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STAFF APPRAISAL REPORT

CHINA

HIGHWAY PROJECT

April 19, 1985

Transportation Division 1
Projects Department
East Asia and Pacific Regional Office

CURRENCY EQUIVALENTS

Currency Unit - Renminbi (RMB)

US$1.00	=	Y (Yuan) 2.84 (as of March 1985)
US$0.35	=	Y 1.0
US$1 million	=	Y 2.84 million
US$352,113	=	Y 1 million

FISCAL YEAR

January 1 - December 31

WEIGHTS AND MEASURES

1 meter (m)	=	3.28 feet (ft)
1 kilometer (km)	=	0.62 mile (mi)
1 square meter (sq m)	=	10.76 square feet (sq ft)
1 square kilometer (km^2)	=	0.4 square miles (sq mi)
1 hectare (ha) = 0.01 km^2	=	2.47 acres (ac) = 15 mu
1 mu	=	666.7 sq m = 0.0667 ha
1 kilogram (kg)	=	2.2046 pounds (lbs)
1 metric ton (m ton)	=	2,204 pounds (lbs)

PRINCIPAL ABBREVIATIONS AND ACRONYMS USED

AADT	-	Average Annual Daily Traffic
CADE	-	Computer-Aided Design and Engineering
CHB	-	County Highway Bureau
CNTIC	-	China National Technical Import Corporation
CTC	-	Central Trucking Company
CTD	-	County Transport Department
ERR	-	Economic Rate of Return
GNP	-	Gross National Product
HB	-	Highway Bureau
HPDI	-	Highway Planning and Design Institute
HSRI	-	Highway Scientific Research Institute
ICB	-	International Competitive Bidding
LCB	-	Local Competitive Bidding
MOC	-	Ministry of Communications
MOE	-	Ministry of Education
MOF	-	Ministry of Finance
PHB	-	Provincial Highway Bureau
PTC	-	Provincial Trucking Company
PTD	-	Provincial Transport Department
SAA	-	State Auditing Agency
VOC	-	Vehicle Operating Costs

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This report is based on findings of a Bank Group mission which visited China in October/November 1984, comprising B. P. Kennedy (Mission Leader), G. Mahoney, R. J. N. Leonard (Engineers), C. Ohri (Procurement Specialist), J. Yenny, S. Teravaninthorn (Economists) and G. Morra (Training Specialist). The report was written by B.P. Kennedy, R. J. N. Leonard, J. Yenny and S. Teravaninthorn and edited by Ms. P. Brereton.

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Loan, Credit and Project Summary

Borrower:	People's Republic of China
Amount:	US$72.6 million equivalent comprising US$42.6 million equivalent IBRD and SDR 30.3 million (US$30 million equivalent) IDA.
Terms:	Loan: 20 years including 5 years of grace; standard variable interest rate. Credit: Standard.
Project Description:	As the Bank Group's first involvement in China's highway subsector, the proposed project would address a number of needs by assisting Government in: (a) improving the quality of future construction works by modernizing highway design, and by updating and improving construction and material specifications; (b) increasing the cost-effectiveness of highway investments, by improving economic evaluation techniques for the evaluation and selection of road investments, and by supporting Government's new policy of moving to competitive bidding for public works; (c) supporting a highway research program, with particular emphasis on improving and strengthening the existing paved national road network, improving road capacity in congested areas and improving road safety; and (d) strengthening the capabilities of staff working in the highway subsector by carrying out a training program. In addition, the project would support the Government's program for completing the national road network by constructing or improving about 230 km out of a total of 4,000 km of missing links in the network. It would also support a national program of improving economic activity in rural areas through the construction or improvement of about 1,400 km of rural roads. There is some risk of delays in project implementation since this is the first time that competitive bidding will be used for highway construction in China, and these delays could increase costs. This risk would be reduced by appropriate supervision in the early project stages.

Project Costs:

	Local	Foreign	Total
	(US$ million)		
Road construction	77.7	51.5	129.2
Design and research improvement	0.1	2.5	2.6
Road maintenance improvement	-	1.8	1.8
Training program	-	2.1	2.1
Consultant services	-	0.6	0.6
Base Cost	77.8	58.5	136.3
Physical Contingencies	7.8	5.9	13.7
Price Contingencies	11.2	8.2	19.4
Total Project Cost /a	96.8	72.6	169.4
Right-of-way cost	7.2	-	7.2
Total Financing Required	104.0	72.6	176.6
Financing Plan: IBRD/IDA	-	72.6	72.6
Government	104.0	-	104.0
Total Financing	104.0	72.6	176.6

Estimated Disbursement:

Bank Group FY	1986	1987	1988	1989	1990	1991
	(US$ million)					
Annual	9	25	30	5	2	1.6
Cumulative	9	34	64	69	71	72.6

Economic Rate of Return: 20%

/a Including taxes and duties of about US$16.8 million equivalent.

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HIGHWAY PROJECT

I. TRANSPORT SECTOR

A. Economic Setting

1.01 Like other centrally planned economies, China's economy is very "transport intensive." In the same land area, U.S. freight traffic is only four and a half times the freight traffic of China with a GNP nine times as large. This intensity of transport is explained partly by: (a) China's economic structure, with the service sector accounting for a very low share of GNP; (b) the historical emphasis on heavy industry, requiring the movement of ores, steel, and other bulk products; and (c) the high level of energy consumption per unit of output in China's industry (energy use per unit of GDP is two and a half times that of other low-income developing countries).

B. Transport System

1.02 China's transport system is heavily concentrated along the eastern seaboard. It comprises about 52,000 route-km of railways, 915,000 km of roads, 109,000 km of rivers navigable by barges of 100 tons or larger, 15 major national ports and a large number of smaller provincial and municipal ports, and 48 major airports. The main transport corridors are Harbin-Dalian and Beijing-Shenyang in the northeast; Beijing-Tianjin-Shanghai along the east coast; Beijing-Wuhan-Guangzhou linking industrial areas in the northeast and southeast; and Shanghai-Wuhan-Chengdu which cuts across the east-west industrial areas. The first four corridors are served mainly by rail, while the last is served mainly by the Changjiang (the Yangtze River). The physical characteristics of the country have also encouraged coastal shipping services. Transport facilities are still very poor in the outlying regions of the northwest and the southwest, where mountainous topography makes investment costs relatively high.

C. Traffic Trends

1.03 Domestic freight traffic in 1983 reached 1,007 billion ton-km, almost a fourteen-fold increase since 1952, or an average annual growth rate of almost 9%, systematically higher than the growth of domestic product. The elasticity of freight growth to overall economic growth is, however, less than that experienced by some other low-income countries and reflects the policy emphasis given to regional self-sufficiency rather than inter-regional trade.

1.04 Passenger traffic reached 310 billion passenger-km in 1983, a 12.5-fold increase since 1952 and an average annual growth rate above 8%. Since 1978, growth has averaged 12% per annum, well above twice the overall rate of economic growth. It is likely that this growth would have been more rapid if it had not been constrained by the limited capacity, particularly of

the railways, to offer more passenger services. Despite the rapid growth of passenger traffic in recent years, the mobility of people in China is still very low, reaching 270 passenger-km per capita in 1982 versus 785 in India, where GNP per capita is lower than in China. Assuming an income elasticity of 1.5-1.7, well below the elasticities observed in India and Brazil, passenger traffic in China would reach about 1,500 billion passenger-km per year by the turn of the century, about five times current levels.

1.05 The amount of traffic carried by the various transport modes is becoming somewhat more balanced than in the past. Railways, which have historically handled the greatest share of freight and passenger traffic and which have shown substantial growth in recent years, are now beginning to show a decreased share in relative terms. Highway traffic has increased steadily, particularly with the recent development of rural areas which generated a vastly increased demand for short distance passenger travel. The share of railways in freight and passenger traffic measured in ton-km and passenger-km decreased from 79% and 73%, respectively, in 1960 to 70% and 59% in 1982. The traffic lost by the railways has apparently gone to highways whose share increased from 2% to 11% for freight traffic and 18% to 36% for passenger traffic over the same period (Tables 1.1 and 1.2). However, the predominance of railways is expected to continue for quite some time, especially for freight traffic.

D. Investments

1.06 Over the period 1949-79, some Y 110 billion, or 17% of all new investment coming under the heading "State Capital Construction," went to transport. In comparison to other countries, the annual investment in China's transport sector has been relatively low. At about 1.1% of GNP, it is comparable to the level in India, but is less than the USSR's 1.4%, 2% in Korea, and 3.3% in Brazil. China's low investment in the sector has made transport a bottleneck to economic development. Coal production, for example, has been curtailed to match available transport, rural areas are short of transport for both agriculture and local enterprises, and ports lack adequate handling facilities for bulk fertilizer and grain.

1.07 In the past, the railways received nearly 70% of all investment in transport and communications, but starting in the late 1970s the share of investment in railways declined to about 50%, implying a redistribution of investment to other transport facilities. However, the highways subsector has not yet benefitted from this redistribution. Investment on highways has steadily decreased from 25% during 1963-65 to only 12% by the end of 1975%; since then, it has stabilized at around 15% of total transport investment.

1.08 In the coming decades, much larger investment will be needed in transport if bottlenecks to economic development are to be avoided. The proposed project would assist in this regard by supporting a major development program of national and rural road construction in order to facilitate both industrial and agricultural growth.

E. Ports and Waterways

1.09 Port traffic increased rapidly in the period 1976-80 at an annual average growth rate of 11.3%, reflecting the economic opening of China to foreign trade. Domestic coastal shipping and inland water transport also increased substantially. As a result, ports became congested despite commendable efforts to achieve higher productivity. A major effort to modernize ports started in the early 1970s and continues, with particular emphasis on container and bulk terminals, the latter mainly for coal. The Bank Group's first involvement in the China transport sector was the Three Ports Project (Loan 2207-CHA) in 1982 which includes a coal berth at Huangpu and container berths at Huangpu, Shanghai and Tianjin. A second ports project is being prepared.

F. Railways

1.10 China's railway system more than doubled in size between 1949 and 1983, when it totalled some 52,000 route-km, of which about 9,182 km were double or multiple tracked and some 2,650 km were electrified. Further double tracking and electrification are in progress. Some 75% of all locomotives are still steam-powered. Rail freight traffic has grown from about 39.4 billion ton-km in 1950 to 665 billion ton-km in 1983, at an average rate of 9% p.a. Since 1978, freight traffic has grown less rapidly, averaging about 4.5% p.a. Ten commodities (coal, timber, iron and steel products, construction materials, petroleum, non-metallic ores, grain, metallic ores, fertilizer and cement, in that order) account for about 74% of the ton-km. Passenger traffic by rail has grown from about 21.2 billion pasenger-km in 1950 to 178.0 billion passenger-km in 1983, at an average annual rate of 6.7%. Passenger traffic has exploded since 1978, increasing 62% in five years and putting heavy demand on the existing equipment and line capacity.

1.11 Railway operations are very efficient and show a high level of track and equipment utilization. Traffic density is the second highest in the world after the USSR, averaging 11.9 million net ton-km per route-km for freight and 3.1 million passenger-km per route-km for passengers. Freight car turnaround time is extremely low (at three days) and further savings will not likely be achieved. The Bank Group's first involvement in China's railway sector was the China Railway I Project (Loan 2394-CHA) in 1984 which financed priority infrastructure investments on two lines as well as equipment, technical assistance and training for improving electric locomotive production. A second railway project has also been prepared.

G. Highways

1.12 The development of the highway network has been relatively neglected compared to the other transport modes. The existing paved network is limited and the quality of road pavements is poor. With motor traffic on the national highways growing at a very high overall annual average rate of 15% since 1978, and in line with the emphasis of Government's new economic policy on the development of light industry and agriculture, and the intention to shift short-distance traffic (less than 200 miles) from the railways to the roads, the Government, in its Seventh Five-Year Development Plan (1986-90), proposes

to increase investment to expand and improve the highway network. The highway subsector is described in detail in Chapter II.

H. Transport Polices and Objectives for the 1980s

1.13 The transport development policy in the 1980s, unlike that of the past 30 years, has broadened to include not only the expansion of individual modes but also the establishment of links between each mode, the incorporation of new technology, and the improvement of institutions. With these objectives in mind, policy discussion has centered on: (a) capacity constraints for both freight and passenger traffic; (b) the appropriate economic role of the various modes and, in particular, the modal allocation of short-distance traffic; (c) management of the transport system, including policy, planning, coordination, and pricing; (d) the choice of technologies for both infrastructure and vehicles; (e) energy conservation; and (f) the training and development of staff to handle the above matters.

II. HIGHWAY SUBSECTOR

A. Network

2.01 Although China's road network is now the sixth largest in the world, it is still relatively underdeveloped. In 1983, the network comprised about 915,000 km, of which only 173,000 km or about 19% had asphaltic concrete or bituminous coated macadam pavements. Most of these pavements are of poor quality, have exceeded their design life, and are deteriorating rapidly with the increased traffic. As a result, maintenance is becoming increasingly more difficult and costly. Under the project, assistance would be given to carry out a pavement evaluation analysis in order to identify strengthening, rehabilitation and maintenance programs for the existing paved road network. Current road density of about 94 km per 1,000 sq km or 9.1 km per 10,000 population is also low, even though the network in 1983 was already 11 times larger than that in 1949. A comparison of China's road density with that of other countries is shown below:

Road Network Density

	km/10,000 population	km/1,000 sq km
China (1981)	9.1	93.49
USSR (1979)	54.1	63.71
Korea (1980)	12.4	476.77
India (1979)	24.3	488.31
Japan (1980)	95.2	2947.95
Brazil (1980)	118.2	163.85
USA (1979)	280.2	673.24

2.02 For purposes of design and technical specifications, the highway network is classified as Expressway, Class 1, 2, 3 and 4. The various classes are designed for the following average annual daily traffic (AADT) capacities; expressway for more than 25,000 vehicles; Class 1 for more than 5,000 vehicles; Class 2 for 2,000-5,000 vehicles; Class 3 for less than 2,000 vehicles; Class 4 roads, which mainly serve agriculture, for less than 200 vehicles. Table 2.1 shows the road-bed and pavement widths for the various classes of road. A road pavement specification classes paved roads into highest, high, medium or low quality (Table 2.2). No expressways have yet been built and only some 2% of the total road length has been built to Class 1 and 2 standards; the network is thus generally of low standard.

2.03 For administrative purposes, roads are classified as trunk, county, rural (communal), and special purpose. Trunk roads, which are the responsibility of the Provincial Transport Departments (PTDs), consist of national and provincial roads. National roads serve as links between provincial capital cities, other important cities, autonomous regions, ports and major transport terminals. They have been so designated regardless of their condition. Provincial roads serve the provinces and cities, whose local governments are responsible for design and technical specifications. Most provincial roads have been built to standards lower than Class 2. County roads, the responsibility of the County Transport Departments (CTDs), are usually lower than Class 3. Most commune roads which are built and maintained by local authorities cannot meet even Class 4 road standards, and some road sections are impassable after severe rain. The special purpose roads, built exclusively for mining, forestry or other purposes, are constructed and maintained by the main user. The length of road in each category is given below.

Road Network by Administrative Category

Road classification	Length (km)	% of total network
Trunk		
National roads	108,000	12
Provincial roads	146,300	16
County	322,700	35
Commune	295,500	32
Special purpose	42,500	5
Total	915,000	100

2.04 The administrative classification of the network has become more systematic since 1978, indicating fundamental improvement in planning and management. One of the results has been the identification of some 4,000 km of national road sections which are either missing entirely or substandard and not currently motorable, and as such are considered to be missing road links.

The upgrading of the national road network, including the construction of missing road links, is among the top priorities of the Ministry of Communications' (MOC) road development plan, which the Bank Group will support under the proposed project by helping to upgrade or construct about 230 km of the identified missing national road links.

B. Traffic Growth and Characteristics

2.05 Although roads have carried a relatively small share of total traffic in China, the recent growth of motor traffic on the trunk highways has been very rapid. This has led to many problems related to the capacity and structural strength of many roads which were not designed for such traffic. Assuming current annual growth rates of 15% for motor traffic and 14.5% for the vehicle fleet, traffic volume will double in less than five years. In the vicinity of some major cities, the annual growth of traffic is now as high as 18-19% and congestion is already a serious problem.

2.06 Traffic growth and congestion have resulted from several factors including the country's rapid economic growth and a general shift of short-haul transport from rail to road. Congestion, however, is mainly due to mixed traffic, with slow-moving vehicles like bicycles, tractors, and animal-drawn vehicles impeding traffic flows. Multipurpose tractors, in particular, cause congestion on trunk roads and will not be easily diverted to other roads in the short term. Assuming that the present traffic composition continues, many segments of the existing trunk road network will be saturated within the next five years. MOC is aware of this problem and will study it with assistance under the proposed project. The study would identify possible solutions such as road widening to separate various types of traffic; the addition of parallel restricted-access links in high-volume corridors; construction of bypasses around cities, towns and villages; and substitution of more small (1/2 to 1 ton) pickup trucks for slow-moving vehicles; or a combination of all these measures. Furthermore, future highway planning should seek to relieve traffic congestion.

2.07 Although the Government is aware of existing constraints, its approach to the traffic problem should be broadened to respond more fully to the needs at hand. In 1978, MOC introduced a thorough traffic counting system for some national and provincial roads. With 120 permanent counting stations on the national network and about 6,000 check points on the provincial road network, the count is on a 24-hour basis, three times a month, year-round and includes non-motorized vehicles. However, more origin-destination surveys are needed in order to obtain more accurate information for highway planning and design.

C. The Vehicle Fleet

2.08 Most motor vehicles in China are domestically produced. Several features of this production are striking. First, unlike other developing countries, trucks outnumber cars by about nine to one. The yearly production of passenger cars is only one car per 84,000 population. This is about 1/4 that of India, 1/28 that of Peru, and 1/135 that of Chile (Table 2.3). Second, there are almost no light trucks (less than 2 ton capacity) and few

large trucks more than 8 ton capacity (Table 2.4). Finally, vehicles have outmoded designs and very low fuel efficiency, with most trucks being gasoline rather than diesel powered.

2.09 Vehicle manufacturing efficiency is low due to the small production scale of the large number of manufacturing plants which exist. Some 70 motor vehicle plants are reported to be in operation, only a few of which can produce between 15,000-70,000 vehicles per year and some serve only local demand and produce less than 20 vehicles a year. Recognizing the inefficiency of these operations, the Government is trying to rationalize the industry by integrating smaller factories into larger companies with each factory specializing in producing certain parts and components for a final assembly plant. The new integrated plants are expected to avoid duplication, increase specialization, and make full use of production equipment so as to gain economies of scale.

2.10 In 1983 China produced some 140,000 trucks and was ranked tenth largest among civilian truck producers worldwide, yet this is still not sufficient for the huge and growing domestic demand. The entire stock of trucks is about 1.6 million units. Assuming a very optimistic 10-year depreciation period per vehicle, the present production would be barely enough to replace those depreciated. With a 9% annual increase in freight transport, a shortage of vehicles is inevitable, and the need for trucks with capacities of over 8 tons and less than 2 tons is expected to be particularly acute. China has been regularly importing trucks but the numbers are small and fluctuating: 21,000 in 1981 and about 8,000 in 1982 and 1983. In the long run, there will also be a problem in planning for the complementary development of the vehicle fleet and the road network. The Bank Group has responded to this situation by initiating discussions on the need for a comprehensive review of the road transport industry in China which would examine industry problems and recommend solutions.

D. The Trucking Industry

2.11 Competition between public trucks operated by MOC and social trucks 1/ is becoming increasingly evident. The share of social trucks in the total fleet grew very rapidly from 30% in 1949 to 86% in 1979. However, MOC trucks still handle more than 25% of freight traffic (Table 2.5). MOC's trucking industry comprises the Central Trucking Company (CTC) and the Provincial Trucking Companies (PTCs). CTC specializes in modern, large-volume transport, including a container trucking service. It handles longer distance inter-provincial traffic, while the PTCs handle the shorter hauls and intermodal transfers.

2.12 Both the MOC and social trucks share problems of misallocation and mismanagement of truck and fuel resources which result in a simultaneous

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1/ The term "social trucks" is loosely equivalent to "own account trucks." Social trucks are owned by factories, communes or any cooperative organization.

shortage of some trucks while a large number of trucks are not fully used. This is a more serious problem for the social trucks, judging from their very low average load factor of about 35% compared to the 65% average load factor for MOC trucks. Aside from empty back hauls, in some communes social trucks are in garages one third of the year because the communes either lack fuel to run them, or have more trucks than necessary. The review of the road transport industry (para. 2.10) would also examine ways to improve operational efficiency, including the potential for using intermodal and road freight terminals.

E. Vehicle Operating Costs, Trucking Tariffs and Profit

2.13 Typical vehicle operating costs (VOCs) for trucks are shown in Table 2.6. For the most commonly used 4-ton truck, costs range from 0.10 to 0.17 Yuan (US 3.5 to 6 cents) per ton-km, depending on the design standards of the road. Fuel (mostly gasoline) and vehicle maintenance account for over 40% of total VOCs (Table 2.7). Gasoline which is rationed by coupons has been priced for many years at an average of Y 800 per ton (US$282). The price varies regionally to reflect differences in transport and distribution costs; and has been well above world market price until the recent major fluctuations in exchange rates. Gasoline sold above the coupon quota is around Yuan 1,000 per ton (US$352), substantially above the FOB Singapore price of US$303 per ton.

2.14 Each year, the Trucking Division of MOC issues a set of planned vehicle operating cost targets and official tariff rates which serve as guidelines for trucking companies. The official tariff rates ranging from 0.18 to 0.20 Yuan per ton-km are about 17% higher than the planned VOC target and in theory would ensure a 17% profit to trucking companies; however, actual VOCs are sometimes higher. Details of costs and tariffs are given in the project file. One reason for higher costs is topography and road conditions; another is the practice of trucking companies of keeping many old, inefficient trucks in their fleets which need to be maintained and overhauled at consideraable expense.

F. Highway Administration

2.15 Highways as well as inland waterways and coastal shipping are under the MOC which is directly under the State Council. MOC has 11 bureaus in four groups under four vice-ministers in charge of roads and road transport, inland waterways and coastal transport, planning and budgeting, and science and technology (Chart 1). One of the bureaus is the Highway Bureau (HB), with 9 divisions. The MOC also controls 13 highway institutes and companies and, indirectly, the Provincial and County Highway Bureaus in the Provincial and County Transport Departments (Charts 2, 3 and 4).

2.16 The HB gives general policy direction and support to the Provincial Highway Bureaus (PHBs). It issues nationwide policies and regulations, specifying construction standards, and provides technical support to the PHBs and

through them to the County Highway Bureaus (CHBs). It also controls the central pool of construction equipment and manpower which can be mobilized to assist some provincial work if necessary, but does not itself take the initiative in constructing major infrastructure. The PHBs have financial independence and carry out road planning, construction, maintenance and administration of their roads in line with HB's general policy guidelines; they also oversee the work of the CHBs. Although HB determines overall road design standards, field engineering designs are normally prepared by the Design Institutes of the PHBs. Construction and supervision of works are also done at the PHB level.

2.17 After 1979, in an effort to unify the planning and development of the national road network, the HB became more active in regulating the PHB's construction and financial decisions. Nevertheless, although the "national road" concept was introduced for the first time, there was no change in the responsibility for the administration, maintenance, or financing of these roads. The PHBs still construct, maintain and administer the national roads in their provinces using their provincial budgets. Only for some very large projects or for major periodic maintenance would HB plan, construct, and share part of the financial burden.

G. Planning, Budgeting, and Financing

2.18 MOC and the State Planning Commission are responsible for overall planning of the country's road network, but are directly involved only in major projects. Approved projects are passed on to lower level authorities for execution. Highway planning shows three main weaknesses: the planning of roads in relation to other transport modes is not being done; selection of road investments has not been based on economic criteria; and design standards recommended by HB are frequently not followed by the provincial implementing agencies due to shortages of funds. While the application of economic criteria for road investments is now becoming an accepted practice following Bank involvement in the sector, the other two problems persist. The present planning and budgeting system is decentralized enough to promote local initiatives in planning provincial transport development with the efficient use of local revenues. However, under this system it is difficult to maintain road construction standards throughout the country because quality and design frequently reflect availability of funds. For provincial and commune roads, the formal planning bodies, i.e., the PTDs and PHBs, have to take into account three factors: the present condition of the highway system, MOC's long-term highway development plan, and projected maintenance fee revenues. Budgetary allocation for roads by the provincial authorities is realistic and adjusted to the predicted road maintenance fee revenues, but recommended standards may be reduced in line with local resources. The question of financing construction will be addressed within the general context of pricing in the transport sector, and specifically through road user charges in the subsector. Under the proposed project, economic criteria have been applied in the selection of road investments. The problem of the lack of intermodal planning would be addressed in the future.

2.19 Road Financing. There are two major sources of road financing: the Capital Construction Investment Budget from the central government and the

road maintenance fee collected by the provincial governments. Funding from the Capital Construction Investment Budget is in the form of a grant or loan depending on whether the project is considered a national investment. It is used only for new investment projects, not for road maintenance. The approved funds can be withdrawn from the People's Construction Bank which also supervises the use of funds. The amount of Capital Investment funds allocated for highways in 1981 amounted to Y 823 million. Total revenues from road maintenance fees amounted to Y 4.0 billion in 1983, 80% of which goes directly for road maintenance expenditures and 20% for expenditures on workshops, machinery, equipment, selected road improvements, research, training, administration and management. On this basis, the direct expenditures for the maintenance of the road network would average about Y 3,500 per kilometer which can be considered high.

2.20 The road maintenance fee is imposed on both MOC and social trucks, but using a different rate system. The road maintenance fee for MOC trucks is a fixed proportion (10-15%) of total revenues, but for social trucks, it is a lump-sum fee charged on the vehicle loading capacity (Y 70-100/capacity-ton/month). With the different systems, MOC trucks tend to pay a lower tax than do social trucks of comparable size. The road maintenance fee rate is especially costly for the many social trucks which are underused. The justification for the two types of road maintenance fee is unclear, particularly since a uniform pricing system exists in most other areas.[1/] The present fee-charging system should therefore be reviewed to determine whether it is an effective tool for use in achieving specific policy targets, that is, whether there is any allocation or distribution rationale behind the non-uniform fee, and what are the economic effects of this fee-charging system. This question will be addressed as part of the Bank Group's dialogue with Government.

H. Engineering

2.21 The engineering of road and bridge projects is done by the Planning and Design Institutes at MOC's central, provincial, prefecture and county levels. Major road and bridge projects are done by the MOC Highway Planning and Design Institute (HPDI), by the First and Second Survey and Design Institutes located at Xian and Wuhan respectively and by Provincial design institutes. There is no fixed arrangement for allocation of work to the MOC Institutes based on geographical or technical considerations, the criterion being the current work load of each Institute. The Highway Scientific Research Institute (HSRI) provides support and advice on materials, etc., as needed. Annex 1 gives a description of the Institutes. The design standards (Table 2.1) and guidelines for engineering design are set by MOC. Expatriate consultants are used only for specialized studies and then in joint venture with the HPDI. Since the workload of the HPDI is expanding in line with the increase in traffic on the highway network, the design capacity of the Institute would be strengthened under the project through the provision of

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1/ Reasons given by MOC for the lump-sum fee charged on social trucks are (a) the difficulty in getting accurate figures on revenues for a revenue-based fee and (b) a lump-sum fee was expected to encourage efficiency.

computer-aided design and engineering equipment and site investigation equipment and through staff training.

