will be monitored and any noise nuisance detected will be corrected. The other major health and safety concern related to the Project is the possibility of fires or explosions in the substations. This will be mitigated through the preparation of a clearly defined safety and emergency procedures manual, with training provided to substation staff. Fire extinguishers and other emergency equipment will be provided and maintained at each substation. Regarding Polychlorinated Biphenyl (PCB), these are no longer used in PRC, and will not be used in this Project.

E. Flora and Fauna

Less than 7 percent of the land within and adjacent to the transmission line corridors is under natural forest (Map 2). Because towers generally will be located on hilltops, and the conductors strung over the intervening valleys, the loss of vegetation will be much less than with similar projects. About 27,000 m^3 of wood will be lost, nearly all of which will be plantation forest for which compensation will be provided to the owners.

Much of land that is under natural forest is located in ANR, which is the only area of major concern. Because ANR stretches for 110 km perpendicular to the DHP-Kunming 500 kV transmission line, rerouting the transmission line corridors was not a feasible option for economic reasons. There will be 16 towers placed within ANR. Measures for tower construction have been carefully considered to minimize the potential impacts to insignificant levels. With these measures in place, permanent loss of trees within ANR is expected to be less than 0.5 hectares (ha). The measures include the following:

Map
Vegetation Distribution Along the 500kV Transmission Line

(i) The transmission line will pass through the narrowest part of ANR (3.5 km), where it is estimated that half of the land is covered by secondary forest and bamboo.

(ii) Access road development and use of heavy equipment will be strictly prohibited inside ANR; material for construction will be carried by hand. (A path already exists along a stream through the ANR and is used by the local population to cross from one side of the mountain to the other.)

(iii) Towers will be sited on hilltops, and 40 m high towers will be used when necessary to maintain a conductor clearance of at least 7 m over all but the tallest trees.

(iv) Tower design has been modified to minimize the tower "foot-print" under which all vegetation must be cleared.

(v) ANR staff will be intensively involved in supervising and monitoring construction activities.

(vi) Rare plant species that may be found within the corridors will be registered, labeled, and protected.

(vii) The amount of time that work crews are in the forest will be minimized, and all laborers will be required to retire outside the forest at the end of each day, bringing any waste material with them; work crews will be kept to a maximum of about 15 persons at any one site.

Similarly, strict precautions will be taken to minimize impacts on wildlife within ANR. Construction will not be allowed during May and June, which is the prime mating season for black gibbons. Workers will not be allowed to possess implements that could be used to hunt or trap wildlife, and any worker found with wildlife will be dismissed and prosecuted under PRC law. No significant threats to wildlife are expected during Project

operation, but ANR staff will continue to monitor the transmission line corridors as part of their normal duties, and report any unexpected problems to YPEPC if they arise. Outside of ANR, no reports of major bird strikes are known from the 500 kV transmission line connected to the Manwan power plant. However, this situation will be monitored during the first two years of operation, and bird avoidance devices will be attached to the conductors in areas where bird strikes are found, if any.

F. Resettlement and Compensation

The Project will require land acquisition and resettlement. For the Project, two land acquisition and resettlement plans have been prepared,[11] and are in accordance with the Bank's policy on involuntary resettlement. Permanent land acquisition for tower footings and substation sites totals 41 ha. In addition, there will be temporary land acquisition of at least 40 ha. After construction, land within the transmission line corridors and beneath tower footings can be used again for farming.

About 146 houses and associated structures will be moved from the transmission line corridors, displacing about 657 people. An additional 212 people will be affected by the loss of land required for the transmission facilities. Small plots of land at 43 sites, each of up to 45 x 45 m, will also have to be acquired permanently for 35 kV substations in the rural electrification program.

