China
Yangtze River Four-Bridge Construction Project

Third-Party Evaluation

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Figure S-1 Project Location

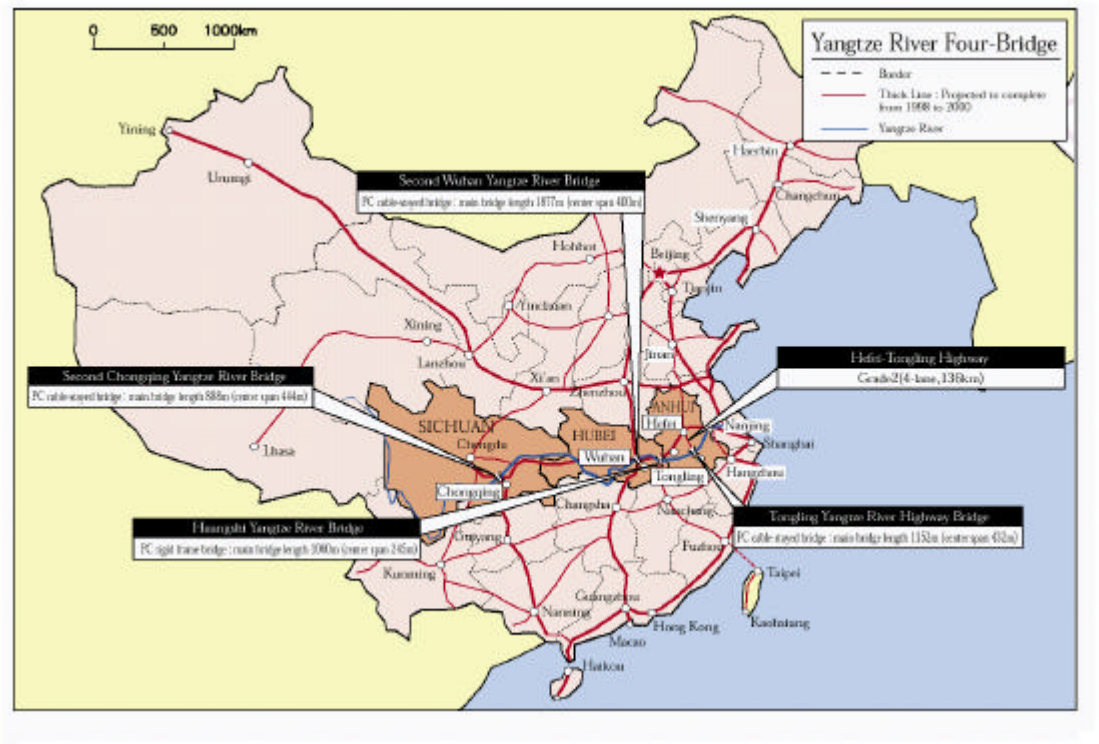


Figure S-2 Project Peripheral Road

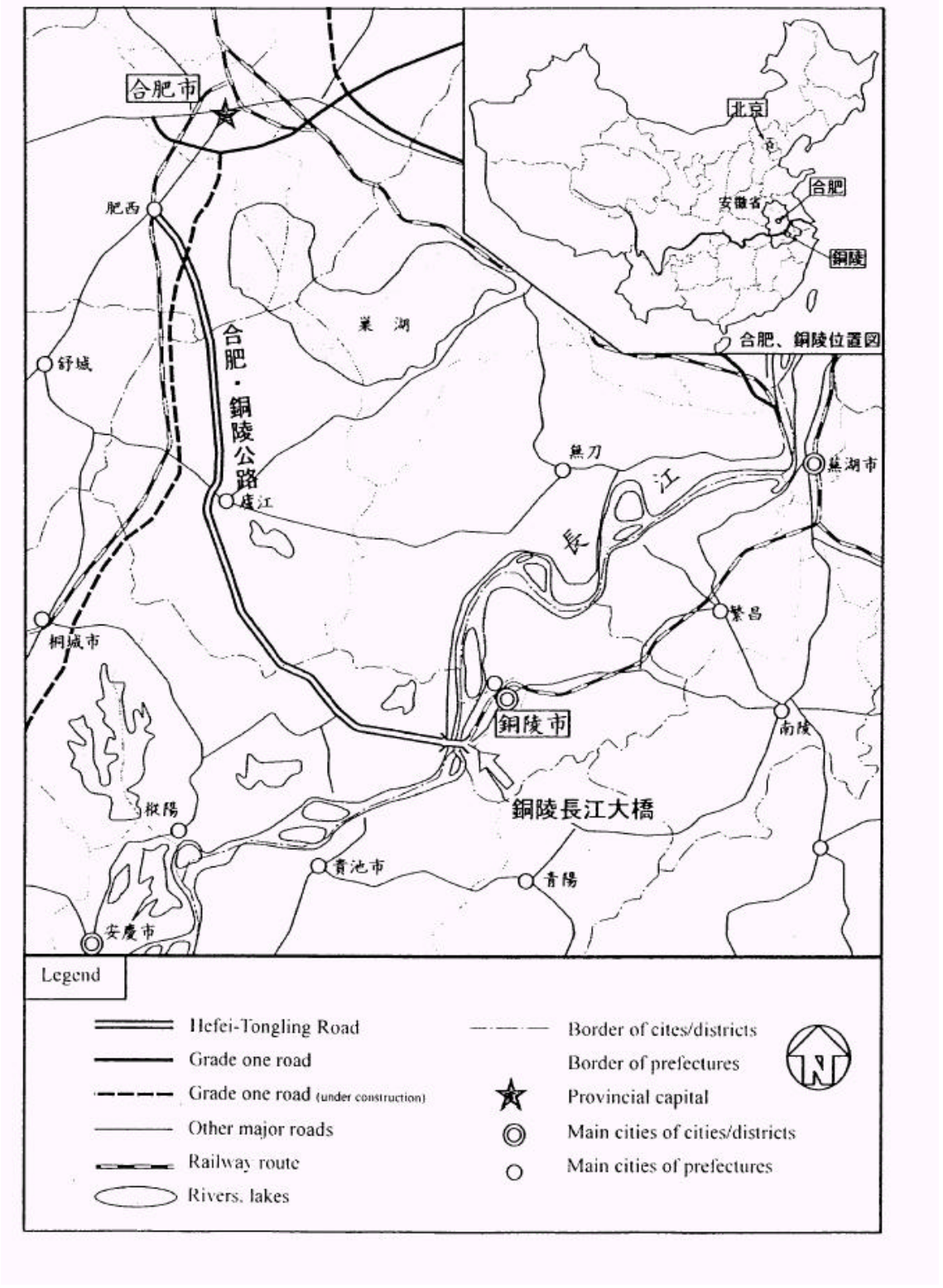