I. Construction and Maintenance

2.22 Construction of roads and bridges was, in the past, normally done as a force account operation by construction bureaus attached to MOC headquarters or to the PTDs and CTDs. The major contractor unit, the China Road and Bridge Engineering Company attached to the MOC, has operated as a contractor in the Middle East and Africa. Formerly called the China Highway Construction Company for Foreign Countries, when it undertook projects financed by China under its aid program, the Company in its new capacity as an international contractor now executes a wide variety of civil works projects abroad. Although well staffed with professional engineers and technicians, the Company lacks staff experienced in international contracting law, contract management, and bid preparation.

2.23 In May 1984 the State Council authorized the introduction of competitive bidding for civil works projects and the establishment of construction companies from the existing public construction bureaus to carry out works on national and provincial roads. The MOC has proposed the use of competitive bidding - both international competitive bidding (ICB) and local competitive bidding (LCB) - for highways to be financed under the proposed project. To support the Government's move to competitive bidding on highways, the Bank Group staff and an expert on bid documentation are helping prepare the documents needed for ICB and LCB, and expertise would also be financed under the project to help MOC supervise works and ensure quality control.

2.24 National and provincial roads are well maintained by the PTDs. However, maintenance of paved roads is becoming more costly, ranging between Y 3,500 and Y 5,000 per kilometer, due to their poor quality and the rapid traffic growth. The proposed study of the paved road network (para. 2.01) would identify strengthening and rehabilitation needs, and thus help to lower future maintenance costs. Maintenance of county roads by the CTDs is adequate in scope and well organized, but due to the labor-intensive methods used, roads are surfaced with large size, hand-crushed stones providing poor riding surfaces. Equipment would be provided to correct this problem in the project areas.

J. Road Safety

2.25 Although the available statistics on road traffic accidents are neither comprehensive nor reliable, it is evident that the situation regarding road safety is far from satisfactory. The low geometric and quality standards of most roads combined with the mix of slow and fast moving traffic are not conducive to road safety. It is proposed to strengthen road safety research in China by having the HSRI carry out a study to identify the causes of road traffic accidents. The study would cover (a) a review of the existing system of reporting, recording and analyzing accident statistics; (b) recommendations on improved traffic accident data collection, recording and analysis; and (c) identification of a program for the reduction of traffic accidents.

K. Staff Training

2.26 Existing staff of the MOC and the PTDs are in general professionally competent, but many have not been exposed to new technology and therefore often use outmoded work methods and equipment. Preliminary estimates indicate that a substantial number of engineers, assistant engineers and technicians would be required each year by MOC to meet the proposed targets in the Seventh Five-Year Development Plan (1986-90). Following the difficult period of the late 1960s and early 1970s, technical manpower planning and assessment of related training needs for the highway subsector have only recently been resumed. There is clearly an urgent need to strengthen and expand the output of formal education and the ongoing training programs to increase and upgrade the number of technical staff required to meet the demand for trained personnel during the Plan period.

2.27 The MOC's Education Bureau has three major divisions, each one responsible for a specific aspect of staff development, as follows: (a) Training Division, responsible for training courses to upgrade administrative staff, engineers, assistant engineers, technicians and skilled and semi-skilled workers; (b) Education Division (technical/vocational level), responsible for education and training activities carried out by some 40 technical schools for mid-level technicians and some 100 vocational schools for skilled workers; and (c) Education Division (engineering level), responsible for three highway institutes, one transportation school, six maritime, waterway, and navigation schools, and one medical college (Chart 4). In addition, the PTDs have their own Provincial Transportation Technical Schools and district training centers and carry out their share of education and training programs in accordance with general guidelines issued by MOC's Education Bureau. Most MOC and PTD institutes, schools and centers lack the physical capacity to meet the increasing manpower demand, have scarce and outmoded training equipment, and need to have most of their curricula upgraded to reflect modern technology in the various highway disciplines. The training component included in the proposed project would therefore assist MOC to correct these deficiencies, and to modernize and raise staff professional standards in the highway subsector.

L. Highway Development: Policy and Objectives for the 1980s

2.28 Government policy for the highway subsector in the 1980s has a joint focus on quality improvement and expansion of the network to meet increasing demand. This differs from the policy of the past 30 years which sacrificed road quality for road length and left China with a legacy of substandard roads unable to sustain the recent increase in traffic resulting from rapid economic growth. The MOC now realizes that programs for road network expansion and rehabilitation must proceed simultaneously, supported by quality improvement programs for construction, construction materials, road transport equipment, and road transport industry management.

2.29 The Bank Group's strategy for the subsector is to support Government's twin objectives for highways by assisting the process of network expansion while helping to direct development policy toward greater quality improvement. This support would be within the framework of longer-term objectives concerned with increasing efficiency and cost-effectiveness in

meeting the increased transport demand in the subsector. These objectives would address specific policy, institutional and technological areas such as: improved economic evaluation techniques for the selection of road investments; improved intermodal planning; transport tariff and road user taxation systems; increased efficiency in the road transport industry; improved efficiency in construction by supporting Government's policy of competitive bidding and development of the local contracting industry; staff training; modernization of highway design and updating and improving construction and material specifications; and supporting highway research. The Bank Group has agreed with Government that a number of these objectives would be dealt with under the proposed project. Action on the remaining objectives will be decided in the course of ongoing discussions with Government relating to the Bank's economic and sector work.

III. THE PROJECT

A. Project Formulation and Preparation

3.01 Preliminary discussions with Government on the highway subsector began in 1980 during preparation of the Bank's first Economic Report on China.[2/] Following further discussion, MOC requested Bank Group assistance to finance a highway project, which was identified in June 1983. A Bank Group preappraisal mission visited China in May 1984 and the project was appraised in October/November 1984. The project was prepared by the Ministry of Communications (MOC) and the Highway Bureaus of the Provincial and County Transport Departments.

B. Project Objectives and Scope

3.02 The proposed project would support the Government's policy and institutional objectives for the subsector by:

(a) improving the quality of future construction works by (i) modernizing highway design and (ii) updating and improving construction and material specifications;

(b) increasing the cost-effectiveness of highway investments by (i) improving economic evaluation techniques for the evaluation and selection of road investments and (ii) supporting Government's new policy of moving to competitive bidding for public works;

(c) supporting a highway research program, with particular emphasis on improving and strengthening the existing paved national road network, improving road capacity in congested areas and improving road safety; and

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2/ Report No. 3391-CHA, China: Socialist Economic Development, June 1, 1981.

(d) strengthening the capabilities of staff working in the highway subsector by carrying out a training program.

3.03 To accomplish these objectives, the project would include:

(a) construction or improvement of about 230 km of national roads;

(b) construction or improvement of about 1,400 km of rural roads;

(c) provision of computer-aided design and engineering equipment and site investigation and related laboratory equipment for the Highway Planning and Design Institute (HPDI) in order to modernize future highway designs;

(d) provision of laboratory testing and other research-related equipment for the Highway Scientific Research Institute (HSRI) in support of their research program, including studies on the strengthening of the paved national road network, road congestion, and road safety;

(e) training of staff from MOC's Highway Bureau, the Provincial Highway Bureaus (PHBs), the HPDI and the HSRI;

(f) consultants' services and technical assistance to help the MOC, the PHBs and the Highway Institutes in the supervision and quality control of road construction, and for studies to be done under the research program and for seminars and workshops as needed; and

(g) purchase of basic road maintenance equipment for selected provinces.

Other Government development objectives would also be supported by the construction works to be carried out under the project. These works would provide important interprovincial road links which would allow increased and more efficient economic activity in and between the provinces. In addition, the improvement of some rural roads would support the Government's policy of promoting economic development in rural areas, where agriculture, the country's primary economic activity, still employs 72% of the country's work force.

3.04 Project roads were selected on the basis of economic criteria and economic evaluation procedures which have been newly introduced into China and which Government intends to follow in the future to ensure the cost-effectiveness of investments. Project road construction, both of the national and rural networks, has been kept modest relative to actual needs and is considered to be well within the capacity of the implementing agencies.

C. Detailed Features

3.05 The Construction or Improvement of National Roads. The 230 km of national roads to be constructed or improved under the project comprise seven road sections located in six provinces (see Maps). The roads, road length, design standard, estimated cost, traffic and provincial distribution are shown

in Table 3.1. Estimated present traffic is relatively heavy and ranges from 264 AADT to 3,064 AADT. One road has been designed to Class 1 standards, two roads to Class 2 and the remainder to Class 3; these design standards are appropriate. Assurances were obtained from Government that road sections to be constructed/improved and the related design standards would be as agreed during negotiations. Existing alignments will be used to the extent compatible with sound engineering and road safety. The significance of each project road is described in Annex 2 and a profile of the project provinces is given in Annex 3.

3.06 The roads, which were selected by the Provincial Transport Departments (PTDs) as the missing links in the national network in most need of urgent construction or improvement, have been the subject of detailed feasibility studies, also prepared by the PTDs with assistance from Bank Group staff. Detailed engineering has been completed and the contract documents for ICB and LCB are being prepared by MOC's Highway Bureau with the guidance of Bank Group staff and the help of expatriate consultants financed under Technical Cooperation Credit 1412-CHA.

3.07 The Construction or Improvement of Rural (County) Roads. The 1,400 km of rural roads to be constructed or improved under the project consist of 59 road sections in six provinces (see Maps). The roads, road length, design standard, estimated cost, and provincial distribution are shown in Table 3.2. The roads have been designed to Class 3 and Class 4 standards which are appropriate. Assurances were obtained from Government that the road sections to be constructed/improved and their design standards would be as agreed during negotiations. Existing alignments and bridges will be used to the maximum extent to reduce costs.

3.08 Feasibility studies and designs for the roads have been completed. More simplified documentation suited to such roads, comprising longitudinal profiles, typical cross-sections and priced bills of major quantities have been prepared. The rural roads have been selected for improvement by the County Transport Departments (CTDs) which have also prepared the feasibility studies and detailed designs with the guidance of PTDs, MOC's Highway Bureau, and Bank Group staff.

3.09 Assistance to the Highway Planning and Design Institute (HPDI). Government's current emphasis on the expansion and improvement of the highway network has involved the Institute in planning and supervising the designs of highways throughout China, but its performance is hindered by outmoded equipment and a lack of trained staff. To help the Institute carry out this increasingly heavy work program more efficiently and more cost-effectively, staff would be trained under the project (para. 3.12), and the Institute's equipment would be upgraded and modernized. Computer-aided design and engineering (CADE) and other computer equipment as well as equipment for site investigations and materials testing would be financed under the project. In addition, to improve management, an engineering data bank including a national roads condition inventory would be computerized, and computerized management information systems introduced.

3.10 Assistance to the Highway Scientific Research Institute (HSRI). The research program of the Institute is described in Annex 1. To support this program. soils and materials testing equipment would be financed under the project. This equipment combined with the training of staff (para. 3.12) would enable the Institute to carry out its program and fulfill its task of being the major scientific and technological research base in China for highway transportation.

3.11 Assistance in the form of equipment and expatriate expertise would also be provided for the following three studies to be carried out by the Institute: a study to assess the methodology for pavement strength evaluation to identify the improvement and strengthening needs of the existing paved national roads (para. 2.01); studies for improving road capacity in congested areas near cities (para. 2.06) and road safety (para. 2.25). Assurances were obtained from Government during negotiations that the studies would be carried out under terms of reference acceptable to the Bank/Association, beginning by July 1, 1986 and completed by December 31, 1987; and that Government and the Bank/Association would exchange views on the findings of the studies.

3.12 Staff Training. The proposed three-year training program (1986-1988) aims at upgrading and modernizing the skills of the technical staff in the various fields concerned with the highway subsector. The program has a two-fold approach and would:

(a) improve the proficiency of engineers and other staff by sending abroad selected personnel to attend academic and practical training courses as well as relevant international conferences; and

(b) strengthen the capacity of MOC's Highway Institutes as well as the Provincial Transportation Technical Schools by: (i) purchasing laboratory, computer and photogrammetry equipment, training aids and essential technical books and publications; (ii) training abroad of professors/instructors; and (iii) inviting foreign academic experts for short visits to help upgrade curricula.

3.13 As part of the program, about 65 overseas fellowships would be needed in transportation planning, soils and materials engineering, aerial photogrammetry, economic analysis, financial management and accounting, highway maintenance and equipment management, construction management and supervision including quality control, bridge hydrology, concrete technology and asphalt concrete and asphaltic cement. It is expected that on their return, the trainees would play a major role in the development and management of the Chinese road system and in the transfer of updated technology to other highway staff. The HB would have overall responsibility for implementation of the training component at the national level since the training program is directly concerned with the highway subsector. The PTDs would be directly responsible for day-to-day training activities in the provinces. This training component, although relatively small compared to MOC's staff development needs, is an essential first step toward a long-term process of modernization of the country's highway subsector. Detailed costs of the training program are given in Table 3.3. Assurances were obtained from Government during

negotiations that the training would be carried out according to a program agreed with the Bank/Association.

3.14 Consultant Services. A total of about 50 man-months of expatriate consultant expertise is estimated to be needed under the proposed project. Local expertise available in the various Institutes in the sector would be used to the extent possible. Expatriate help would be sought only for those areas of advanced technology where local expertise is lacking. Such areas include the use of advanced instrumentation for measuring road deterioration, analysis of traffic flows, transport economics, etc. Supervision of national road construction or improvement works will be done mainly by local staff supported by a number of key expatriates; about 20 man-months of foreign expertise is estimated to be needed to help set up and implement the organizational systems and procedures for effective quality control on site. About 15 man-months of expatriate expertise would be needed for studies and the research program to be done by the HSRI (para. 3.11) and about another 15 man-months for help on seminars and workshops on specialized topics related to the highway subsector. During negotiations, agreement was reached with Government on terms of reference for the consulting services. All consultants would be employed under terms and conditions acceptable to the Bank/Association and in accordance with Bank Group Guidelines.

3.15 Road Maintenance Equipment. Maintenance of the existing rural roads is difficult because the roads are mostly surfaced with uncompacted large size hand-crushed stone, which gives a very rough riding surface. The level of service of these roads could be greatly improved with the application of fine crushed material compacted to a dense layer. Under the project, some maintenance equipment, such as motor graders, mobile crushers and smooth-wheel rollers, would be provided to the CTDs for the maintenance of these roads and the rural roads to be constructed or improved under the project.

D. Cost Estimates

3.16 The total project cost including physical and price contingencies but excluding right-of-way costs is estimated at about Y 450.4 million, or US$169.4 million equivalent, with a foreign exchange component of US$72.6 million or about 43%. Project costs are shown on page 18. All base costs are estimated in March 1985 prices. Physical contingencies are calculated at 10% of base cost estimates and applied to all components. For the calculation of price contingencies, it is assumed that exchange rate adjustments will, on average, be made to maintain "purchasing power parity" during the project implementation period. On this basis, price escalation for both foreign and local costs, (a) when expressed in U.S. dollars, is based on expected international annual inflation rates of 5% in 1985, 7.5% in 1986 and 8% in 1987-1988; (b) when expressed in Yuan, is based on expected domestic inflation of 3% p.a. in 1985-1989. Taxes and duties on construction are estimated at US$16.8 million equivalent.

3.17 The costs of civil works on national and rural roads have been estimated by the PTDs and CTDs and are based on work quantities calculated from detailed designs. Unit prices for the work items have been computed on the basis of MOC's standard manuals for labor and equipment productivity and

PROJECT COST SUMMARY /a

Project element	Total Local (Yuan'000)	Total Foreign (Yuan'000)	Total Total (Yuan'000)	Total Local (US$'000)	Total Foreign (US$'000)	Total Total (US$'000)	% of foreign exchange	% of total base costs
National Road Construction								
Yancheng-Gaotang (53 km)	16,657	16,657	33,314	5,865	5,865	11,730	50	9
Xian-Sanyuan (35 km)	34,073	34,073	68,147	11,998	11,998	23,995	50	17
Other roads (138 km)	30,233	20,155	50,388	10,645	7,097	17,742	40	13
Rural road construction	139,751	75,251	215,002	49,208	26,497	75,705	35	55
Equipment								
HPDI	311	3,149	3,460	110	1,109	1,218	91	1
HSRI	-	3,900	3,900	-	1,373	1,373	100	1
Training	-	6,049	6,049	-	2,130	2,130	100	2
Consultant services	-	1,778	1,778	-	626	626	100	1
Road maintenance equipment	-	5,200	5,200	-	1,831	1,831	100	1
Total Base Costs	221,026	166,212	387,238	77,826	58,525	136,351	43	100
Physical contingencies	22,103	16,621	38,724	7,783	5,853	13,635	43	
Price contingencies	14,156	10,265	24,421	11,264	8,188	19,452	42	
Total	257,284	193,098	450,382	96,873	72,565	169,438	43	
Right-of-way costs	20,269	-	20,269	7,137	-	7,137		
Total Financing Required	277,553	193,098	470,651	104,010	72,565	176,575	41	

/a Columns may not add up due to rounding.

the related annually-updated costs, combined with the current costs of materials; the unit prices include adequate allowances for equipment depreciation, overheads and profit for contract work. The cost estimates were reviewed at appraisal and found satisfactory.

3.18 The base cost per kilometer of the Class 1, dual two-lane Xian-Sanyuan national road is about US$680,000, which is acceptable since it includes about 2,000 meters of major bridge works and an underpass to the railway. The base cost per kilometer for the remaining two-lane national roads is about US$155,000, and about US$55,000 for the rural roads. The foreign exchange component is estimated at about 50% for foreign contractors, and about 40% for domestic contractors. For the force account work on rural roads, the foreign exchange component is estimated at about 35% which reflects the more labor-intensive construction method to be used.

3.19 The costs of computer and laboratory equipment are based on prices quoted by manufacturers outside China. A notional amount has been included for the road maintenance equipment pending finalization of a list of the PTDs' needs. The costs of the training program are shown in Table 3.3.

E. Financing

3.20 The Bank loan of US$42.6 million and an IDA credit of SDR 30.3 million (US$30 million equivalent) would finance about 43% of total project costs, or about 100% of the foreign exchange costs. The Government would provide about US$104.0 million equivalent to meet the remaining capital costs of the project. Details of project financing are shown in the following table:

FINANCING PLAN

	Government (MOC and PTDs)		Bank/IDA (US$ million)	Total
National Road Construction	-	28.5	25.0	53.5
Rural Road Construction	-	49.2	26.5	75.7
Equipment for HPDI and HSRI	0.1	-	2.5	2.6
Road Maintenance Equipment	-	-	1.8	1.8
Training	-	-	2.1	2.1
Consultant Services	-	-	0.6	0.6
Subtotal	0.1	77.7	58.5	136.3
Contingencies	-	19.0	14.1	33.1
Right-of-way costs	-	7.2	-	7.2
Total	0.1	103.9	72.6	176.6

F. Implementation

3.21 MOC would have overall responsibility for implementing the project. National roads would be constructed or improved under unit priced contracts and supervised by the PTDs, which are part of the provincial governments but under MOC leadership. Construction Bureaus presently attached to the MOC or PTDs which have satisfactory experience on road works and adequate resources are being set up as financially and legally independent construction companies to bid on the national road contracts; these companies will form the basis of the new contracting industry in China. PTDs will supervise the contracts through a project management unit to be established in each province; each unit will be comprised of a project manager, engineer, supervisor and other staff as needed. Construction of national roads is expected to start in early 1986 and be completed in about two and a half years.

3.22 Construction or improvement of rural roads (US$94.1 million) would be carried out under force account by CTD construction units for reasons of efficiency. The CTD construction units are well organized and experienced, and have adequate resources and ready access to local materials and local labor, enabling them to start work without delay. Because the works are generally small in scope and are located in remote mountainous areas, international contractors are unlikely to be interested, nor would the preparation

of detailed engineering and bid documents to ICB standards be cost-effective for such low standard roads. Similarly, for domestic contracting, there are at present virtually no local contractors for such work in these areas, and the construction companies newly-formed for purposes of national and provincial road construction and upgrading (para. 2.23) would face substantial mobilization costs, given the lack of familiarity with these areas and their remoteness. The construction units would be directly supervised by the CTDs, but under the overall control of the PTD project management units. The construction of rural roads is expected to start by late 1985 and be completed within two years. Funding for rural roads under the project will come from the Bank Group, and provincial and local sources. No central government resources are anticipated. Local contributions would cover the costs of local labor and materials, and compensation within the right-of-way. The scattered location of project rural road construction will require frequent and carefully planned supervision by Bank staff. Supervision will be assisted by quarterly reports on project physical and financial progress, which will be based on agreed priced Bills of Quantities for each rural road subproject (para. 3.30) and submitted to the Bank by MOC (para. 3.36). The reports, combined with selective site visits to the various provinces during supervision missions, are expected to provide a satisfactory means of monitoring progress.

3.23 Road works included in the project represent the total road programs of the various provincial and county governments involved during the project period. Under the project, specialized expertise would be made available to both the provincial and county authorities to help them set up suitable organizations with appropriate systems and procedures to control the quality of work.

3.24 The PTDs are part of the provincial governments, but professionally under the leadership and guidance of MOC. Decisions will be required at the provincial level for project implementation by the PTDs, including allocation of funds and road maintenance charge revenues. Consequently, assurances were obtained from Government during negotiations that MOC and the project provinces will enter into a Project Implementation Agreement setting out their respective responsibilities in project implementation. While the Bank Group would not be a party to this Agreement, signing of the Project Implementation Agreement on terms and conditions satisfactory to the Bank/Association would be a condition of loan/credit effectiveness, and non-compliance with its provisions could be grounds for default under the loan/credit agreement.

3.25 MOC's Highway Bureau would be responsible for implementation of the training component, which would start in late 1985 and continue until end of 1988. The HSRI would continue its research program during the project period and would carry out the three project studies during 1986-87.

3.26 The MOC would be responsible for selecting consultants to provide the expertise on supervision and quality control of civil works; the experts are expected to start work in early 1986 in order to help establish the supervisory organization prior to start of civil works. The expatriate experts needed for the HSRI studies and research program would be recruited as needed from early 1986 and during the period of the studies. It is expected that the procurement of all research equipment would start in early 1986 and be completed by late 1986.

3.27 An implementation schedule for the proposed project (Annex 4) was agreed with Government during negotiations.

G. Procurement

3.28 Procurement under the project would be carried out as shown in the following table.

Project Element	Procurement Method			Total Cost
	ICB	LCB	Other	
	(US$ million)			
Civil Works				
National Roads	44.4 (20.5)	22.0 (10.2)	- -	66.4 (30.7)
Rural Roads	-	-	94.1 (33.1)	94.1 (33.1)
Equipment	2.3 (2.3)		3.2 (3.1)	5.5 (5.4)
Training and Consultants	-	-	3.4 (3.4)	3.4 (3.4)
Total	46.7 (22.8)	22.0 (10.2)	100.7 (39.6)	169.4 (72.6)

Note: Figures in parentheses are the respective amounts financed by the Bank Group. All figures include estimated physical and price contingencies.

3.29 Construction of national roads under the project will be carried out under international and local competitive bidding (ICB and LCB). The International Tendering Corporation of the China National Technical Import Corporation (CNTIC), in conjunction with MOC, will organize the ICB. MOC and the provinces will organize the LCB. Local bidders will be required to be financially and legally autonomous. Two major national road contracts (US$44.4 million) will be carried out through contracts awarded on the basis of ICB by prequalified firms in accordance with Bank Group Guidelines. The other national roads (US$22.0 million), which are unlikely to attract international contractors because of their dispersed location and size, would be awarded on the basis of LCB, the documentation for which is being prepared (para. 3.06).

3.30 Construction or improvement of rural roads (US$94.1 million) would be carried out under force account (para. 3.22). Currently, such construction is done under a Guarantee Letter from the provincial government to MOC and the

Ministry of Finance (MOF), ensuring that the funds will be made available from budget, loan or grant sources for the roads in question, based on a guarantee from the CTD to the PTD. In the future and under the proposed project, the PTDs would sign priced agreements with the county governments for the construction of works. During negotiations agreement was reached with Government on a priced Bill of Quantities for each rural road subproject in order to establish a firm and agreed cost.

3.31 Road maintenance equipment (US$2.3 million) would be procured by ICB, but as the equipment to be procured for the HPDI and HSRI (US$1.4 million and US$1.7 million, respectively) and for the training component is highly specialized, limited international bidding from at least three suppliers would be used. However, items or groups of items estimated to cost less than the equivalent of US$50,000 per contract, up to an aggregate amount not to exceed the equivalent of US$300,000, may be procured on the basis of a comparison of price quotations solicited from at least three suppliers eligible under the Guidelines, and in accordance with procedures acceptable to the Bank/Association. CNTIC or another authorized government agency would be responsible for all equipment procurement through ICB.

3.32 Under ICB, qualifying domestic contractors and manufacturers would be permitted to participate and would be eligible for a margin of preference of 7½% for civil works and 15% for goods, or the prevailing customs duties, whichever is lower, in the comparison of bids. Since this would be the first time that contracts would be awarded on the basis of competitive bidding in the highway subsector in China, all contracts for civil works and equipment would be subject to prior review and agreement by the Bank Group.

H. Disbursements

3.33 Disbursement of the Bank loan/IDA credit would be as follows:

(a) 46% of the total cost of national road construction;

(b) 35% of the total cost of rural road construction;

(c) 100% of foreign expenditures for directly imported equipment or 100% of local expenditures (ex-factory) and 75% of local expenditures for other items locally procured;

(d) 100% of the costs of foreign consulting services and local experts; and

(e) 100% of the costs of overseas training of staff.

To facilitate disbursement, a Special Account would be opened in US dollars in a Bank acceptable to the Bank Group with an initial deposit of the US dollar equivalent of SDR 10.0 million, which represents the estimated maximum expenditures for a four-month period. Applications for replenishment of the Special Account would be submitted quarterly or whenever the Special Account is drawn down to 50% of its initial deposit, whichever comes first. The project would be completed by June 30, 1990. Loan/credit closing is expected

by June 30, 1991. A schedule of estimated disbursements is given in Table 3.4 which also shows the Regional highway project disbursement profile. Disbursements under the proposed project are estimated to be completed slightly earlier than the regional profile shows. Since China's economy is growing steadily, revenue accrual is expected to remain strong during the project period and therefore delays due to budgetary constraints are not anticipated. Although the new competitive bidding procurement method is being introduced for the first time in China for highways and could cause problems, any delays are expected to be minimized by appropriate Bank Group supervision and assistance during the early stage of the project.

3.34 Loan/credit disbursements would be made against priced contracts for national road civil works and equipment, and priced agreements for the force account civil works on rural roads. Interim certification of civil works completed and costed at unit rates in the contracts and agreements will be done by the Provincial and County Highway Bureaus and certified by the MOC. Loan/credit disbursements for training overseas will be made against the actual costs of travel, subsistence and tuition or training fees. Disbursements against statements of expenditure will be needed for the training component and for goods or services costing less than US$50,000. Documents to support statements of expenditure would not be submitted to the Bank Group, but would be retained by the MOC and made available for review by Bank supervision missions.

I. Auditing, Reporting and Monitoring

3.35 A State Auditing Agency (SAA) has been established to carry out detailed audits of government agency accounts. Assurances were obtained from Government during negotiations that the accounts of project-related expenditures would be audited by independent auditors acceptable to the Bank/Association, and that audit reports would be sent to the Bank Group for review within six months of the close of each fiscal year. The Bank Group currently accepts SAA audits for this purpose.

3.36 Assurances were obtained from Government during negotiations that project progress reports would be submitted to the Bank Group quarterly by MOC, based on the Project Monitoring Indices shown in Annex 5. Assurances were also obtained on the preparation and submission by Government of a Project Completion Report not later than six months after the loan/credit closing date.

J. Environmental Effects

3.37 The road improvements should cause no significant environmental problems. By following existing alignments to the extent technically and economically feasible, the acquisition of scarce agricultural land will be minimized. The improved alignment and reduction of existing hazardous dust and mud by paving would improve road safety.