Design measures to minimize resettlement have included (i) careful location of foundation pylons; (ii) the choice of a v-shaped isolator arrangement, which allows for narrowing the distance between the outer conductors from 28 to 22 m; and (iii) avoidance of villages, schools, hospitals, and residences to the extent possible during the first layout of the transmission line corridor. For people whose resettlement cannot be avoided, compensation will be designed to ensure equal or better future livelihoods and living standards. The resettlement strategy is twofold. First, people losing

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[11] *SWEPDI prepared the Land Acquisition and Resettlement Plan for the 500 kV Dachaoshan to Baofeng transmission line component. The Kunming Electric Power Supply Bureau prepared a similar plan for the 110 kV and 220 kV Project components.*

housing will receive either direct compensation or assistance to build a new house, a replacement house site, and transfer costs. Second, most people losing farmland will receive land nearby through adjustment of the village land use contracts, and supplementary agricultural intensification.

People within the Project area that belong to ethnic minorities will be little affected by the Project, and those that will be affected will be on a family-by-family basis rather than as a community. It was not deemed necessary, therefore, to prepare an indigenous people's plan.

G. Other Potential Impacts and Mitigation

The Project will involve the closure of three old and inefficient coal-fired thermal power plants in Xuanwei, Kaiyuan, and Penshuidong with a total generating capacity of 282 MW. The Government will prepare a closure management plan covering the rehabilitation of sites, reassignment of workers, and the incorporation of environmental and social considerations that will be submitted to the Bank for review.

Radio interference of the substations at a distance of 20 km will be between 20 and 40 decibels, well below the allowable 50 decibels. The 100 kV lines will be placed underground along or near sidewalks, causing some inconvenience to local residents and disruption of traffic. These impacts will be mitigated by keeping construction activities within a defined corridor, limiting heavy construction to daylight hours, and making provisions for redirecting traffic. No significant disruptions related to other public utilities are expected. Potential forest fire hazards will be minimized by regular trimming of trees where necessary. Expansion of the existing 500 kV Chaopu Substation will be confirmed within the existing substation premises.

The Project includes a microwave communications system between Dachaoshan and Kunming extending over 600 km via 16 intermediate stations in southern Yunnan Province. Five intermediate stations will share the same building and antenna facilities of existing telecommunication stations. Of the remaining 11 stations, five will be constructed at mountain tops for which new antenna structure, small access roads (totaling 13 km), power supply at 10 kV (totaling 16 km), and buildings will be required. Six

stations will be constructed at or near population centers. The stations will be small, covering about 800 m^2 for the compound containing the station building. Tower footing will be 12 x 12 m for the highest tower (30 m). The impacts will be limited. The locations of these new facilities have not yet been precisely identified, but they will be located and constructed under the same environmental and social criteria as for the 500 kV transmission line component, e.g., compensation will be provided for lost assets, and natural forests will be avoided.

Impacts from the installations of rural electrification lines will be minor, as the lines will follow existing roads and substations are small (up to 40 x 40 m). No significant loss of private assets or vegetation is expected. Measures to mitigate dust, noise, and other minor impacts will be as stated for the 500 kV transmission line component. Because the precise locations of the associated small substations have not been identified, a supplementary environmental assessment (to also include the communication stations) will be undertaken once the locations have been identified, and the report submitted to the Bank for review before construction. The Project costs include the provision for expected compensation and mitigation measures. Contingency has been included in the Project costs to cover any unforeseen compensation and mitigation requirements.

H. Hydropower Plant Impacts and Mitigation

The impacts of water regulation are a primary concern related to any hydropower project. In the case of the DHP, the design is run-of-river, thereby minimizing downstream impacts. The reservoir capacity is very small in comparison with the annual flow of the river: total storage is 2 percent of annual flow, and live storage is only 0.9 percent. Therefore, the reservoir has only a small seasonal storage capacity and a low flood regulation capacity, limiting impacts to a relatively small area within the vicinity of the DHP project site.