Figure S-3 Project Peripheral Road

Figure S-4 Wuhan City Road Map

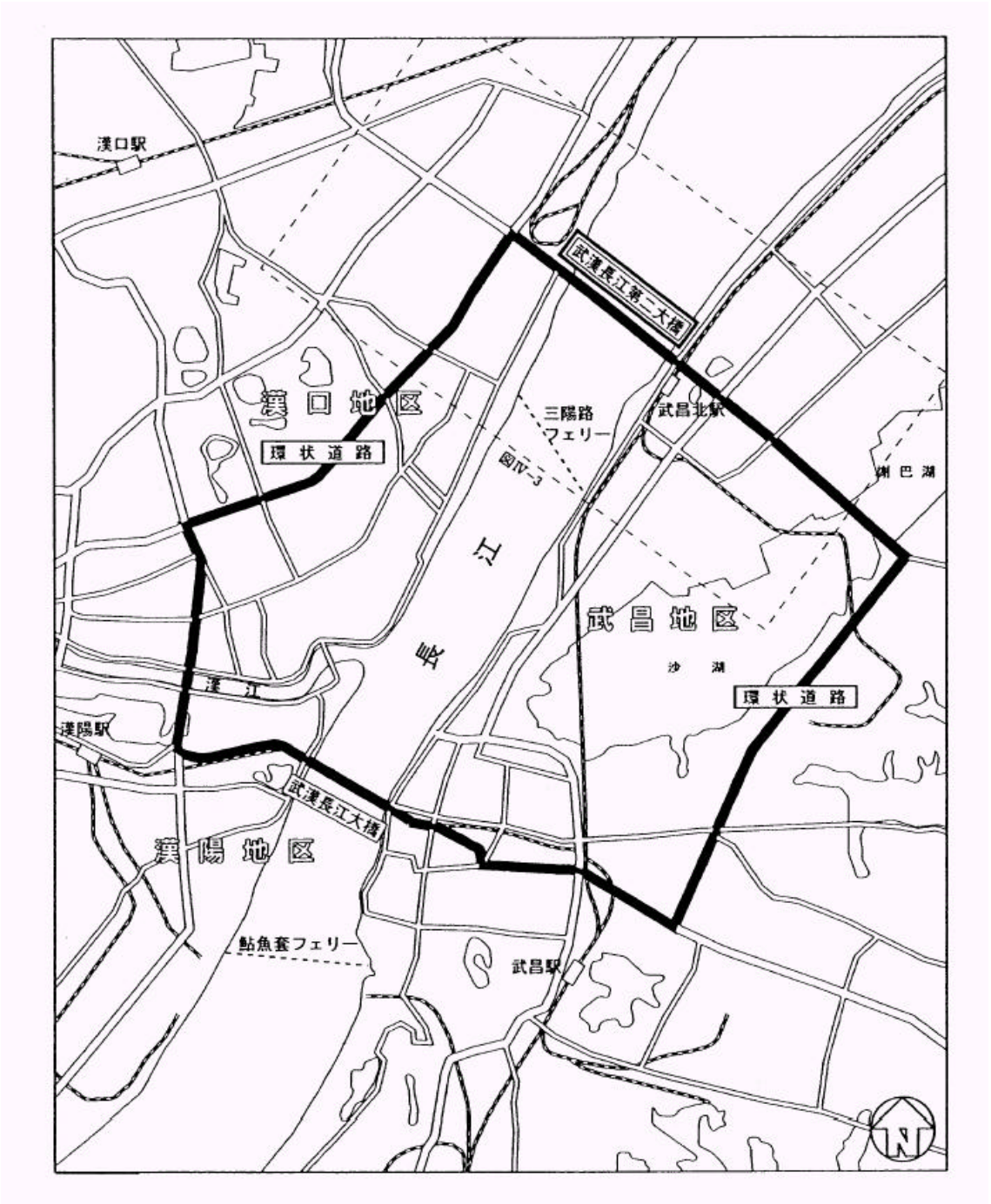
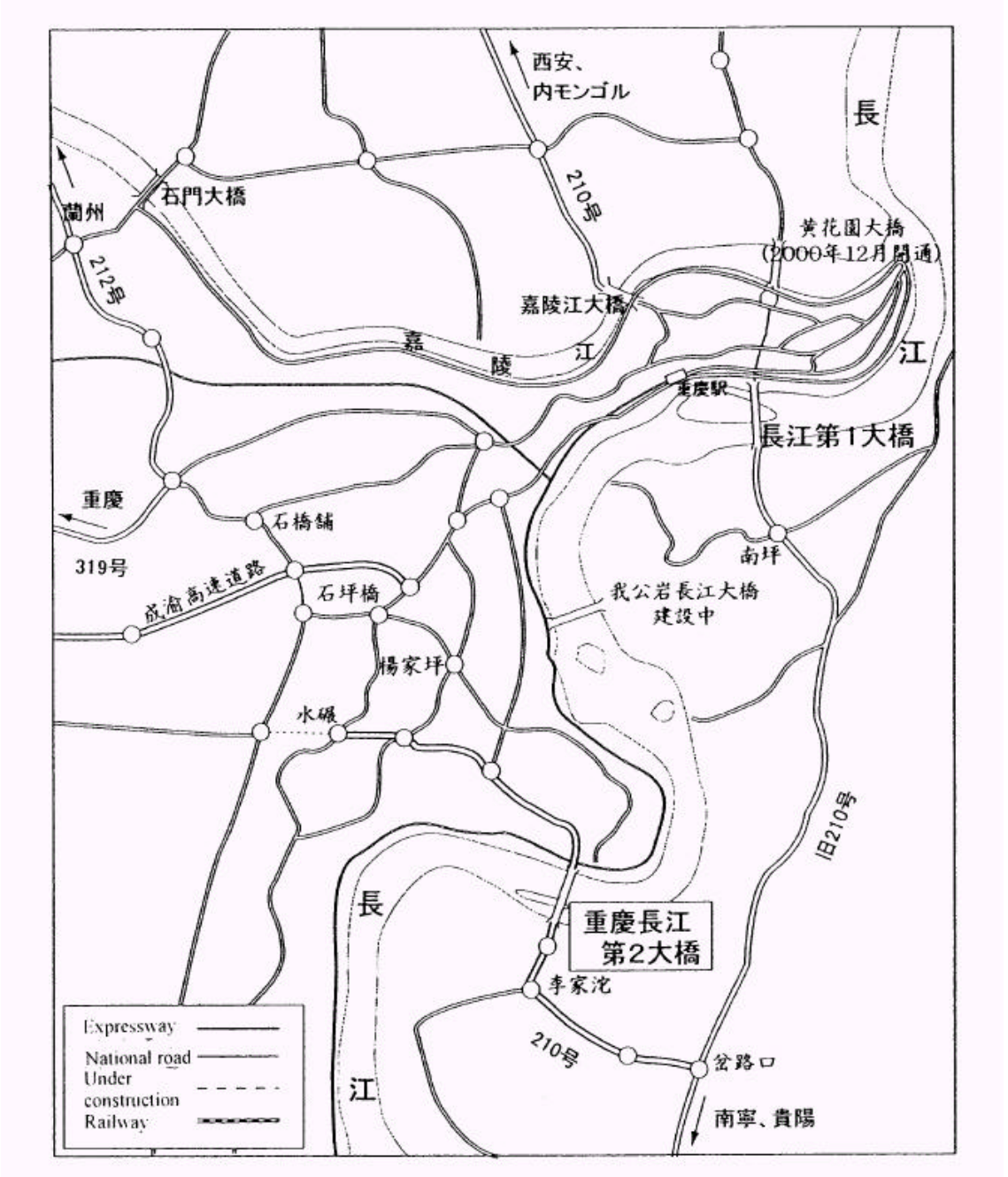