IV. ECONOMIC EVALUATION

A. General

4.01 China's new economic policies, particularly the emphasis on light industry and the economic responsibility system in agriculture.[3/] are creating a rapidly growing demand for both long- and short-distance road transport. The rapidly increasing output of textile, chemical, electronic and food processing industries, which are all well suited to road transport, has been accompanied by a growing demand for transport from producer to consumer between cities and often across provincial boundaries. In rural areas, agricultural production as well as the increasing production of household and rural enterprises must be transported, often very rapidly, to nearby towns and other neighboring areas. Moreover, various enterprises have come to realize the financial advantages of highway transport, which enables them to deliver industrial goods and perishable products rapidly and promptly to cities. The development of tourism throughout China and the very rapid increase in highway passenger traffic have also indicated the need for substantial development of highway infrastructure to serve the various and steadily increasing needs of China's economy.

4.02 To handle the emerging demand for both long- and short-distance road transport, development of roads should be on two fronts: (a) the improvement and strengthening of major intercity highways, including bridges; and (b) the development and expansion of rural road networks. The proposed project would address both of these needs by directly contributing to the Government's plan of closing gaps in the national road network to facilitate interprovincial road transport, and by helping to develop rural roads in areas presently accessible only by footpaths. The benefits of the national road construction will accrue widely throughout the economy. Rural roads will open opportunities to exploit resources for which low-cost motorized transport is required, and benefits will accrue to the residents of the areas served. The detailed economic analyses of the major project components are given below.

4.03 For this analysis, all inputs and outputs were evaluated in September 1984 constant economic prices. Taxes and duties were excluded from financial prices. For traded goods, the c.i.f. prices of imports and f.o.b. prices of exports were used in estimating the cost of materials and equipment with due adjustment for the cost of inland transportation. The official exchange rates were used to convert foreign currencies to Renminbi. A conversion factor of 0.5 was applied for unskilled labor costs, while the shadow wage rate was calculated at four times the actual wage for highly qualified supervisory staff.

3/ Under the economic responsibility system, surplus production belongs to the producing farmer.

B. Construction and Improvement of National Roads

4.04 Since the road sections included in the project are missing links in the network, traffic will be diverted from more circuitous routes. In order to estimate potential traffic diversion, traffic counts carried out on these routes since 1980 have been used, supplemented by origin-destination surveys in 1983 and 1984. The 1984 traffic levels that could have been expected on the project roads if they had existed range from 264 AADT to 3,064 AADT. Traffic volumes have been estimated by using a growth rate of 9% p.a. between 1984 and 1988, when the roads would be opened. Allowance for generated traffic was made by increasing the growth rate to 12% p.a. for two years following opening of the roads and then a gradually decreasing growth rate over the project life. Traffic forecasts are shown in Table 3.1.

4.05 The main benefits obtained from the construction of the roads are substantial savings in vehicle operating costs (VOCs) resulting primarily from distance savings and to a lesser extent from reduced VOCs due to improved surface conditions. Other benefits such as time savings and reduced accidents and congestion on the existing alternate routes are smaller and have only been quantified when significant on roads with the highest traffic volumes. Annex 6 gives the detailed analysis for the Xian-Sanyuan road, and the economic rates of return (ERR) for other roads, calculated in the same way, are given in Table 3.1. They range from 17% to 37%.

C. Construction and Improvement of Rural Roads

4.06 The benefits of rural roads would be in terms of transport cost savings as well as value added to new production which the roads would make possible by reducing transport costs. The service areas of the project roads are presently only accessible by trails and all transport is by porters. Usually a porter can carry a 50 kg load for about 20 km each day; the cost per ton-km is between 3 and 4 yuan. With the road, transport costs will fall to some 0.2 yuan per ton-km. The largest benefit however will be in terms of value added through the exploitation of resources which are uneconomical at the prevailing transport cost and impractical in terms of the hard labor involved. Since the proposed roads to be constructed are in the more hilly areas of the various provinces included in the project, the resources are mainly from mining of coal, construction materials, marble, timber and bamboo production, and only to a lesser extent from increased agricultural production of cash crops. Annex 7 gives the detailed analysis for one rural road in Sichuan Province, and the ERRs for the others calculated with the same model are given in Table 3.2. They range from 14% to 37%.

D. Overall Evaluation and Risks

4.07 Based on the combined costs and benefits of all project roads and some minor maintenance equipment to be provided under the project, the overall ERR of the project is 20%.

4.08 The major project risk involves possible delays in project start-up and implementation due to the introduction of ICB and LCB. To minimize this risk, appropriate Bank Group assistance and supervision will be provided in the early project stages. It is unlikely that traffic growth will be lower than estimated since road transport in China is at an early stage of development and the potential for growth is very large. Traffic growth may well be higher than estimated. The risk is therefore very low that the rate of return would fall below the above estimate. The sensitivity for the major project components is summarized below:

	Internal Economic Rates of Return		
	National Roads (%)	Rural Roads (%)	Entire Project (%)
Best estimate	21	21	20
Construction cost up 20%	18	18	17
Traffic growth reduced by 10%	20	n.a.	n.a.
Slower increase in value added by 25%	n.a.	17	n.a.

n.a. - not applicable.

V. AGREEMENTS REACHED AND RECOMMENDATION

5.01 Agreement with Government was reached during negotiations on:

(a) road sections to be constructed under the project and their design standards (paras. 3.05 and 3.07);

(b) an implementation schedule for the training program (para. 3.13);

(c) terms of reference for consulting services for the project (para. 3.14);

(d) a project implementation schedule (para. 3.27); and

(e) a priced Bill of Quantities for each rural road subproject (para. 3.30).

5.02 Assurances were obtained from Government during negotiations that:

(a) road segments to be constructed/improved and related design standards would be as agreed (paras. 3.05 and 3.07);

(b) studies would be carried out under terms of reference and timing acceptable to the Bank/Association and Government and the Bank/Association would exchange views on the findings of the studies (para. 3.11);

(c) training would be carried out according to an agreed program (para. 3.13);

(d) the audited accounts of project-related expenditures prepared by the State Auditing Agency will be sent to the Bank Group for review within six months of the close of each fiscal year (para. 3.35); and

(e) project progress reports will be submitted quarterly to the Bank Group, and a Project Completion Report will be submitted to the Bank Group not later than six months after the loan/credit closing date (para. 3.36).

5.03 Signing of the Project Implementation Agreement (para. 3.24) and State Council approval of the Loan/Development Credit Agreements would be conditions of loan/credit effectiveness.

5.04 With the above agreements, assurances and conditions, the proposed project is suitable for a Bank loan of US$42.6 million for a term of 20 years, including a grace period of five years at the standard variable interest rate, and an IDA credit of SDR 30.3 million (US$30 million equivalent) on standard IDA terms. The borrower would be the People's Republic of China.

Table 1.1

CHINA

HIGHWAY PROJECT

Annual Growth and Modal Split in Freight Traffic, 1949-83
(Billion ton-km)

Years	Highways		Railways	Inland waterways	Pipelines
The Expansion Period (1950s)					
1949	0.81		18.4	6.31	
1950	n.a.		39.4	n.a.	
1952	1.45		60.2	14.58	
1957	4.80		134.6	n.a.	
1958	6.96		185.5	n.a.	
1960	n.a.		228.0	n.a.	
Annual growth over the period (%)	27.0		25.0		
Modal split (%)	1.9		79.0	19.1	
The Retrenchment Period (1960s)					
1965	9.51		269.6	n.a.	
1970	17.50		272.0	n.a.	
Annual growth over the period (%)	13.0		1.8		
The Re-expansion Period (1970s)					
1975	20.26		427.6	102.1 /b	
1979	26.83	(74.5)/a	559.8	139.0	47.6
Annual growth over the period (%)	4.8		8.0	11.0	
Modal split (%)	9.6		72.4	18.0	
The Modernization Period (1980s)					
1980	25.5	(76.4)	571.7	152.3	49.1
1981	25.3	(78.0)	571.2	150.7	49.9
1982	30.3	(94.9)	612.0	170.8	50.1
1983		(108.4)	664.6	180.5	52.4
Annual growth 1980-83 (%)	4.2	(8.5)	3.5	7.2	
Modal split (%)	11.0		66.0	18.0	5

/a In the case of highways, figures in parentheses show total freight traffic in the country; figures not in parentheses show freight traffic handled by public trucks.
/b 1977 figure.

Sources: Ten Great Years, pp. 146, 148, Beijing, September 1959 (for 1949-1958 figures); Joint Economic Committee, Congress of the United States, People's Republic of China: An Economic Assessment, Washington, D.C. 1972 (Estimated figures for 1960-1970); China Economic Yearbook, 1981 (for 1970-1975 figures); Communique issued by the State Statistical Bureau, Beijing, April 1982 (for 1975-1982 figures).

Table 1.2

CHINA

HIGHWAY PROJECT

Annual Growth and Modal Split in Passenger Traffic, 1949-83
(Billion passenger-km)

Years	Highways	Railways	Inland-waterways	Aviation	Total
The Expansion Period (1950s)					
1949	0.8	13.0	1.5		
1950	1.3	21.2	1.5		
1952	2.3	20.1	2.4		
1957	8.8	36.1	4.6		
1958	11.6	40.9	4.6		
1960	14.6	67.4	4.6		
Annual growth over the period (%)	35	13.8	15		21.6%
Modal split (%)	17.8%	72.8%	9.4%		
The Retrenchment Period (1960s)					
1965	16.8	47.8	4.74		
1970	24.0	71.8	7.1		
Annual growth over the period (%)	24.3	68.9	6.8		
Modal split (%)	31.2	62.9	5.9		
The Re-expansion Period (1970s)					
1975	37.45	95.3	9.06		
1979	60.30	121.6	11.40	3.5	
Annual growth over the period (%)	12.8	6.4	6.0		8.4%
Modal split (%)	31.2%	62.9%	5.9%		
The Modernization Period (1980s)					
1980	72.9	138.3	12.9	4.0	
1981	83.9	147.3	13.8	5.0	
1982	96.4	157.5	14.5	6.0	
1983	110.6	177.6	15.4	5.9	
Annual growth 1980-83 (%)	17.0	9.0	8.4		11.6%
Modal split (%)	36.0	57.0	5.0	2	

Table 2.1

CHINA

HIGHWAY PROJECT

Highway Design Standards in China

	Expressway		Class 1		Class 2		Class 3		Class 4	
	Plain-hilly area	Hilly-mountain area	Plain-hilly area	Hilly-mountain area	Plain-hilly area	Hilly-mountain area	Plain-hilly area	Hilly-mountain area	Plain-hilly area	Hilly-mountain area
Number of vehicles accommodated	----->25,000-----		--5,000-25,000--		--2,000-5,000---		-----<2,000-----		------<200------	
Design travel speed (km/hr)	120	80	100	60	80	40	60	30	40	20
Surface width (m)	2x7.5	2x7.0	2x7.5	2x7.0	9	7	7	6	3.5	3.5
Subgrade width (m)	26	23	23	19	12	8.5	8.5	7.5	-------6.5-------	
Minimum radius of horizontal curves (m)	650	250	400	125	250	60	125	30	60	15
Maximum gradient (%)	3	5	4	6	5	7	6	8	6	9
Minimum passing sight distance (m)	210	110	160	75	110	40	75	30	40	20
Nonsuperelevated radius of horizontal curve (m)	5,500	2,500	4,000	1,500	2,500	600	1,500	350	600	150

Source: Technical Standard on Road Engineering, Highway Bureau, Ministry of Communications, Beijing, 1981.

Table 2.2

CHINA

HIGHWAY PROJECT

Road Pavement Standards

Pavement surfacing	Pavement surfacing material	Vehicle accommodation capacity (number of vehicles/day)
Highest standard	Asphaltic concrete Cement concrete Hot-mix macadam	>5,000 (expressway and Class 1 roads)
High standard	Penetration macadam surface Cold-mix macadam	2,000-5,000 (Class 2 roads)
	Bituminous-coated macadam	300-2,000 (Class 3 roads)
Medium standard	Bituminous-lime treatment	50-400 (Class 4 roads)
	Graded-aggregate, gravel surface	50-300 (Class 4 roads)
Low standard	Improved earth surface	<50 (rural roads)

Source: Ministry of Communications.

Table 2.3

CHINA

HIGHWAY PROJECT

International Comparison of Vehicle Production in 1980 /a

Country	Population ('000 people)	Area ('000 sq km)	Cars	Trucks & buses	Total	Population/car	Area (sq km)/ truck
China	1,000,410	9,600	11,940	163,705	175,645	83,786	58.6
(% of total)			(6.8)	(93.2)			
India	680,000	2,974.7	29,183	72,044	101,227	23,301	41.3
(% of total)			(28.8)	(71.2)			
Romania	22,300	237.5	75,020	37,116	112,136	297	6.4
(% of total)			(66.9)	(33.1)			
Turkey	45,217	780.6	43,808	29,001	72,809	1,032	26.9
(% of total)			(60.2)	(39.8)			
Peru	17,293	1,285.2	5,808	4,940	10,745	2,977	260.1
(% of total)			(54.0)	(46.0)			
Chile	11,136	741.8	18,015	2,136	20,151	618	347.3
(% of total)			(89.4)	(10.6)			
Philippines	47,914	299.7	34,831	32,740	67,571	1,375	9.1
(% of total)			(51.5)	(48.5)			
Malaysia	13,297	329.6	60,582	14,395	74,977	219	23.0
(% of total)			(80.8)	(19.2)			

/a Data for China are for 1981.

Source: The World Automotive Market.

Table 2.4

CHINA

HIGHWAY PROJECT

Motor Vehicles Manufactured in and Imported into China, 1980-1984
(thousands)

Type	1980	1981	1982	1983	1984
Domestic Production					
Total Vehicles	222.3	175.6	196.2	239.8	(305.0)/a
of which trucks	135.5	108.3	121.8	137.1	n.a.
as % of total	61.0	62.0	62.0	57.0	
Imports					
Cars		1.4	1.1	5.8	
Trucks	22.0	20.8	7.7	8.4	
Dump trucks		1.5	1.1	2.3	
Chassis with engines		0.3	0.4	0.9	
Total		24.0	10.3	17.5	

/a Estimated. "The Beijing Review" (March 11, 1985) reports a 27% increase over 1983 production.

Source: Statstical Yearbook of China 1982, 1983 and 1984.

Table 2.5

CHINA

HIGHWAY PROJECT

Total Freight Transport Handled by State and Social Trucks

	Freight volume (million tons)			Freight density (billion ton-km)		Average distance (km)	
	Public truck	Social truck	Total	Public truck	Social truck	Public truck	Social truck
1978	852	2,406	3,258	27.4	44.6	32.1	18.5
1979	816	2,748	3,564	26.8	47.7	32.8	17.4
1980	760	2,060	2,820	25.5	50.9	33.5	24.7
1981	715	2,922	3,637	25.3	52.7	35.4	18.0
1982	788	3,004	3,792	30.3	64.6	38.4	21.5
1983	n.a.	n.a.	4,010	33.5	74.9	n.a.	n.a.

Note: Percentage of truck distribution: Public trucks = 14%
Social trucks = 86%

Source: Ministry of Communications, 1984
China Statistical Yearbook, 1983

Table 2.6

CHINA

HIGHWAY PROJECT

CTC's Vehicle Operating Cost in 1983 /a

Type of vehicle	Cost
4-10 ton trucks (Y/1,000 ton-km)	154
Container truck (Y/1,000 container-km)	1,245
Truck-Trailer (Y/1,000 ton-hr)	960
Standard 4-ton truck (Y/1,000 ton-km)	107-167/b

/a Data may represent planned targets.

/b Ranges as follows: Y 107/1,000 ton-km on Class 1 roads; Y 134 on Class 2 roads; and Y 167 on Class 3 roads.

Note: Statistics are based on CTC's branch office in Tienjin.

Source: Central Trucking Company.

Table 2.7

CHINA

HIGHWAY PROJECT

Composition of Vehicle Operating Cost: A Comparison

Cost composition	Sichuan Province	Shanghai	CTC average
Fuel	28.9	22.0	15.2
Vehicle repair	15.2	23.0	17.8
Overhauls	4.0	n.a.	9.1
Road maintenance fee	15.6	7.0	14.0
Tires	9.7	7.0	12.7
Labor cost	5.6	17.0	3.5
Vehicle depreciation	5.4	5.0	8.5
Administration and misc.	15.6	19.0	19.2
Total	100.0	100.0	100.0

Sources: Sichuan Provincial Transport Office, 1981; Shanghai Transport Office, 1981; and Central Trucking Company, 1983.

Note: Gasoline cost = Y 0.60/liter
Diesel cost = Y 0.40/liter
Average gasoline consumption = 0.086 - 0.0906 liters/ton-km
Average diesel consumption = 0.065 - 0.73 liters/ton-km

Table 3.1

CHINA

HIGHWAY PROJECT

National Road Sections to be Improved or Newly Built

Section No.	From - To	Length (km)	Standard	Investment cost /a (at 1985 prices: Y mln)	Actual traffic (1984) (AADT)	Forecast Traffic (AADT) 1988 (opening year)	1997 (After 10 years)	Annual growth rate (%)	ERR
Shandong									
01	Huihe-Majiadian	20.85	Class 2	9.39	726	1,127	2,126	7	19
02	Yancheng-Gaotang	53.20	Class 2	33.31	1,100	1,708	3,222	7	17
Shaanxi									
03	Xian-Sanyuan	35.18	Class 1	80.30	3,064	4,758	8,974	7	18
Anhui									
04	Laibang-Baojiahe	35.11	Class 3	7.59	264	429	809	7	23
Fujian									
06	Gaotien-Huashanjie	32.45	Class 3	13.41	469	668	1,260	7	37
Sichuan									
07	Longtai-Tangba	28.26	Class 3	17.50	507	787	1,485	7	20
Yunnan									
08	Yangwu-Honglongchang	21.39	Class 3	9.34	774	1,202	2,267	7	24
	Total	226.44		158.69					

/a Includes right-of-way costs and MOC contingencies.

Note: Road Number 05 has been canceled.

CHINA

HIGHWAY PROJECT

Rural Roads to be Improved or Newly Built

Section No.	From - To	Length (km)	Road class standard	Investment cost/a (at 1985 prices: Y million)	ERR
Zhejiang (01-11)	Total	261.74		40.05	
01	Deqing-Tongxiangzhouquan	36.00	3	6.61	31
02	Yukangtangqi - Deqing	17.34	3	3.20	28
03	Lin'antuankou - Chun'anxiazhong	28.00	4	3.11	16
04	Majian-Jinshazhuji	4.60	4	0.61	26
05	Pan'anfangqian - Tiantaihuaqiang	8.82	3	1.37	26
06	Yongjiaxiasheng - Jinyunnanxi	30.98	4	3.23	17
07	Rui'anyaozhuang - Ouhaiheshangling	10.00	4	1.36	28
08	Qingtiantangqiang - Rui'anshilong	49.40	3	9.27	22
09	Wenchengshanxi - Taishunxiahong	40.80	4	5.47	20
10	Yunhedajun - Shawan	21.80	4	3.86	16
11	Qingyuanjianggen - Shouningkengdi	14.00	4	1.96	15
Anhui (12-16)	Total	195.63		23.36	
12	Jiapeng-Jingzhou	30.00	4	2.67	23
13	Nanyuankou-Shendu	30.02	4	3.06	19
14	Huangbei-Xiaochuan	20.35	4	1.72	18
15	Tangpohe-Qianshan-Yuexi	60.10	3	9.44	34
16	Huanggang-Bailitun	55.16	4	6.47	29
Jiangxi (17-31)	Total	284.30		41.84	
17	Linjia-Fanzhen	10.35	4	1.25	33
18	Wuning-Xinji	25.75	3	5.46	17
19	Huangshageng-Xixia	12.87	4	2.32	29
20	Yushan-Tongfang	55.78	4	4.45	19
21	Yaoli-Mifengjie	10.40	4	1.57	33
22	Jiaokang-Le'an	38.94	4	5.33	30
23	Yutang-Lujiang	14.40	4	1.41	30
24	Xincheng-Qiusha	16.80	4	3.87	22
25	Wanhe-Potou	11.60	4	1.78	22
26	Hanxia-Nanlin	5.60	4	0.73	28
27	Juncun-Huangtang	23.71	4	3.39	22
28	Ruikeng-Shatianshui	5.00	4	0.72	37
29	Lintan-Guting	14.00	4	2.18	27
30	Zhuangkuo-Huangling	29.80	4	6.01	21
31	Longbu-Tianxin	9.30	4	1.37	20

Section No.	From - To	Length (km)	Road class standard	Investment cost/a (at 1985 prices: Y million)	ERR
Guanxi (32-38)	Total	185.60		34.60	
32	Xindu-Huaiji	32.80	3	6.85	25
33	Yunbiao-Nayang	18.00	3	3.08	32
34	Tiandong-Zukong	13.80	3	6.24	18
35	Dishui-Luoxiang	32.00	4	4.66	16
36	Baizhupu-Niutangjie	39.00	4	4.00	20
37	Antai-Dongtou	13.00	4	2.49	18
38	Chuanshan-Xiangzhou	37.00	3	7.28	20
Sichuan (42-58)	Total	276.34		59.45	
42	Linkou-Miaoxi	25.74	4	4.24	20
43	Lujiao-Gongtan	15.00	4	1.50	18
44	Yushan-Lianhe	16.50	4	3.54	17
45	Xiangkou-Baima	25.00	4	6.91	27
46	Fucheng-Yuquan	16.00	4	4.40	18
47	Zhouhe-Wangyu	5.50	4	1.84	17
48	Sijing-Yuquan	11.00	4	2.20	16
49	Kuile-Nanbaoshan	16.10	4	4.60	18
50	Minzhi-Minhe	15.05	4	3.78	16
51	Wudu-Tuanshan	9.70	4	4.27	21
52	Jinshan-Zhuyuan	12.30	4	2.46	16
53	Mingjing-Sanhekou	30.03	4	5.37	18
54	Yaojia-Jinshan	17.20	4	2.17	17
55	Fenshuiling-Shanhekou	14.41	4	1.68	18
56	Puguang-Fenshuiling	10.03	4	1.42	18
57	Dayuan-Qifo	25.78	4	5.67	19
58	Yanjing-Tianhuaban	11.00	4	3.40	16
Yunnan (59-62)	Total	168.37		26.56	
59	Mongzi-Bada	51.52	4	6.61	14
60	Kunluoxian-Nannuoshan	11.55	4	2.07	15
61	Jinghong-Monglun-Xiaomenglum	70.30	4	12.04	19
62	Mengla-Yaoqu	35.00	4	5.84	16
	Total Length	1,371.98			
	Total Cost			225.86	

/a Includes right-of-way costs and MOC's contingencies.

Note: Roads 39, 40 and 41 have been canceled.

Table 3.3

CHINA

HIGHWAY PROJECT

Training Program

Description	US$
Training Equipment and Materials	720,000
Audiovisual training aids and laboratory, computer, and other training equipment for Provincial Transportation Schools (PTS) in project provinces.	
Work Visits of Expatriate Experts to China	100,000
Short visits to selected MOC Highway Colleges and PTS by expatriate experts to upgrade relevant curricula.	
Books and Technical Publications	48,000
Essential books and technical publications for MOC, HPDI, HSRI, and PTD/PTS of project provinces.	
Training Abroad (Fellowships) /a	1,262,000
- Short courses on teaching methodology for about 20 teachers-lecturers of PTS of project provinces.	160,000
- Practical secondments for about 24 MOC senior engineers and PTD design and construction technical managers connected with the project for about 6 months.	440,000
- Training courses and practical secondments on project management, accounting, planning (economic) and statistical information for about 20 MOC and PTD staff for about 3 months.	150,000
- HPDI and Provincial HPDIs. Courses and practical secondments for survey and design of highways and bridges, for 14 engineers for about 2 months.	90,000
- HSRI and Provincial HSRIs. About 20 staff to attend courses related to their respective research programs for about about 3 months.	150,000
- Short courses on engineering management, subgrade and pavement technology, aerial survey, etc., for about 22 PTD staff for about 3-6 months.	240,000
- Advanced courses /b for interpreters from MOC and PTDs.	32,000
Total	2,130,000

/a Specific number of trainees and duration of courses, secondments, etc., will depend on availability of courses and actual cost of programs.

/b Some of these courses may be conducted in China.

Table 3.4

CHINA

HIGHWAY PROJECT

Estimated Disbursement Schedule

IBRD/IDA fiscal year and semester	Estimated cumulative disbursements US$ million	%	Disbursement profile of Regional highway projects (%)
1986			
December 31, 1985	2.0	3	
June 30, 1986	9.0	12	7
1987			
December 31, 1986	21.0	29	
June 30, 1987	34.0	88	22
1988			
December 31, 1987	50.0	69	
June 30, 1988	64.0	88	42
1989			
December 31, 1988	67.0	92	
June 30, 1989	69.0	95	63
1990			
December 31, 1989	70.0	96	
June 30, 1990	71.0	98	80
1991			
December 31, 1990	72.6	100	92
June 30, 1991			
1992			
December 31, 1991			
June 30, 1992			100

CHINA

HIGHWAY PROJECT

MOC Highway Institutes

The Highway Planning and Design Institute

1. Located in Beijing with a staff of more than 240 engineers and technicians, of whom some 60% are senior engineers and specialists, the Institute has, for 30 years, played a leading role in the planning, design and management of the highway system in China.

2. The principal responsibilities of the Institute are:

(a) Preparation of Master Plans for the Highway Networks. This covers long- and short-term planning of the national highway network, overall guidance in planning of the provincial highway network and preparation of programs for the improvement and reconstruction of the existing national highway network. Some 133 permanent traffic counting stations and 3,000 semi-permanent traffic counting stations have been set up to provide data which are combined with the findings of studies on key industries such as agriculture and industry to develop patterns for highway transport.

(b) Preparation of feasibility studies for key highway projects as well as budgetary estimates for highway projects.

(c) Preparation of national design standards for highways and bridges such as:

- Code of Practice for Site Reconnaissance and Survey of Highway Bridges;
- Standard Specifications for Design of Flexible Pavements;
- Standard Specifications for Design of Concrete Pavements;
- Design Specifications for Roads in Factory and Mining Areas; and
- Standard Specifications for the Design of Highway Bridges and Culverts.

(d) Preparation of standard plans for bridges and culverts.

(e) Design of major bridges and expressways.

(f) Design of highway industry buildings, automobile repair shops, container and long-distance bus terminals.

The Highway Scientific Research Institute

3. Located in Beijing, the Institute has a total staff of 485 of whom about half are scientists and engineers. about 70% of the scientists and engineers have more than 15 years practical experience and 22 are senior engineers and researchers. Facilities include laboratories and experimental areas for bridge structures, motor vehicle operation, civil engineering materials, etc. Construction of a new building for experiments started in 1983 and will be completed in 1986 to provide an additional 15,200 sq m of space. On completion, it is intended to rearrange the laboratories and introduce more advanced experimental capability. The Institute provides technical and scientific advice to help formulate, develop and implement government policy on highways and highway transport and is the main scientific and technological base for highway transportation in China.

4. The Institute's main tasks are:

- to help formulate highway transport policy and the highway scientific and technological development program;
- to coordinate scientific research work on highway transport in the country;
- to undertake research and development related to planning, design, construction and maintenance, highway structures including bridges and tunnels, engineering materials, road construciton and maintenance equipment, traffic engineering, computer applications and the operation, maintenance and energy efficiency of motor vehicles;
- to serve as a medium for the evaluation and introduction of advanced or new technology on highway transport; and
- to foster graduate students and in-house expertise in specialized aspects of highway transport.