The DHP EIA was reviewed by Bank-financed consultants. Their overall conclusion was that all the main environmental aspects had been taken into consideration, that the main impacts have been correctly identified, and that with a few exceptions, the appropriate mitigation measures

have been formulated. They could identify no impacts caused by the DHP that would make it unacceptable from an environmental perspective, including impacts on migrating fish, which are already impeded by the Manwan dam 90 km upstream.

Regarding the exceptions noted by the consultants, the Bank has been assured that: (i) biomass clearance will be done in the inundation area, thereby preventing the potential for water quality problems; (ii) the dam design will include a bottom outlet for sediment flushing (a special environmental monitoring station will be established to monitor downstream impacts, based on which a sediment flushing schedule will be prepared and implemented); and (iii) Provincial Order No. 43 (1997), which requires that 200 ha of natural forest lost to the DHP project be compensated through reforestation of other sites, will be adhered to.

The DHP will affect 38 administrative villages.[12] People designated for relocation include about 84 individuals losing houses, 5,005 losing productive land, and 440 threatened by slope instability. The bulk of resettlement will take place in 2000. The consultants' review of resettlement arrangements noted that a new Resettlement Action Plan was prepared in 1993, which improved the resolution of compensation and resettlement issues considerably. However, they identified potential problems related to notification of project-affected people concerning precisely how they will be affected by the project, and the lack of detailed household surveys. They also noted contradictory information concerning ethnic minority groups. Although these problems are important, they are not of such magnitude as to place in question the overall integrity of the proposed compensation and resettlement process. They do require immediate remedial measures, however. Therefore, the Government has received short-term assistance from the Bank[13] for purposes of gathering this information, integrating it into the overall Resettlement Action Plan, providing advice on any other minor

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[12] *The Beijing Hydropower Investigation and Design Institute prepared a Land Acquisition and Resettlement Plan for the Dachaoshan Hydropower Project.*

[13] *An internationally recruited staff consultant will assist YPEPC and Yunnan Provincial Resettlement Office to do this work from 8 July 1998 to 12 August 1998 (5 weeks) in Yunnan.*

modifications that may be required in the Plan, and ensuring that the Bank's Policy on Indigenous Peoples is met.

V. Alternatives

Based on the demand forecast, YPEPC, with assistance from Beijing Economic Research Institute (BERI) carried out least-cost generation expansion planning by using a special model developed by BERI.[14] Two alternatives for the Dachaoshan transmission line were feasible in addition to the preferred option as described in Section II. The first alternative involves sharing the existing transmission lines from the Manwan hydropower plant (70 km north of Dachaoshan) to Kunming, and requires the addition of only one single-circuit 500 kV line from Dachaoshan to Kunming and a single-circuit 500 kV line connecting Dachaoshan to Manwan. Although this alternative is $37 million less costly than the preferred alternative, YPEPC did not propose it for Bank financing since it is less secure and reliable. A preliminary economic comparison of the two alternatives quantified the reliability aspects and concluded that the preferred alternative is superior if unserved electricity due to forced power outages is valued in terms of losses to the economy. Although there would be fewer environmental and social impacts by constructing one single-circuit line instead of two, the magnitude of impacts avoided was not considered to be significant in relation to the economic gains derived from two circuits combined with the costs of mitigation measures for the second line factored in.

The second alternative would involve construction of a 1,200 MW coal-fired power generation plant and a 200 MW diesel-fired gas turbine in the Kunming area. This alternative was less acceptable on environmental grounds due to the resulting increase in ambient levels of total suspended particulates (TSP), sulfur dioxide (SO_2), and nitrogen oxides (NO_x), and

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[14] *GESP II is a multiregional power generation expansion planning. It minimizes the objective function (the present value of system costs) to meet power demand under predetermined reliability criteria. It was developed by BERI and has been used in many Bank and World Bank power projects.*

other environmental impacts associated with the mining, transporting, handling, and storing of coal.

Four possible transmission line corridors were studied, including:

(i) the central corridor, which is the preferred option;

(ii) the north corridor, which is similar to the central corridor but would pass through the northern part of ANR and cover 295 km;

(iii) the south corridor, which would pass through the southern part of ANR and cover 285 km; and

(iv) the south-south corridor, similar to the south corridor.