5. The Institute's major research tasks over the next five years would be on:

(a) technology concerned with the qualitative evaluation of existing paved highways and bridges in order to prepare a strengthening, rehabilitation and maintenance program for these facilities;

(b) low-cost solutions to road congestion near cities;

(c) identification of optimum axle loads for China;

(d) prevention of road traffic accidents;

(e) design of semi-rigid base layers under asphaltic ~~concrete~~ surfacing;

(f) the potential for preparing high grade asphaltic concrete pavement, using locally produced asphaltic cement;

(g) the use of cement concrete highway pavement;

(h) the compaction of highway foundation layers in relation to various soil and moisture characteristics in order to improve technology for constructing highways under various conditions such as frost, desert, morass, saline, etc.;

(i) technology related to the management of expressways;

(j) the geometric structure of highways in order to formulate a rational basis for classification and for design criteria;

(k) bridge hydrology;

(l) technology related to the quality control of concrete;

(m) special concretes; and

(n) soil stabilization.

The First Survey and Design Institute

6. Locatied in Xian, Shaanxi Province, the Institute was founded in the early days of the People's Republic as the Northwest Design Company. The Institute, which is connected to the China Road and Bridge Engineering Company, has a total staff of 305, comprising 5 high-level civil engineers, 104 civil and management engineers, 67 assistant engineers, 10 technicians and about 119 university and middle school graduates.

7. The Institute's main tasks are the survey and design of major highways, large- and medium-size highways, bridges and tunnels, urban highways, rehabilitation works, as well as geological and site investigations including the location of aquifers and the preparation of technical feasibility studies. Since its founding, the Institute has surveyed and designed highways, bridges, tunnels and other engineering projects in China as well as in Asia and Africa. Recent major projects in China include the Qinghai-Tibet Highway (Roof-of-the-World Highway); the Tianshan Highway crossing the Tianshan mountain range; the Luanchi Highway in the Yanshan Region; and high-grade highways for the Zhunger coal fields and the Beijing-Tiangin-Tanggu Expressway. Major bridges surveyed and designed include: Wujiang Bridge, Gezhentan Yellow River Bridge, the Lanzhou Yellow River Bridge and Jiangsu Guan River Bridge. Major tunnels surveyed and designed include the 1,000 meter long Yuxi Molegai Tunnel at 3,400 meter altitude on the Tianshan Highway in a geologically complex area, and four tunnels on the Luanchi Highway beyond Yantai. The Institute was also concerned with the proposed Nanjing-Hangzhou-Ningho and the Guangzhou-Shenshen-Zhuhai expressways. Overseas, the Institute has surveyed and designed about 1,520 km of highways in Vietnam, Somalia, Iraq, Yemen Arab Republic and the People's Democratic Republic of Yemen.

CHINA

HIGHWAY PROJECT

Significance of Proposed National Road Investments

Province	Road number	Class	Justification of choice
Shandong	01	2	- Completes the links between Bingzhou City to Jinan, the provincial city of Shandong. It will contribute to the industrial development of this area.
	02	2	- Completes the links from Jinan to Hebei Province, and has junctions with several other trunk roads. It will contribute immensely to industrial development.
Shaanxi	03	1	- Links Xian-Sanyuan to Tongchuan and Shaanbei, an important coal mining and industrial area of Shaanxi. This area is called the "Black Belt of Shaanxi."
Anhui	04	3	- To transport approximately 100,000 tons of agricultural products between Laibang and Baojiahe counties. It is a hilly area close to Hubei Province.
Fujian	06	3	- At the border of Fujian and Jiangxi Provinces. This road is linked to the economic development of the mountainous province of Guangfeng county.
Sichuan	07	3	- Completes the links from Chengdu, capital city of Sichuan, to Chongquing, the most important industrial city of the province. The population density and the level of development of the two cities are as high as that of the Beijing and Tianjin area.
Yunnan	08	3	- To reduce the distance between Suijiang and Xinshizhen by 89 km. It will make a major contribution to the agricultural economies in these counties.

Note: Road No. 05 has been canceled.

CHINA

HIGHWAY PROJECT

Provincial Profiles

Province		Geographical and economic conditions
Shandong	-	Located in the northeast, with 65% of its area swampy and 35% hilly. Flooding from the Yellow River reduces the harvest, and it was not self-sufficient in agricultural products until 1970. There are some coal mines, gold mines, iron ore and tin. Its industrial products are cement, cotton textiles, chemical fertilizers and machines.
Shaanxi	-	Located in the middle range of the Yellow River with 45% of its area highland, 35% mountainous and 20% plain. Agriculture and irrigation have long been developed, but there still is a serious problem of land erosion. Mineral resources are abundant, especially coal in the Tongchuan area to the north of the Weihe River, in the area called the "Black Belt of Shaanxi." This is also an industrial center for Shaanxi. Light industries are textile and paper mills. Heavy industries are steel, machine building, cement, chemical fertilizers, etc. The proposed national road link will pass through this industrial center.
Anhui	-	The Chang Jiang (Yangtze River) passes through the southern half of the province. An irrigation system has been well developed over a long time. The land is very fertile even though 70% of the area is mountainous and hilly. There is also an abundance of iron ore and coal. However, industry has developed only in the past 30 years and comprises food processing, paper products and chemical industries.
Sichuan	-	The province, in the southwest, has long been important economically, culturally, militarily and politically. In terms of politics, it has been the passage leading the Han people to the tribal people in the west. In terms of economics it is very fertile land for tropical plants, particularly cotton, oil seed and sugarcane. Industrial development started relatively early, beginning with silk weaving. Now there are machine, chemical, fertilizer and wood processing industries. There is also a vehicle manufacturing plant in Chongqing. The population density in the two major cities, Chengdu and Chongqing, is comparable to that of Beijing and Tianjin. However, because of the difficult topography characterized by high mountains and deep valleys, transportation investment costs in this province are high.

Province		Geographical and economic conditions
Fujian	-	Located on the southeastern coast of China with 90% of its area mountainous. Main economic activities are tea plantations and forestry. There are also some mineral resources. Industrial development started only after 1950, with steel, textile, paper, timber and sugar refining industries.
Yunnan	-	Located on the southern border of China close to Burma, Lao PDR and Viet Nam. It has many tribal people. 93% of the total area is mountainous and highlands and only 6% is cultivable land. The main economic activity is forestry. There are large amounts of tin ore. Industrial development is still at an early stage.
Zheijiang	-	Located on the east coast with 70% of its areas mountainous and 30% valley. It is a very fertile area with good irrigation developed since the second century; 80% of the cultivated area is irrigated. Industrial development began at the beginning of the twentieth century. It was very famous for textile, paper, tea and distilling industries. During the past 30 years, it has introduced heavy industries such as chemicals and machine building. The transport sector is also one of the relatively well developed sectors. This is one of the richest provinces in China.
Jiangxi	-	Located south of the Chang Jiang with 70% of its area mountainous and hilly; land erosion is serious, and drought common. However, it is the most important tungsten ore area in China. It is also very famous for ceramic work. Some heavy industries started after the 1950s but are not yet well developed.
Guangxi	-	On the southern boundary of China and the autonomous region for the Juan tribe which is the largest minority in China. The topography is 85% mountainous and 15% plain. Agriculture products are paddy, tropical plants, timber and marine products. There is an abundance of natural resources, the most important being manganese. Light industry is being developed, mainly sugar refining, canned food products and handicrafts. Development is still slow, and it is one of the lowest income provinces of the country.

CHINA

HIGHWAY PROJECT

Project Implementation Schedule

	Implementation	
	Start	Complete
Part A - National Road Construction and Improvement		
- Prequalification of contractors including Bank review	Mar 5, 1985	May 31, 1985
- Bid period	Jun 10, 1985	Aug 31, 1985
- Receive and open bids, evaluation and receipt by Bank of copy of Evaluation Report and Government recommendations	Sep 1, 1985	Dec 20, 1985
- Appoint supervision staff		Jan 01, 1986
- Select consultants for organization of supervision of works and award contracts		Jan 20, 1986
- Construction of national road links	Mar 1, 1986	Jun 30, 1988
Part B - Rural Road Construction and Improvement		
- Sign contracts with County Governments		Sep 30, 1985
- Set up Project Management Unit		Oct 15, 1985
- Appoint supervision staff		Nov 01, 1985
- Construction/improvement of rural roads	Nov 15, 1985	Nov 15, 1987
Part C - The Provision of Computer Aided Design and Engineering (CADE) and Other Computer Equipment for the HPDI and the HSRI		
- HPDI and HSRI prepare functional requirement study		Jul 31, 1985
- Consultant review of functional requirement study	Aug 1, 1985	Sep 30, 1985
- Prepare specifications and documents	Oct 1, 1985	Nov 30, 1985
- Invite bids from selected international suppliers		Dec 15, 1985
- Evaluation of bids and receipt by Bank of report on evaluation with Government recommendation	Mar 15, 1986	Apr 15, 1986
- Carry out bench tests of equipment selected for consideration	May 01, 1986	May 31, 1986
- Evaluate bench tests		Jun 15, 1986
- Negotiate with selected supplier	Jul 01, 1986	Jul 31, 1986
- Carry out acceptance testing of equipment		Sep 01, 1986

	Implementation	
	Start	Complete
Part D - Provision of Site Investigation and Laboratory Testing Equipment for the HPDI and the HSRI		
- Prepare equipment list, specifications and bid documents and submit to Bank for review		Oct 31, 1985
- Invite bids from selected international suppliers		Nov 15, 1985
- Evaluation of bids	Jan 15, 1986	Jan 30, 1986
- Receipt by Bank of report on evaluation with recommendation for award		Feb 15, 1986
- Award contracts		Mar 01, 1986
- Delivery of equipment.	Apr 01, 1986	Sep 31, 1986
Part E - Consulting Services		
- Assistance in supervision of construction	Nov 01, 1985	Nov 15, 1988
- Assistance in CADE equipment procurement including function requirement study, evaluation of proposals, testing, etc.	Jul 31, 1985	May 01, 1986 (part-time)
- Assistance in studies, seminars and workshops	Jan 01, 1985	Jan 01, 1988 (part-time)
Part F - Studies by HSRI		
- Paved road evaluation study for the preparation of paved road strengthening and rehabilitation	Jul 1, 1986	Dec 31, 1987
- Study to identify a low cost solution to road congestion near cities	Jul 1, 1986	Dec 31, 1987
- Road traffic safety study	Jul 1, 1986	Dec 31, 1987
Part G - Staff Training		
- Selection of trainees		Aug 31, 1985
- Placement of trainees	Sep 30, 1985	Sep 30, 1986
- Training	Continuous	
- Workshops	As needed	
- Seminars	As needed	

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HIGHWAY PROJECT

Project Monitoring Indices

Project Component	Estimated	Actual	Actual as % of estimated	Reason for difference (if any)	Action to be taken
National Road Construction and Improvement					
(a) Contract awards (dates)					
(b) Earthworks completed (m^3)					
(c) Paving completed (km)					
(d) Culverts (number)					
(e) Bridges (number)					
(f) Construction work completed (date)					
(g) Maintenance certificate issued (date)					
(h) Completion certificate issued (date)					
(i) Final cost					
Supervision of Construction (m/months)					
Rural Road Construction and Improvement					
(a) Contracts signed (dates)					
(b) Earthworks completed (m^3)					
(c) Pavement completed (km)					
(d) Culverts (number)					
(e) Bridges (number)					
(f) Construction work completed (date)					
(g) Final cost					
Consultant Services					
Supervision of Construction					
(a) Consultants selected					
(b) Consultants start work					
(c) Supervision organization, procedures and systems agreed by MOC and Bank					
(d) Supervision staff appointed					
(e) Office and laboratory buildings constructed					
(f) Laboratory equipment in place					
(g) Supervision of construction in progress					

Project Component	Estimated	Actual	Actual as % of estimated	Reason for difference (if any)	Action to be taken
Consultant Services (cont'd)					
Studies/Workshops					
CADE and Other Computer and Laboratory Equipment for HPDI and HSRI, and Road Maintenance Equipment					
(a) Prepare equipment list and specifications					
(b) Complete functional requirement study on computer equipment					
(c) Invite bids from selected international suppliers for computer equipment					
(d) Invite bids for road maintenance equipment					
(e) Evaluate bids and send government report on evaluation to Bank					
(f) Make bench tests of computer equipment selected for consideration					
(g) Evaluate bench tests of computer equipment selected for consideration					
(h) Evaluate bid for road maintenance equipment					
(i) Negotiate with selected computer equipment suppliers for software, etc.					
(j) Carry out acceptance tests of computer equipment					
(k) Delivery of laboratory equipment					
HSRI Research Program					
(a) Program implementation					
(b) Studies					
(i) Paved road evaluation					
(ii) Road congestion					
(iii) Road safety					
Staff Training					
(a) Selection of trainees					
(b) Placement of trainees					
(c) Training					
(d) Curriculum review					

CHINA

HIGHWAY PROJECT

Economic Evaluation of the Xian-Sanyuan National Road

Road-Route and Function

1. The road will be the most direct route from Xian, the capital of Shaanxi Province, to Sanyuan where it will connect with the existing Class 2 road to Tongchuan, an important industrial area in Shaanxi. The construction of this road is divided into two sections. One is a 8.6 km section from Xian to Zhangjiabao including part of the ring road around Xian City. (This section is not included in the Bank-financed project, but is being built separately by Xian municipality.) The other is a 35.18 km section from Zhangjiabao to Sanyuan which is included in the project.

2. This section of national road will be the first 'Class 1' road in Shaanxi Province and is important in three ways. First, it will improve access to coal mining areas in Shaanbei (northern Shaanxi Province) and to the industrialized area around Tongchuan. Second, it will fill in important gaps in national roads 210 and 211. National road 210 is a major north-south axis starting from Baotou in Nei Mongol Province, and crossing Shaanxi, Sichuan and Guizhou Provinces to reach Nanning in Guangxi Province. Road 211 originates at Xian, extending northwest to Yunchuan. Third, this road will provide access to the new international airport which is planned to open by 1990. An access road from the airport will join the project road north of the Wei River bridge.

3. In addition to providing a main link into the national network, the new road will also serve the industrial and agricultural development of five major cities and towns, i.e., Xian, Sanyuan, Tongchuan, Jingyang and Kaoling (Table 1). The industries which will benefit are textiles around Xian, coal and cement in Tongchuan and Sanyuan, and agriculture in Jingyang and Kaoling.

Table 1: KEY CHARACTERISTICS OF THE XIAN-SANYUAN ROAD INFLUENCE AREA

	Xian City	Sanyuan county	Tongchuan City	Jingyang county	Kaoling county
Total Area (sq km)	2,441.0	569.0	2,204.0	792.0	294.0
Cultivated land ('000 Mu)	1,635.5	562.0	959.6	734.5	305.0
Population ('000)	2,822.5	305.5	603.3	376.8	177.8
Total Value of Industry and Agriculture Product (Y mln)	5,196.9	154.1	462.9	159.3	75.1
Of which:					
Industry	4,821.5	79.4	403.7	54.1	21.3
Agriculture	375.4	74.7	59.3	105.1	53.8
Per capita output (Y mln)	1,841.2	504.4	767.3	422.8	422.4
Existing civilian vehicles (No.)	20,020.0	n.a.	2,610.0	319.0	181.0
Existing tractors (No.)	7,928.0	1,492.0	n.a.	1,216.0	744.0
Motorable roads (km)	1,035.0	620.0	542.0	895.0	273.0
Road density (km/'000 km^2)	424.0	1,090.0	246.0	1,130.0	929.0

Traffic

4. Present Situation. At present there is no direct route from Xian to Tongchuan. The two existing alternatives, one in the east and one in the west, are 13 km and 15 km respectively longer than the proposed road. A railway line also follows the western alignment, crossing the Wei River at Xianyang. The roads carry 88% of the passenger traffic between Xian and Tongchuan while the railway carries about 75% of the freight; its capacity is saturated. After completion of the project, the distance from Xian to Tongchuan will only be 112 km versus 158 km by railway. Besides savings in time and vehicle operating costs for the shorter distance, congestion on the existing roads will be reduced. Traffic on the existing roads is already very heavy and is increasing with the present high economic growth. It reaches 3,980 AADT east of Xian and 3,736 AADT west of Xian, decreasing to 1,223 and 2,004 north of the Jing and the Wei Rivers. (The figures are only for motorized vehicles.) According to six traffic count stations, traffic growth in this area averaged 9% in 1983. (The six stations are Huokou and Yaoxian on national road 210, Weihe bridge, Potou, Yunyang and Tunhuo on national road 211.) Congestion was also particularly serious there due to the traffic-mix of slow and fast moving vehicles.

5. Anticipated Future Traffic. The anticipated traffic on the project road comes from three main sources: (a) traffic diverted from national roads 210 and 211, local traffic, and traffic diverted from the Xian-Tongchuan railway; (b) traffic generated from newly developed industrial and agricultural activities in the area, including the new cement plant project in Yaoxian; and (c) traffic from the new Xianyang international airport. To determine the required capacity of the road, all traffic was converted to a car equivalent, using the conversion factor of traffic moving on 50% flat land, 50% hilly land. Based on an origin-destination survey done in July-August 1984, it is estimated that traffic on the proposed road would be equivalent to 10,761 car AADT in 1984 (Table 2). Assuming a 9% p.a. growth rate, AADT in 1988 would be equivalent to 13,936 cars and would require a 4-lane road.

Table 2: ANTICIPATED TRAFFIC CAPACITY IN TERMS OF CAR EQUIVALENT (1984)

	Conversion factors to car equivalent	Total	Gengzhen station on road 210		Jingyang station on road 211		Yong-le station between Xian to Sanyuan	
Motorized Vehicles (excluding tractors)								
- small truck	(2.0) /a		(250)/b	500	(23)/b	46	(118)/b	236
- medium truck	(3.0)		(1,670)	5,010	(488)	1,464	(384)	1,156
- large truck	(4.0)		(213)	852	(52)	208	(72)	288
- small passenger car	(1.0)		(200)	200	78)	78	(65)	65
- large passenger car	(3.0)		(184)	552	(35)	105	(30)	90
- truck trailer	(5.0)		(225)	1,125	(29)	145	(148)	740
Total (in car equivalent)				8,239		2,046		2,511
Diversion factor (%)				73.3%		20.6%		50%
Expected traffic on new road		7,716.16		6,039.2		421.5		1,255.5
Tractors								
- small	(2.0)		(133)	266	(51)	102	(374)	748
- large	(3.0)		(179)	537	(106)	318	(123)	369
Total (in car equivalent)				803		420		1,117
Diversion factor (%)				19.4%		7.7%		80%
Expected traffic on new road		1,081.7		155.8		32.3		893.6
Man & Animal Drawn Carts	(3.0)		(141)	423	(54)	162	(213)	639
Diversion factor (%)				0%		0%		100%
Expected traffic on new road		639		0		0		639
Bicycle	(0.5)		(2,950)	1,475	(804)	402	(2,649)	13,245
Diversion factor (%)				0%		0%		100%
Expected diversion to new road		1,324.5		0		0		1,324.5
Grand Total		10,761.36						

/a Figures in parentheses are car equivalent factors of vehicles moving on 50% flat land and 50% hilly land.

/b Figures in parentheses are the absolute number of traffic counted by each origin-destination survey station in 1984.

Economic Evaluation

6. Capital Cost. Table 3 shows the derivation of economic costs starting from financial costs and applying either CIF prices of traded goods or conversion factors for non-traded goods.

Table 3: Adjusted Economic Cost on Xian-Sanyuan National Road (million Yuan)

Components	Financial cost	Economic cost /a	Conversion factors	Adjusted economic cost
Design Cost	1.20	1.20	4.00 /b	4.80
Land	9.54 /c	9.54	1.00	9.54
Construction Cost	74.96 /d	74.12	0.97	72.42
Labor (12%)	9.00	9.00	0.50 /b	4.50
Materials				
- Cement (7%)	5.25	5.14	1.00	5.14
- Timber (4%)	3.00	2.97	1.00	2.97
- Steel (5%)	3.75	3.67	1.00	3.67
- Bitumen (12%)	9.00	8.64	1.00	8.64
Equipment (22%)	16.49	16.49		
- domestic (50%)	8.25	8.25	1.34	11.05
- foreign (50%)	8.25	8.25	1.00	8.25
P.O.L. (12%)	9.00	9.00	1.00 /e	9.00
Overhead (10%)	7.50	7.50	1.00	7.50
Profit (11%)	8.25	8.16	1.00	8.16
Mis. (5%)	3.54	3.54	1.00	3.54
Total	85.70	84.86	1.02	86.76

/a Economic cost is net of duty and taxes. For the four traded commodities, cement, timber, steel and bitumen, the prices are based on recent import contracts and reflect CIF prices.

/b A conversion factor of 4.00 is used for works that require highly skilled manpower and 0.50 for unskilled labor.

/c The financial cost of land including funds for relocation of the displaced population and removal of electricity poles.

/d 10% physical contingency is included.

/e In 1984 the Chinese Government increased the diesel price by about 30%, which made the domestic price reflect the international price.

7. Other Costs. The road requires routine maintenance every year and periodic maintenance every ten years. The routine maintenance cost is estimated at Y 4,000/km for a 4-lane paved road, and periodic maintenance is 10% of the construction cost. Maintenance cost reduction on existing roads is expected to be small and has been omitted. (All national roads in this project use the same costing method.)

8. Benefits and Internal Economic Rate of Return. The principal benefits of this road are attributed to the transport cost saving due to the shorter distance (45%) and road improvement (28%). Other benefits are time saving, road safety, and congestion reduction on the old road. In order to calculate the transport cost saving, the anticipated traffic volume for 1984 has been converted into an equivalent number of trucks. Based on the origin-destination survey, some 3,064 AADT (motorized vehicles excluding tractors) could be expected to use the Xian-Sanyuan road in 1984: 66% diverted from national road 210; 4% from national road 211; 14% local traffic, and 16% diverted from the railway (Table 4).

Table 4: EXPECTED TRAFFIC ON XIAN-SANYUAN ROAD: A DERIVATION FROM THE ORIGIN-DESTINATION SURVEY (1984)

	Total diver-sion	Gengszhen station on road 210	Jingyang station on road 211	Yong-le station between Xian to Sanyuan	Traffic diverted from railway
Motorized Vehicles (excluding tractors)					
Small truck (1.0)/a		250	23	118	
Medium truck (1.0)		1,670	488	384	
Large truck (1.0)		213	52	72	
Small passenger car (0.5)		200	78	65	
Large passenger car (1.0)		184	35	30	
Truck trailer (1.5)		225	29	148	
Total (no. of vehicles)		2,742	705	817	
Total (in standard vehicles)		2,754	680	859	
Diversion factor (%)		73.3	20.6	50.0	
Expected diversion to new road	3,064	2,019	140	429	476
% of total	(100)	(66)	(4)	(14)	(16)

/a Figures in parentheses are truck equivalent conversion factors.

9. Traffic growth is estimated to be 9% p.a. between 1984 and 1988, a one-time increase of 10% in 1988 to account for traffic generated by the road, and 12% p.a. from 1988 to 1990 due to the opening of the new Xianyang international airport and full operation of the industrial and agricultural projects being developed. After 1990, traffic growth is assumed to stabilize at 6% p.a. The resulting traffic by year is shown in Table 5.

Table 5: ANTICIPATED TRAFFIC ON XIAN-SANYUAN ROAD (1984-2000)

Year	No. of motorized vehicles	Growth rate (%)
1984	3,064	9
1985	3,349	
1986	3,640	
1987	3,968	
1988	4,325 + 432/a	
1989	5,329	12
1990	5,968	
1991	6,326	6
1992	6,706	
1993	7,108	
1994	7,534	
1995	7,986	
1996	8,466	
1997	8,974	
1998	9,512	
1999	10,083	
2000	10,688	

/a Normal increase 9% plus 10% increase for the opening year.

10. Benefits are calculated in Table 6; the method of estimation is as follows:

(a) The annual transport cost saving due to the shorter distance represents the savings for all vehicles that would have traveled on the extra length of the old road with the old VOC if the new shorter road had not been constructed. This is based on the annual traffic volume (AADT x 365), the difference in length between the old and new roads, the VOC for the old road, the average load, and the conversion of all vehicle types into the AADT of standard trucks.

(b) The annual transport cost saving due to road improvement represents the savings of all vehicles that would travel on the new road with the lower VOC. This is based on the annual traffic volume, the new

road length, and the difference in VOC between the old and new roads, the average load and the conversion factor.

(c) Time savings for freight (or for passengers) represents the value of time of freight (or passengers) that would have been spent on the old road with its congestion and slow moving traffic, if the new road had not been built. This is derived from the annual volume of freight (or passenger) traffic, average hours saved, and opportunity cost of time for freight (or passengers).

(d) The benefit from road safety represents the financial value of the reduction in road accidents based on the number of road accidents avoided and the cost of each accident.

(e) Congestion reduction represents the contribution of the new road to relieve the congestion on some sections of the old road. It is the annual traffic remaining on the old road, and the VOC reduction resulting from congestion relief on the previously congested sections.

11. The total benefit for the opening year of the road is 9.7 million yuan which is 11% of the construction cost. The net benefit flow yields an economic rate of return (ERR) of 18%.

12. Sensitivity and Risk Analysis. The main risks of this road are: lower traffic growth and construction cost overrun. The sensitivity of the ERR to these factors and to the value of these has been tested with the following results:

	ERR
Best Estimate	18
Smaller Traffic Growth	
- Traffic growth reduced to 7% from 1989-2000	17
- Traffic growth reduced to 7% from 1985-2000	15
Investment Cost Overrun	
- 20% cost increase	15
- 20% cost increase and traffic growth reduced to 7% from 1985-2000	12
Opportunity Cost of Time Saved	
- Decrease by 50%	16
- Decrease by 100%	14

Table 6: Economic Analysis of Xian-Sanyuan National Road

Parameters:

Road length (old)	45.81	(km)	= LO
Road length (new)	34.46	(km)	= LN
Ave length diff.	11.35	(km)	= LD
VOC on old road	0.134	(Y/t-km)	= CO
VOC on new road	0.107	(Y/t-km)	= CN
Cost diff.	0.027	(Y/t-km)	= CD
Conv.factor	0.943		= CF
Tonnage(stand.ve)	4.36	(ton)	= TV
Load factor	0.644		= LF
Average load	2.808	(ton)	= AL
Ave time saving	0.615	(hr)	= TS
Time value(fr.)	2.05	(Y/hr/pa)	= TVF
Time value(pass.)	0.327	(Y/hr/ve)	= TVP
Accident Reduce	187	(case)	= AC
Price of accident	2430	(Y/case)	= Pac
VOC red.on old Rd	0.003	(Y/t-km)	= CRO
Cong.sec.(old rd)	18	(km)	= CSO

(1) TCS due to shorter distence = Traffic volumn*365*LD*CO*AL
(2) TCS due to road improvement = Traffic volumn*365*LN*CD*AL
(3) Time saving of freigth = Freigth traffic*365*TS*TVF
(4) Time saving of passenger = Passenger traffic*365*TS*TVP
(5) Road safety = AC*Pac
(6) Congestion reduction on old road = Remaining Traffic *365*CRD*CSO

	Traf.Vol (AADT)	Cons.Cost ('000Y)	Dist.TCS ('000Y) (1)	RdImp.TCS ('000Y) (2)	PassTrans (000P/yr)	TimeSav.P ('000Y) (3)	Fr.Trans (000V/yr)	TimeSav.F ('000Y) (4)	RoadSafe ('000Y) (5)	OldRdTraf (AADT)	CongesRed ('000Y) (6)	Net Ben. ('000Y)
1984	3064	4800										-4800
1985	3340	14453										-14453
1986	3640	28907										-28907
1987	3968	28907										-28907
1988	4758	14453	3708	2268	5332	1072	1637	2064	454	5377	106	-4781
1989	5329	141	8306	5081	5972	1201	1833	2311	454	5753	113	17326
1990	5968	141	9302	5691	6688	1345	2053	2589	454	6156	121	19362
1991	6326	141	9860	6032	7090	1426	2176	2744	454	6587	130	20506
1992	6706	141	10452	6394	7515	1511	2307	2909	454	7048	139	21719
1993	7108	141	11079	6778	7966	1602	2445	3083	454	7542	149	23004
1994	7534	141	11744	7184	8444	1698	2592	3268	454	8069	159	24367
1995	7986	141	12449	7615	8951	1800	2748	3464	454	8634	170	25812
1996	8466	141	13195	8072	9488	1908	2913	3672	454	9239	182	27344
1997	8974	141	13987	8557	10057	2023	3087	3892	454	9885	195	28967
1998	9512	696	14826	9070	10660	2144	3272	4126	454	10577	208	30133
1999	10083	141	15716	9614	11300	2272	3469	4373	454	11318	223	32513
2000	10688	141	16659	10191	11978	2409	3677	4636	454	12110	239	34447

IRR = 18 %

CHINA

HIGHWAY PROJECT

Economic Evaluation of the Fucheng-Yuquan Rural Road

A. Background

1. The road will be located in Ya-an Prefecture, southwest of Chengdu, the capital city of Sichuan Province. The road will be a Class 4 mountainous road running along the Jing River passing four villages: Fucheng, Shize, Fengyu and Yuquan. The road is 16 km long, with an influence area covering about 290 sq km and a population of 10,000. The area has abundant natural resources: coal, timber, bamboo, iron ore and asbestos. However, the present production of these resources is limited to the amount that local households can consume, because the area is served by only a track which is impassable by motorized vehicles. Transport is mainly by porters and the transport cost is too high to commercialize the resources. Thus, besides improving agricultural production, opening of the road will contribute greatly to mining and forestry in the area.

2. In 1983, out of the 15,500 tons produced in the influence area of the road, a surplus of some 3,000 tons, including 2,000 tons of timber, was marketed (details in Table 2). Without improvement of the road, production would continue to grow slowly at 3-4% p.a. and the market tonnage would reach 3,500 tons in 1987, when the road would be opened and 4,800 tons ten years later. With the road, however, production of coal, timber and bamboo will increase greatly as the reduced transport cost will make production economically justified and attractive.

B. Economic Cost and Benefit of the Road

Capital Cost

3. The adjusted economic cost of this road is Y 4.25 million. The derivation of economic costs starting from financial costs and applying either CIF prices of traded goods or conversion factors for non-traded goods is shown in Table 1.

Other Costs

4. The road requires routine maintenance every year and periodic maintenance every ten years. The routine maintenance cost is estimated at Y 1,000/km for a Class 4 rural road. Periodic maintenance is 10% of the construction cost.

Benefits

5. The project road has two main quantifiable benefits:

(a) transport cost savings for the commodities which are and would continue to be transported mainly by porters and other non-motorized transport means without the project; and

(b) value added to the production which is generated by the lower transport costs made possible by the opening of the project road.

6. Transport Cost Savings Benefit. The transport cost savings benefit is the difference between the transport cost without the project and that with the project. Transport by porters is commonly valued at 3-4 yuan per ton-km on the basis of one man carrying about 1 ton-km per day (equivalent to carrying a 50 kg load for 20 km). Therefore, the present transport cost per marketed ton is estimated at Y 44. With the road, the transport cost is expected to fall to some Y 2/ton or a saving of Y 42/ton. The total benefit is calculated by multiplying the tonnage that would be transported without the project by the unit transport cost saving. It has been assumed that the tonnage transported without the project would continue growing at an average 3.7% p.a. (details by commodity are given in Columns (3A) to (5A) of Table 2 and the total benefits for 1987 and 1996 are in Columns (7A) and (9A).

7. Value-added Benefit. All production in addition to what would occur without the project is directly attributable to the project. Project production for 1987 is shown in Column (6B) of Table 2 as the difference between the forecasts of production marketed with the project (Column 2B) and without the project (Column 4A). The value-added of this generated production is the difference between its market value and its production plus transport cost (Column 7B for 1987). The same calculation is done for 1996.

The Economic Rate of Return

8. Table 3 shows the streams of costs and benefits calculated as explained above. For the benefit streams, a constant annual growth rate was applied between 1987 and 1996, to reach the estimated benefit for 1996. As the road will open about mid-1987, only half of the estimated benefits were attributed to that year with the full benefit starting in 1988. The transport cost saving benefits account for 29% of total benefits in the opening year, decreasing to 12% by the year 2000. The value-added benefit will be the principal benefit, and constitutes 71% and 88% of total benefits in 1987 and 1996, respectively. The resulting ERR is 18%.

9. Sensitivity and Risk Analysis. The main risks of the proposed investment are: (a) a lower growth of value-added benefit, (b) construction cost overrun, and (c) a delay in benefits. The sensitivity of the ERR to the change in these factors has been tested with the following results:

	ERR (%)
Best estimate	18
Growth of Value-added Benefit	
lower by 50%	12
lower by 25%	15
Cost Overrun	
increase by 20%	15
Benefit	
delayed for one year	14

CHINA

HIGHWAY PROJECT

Adjusted Economic Cost on Fucheng-Yuquan Rural Road
('000 yuan)

Components	Financial cost	Economic cost /a	Conversion factors	Adjusted Economic cost
Land	110.05 /b	110.05	1.00	110.05
Construction cost	4,577.05 /c	4,526.69	0.90	4,139.92
Labor (22%)	1,006.95	1,006.95	0.50	503.47
Materials				
cement (12%)	549.25	527.28	1.00	527.28
timber (11%)	503.47	493.40	1.00	493.40
steel (10%)	457.70	439.39	1.00	439.39
Equipment (15%)				
domestic (7.5%)	343.28	343.28	1.34	459.99
foreign (7.5%)	343.28	343.28	1.00	343.28
P.O.L. (8%)	366.16	366.16	1.00	366.16
Overhead (15%)	686.56	686.56	1.00	686.56
Miscellaneous (7%)	320.39	320.39	1.00	320.39
Total	4,6867.10	4,636.74	0.91	4,249.97

/a Economic cost is net of duty and taxes. For the three traded commodities, cement, timber and steel, the prices are based on recent import contracts and reflect c.i.f. prices.

/b The financial cost of land including funds for relocation of the displaced population and removal of electricity poles.

/c 10% physical contingency is included.

CHINA

ANNEX 7
Table 2

HIGHWAY PROJECT

Economic Analysis of Fucheng-Yuquan Rural Road

Basic Information:

Road length (old)		(km)	
Road length (new)	16.00	(km)	
Transport Cost (old)	44.00	(Y/ton)	= TCO
Transport Cost (new)	2.09	(Y/ton)	= TCN
Transport Cost Saved	41.91	(Y/ton)	= TCS

Calculation Method:

Columns(1A)-(9A)are for transport cost saving benefit assuming a natural growth of traffic without additional traffic generated by project road:

(1A) 1983 Production	=	Observed		
(2A) 1983 Marketed product	=	Observed		
(3A) Assumed growth rate	=	Assumed		
(4A) 1987 Marketed product	=	Forecasted	=	(2A)*(3A)^4
(5A) 1996 Marketed product	=	Forecasted	=	(2A)*(3A)^9
(6A) Unit TC Saving (UTCS)	=	Observed	=	TCO-TCN
(7A) 1987 Transport Cost Saving	=	Forecasted	=	(4A)*(6A)
(8A) Unit TC Saving (UTCS)	=	Observed	=	TCO-TCN
(9A) 1996 Transport Cost Saving	=	Forecasted	=	(5A)*(8A)

Columns (1B) to (10B) are for value-added benefit from the project road generated traffic

(1B) 1987 Production (with project)	=Forecasted	
(2B) 1987 Marketed (with project)	=Forecasted	
(3B) 1996 Marketed (with project)	=Forecasted	
(4B) Price of marketed products	=Observed	
(5B) Production cost	=Observed	
(6B) 1987 Value-added in ton	=Forecasted	= (2B)-(4A)
(7B) 1987 value-added in Yuan	=Forecasted	={(4B)-(5B)-TCN}*(6B)
(8B) 1996 value-added in ton	=Forecasted	=(3B)-(5A)
(9B) 1996 value-added in Yuan	=Forecasted	={(4B)-(5B)-TCN}*(8B)
(10B)Annual growth of value-added ,1987-1996		= {(9B)/(7B)}^(1/9)

Benefit from Transport Cost Saving

Items	(1A) Prod'83 (ton)	(2A) Mark'83 (ton)	(3A) AnnGrow (%)	(4A) Traf'87 (ton)	(5A) Traf'96 (ton)	(6A) UTCS'87 (Y/ton)	(7A) TCS'87 (Y)	(8A) UTCS'96 (Y/ton)	(9A) TCS'96 (Y)
Food Grain	11951	466	0.01	485	530	41.91	20323	41.91	22227
Oil Seed	36	23	0.04	27	38	41.91	1128	41.91	1605
Swine	403	117	0.04	137	195	41.91	5736	41.91	8165
Tea	49	39	0.04	46	65	41.91	1912	41.91	2722
Timber	2287	2050	0.04	2398	3413	41.91	100509	41.91	143056
Bamboo	379	359	0.04	420	598	41.91	17601	41.91	25052
Coal	340	0	0.04	0	0	41.91	0	41.91	0
In-coming Traffic	na.	na.		na.	na.	41.91	0	41.91	0
Total TCS Benefit							147210		202826
Weighted Ave.Growth					0.037 %				

Value Added Benefit

Items	(1B) Prod'87 (ton)	(2B) Mark'87 (ton)	(3B) Mark'96 (ton)	(4B) M.Price (Y/ton)	(5B) ProdCost (Y/ton)	(6B) VA'87 (ton)	(7B) VA'87 (Y)	(8B) VA'96 (ton)	(9B) VA'96 (Y)	(10B) AnnGrowth (%)
Food Grain	13714	509	664	260	153	24	2526	134	14021	0.21
Oil Seed	40	24	33	780	420	0	0	0	0	na.
Swine	509	135	204	1440	1220	0	0	9	2002	na.
Tea	53	42	51	1100	700	0	0	0	0	na.
Timber	4754	3399	5568	150	60	1001	87979	2155	189411	0.09
Bamboo	2670	2416	5362	120	70	1996	95629	4764	228255	0.10
Coal	30724	30000	154793	22	14	30000	177300	154793	914827	0.20
Total VA Benefit							363435		1348515	0.157

CHINA

HIGHWAY PROJECT

Economic Rate of Return of Fucheng-Yuquan Rural Road

	ConsCost (Y)	TCSBen. (Y)	VA Ben. (Y)	NetC.Flow (Y)
1985	1062000			-1062000
1986	2125000			-2125000
1987	1062000	73605	181718	-806678
1988	16000	152613	420494	557107
1989	16000	158213	486512	628725
1990	16000	164020	562894	710914
1991	16000	170039	651269	805308
1992	16000	176280	753518	913798
1993	16000	182749	871820	1038570
1994	16000	189456	1008696	1182152
1995	16000	196409	116 061	1347470
1996	16000	203618	1350290	1537907
1997	425000	211090	1562285	1348376
1998	16000	218837	1624777	1827614
1999	16000	226869	1689768	1900636
2000	16000	235195	1757358	1976553

IRR = 18 %

CHINA

HIGHWAY PROJECT

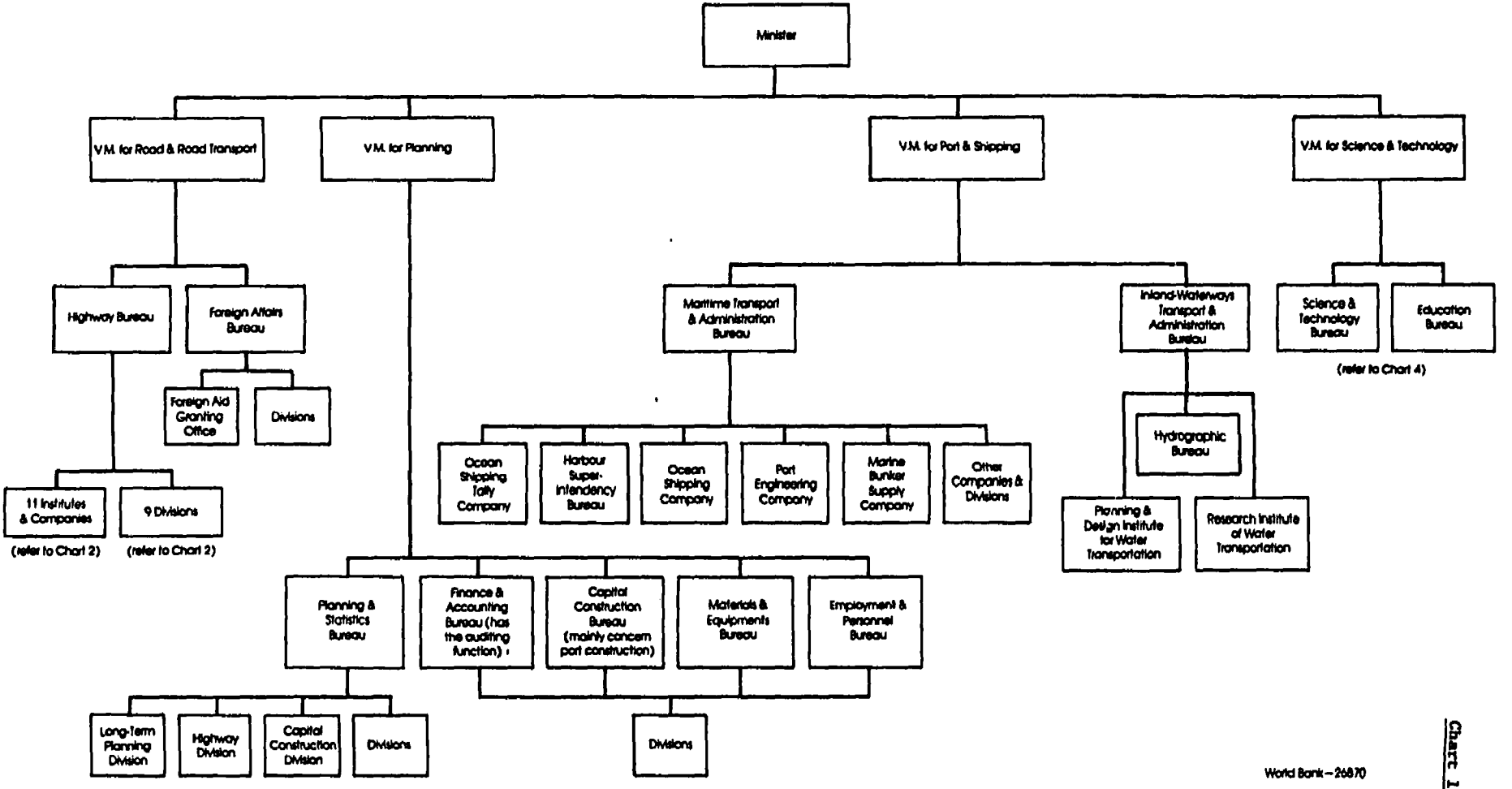
Selected Documents and Data Available in the Project File

A. General Reports
- A.1 CHINA: Socialist Economic Development, World Bank, June 1, 1981.
- A.2 Statistical Yearbook of China, 1983, State Statistical Bureau, PRC.

B. General Reports and Studies on the Sector or Subsector
- B.1 CHINA: Socialist Economic Development - Annex F.
- B.2 Transport Sector, June 1, 1981, AEA.
- B.3 Transport Sector Paper, December 10, 1984, AEPT1.
- B.4 Basic Data on Chinese Highway Subsector - Answers to Questionnaire (Chinese with English translation).

C. General Reports and Studies Relating to the Project
- C.1 Feasibility Study of 8 National Roads (Chinese).
- C.2 Feasibility Study of 60 Rural Roads (Chinese).
- C.3 Proposed Cost Calculation for Physical and Price Contingencies.
- C.4 Estimation of Tax and Foreign Exchange Component of Road Construction Costs.

CHINA
HIGHWAY PROJECT
Organization of the Ministry of Communications



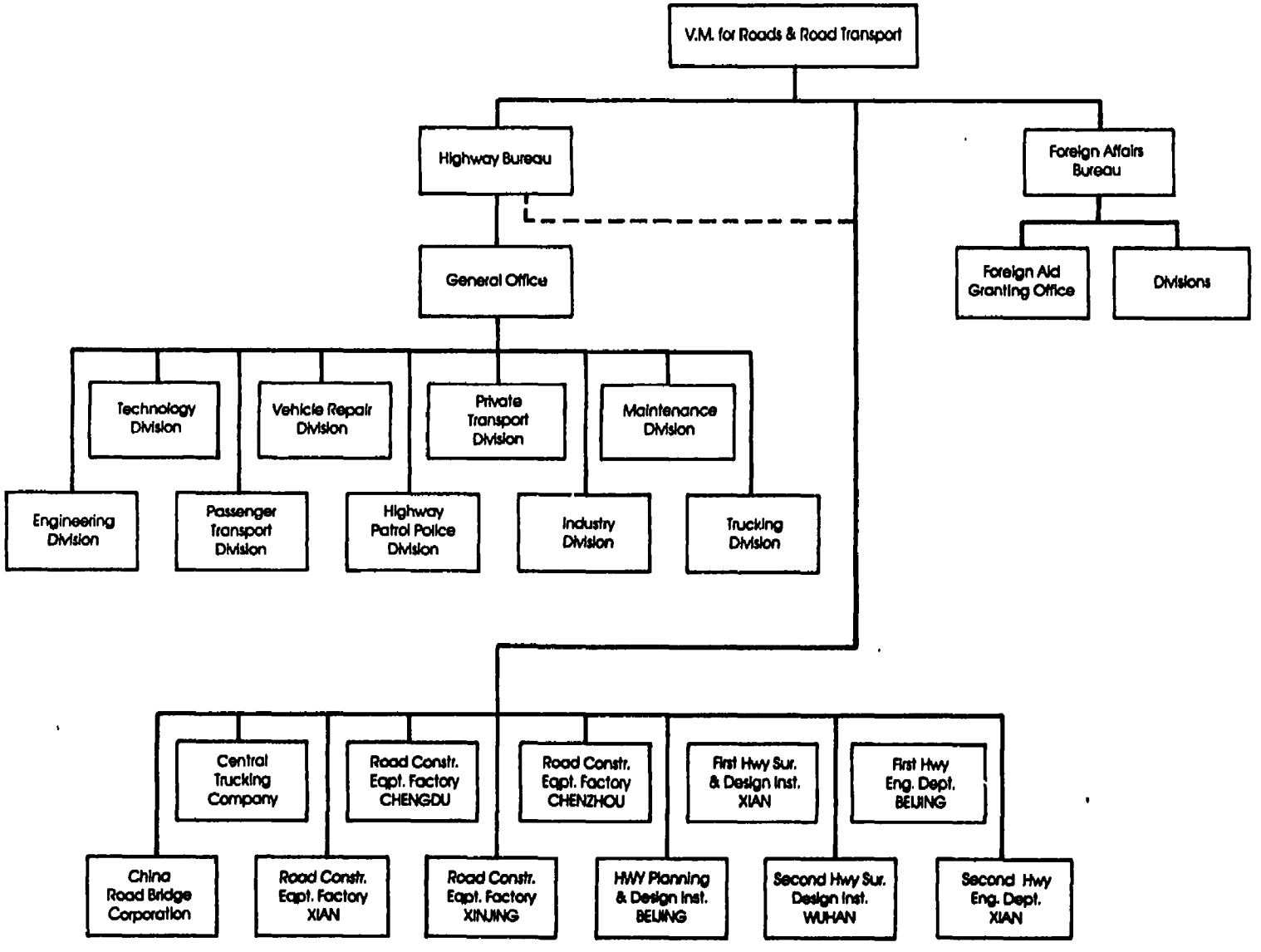
October 1984

World Bank – 26870

Chart 1

Chart 2

CHINA
HIGHWAY PROJECT
Organization of the Highway Bureau in the Ministry of Communications

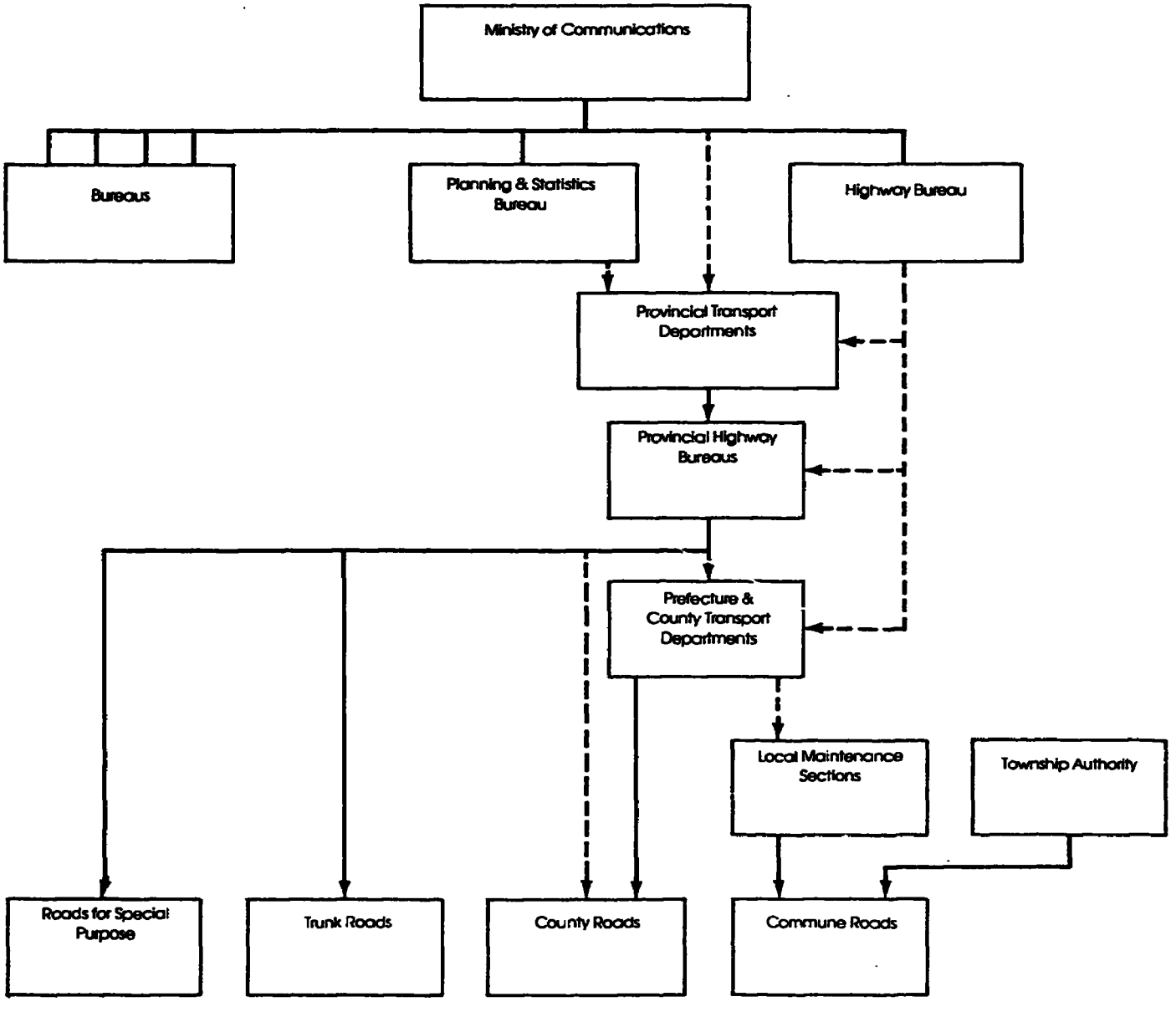


October 1984

World Bank—26871

Chart 3

CHINA
HIGHWAY PROJECT
The Relationship Between Central and Provincial Transport Departments



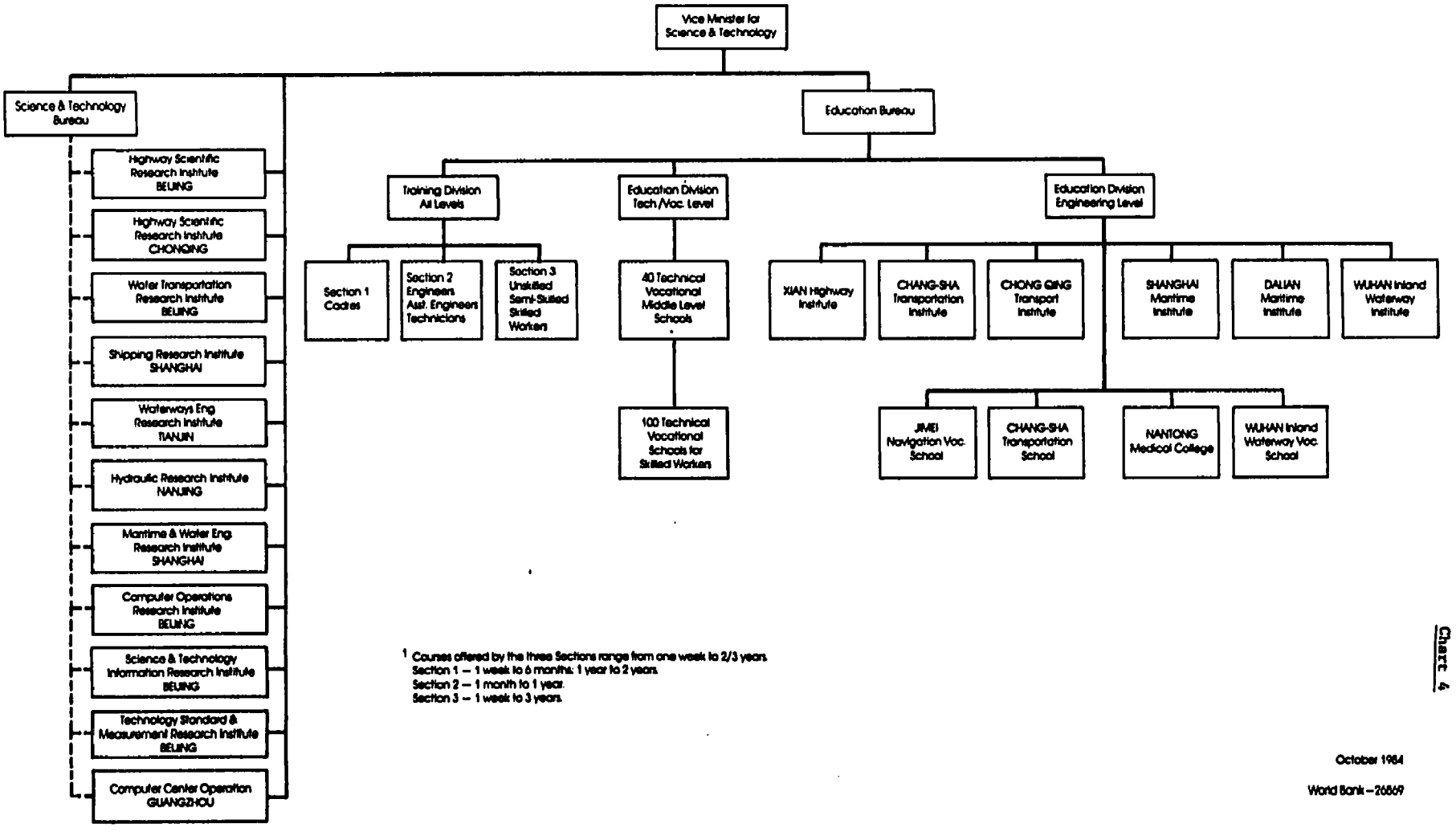
Note:
[1] The broken lines show the control over policy & administrative issues.
[2] The solid lines show the direct control over financial decisions aside from policy and administrative issues.