After comparison of these four alternatives, the central corridor option was chosen mainly because it is shorter, crosses ANR at its narrowest point, offers a more favorable topography, and does not create conflicts with mining areas.

VI. Cost-Benefit Analysis

The total Project cost is $315.8 million, of which the foreign exchange costs are $108.0 million, or about 34 percent and local currency costs are $207.8 million. Land acquisition amounts to $5.8 million equivalent in local currency, rural electrification to $13.1 million and compensation to $8.5 million.

The Project's economic internal rate of return has been calculated at 19.3 percent. Among the Project's social benefits, it can be assumed that 25 percent of the consumer surplus and 30 percent of surplus for labor will go directly to those living below the poverty line. The Project's poverty impact ratio (that expresses the proportion of net economic benefits accruing to the poor) is about 27 percent. The improved system reliability and the increased power supply will benefit YPEPC directly and will indirectly benefit

all of the connected industrial, commercial, and residential consumers. It is estimated that, of the total net present value of the Project, Y2,553 million will accrue to consumers (consumer surplus).

Based on 1995 data, Kunming ranked 26 out of 37 major PRC cities in terms of six air and water pollution indicators. Specifically, the TSP concentration in Kunming was 0.337 milligrams (mg) per m^3, making Kunming the fourth worst of all southern PRC cities for TSP. Similarly, the annual daily concentration of SO_2 was 0.072 mg/m^3, exceeding the national standard of 0.06 mg/m^3. The corresponding figure for NO_x was at the upper limit of the national standard. By foregoing the need to construct a 1,200 MW coal-fired plant and 200 MW diesel plant (the Project alternative), the Project will avoid adding about 476,000 tons of SO_2 emissions annually that would exacerbate current air quality problems. If the avoided economic cost of the environmental impacts from a comparable coal-fired plant in the Kunming area were added to the Project benefits (with appropriate costs factored in to mitigate environmental impacts of the DHP), the economic internal rate of return is preliminarily estimated to increase to 21.7 percent. Moreover, additional environmental benefits will be gained from closure of the three existing coal-fired plants.

Environmental mitigation and monitoring costs for each of the major components are as follows: (i) 220 kV and 110 kV substations—Y620,000; (ii) Baofeng substation—Y1,925,000; (iii) 500 kV transmission lines (including Y12.7 million to heighten towers to clear tree canopies)—Y18,894,000; and (iv) 220 kV and 110 kV lines and cables—Y850,000. The total estimated environmental mitigation and monitoring costs are Y22.3 million, or about $2.7 million. The total estimated costs for compensation and resettlement are Y70.6 million. Funds to meet these costs are provided under the Project.

VII. Institutional Requirements and Environmental Monitoring Program

A. Institutional Requirements

Given the nature of the Project's environmental mitigation needs, most of the mitigation will be undertaken by the contractors. Specific clauses will be included in the contractual documents to define the responsibilities of the contractors in this regard.

During the construction period, an environmental management organization (EMO) will be established by YPEPC. It will consist of staff from YPEPC's Environmental Protection Office and ANR authorities, with assistance provided by officials from the Yunnan Provincial Environmental Protection Bureau and the County Environmental Protection Bureau for each affected county. The contractors' environmental officer will attend EMO meetings on invitation. The EMO will report to YPEPC's Project director and will undertake regular compliance monitoring based on the overall schedule presented in an Environmental Management Plan, and on detailed annual environmental monitoring plans that it will develop. Due to the limited nature of expected environmental impacts, regular Bank loan review missions and submission by YPEPC of quarterly and annual environmental progress reports will suffice to check on the effectiveness of the mitigation and monitoring activities. YPEPC's Environmental Protection Office and local environmental protection bureaus will be responsible for monitoring impacts during Project operation.