World Bank—26423

October 1984

Chart 4

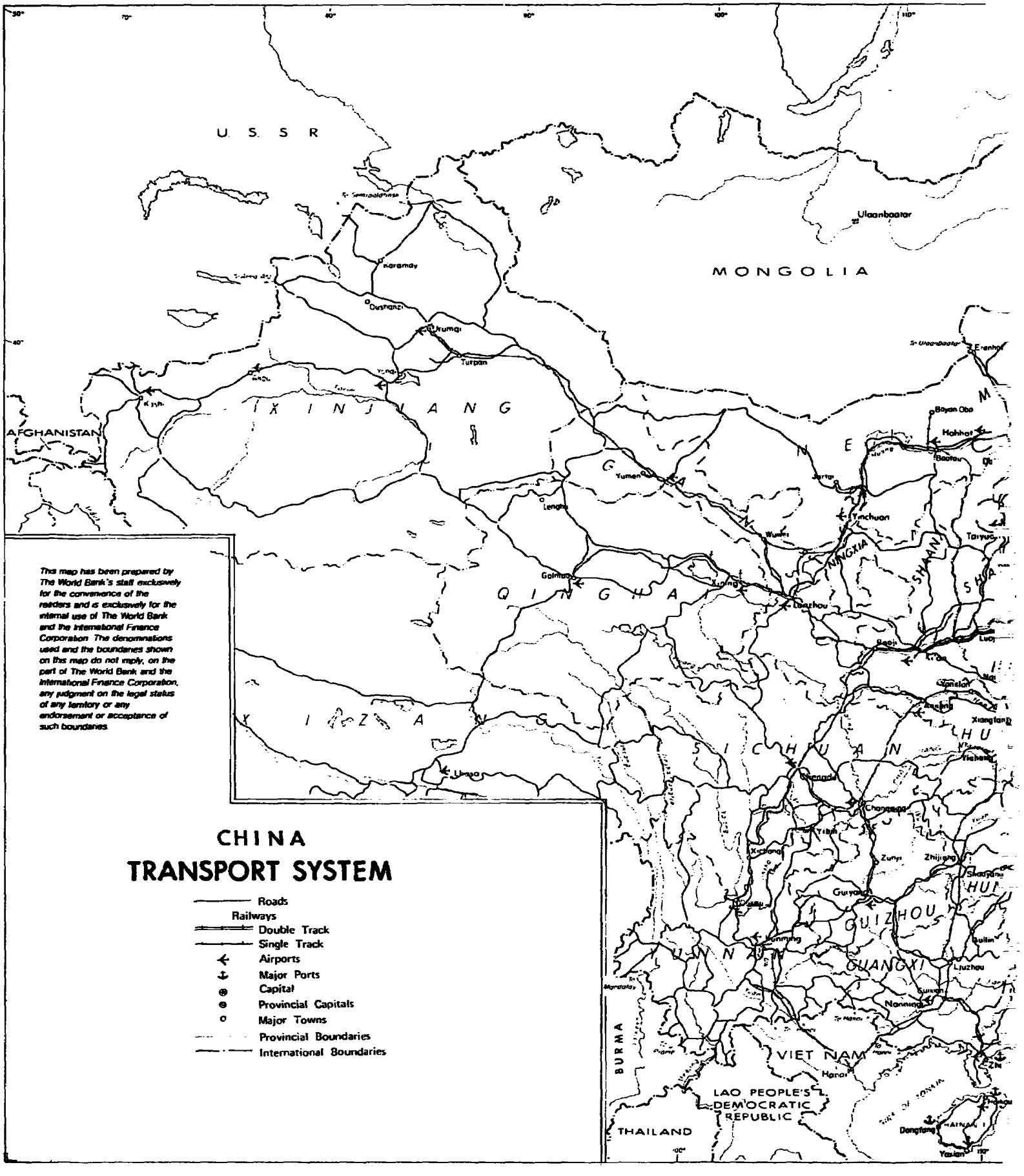
CHINA
HIGHWAY PROJECT
Organization of the Education and Science and Technology Bureaus of the Ministry of Communications



[1] Courses offered by the three Sections range from one week to 2/3 years.
Section 1 — 1 week to 6 months; 1 year to 2 years.
Section 2 — 1 month to 1 year.
Section 3 — 1 week to 3 years.

October 1984

World Bank — 26869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Ulaanbaatar
Karamay
Dushanzi
Urumqi
Turpan
Kashi
AFGHANISTAN
XINJIANG
Erenhot
Bayan Obo
Hohhot
Baotou
Yumen
Lenghu
Yinchuan
Golmud
Lanzhou
QINGHAI
Taiyuan
Xining
Ulugo
Chengdu
Chongqing
Yibin
Xichang
Zunyi
Zhijiang
Guiyang
GUIZHOU
Kunming
YUNNAN
Guilin
Liuzhou
GUANGXI
Nanning
BURMA
VIET NAM
Hanoi
LAO PEOPLE'S DEMOCRATIC REPUBLIC
THAILAND
Dongfang
HAINAN I.
Yaxian
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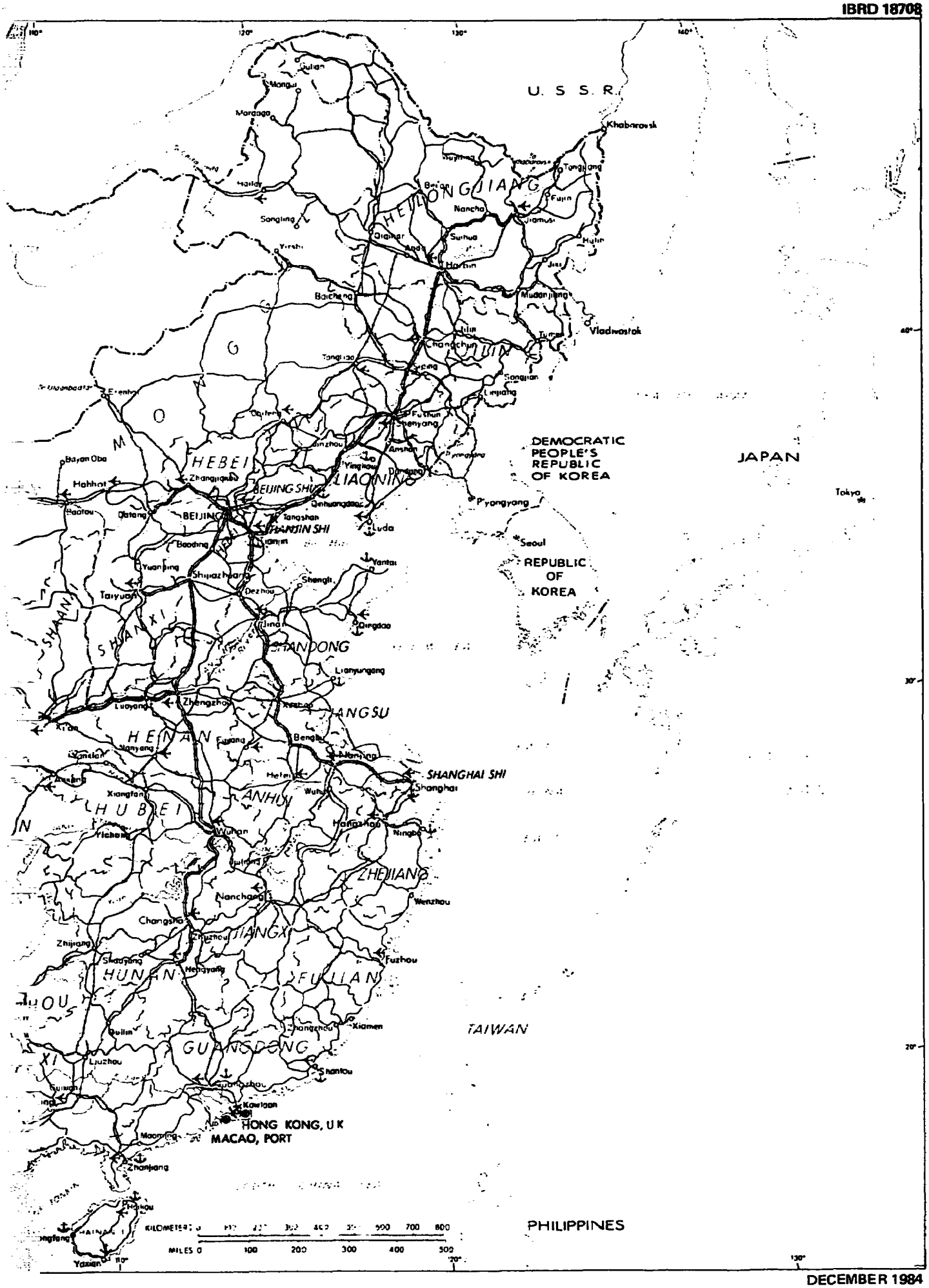
CHINA
TRANSPORT SYSTEM
Roads
Railways
Double Track
Single Track
Airports
Major Ports
Capital
Provincial Capitals
Major Towns
Provincial Boundaries
International Boundaries


U. S. S. R.
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Tongjiang
Fujin
Jiamusi
Nancha
HEILONGJIANG
Qiqihar
Anda
Suihua
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Hulin
Jixi
Mudanjiang
Vladivostok
Baicheng
Jilin
Changchun
Tumen
Tongliao
Siping
Songjiang
Linjiang
Fushun
Shenyang
Anshan
Dandong
Pyongyang
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA
JAPAN
Tokyo
Seoul
REPUBLIC OF KOREA
Jinzhou
Yingkou
Bayan Oba
Hohhot
Zhangjiakou
HEBEI
BEIJING SHI
LIAONING
Baotou
Datong
BEIJING
Qinhuangdao
Tangshan
TIANJIN SHI
Luda
Baoding
Yantai
Yuanping
Shijiazhuang
Shengli
Taiyuan
Dezhou
Qingdao
SHANXI
Jinan
SHANDONG
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Luoyang
Zhengzhou
Xuzhou
JIANGSU
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ANHUI
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Wuhan
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JIANGXI
Zhijiang
Shaoyang
Fuzhou
Hengyang
HUNAN
FUJIAN
Zhangzhou
Xiamen
TAIWAN
Guilin
Liuzhou
GUANGDONG
Shantou
Guangzhou
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HONG KONG, U K
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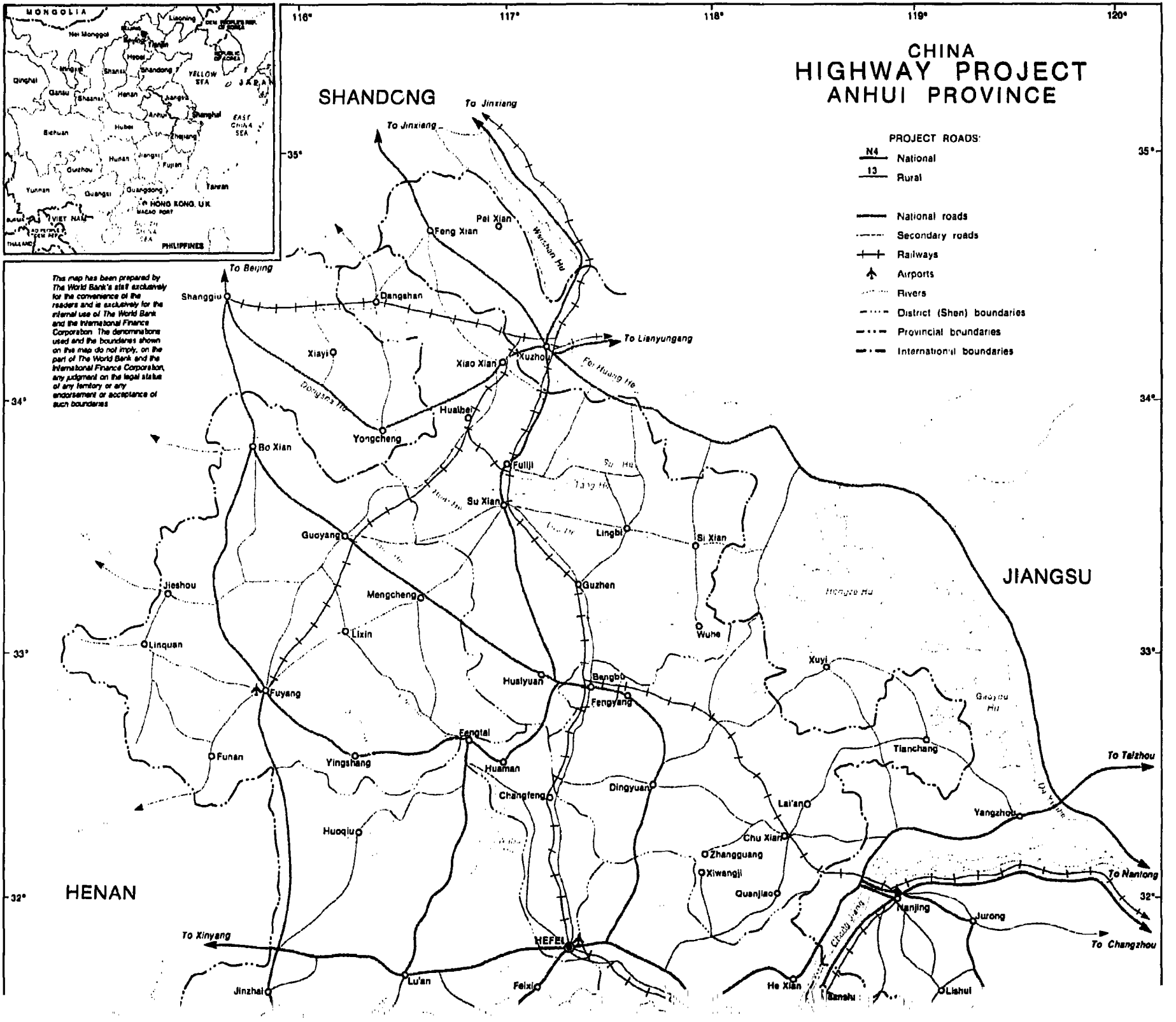

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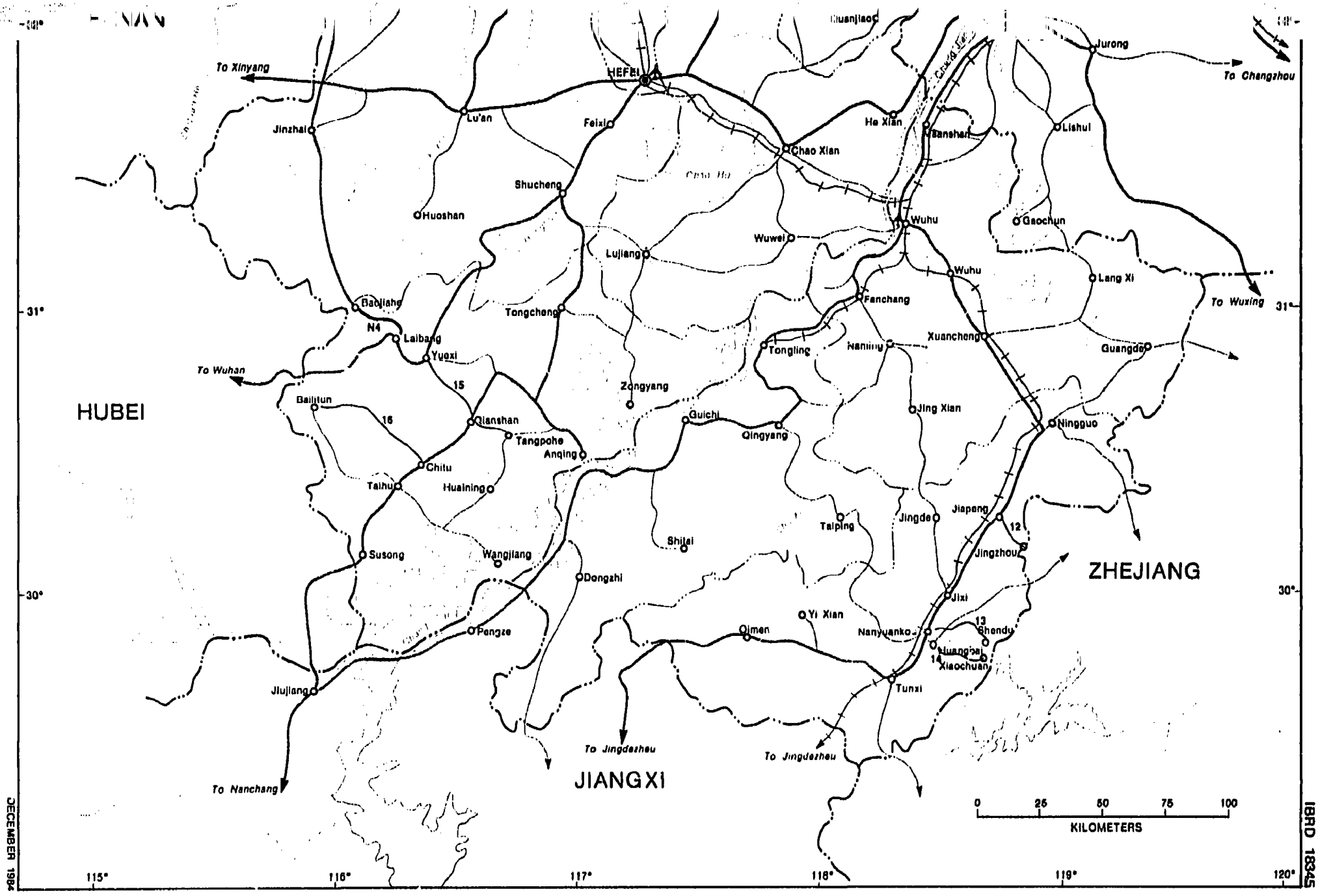
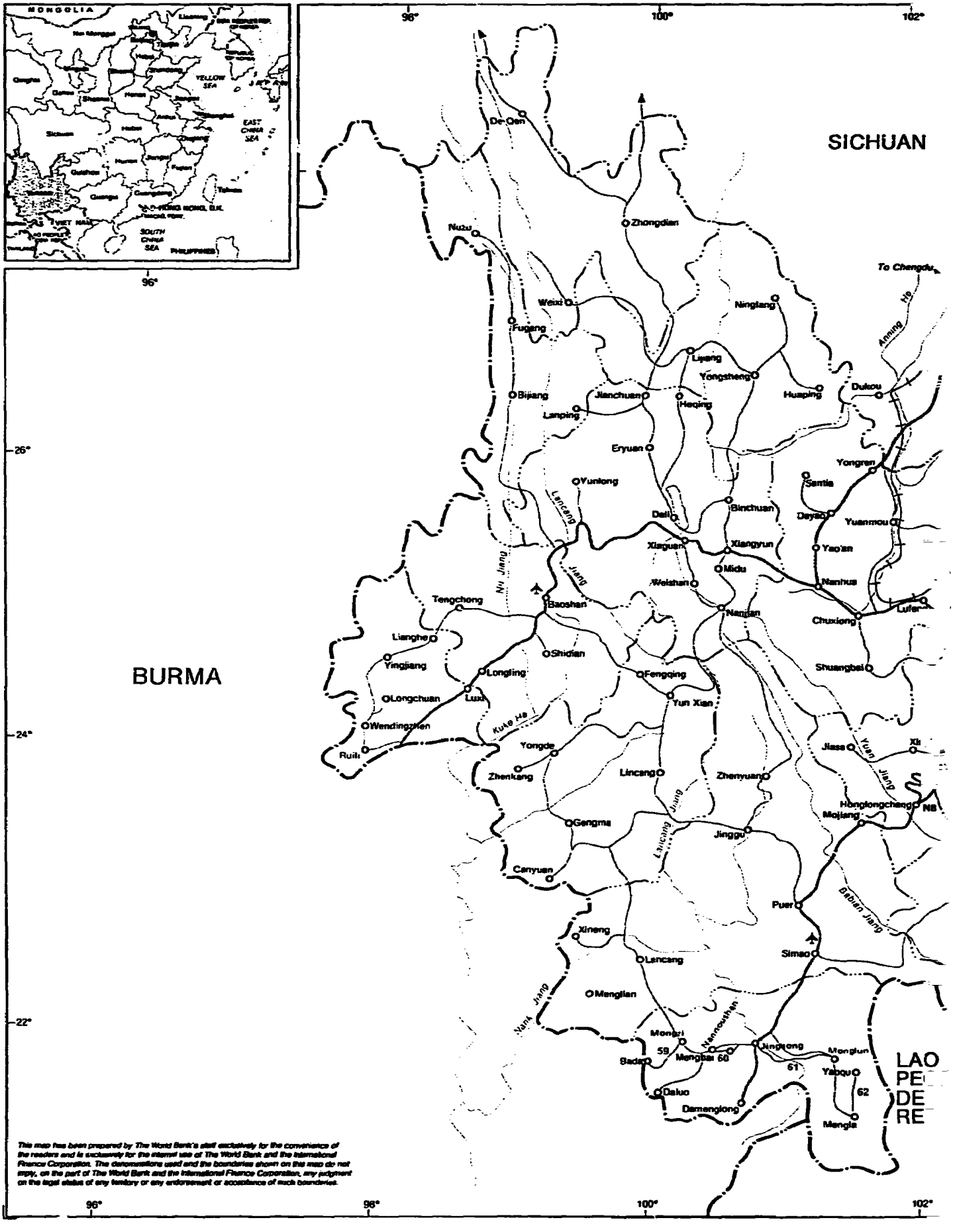


DECEMBER 1984

IBRD 18345



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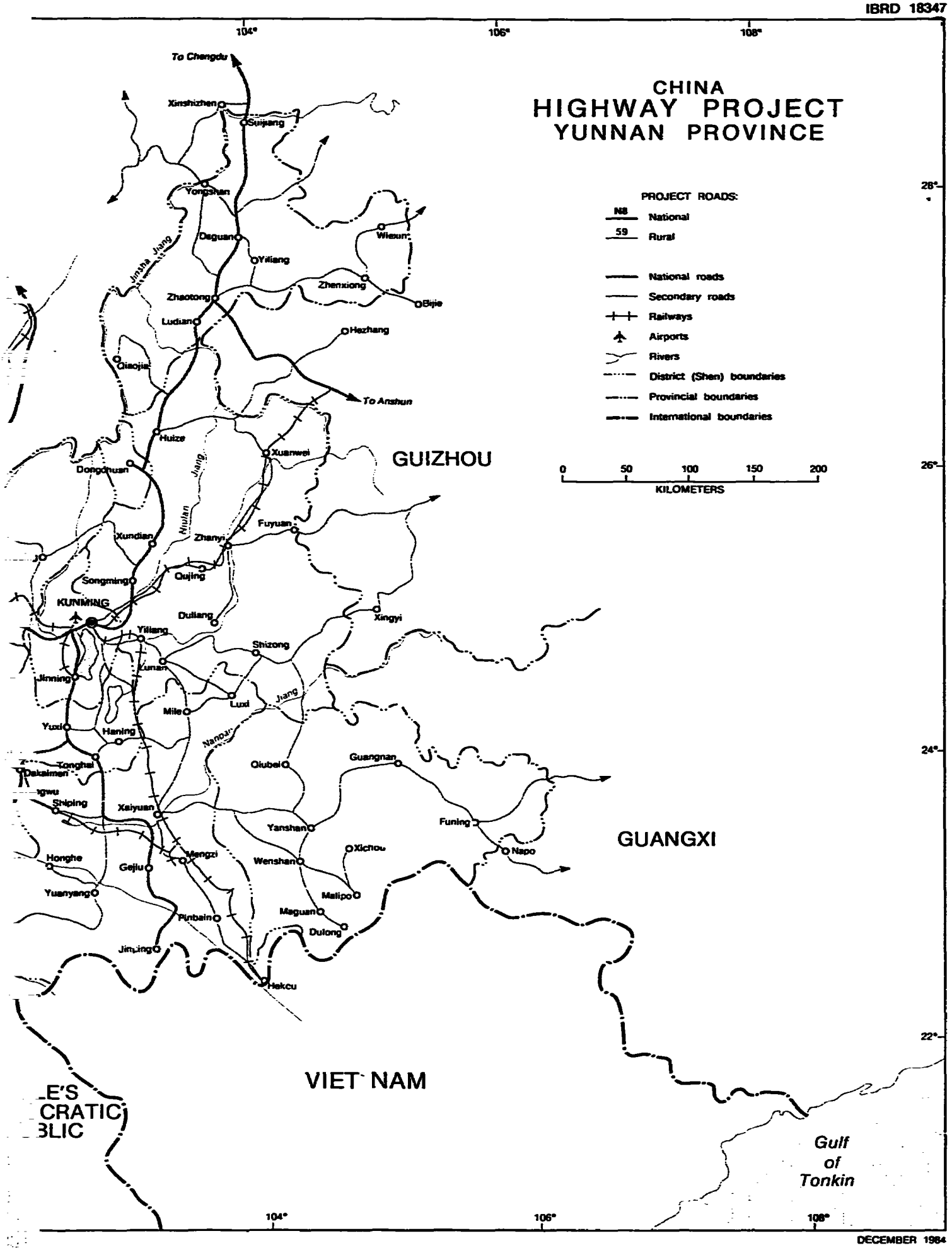
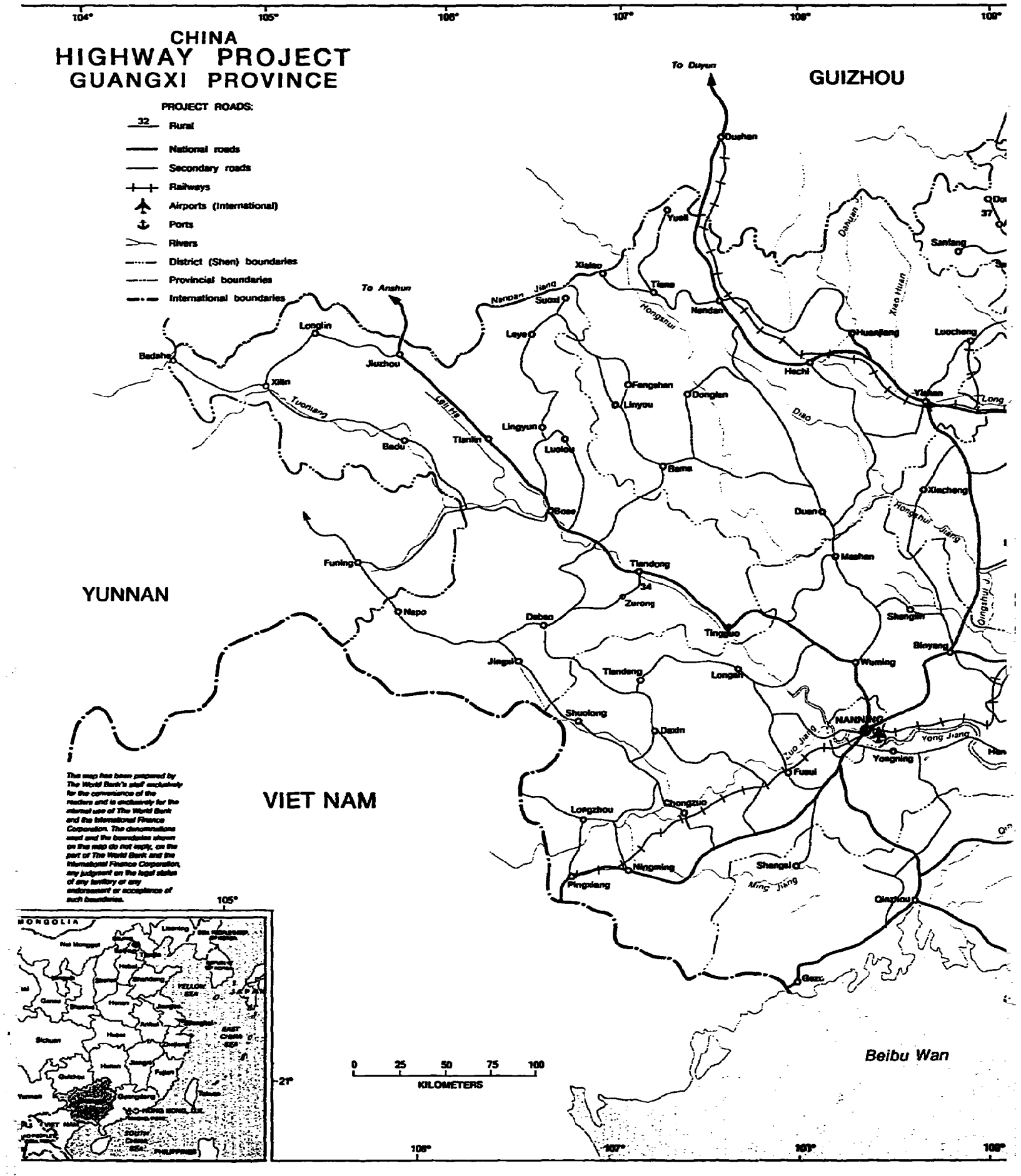

CHINA
HIGHWAY PROJECT
YUNNAN PROVINCE
PROJECT ROADS:
N8 National
59 Rural
National roads
Secondary roads
Railways
Airports
Rivers
District (Shen) boundaries
Provincial boundaries
International boundaries
0 50 100 150 200
KILOMETERS
104°
106°
108°
28°
26°
24°
22°
To Chengdu
To Anshun
Xinshizhen
Suijiang
Yongshan
Daguan
Yiliang
Wiexun
Zhenxiong
Bijie
Zhaotong
Ludian
Hezhang
Qiaojia
Huize
Xuanwei
Dongchuan
GUIZHOU
Fuyuan
Zhanyi
Xundian
Qujing
Songming
KUNMING
Dulang
Xingyi
Yiliang
Shizong
Jinning
Luxi
Mile
Yuxi
Hanning
Qiubei
Guangnan
Tonghai
Dakaimen
Shiping
Xaiyuan
Funing
Yanshan
Napo
GUANGXI
Xichou
Honghe
Gejiu
Mengzi
Wenshan
Yuanyang
Malipo
Pinbain
Maguan
Dulong
Jinping
Hekcu
VIET NAM
Gulf
of
Tonkin
Jinsha Jiang
Nujian Jiang
Nanpan Jiang



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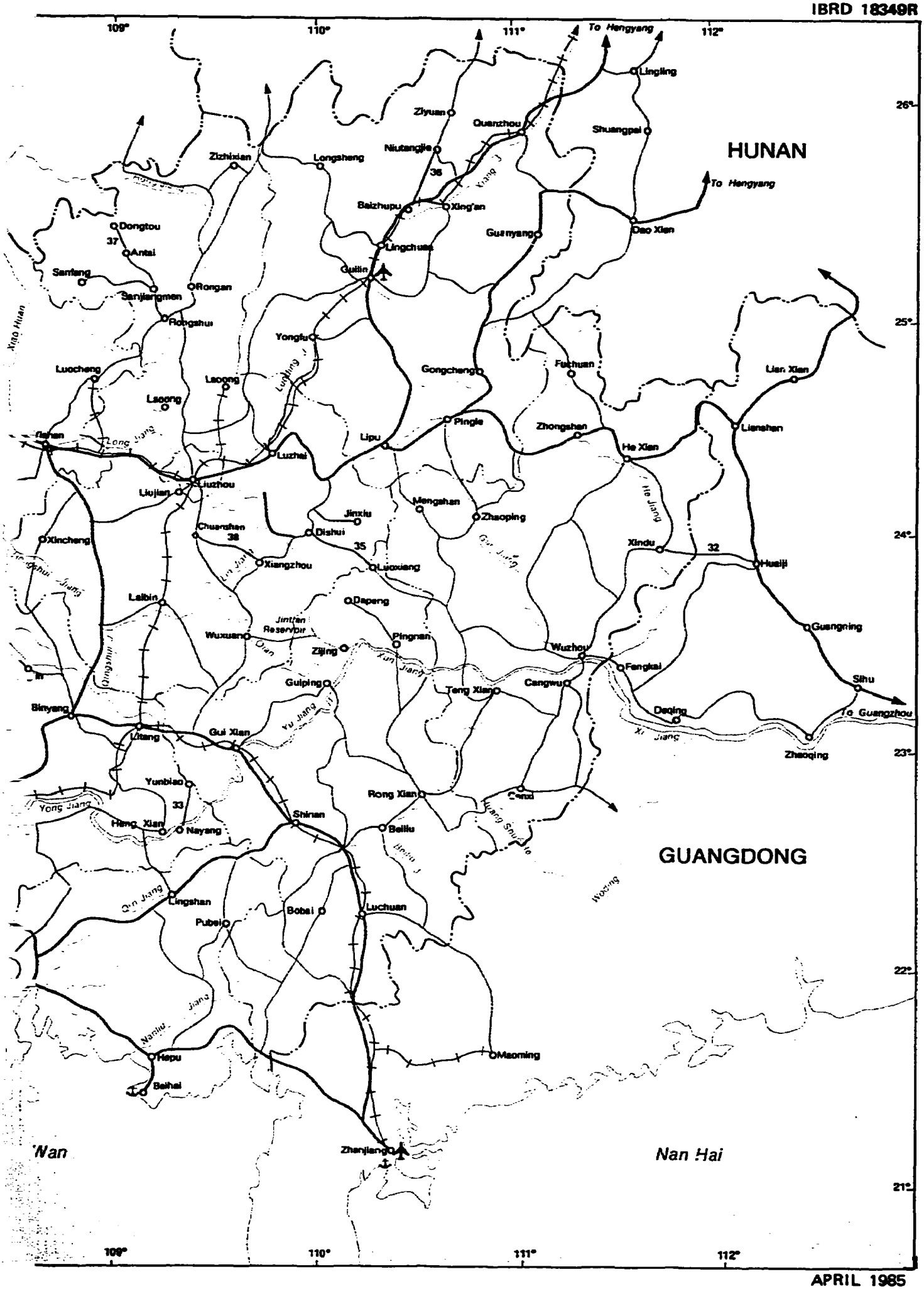
HUNAN
GUANGDONG
To Hengyang
To Hengyang
To Guangzhou
Nan Hai
109°
110°
111°
112°
26°
25°
24°
23°
22°
21°
Lingling
Zhyuan
Quanzhou
Shuangpai
Zizhixian
Longsheng
Niutangjie
Xiang J
Baizhupu
Xing'an
Guanyang
Dao Xian
Dongtou
Antai
Lingchuan
Guilin
Sanfang
Rongan
Sanjiangmen
Rongshui
Yongfu
Luocheng
Laocong
Gongcheng
Fuchuan
Lian Xian
Liangshan
Pingle
Zhongshan
He Xian
Lipu
Luzhai
Liuzhou
Liujian
Mengshan
Zhaoping
Jinxiu
Chuanshan
Dishui
Xindu
Huaiji
Xincheng
Xiangzhou
Luoxiang
Laibin
Dapeng
Jintan Reservoir
Wuxuan
Pingnan
Zijing
Guangning
Wuzhou
Fengkai
Cangwu
Teng Xian
Sihu
Guiping
Binyang
Gui Xian
Deqing
Zhaoqing
Yunbiao
Rong Xian
Cenxi
Hengxian
Nayang
Shinan
Beilu
Lingshan
Bobai
Luchuan
Pubei
Maoming
Hepu
Beihai
Zhanjiang
Wuzhi
Xi Jiang
Yu Jiang
Qin Jiang
Nanliu Jiang
Luoding
Xiao Huan
Long Jiang
Qingshui Jiang
Yong Jiang
Lin Jiang
Gan
Xun Jiang
He Jiang
Gui Jiang
Luoding
Jiang Shuang He

CHINA
HIGHWAY PROJECT
ZHEJIANG PROVINCE

PROJECT ROADS:

07 Rural

National roads

Secondary roads

Railways

Airport

Ports

Rivers

District (Shen) boundaries

Provincial boundaries

International boundaries

0 25 50 75 100

KILOMETERS

117° 118° 119° 120°

31° 30° 29° 28°

JIANGSU

ANHUI

JIANGXI

FUJIAN

To Changzhou

Changxing

Wuxing

Deqing

To Wuhu

Yuhang

HANGZHOU

Linantuankou

03

Tianmu

Fuyang

Chunanlazhong

Fuchun Jiang

To Tunxi

Xian Jiang

Tonglu

Jiesha

04

Zhu

Chunan

Jinan

Jiande

Pujiang

Yiwu

Do

Lanxi

Jinhua Jiang

Ou Jiang

Jinhua

Pa

Ou Xian

Changshan

Lingshan Gang

Yongkang

Jiangshan

To Shangrao

Liuchen

Jinyun

Suichang

Lishui

Longquan Xi

Yunhedajun

Qingtiantangqia

Longquan

10

Shawan

Wenchengshanxi

Qingyuanjianggen

11

09

Taishunxiahong

Shouningkendi

To Fuzhou

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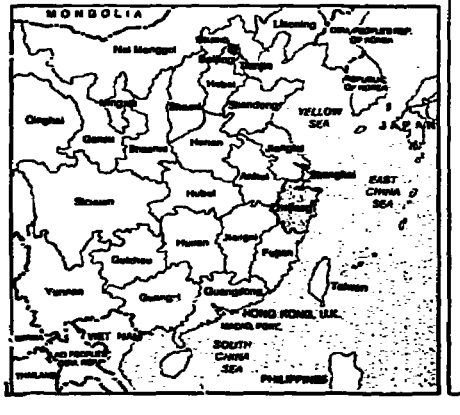
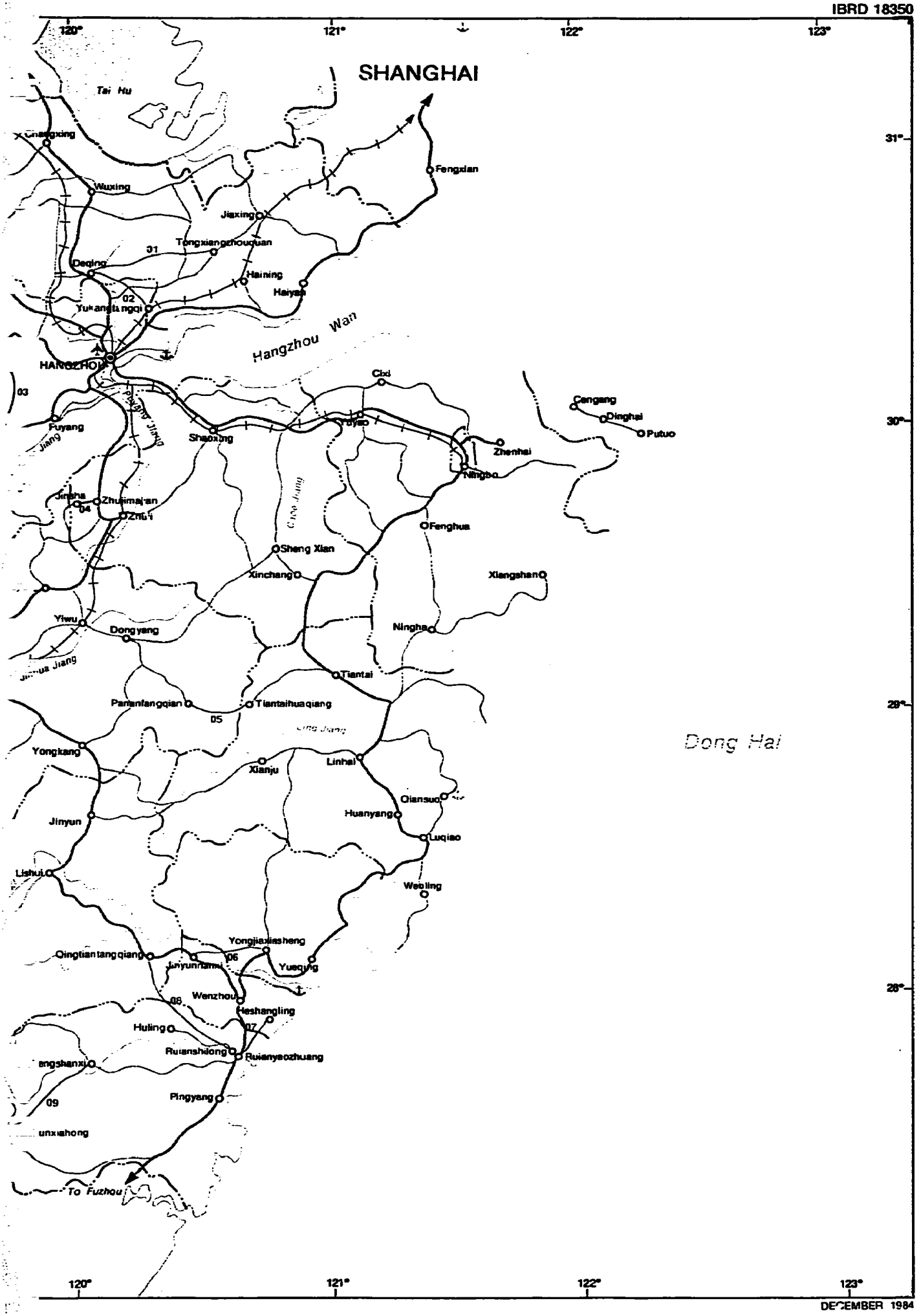
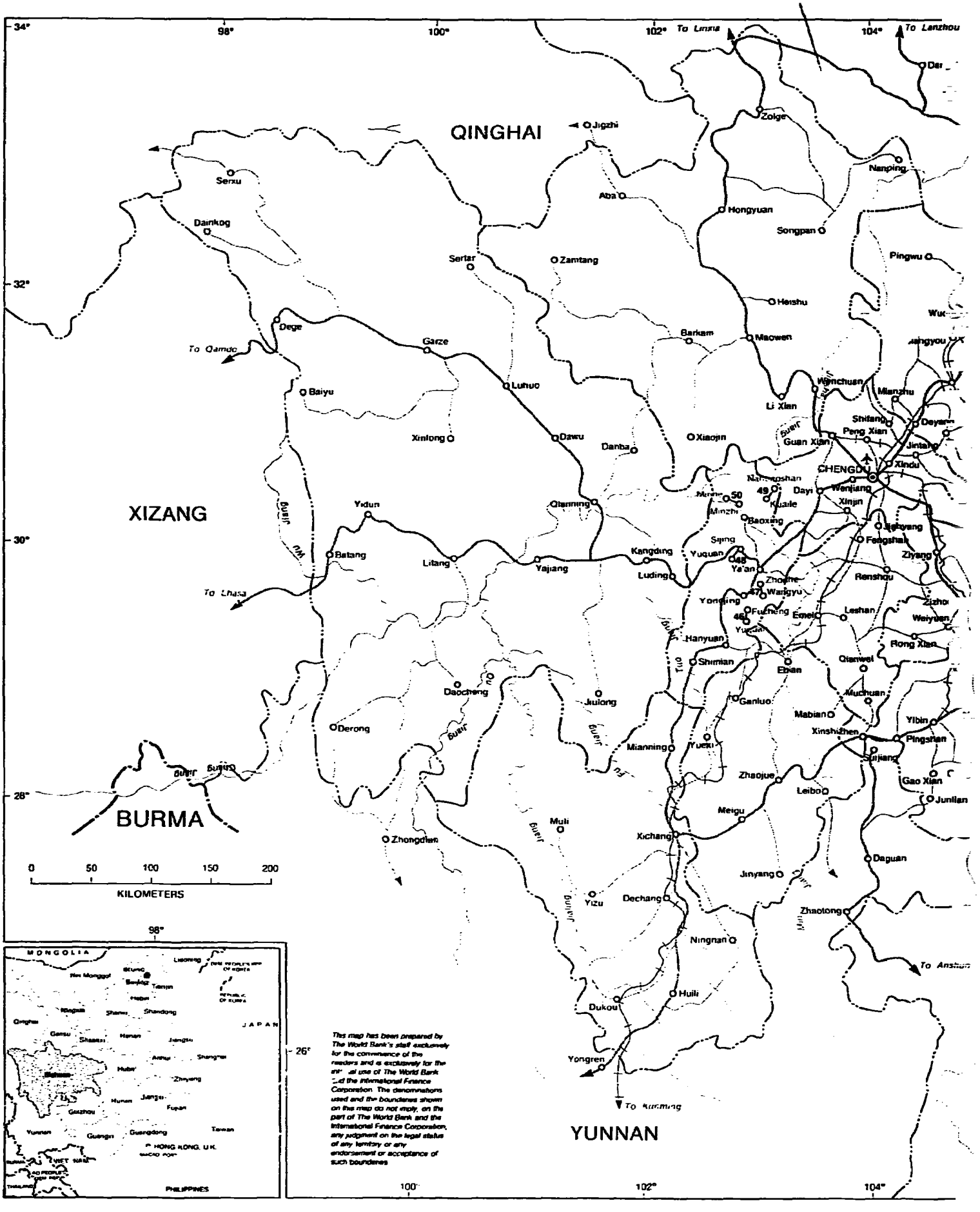



120°
121°
122°
123°
31°
30°
29°
28°
SHANGHAI
Tai Hu
Changxing
Wuxing
Fengxian
Jiaxing
Tongxiangzhouquan
Deqing
Haining
Haiyan
Yuhangtangqi
Hangzhou Wan
HANGZHOU
Cixi
Cengang
Dinghai
Putuo
Fuyang
Shaoxing
Yuyao
Zhenhai
Ningbo
Jinsha
Zhuji
Fenghua
Sheng Xian
Xinchang
Xiangshan
Yiwu
Dongyang
Ninghai
Tiantai
Panlanfangqian
Tiantaihuaqiang
Dong Hai
Yongkang
Xianju
Linhai
Qiansuo
Huanyang
Jinyun
Luqiao
Lishui
Wenling
Yongjiaxiesheng
Qingtiantangqiang
Jinyuntanmu
Yueqing
Wenzhou
Heshangling
Huling
Ruianshilong
Ruianyaozhuang
Pingyang
To Fuzhou


QINGHAI
XIZANG
BURMA
YUNNAN
CHENGDU
To Lanzhou
To Linxia
To Qamdo
To Lhasa
To Anshun
To Kunming
Jigzhi
Zolge
Serxu
Dainkog
Aba
Hongyuan
Songpan
Nanping
Pingwu
Sertar
Zamtang
Heishu
Dege
Garze
Barkam
Maowen
Baiyu
Luhuo
Wenchuan
Mianzhu
Li Xian
Shifang
Deyang
Peng Xian
Guan Xian
Jintang
Xinlong
Dawu
Danba
Xiaojin
Xindu
Wenjiang
Dayi
Kuaile
Xinjin
Minzhi
Baoxing
Qianning
Yidun
Batang
Litang
Yajiang
Kangding
Luding
Yuquan
Ya'an
Zhongjie
Wanyu
Yongjing
Fucheng
Emei
Leshan
Renshou
Ziyang
Zizhong
Weiyuan
Rong Xian
Hanyuan
Shimian
Ebian
Qianwei
Daocheng
Jiulong
Ganluo
Muchuan
Mabian
Yibin
Xinshizhen
Pingshan
Junjiang
Gao Xian
Junlian
Derong
Mianning
Yuexi
Zhaojue
Leibo
Meigu
Muli
Xichang
Zhongdian
Daguan
Jinyang
Yizu
Dechang
Zhaotong
Ningnan
Huili
Dukou
Yongren
0 50 100 150 200
KILOMETERS
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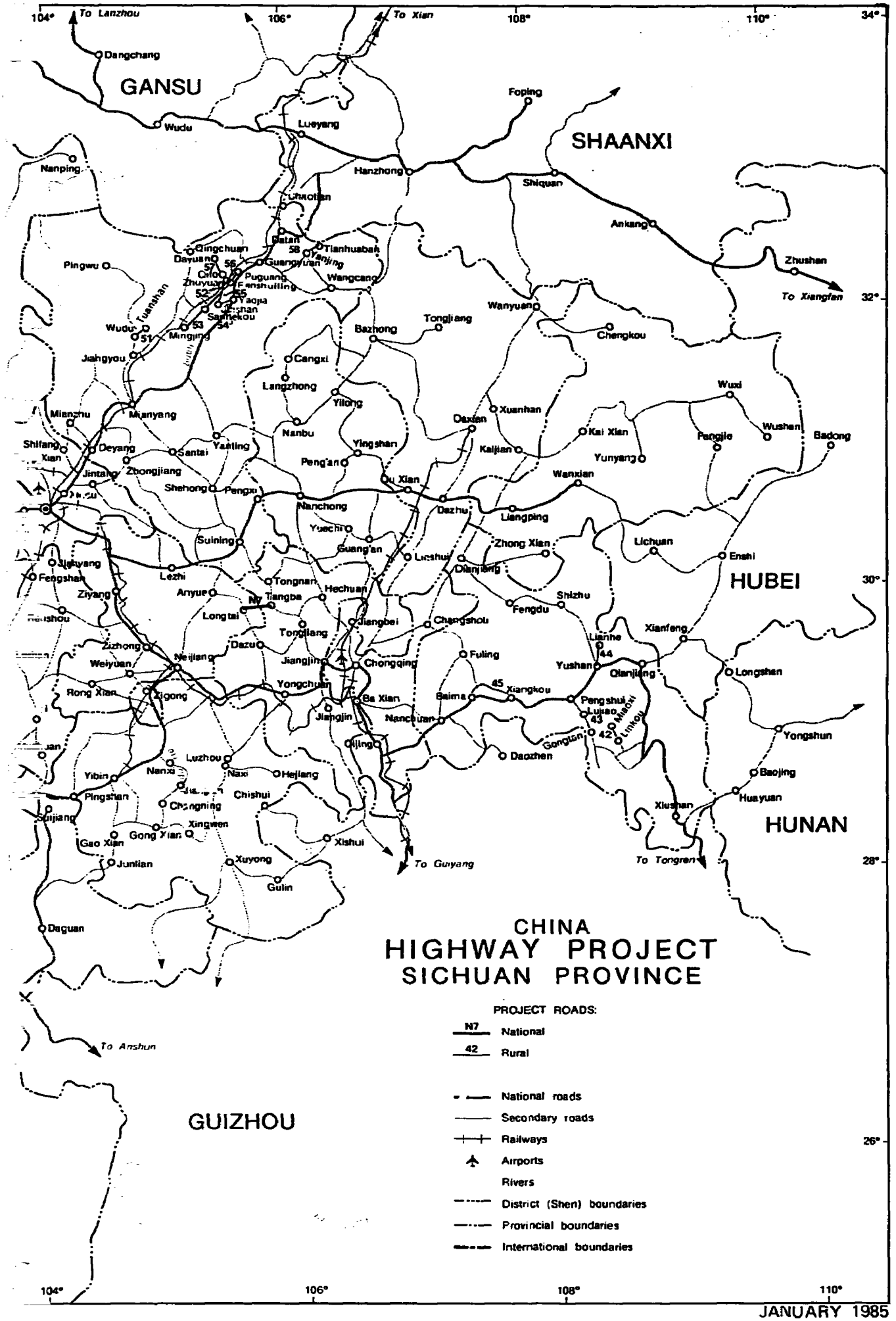
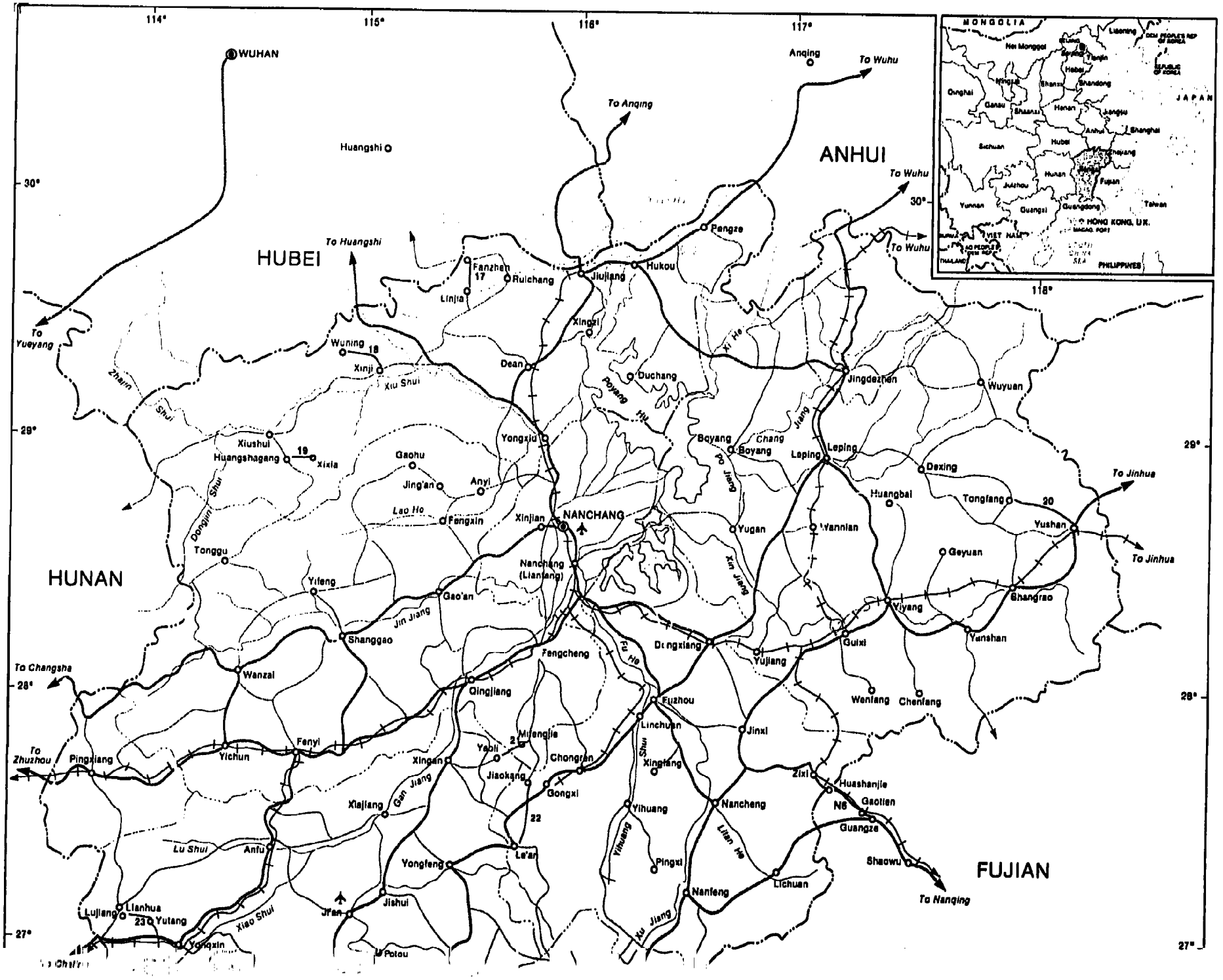
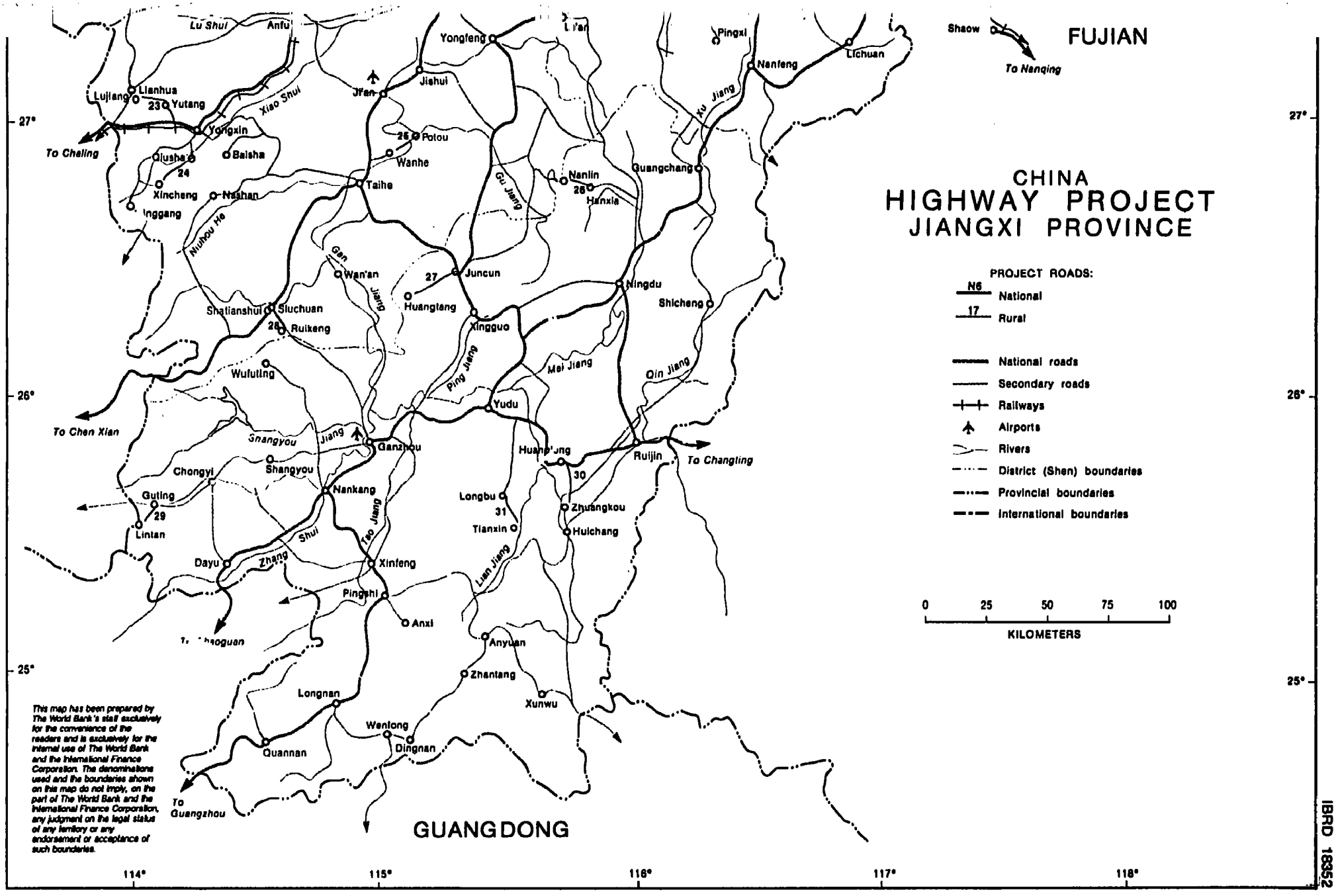
MONGOLIA
JAPAN
PHILIPPINES
HONG KONG, U.K.