YPEPC will assume the lead responsibility for implementing resettlement according to the agreed plan. YPEPC will report to the Bank on progress in land acquisition and resettlement through quarterly and annual progress reports. YPEPC will engage an independent agency to monitor the extent to which the entitlements delivered have restored incomes, livelihoods, and living standards, and will evaluate the resettlement upon completion and one year after completion. The affected municipalities and prefectures will facilitate the implementation of resettlement at county or district, township, and village levels. They will distribute resettlement entitlements to affected people before construction activities start.

B. Monitoring Program

Because the main impacts of the project will occur during the construction phase, monitoring also concentrates on this period. The following are the most important areas of environmental impact to be monitored:

(i) the impact of transmission line construction on ANR and monitoring of any impacts on wildlife, mainly birds, during the first two years of Project preparation (Close supervision will be provided by ANR staff from the two affected counties.);

(ii) the impact of material storage, stringing yards, and other temporarily used areas;

(iii) the impact on (mainly plantation) trees through restricting cutting to the minimum necessary;

(iv) the impact of dust, air quality, and noise during construction of the substations and the transmission lines and cables within Kunming; and

(v) the impact on water quality through regular monitoring of treatment facilities and receiving waters (This will be extended into the operation phase as well.).

Related activities will include monitoring of electromagnetic fields within and near substations to ensure that the exposure is not above allowable standards, monitoring of bird strikes and presence of migratory birds, and environmental restoration of construction sites.

VIII. Public Involvement

Nine meetings were held in the affected counties and prefectures during the Project feasibility study and EIA. Representatives of the local

population and of local organizations participated in these meetings, including village and county leaders; representatives of local women's unions, town councils, and technical institutes; and others. These meetings had two objectives: (i) to inform representatives of the local population or their representatives about the Project, and especially about anticipated social and environmental impacts and mitigation measures; and (ii) to obtain additional information and proposals for mitigation measures in order to make the Project acceptable on a local level.

Public involvement is an ongoing process, especially for compensation and resettlement issues. During further processing of the loan, mechanisms for consultation in resettlement will be strengthened. The Resettlement Action Plan includes mechanisms for redress of grievances.

IX. Conclusions

The major environmental concern related directly to the Project was the potential for harmful impacts on ANR. This was the subject of a special, in-depth study that identified a comprehensive range of design adjustments and mitigation measures that, if implemented, could help avoid all potential significant impacts on flora and fauna and reduce other short- and long-term impacts to minimal levels. Other environmental impacts of the 500 kV, 220 kV, and 110 kV lines and substation are those normally associated with transmission line projects, and all significant impacts along with mitigation measures have been identified. Minor compensation and mitigation measures will be required for the five communication stations and for the 35 kV substations. These will follow measures prescribed for the other Project components. However, because the precise locations of these stations will not be determined until after Project implementation has begun, the Government will prepare a supplementary environmental assessment for review by the Bank when the locations have been identified. Adequate provision has been made in the Project cost estimates to cover environmental mitigation and monitoring requirements.

Comprehensive Land Acquisition and Resettlement Plans have been prepared in accordance with the Bank's policy on involuntary resettlement.

Independent monitoring of the Plans will be provided to ensure that affected persons are not disadvantaged socially or economically by the Project.

Reviews were undertaken of environmental and social documentation related to the DHP. With three exceptions, the review found that all major environmental issues had been correctly identified and appropriate mitigation measures recommended. The Government has assured the Bank that mitigation measures for the three issues found to be inadequately addressed either had already been included in the Project or would be included.

The consultants' review of resettlement arrangements identified potential problems related to notification of project-affected people concerning precisely how they will be affected by the project, and the lack of detailed household surveys. The Bank has provided short-term assistance to the Government for purposes of gathering this information, integrating it into the overall Resettlement Action Plan, and providing advice on any other minor modifications that may be required in the Plan. None of the problems identified are of a magnitude to call into question the advisability of financing the Project on social or environmental grounds.