CHINA
HIGHWAY PROJECT
SICHUAN PROVINCE
PROJECT ROADS:
N7 National
42 Rural
National roads
Secondary roads
Railways
Airports
Rivers
District (Shen) boundaries
Provincial boundaries
International boundaries
GANSU
SHAANXI
HUBEI
HUNAN
GUIZHOU
To Lanzhou
To Xian
To Xiangfan
To Guiyang
To Tongren
To Anshun
104°
106°
108°
110°
34°
32°
30°
28°
26°
Dangchang
Wudu
Lueyang
Foping
Nanping
Hanzhong
Shiquan
Ankang
Zhushan
Pingwu
Qingchuan
Dayuan
Tianhuaban
Guangyuan
Wangcang
Wanyuan
Tongjiang
Chengkou
Bazhong
Cangxi
Langzhong
Yilong
Jiangyou
Mianyang
Mianzhu
Shifang
Deyang
Santai
Yanting
Nanbu
Yingshan
Peng'an
Daxian
Xuanhan
Kai Xian
Kaijian
Yunyang
Wuxi
Wushan
Badong
Pengjie
Wanxian
Shehong
Pengxi
Nanchong
Dazhu
Liangping
Suining
Yuechi
Guang'an
Lushui
Zhong Xian
Lichuan
Enshi
Jianyang
Fengshan
Lezhi
Tongnan
Hechuan
Dianjiang
Ziyang
Anyue
Tianba
Shizhu
Fengdu
Neishou
Longtai
Tongliang
Jiangbei
Changshou
Xianfeng
Zizhong
Dazu
Lianhe
Weiyuan
Neijiang
Jiangjing
Chongqing
Fuling
Yushan
Qianjiang
Longshan
Rong Xian
Yongchuan
Ba Xian
Baima
Xiangkou
Pengshui
Luxao
Miaoxi
Lunkou
Jiangjin
Nanchuan
Yongshun
Qijing
Gongtan
Daozhen
Luzhou
Nanxi
Naxi
Hejiang
Yibin
Baojing
Pingshan
Chishui
Huayuan
Chengning
Xiushan
Suijiang
Xingwen
Gong Xian
Gao Xian
Xishui
Junlian
Xuyong
Gulin
Daguan


114°
115°
116°
117°
118°
30°
29°
28°
27°
WUHAN
Huangshi
To Yueyang
To Huangshi
HUBEI
ANHUI
To Anqing
Anqing
To Wuhu
To Wuhu
To Wuhu
Pengze
Hukou
Jiujiang
Fanzhen
17
Ruichang
Linjia
Xingzi
Wuning
18
Xinji
Xiu Shui
Dean
Duchang
Poyang Hu
Xi He
Jingdezhen
Wuyuan
Zhaun Shui
Xiushui
Huangshagang
19
Xixia
Gaohu
Jing'an
Anyi
Yongxiu
Boyang
Chang Jiang
Leping
Dexing
To Jinhua
Huangbai
Tongfang
20
Yushan
To Jinhua
Lao He
Fengxin
Xinjian
NANCHANG
Yugan
Wannian
Geyuan
Dongjiang Shui
Tonggu
HUNAN
Yifeng
Nanchang (Lianfang)
Gao'an
Jin Jiang
Shangrao
Yiyang
Yanshan
Shanggao
Fengcheng
Fu He
Dongxiang
Yujiang
Guixi
To Changsha
Wanzai
Qingjiang
Fuzhou
Wenfang
Chenfang
Linchuan
Jinxi
To Zhuzhou
Pingxiang
Yichun
Fenyi
Yabli
21
Mifengjie
Xingan
Chongren
Xingfang
Jiaokang
Gan Jiang
Gongxi
Zixi
Huashanjie
N6
Gaotien
Xiajiang
22
Yihuang
Nancheng
Guangze
Lu Shui
Anfu
Le'an
Yihuang
Pingxi
Shaowu
FUJIAN
Yongfeng
Lian He
Nanfeng
Lichuan
To Nanqing
Lujiang
Lianhua
23
Yutang
Jishui
Ji'an
Xiao Shui
Yongxin
Xu Jiang
Potou
MONGOLIA
Liaoning
Nei Mongol
Beijing
Tianjin
Hebei
Shanxi
Shandong
Qinghai
Gansu
Shaanxi
Henan
Jiangsu
Anhui
Shanghai
Sichuan
Hubei
Zhejiang
Guizhou
Hunan
Fujian
Yunnan
Guangxi
Guangdong
Taiwan
HONG KONG, U.K.
MACAO, PORT
VIET NAM
THAILAND
PHILIPPINES
JAPAN



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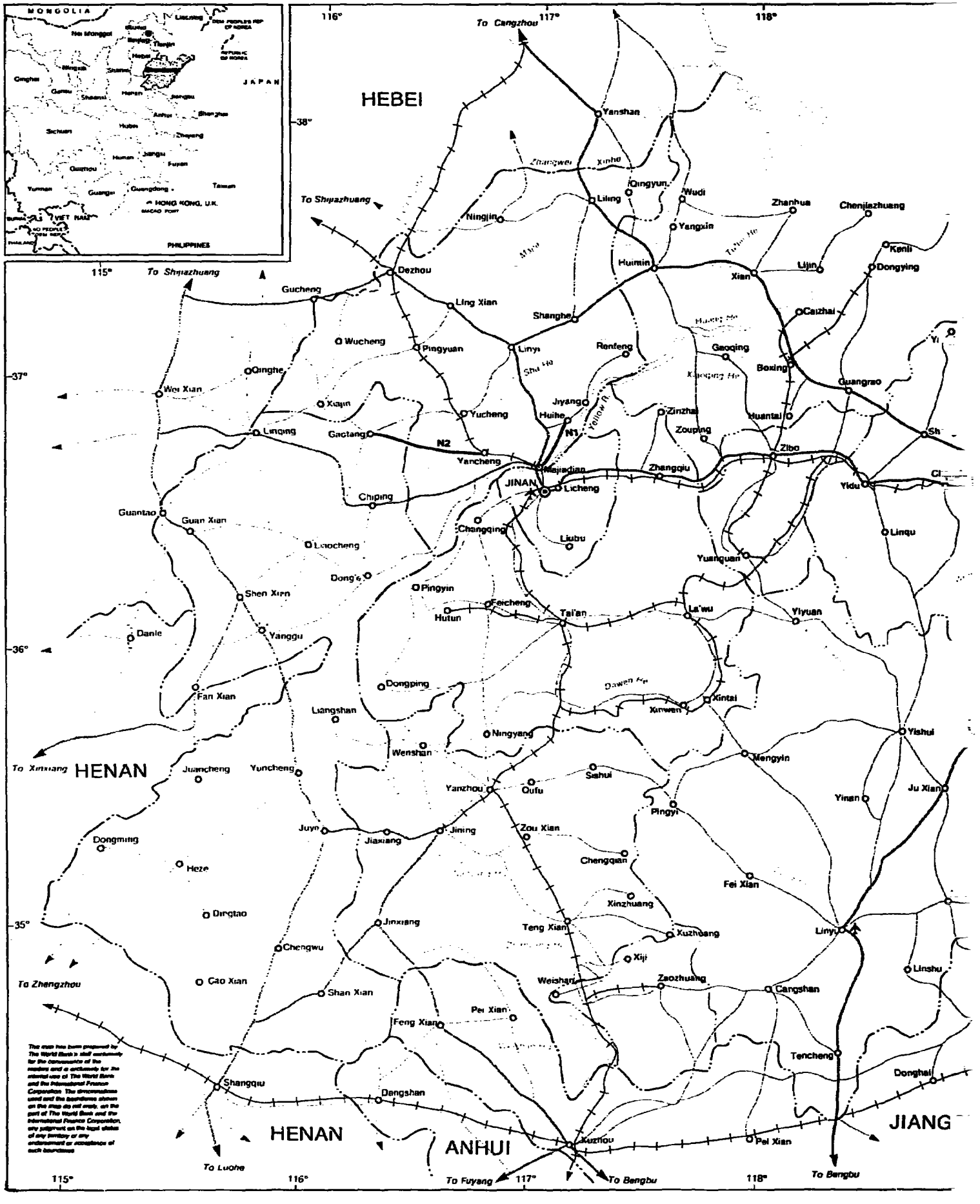
IBRD 16352


MONGOLIA
Liaoning
Nei Mongol
Beijing
Tianjin
Hebei
Ningxia
Shanxi
Qinghai
Gansu
Shaanxi
Henan
Jiangsu
Anhui
Shanghai
Sichuan
Hubei
Zhejiang
Hunan
Jiangxi
Guizhou
Fujian
Yunnan
Guangxi
Guangdong
Taiwan
HONG KONG, U.K.
MACAO PORT
VIET NAM
LAO PEOPLE'S DEM. REP.
THAILAND
PHILIPPINES
JAPAN
REPUBLIC OF KOREA
116°
117°
118°
115°
38°
37°
36°
35°
To Cangzhou
HEBEI
Yanshan
Zhangwei Xinhe
Qingyun
Wudi
Liling
Ninglin
Yangxin
Zhanhua
Chenjiazhuang
To Shijiazhuang
Huimin
Xian
Lijin
Kenli
Dongying
Dezhou
Gucheng
Ling Xian
Shanghe
Caizhai
Wucheng
Pingyuan
Linyi
Renfeng
Gaoqing
Boxing
Guangrao
Qinghe
Wei Xian
Xiajin
Jiyang
Huihe
Yellow R.
Zinzhai
Huantai
Yucheng
Linqing
Gaotang
N2
N1
Zouping
Zibo
Yancheng
Majiadian
Zhangqiu
JINAN
Licheng
Yidu
Chiping
Guantao
Guan Xian
Changqing
Liubu
Linqu
Liaocheng
Yuanquan
Dong'e
Pingyin
Shen Xian
Feicheng
Hutun
Tai'an
La'wu
Yiyuan
Danle
Yanggu
Dongping
Fan Xian
Dawen He
Xintai
Liangshan
Xinwen
Ningyang
Yishui
Wenshan
To Xinxiang
HENAN
Juancheng
Yuncheng
Mengyin
Sishui
Yanzhou
Qufu
Ju Xian
Yinan
Pingyi
Juyn
Jiaxiang
Jining
Zou Xian
Dongming
Chengqian
Heze
Fei Xian
Xinzhuang
Dingtao
Jinxiang
Teng Xian
Xuzhoang
Linyi
Chengwu
Xiji
Linshu
To Zhengzhou
Cao Xian
Weishan
Zaozhuang
Cangshan
Shan Xian
Pei Xian
Feng Xian
Tencheng
Donghai
Shangqiu
Dangshan
HENAN
ANHUI
JIANG
Xuzhou
Pei Xian
To Luohe
To Fuyang
To Bengbu
To Bengbu
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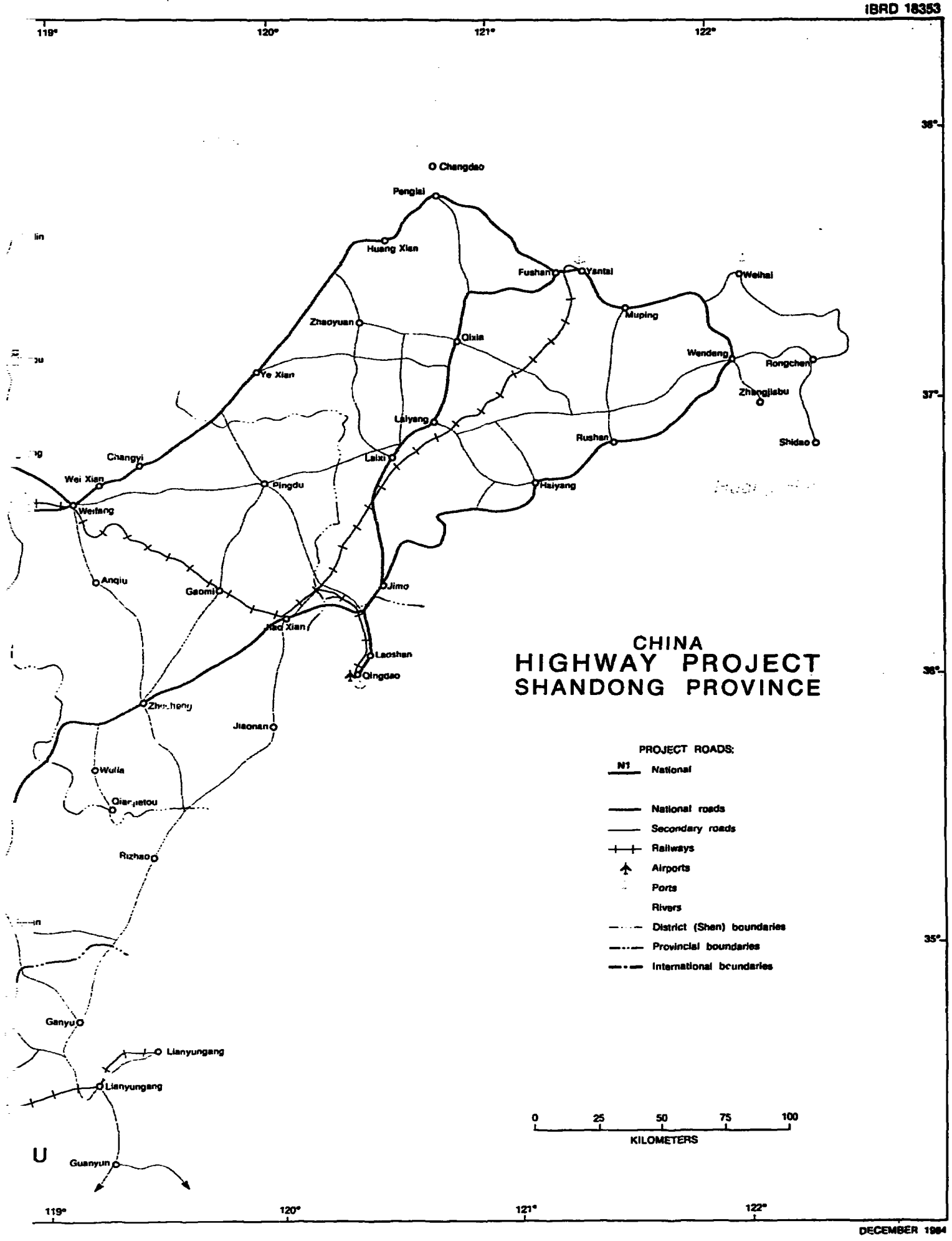
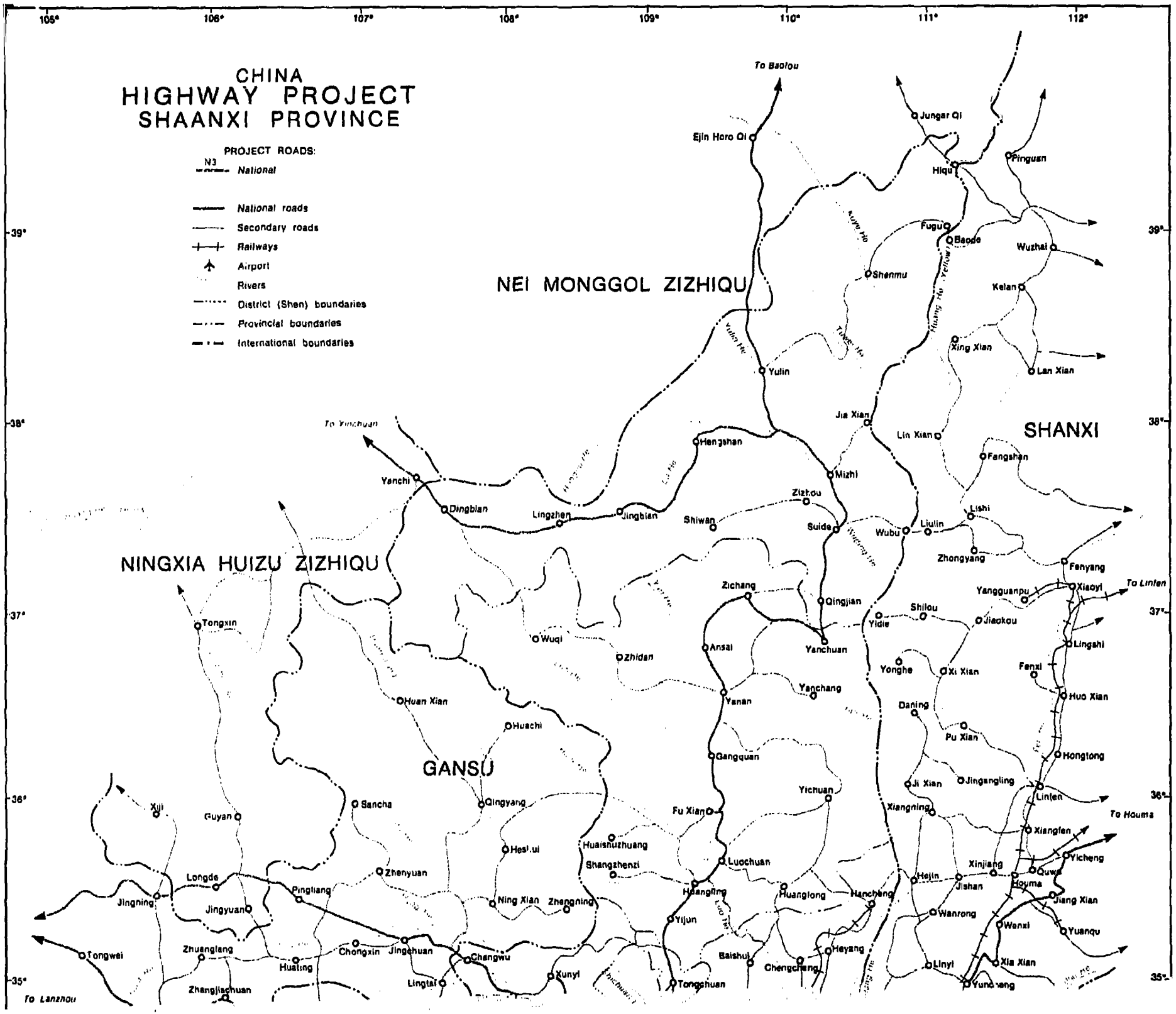
IBRD 18353



DECEMBER 1984


CHINA
HIGHWAY PROJECT
SHAANXI PROVINCE
PROJECT ROADS:
N3 National
National roads
Secondary roads
Railways
Airport
Rivers
District (Shen) boundaries
Provincial boundaries
International boundaries
105°
106°
107°
108°
109°
110°
111°
112°
39°
38°
37°
36°
35°
NEI MONGGOL ZIZHIQU
NINGXIA HUIZU ZIZHIQU
GANSU
SHANXI
To Baotou
To Yinchuan
To Lanzhou
To Linfen
To Houma
Ejin Horo Qi
Jungar Qi
Hiqu
Pinguan
Fugu
Baode
Wuzhai
Shenmu
Kelan
Xing Xian
Lan Xian
Yulin
Jia Xian
Lin Xian
Fangshan
Hengshan
Mizhi
Yanchi
Dingbian
Lingzhi
Jingbian
Zizhou
Shiwan
Suide
Wubu
Liulin
Lishi
Zhongyang
Fenyang
Yangguanpu
Xiaoyi
Zichang
Qingjian
Shilou
Yidie
Jiaokou
Tongxin
Wuqi
Zhidan
Ansai
Yanchuan
Yonghe
Xi Xian
Fenxi
Lingshi
Huo Xian
Huan Xian
Yanchang
Yanan
Daning
Huachi
Pu Xian
Gangquan
Hongtong
Ji Xian
Jingangling
Yichuan
Linfen
Xiji
Guyan
Sancha
Qingyang
Fu Xian
Xiangning
Xiangfen
Hesi.ui
Huaishuzhuang
Shangzhenzi
Luochuan
Yicheng
Xinjiang
Quwo
Longde
Zhenyuan
Pingliang
Hejin
Jishan
Houma
Jingning
Jingyuan
Ning Xian
Zhengning
Huangling
Huanglong
Hancheng
Jiang Xian
Wanrong
Yijun
Wenxi
Yuanqu
Tongwei
Zhuanglang
Chongxin
Jingchuan
Changwu
Huating
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Heyang
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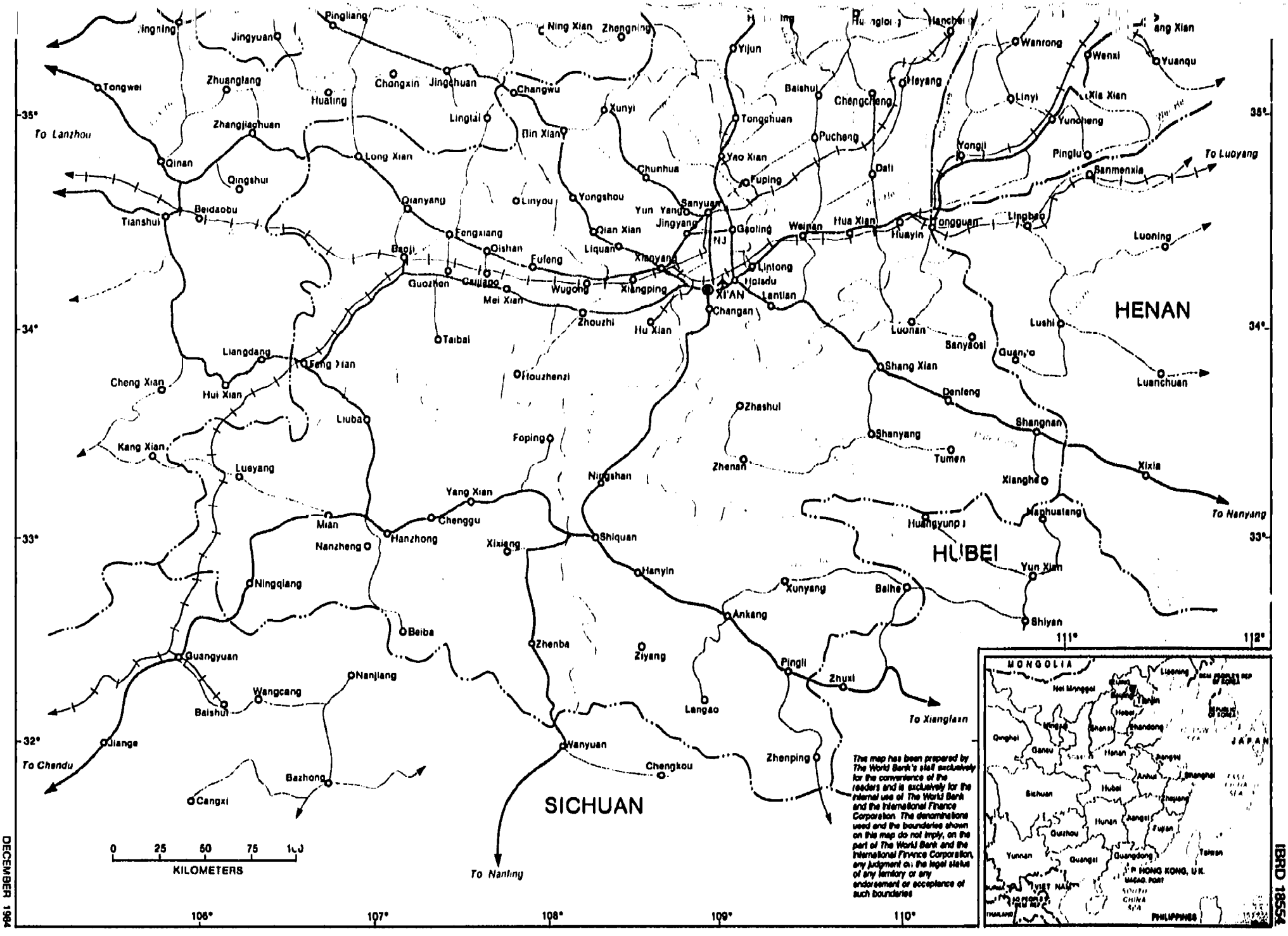
Xia Xian
Zhangjiachuan
Lingtai
Xunyi
Tongchuan
Yuncheng



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DECEMBER 1984

IBRD 18554