Figure S-5 Second Chongqing Bridge Peripheral Road Map



Project Description (Two Projects by Ministry of Communications)

Project Name / Project Description	Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge	Huangshi Yangtze River Bridge Construction Project
Borrower	Ministry of Foreign Trade and Economic Cooperation, People's Republic of China	Same as left
Executing Agency	Ministry of Communications	Same as left
Exchange of Notes	September 1991	November 1990
L/A Signing	October 1991 (FY1991) October 1992 (FY1992)	November 1990
Loan Disbursed Period	November 1996 (FY1991) November 1997 (FY1992)	December 1995
Loan Amount	¥8,603 million	¥3,700 million
Loan Disbursed Amount	¥8,505 million	¥3,674 million
Procurement Conditions	General Untied	Same as left
Loan Conditions		
Interest rate	2.6%	2.5%
Repayment period	30 years (10 years for grace period)	Same as left

Project Description (Two Projects by Ministry of Construction)

Project Name / Project Description	Second Wuhan Yangtze River Bridge Construction Project	Second Chongqing Yangtze Rvier Bridge Construction Project
Borrower	Ministry of Foreign Trade and Economic Cooperation, People's Republic of China	Same as left
Executing Agency	Ministry of Construction	Same as left
Exchange of Notes	November 1990	September 1991
L/A Signing	November 1990	October 1991
Loan Disbursed Period	December 1995	November 1996
Loan Amount	¥4,760 million	¥4,764 million
Loan Disbursed Amount	¥4,757 million	¥4,660 million
Procurement Conditions	General Untied	Same as left
Loan Conditions		
Interest rate	2.5%	2.6%
Repayment period	30 years (10 years for grace period)	Same as left

<Reference>

(1) Currency: Yuan, RMB

(2) Exchange Rate / Consumer Price Index (CPI: 1990 = 100)

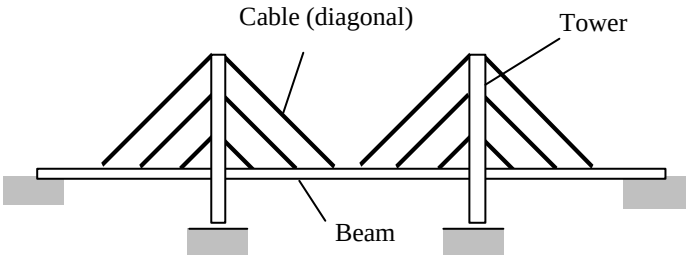
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999*
JP¥/US$	144.79	134.71	126.65	111.20	102.21	94.06	108.78	120.99	130.91	12.11
Yuan/US$	4.78	5.32	5.51	5.76	8.62	8.35	8.31	8.29	8.28	8.28
CPI	100.0	103.5	110.0	126.1	156.6	183.1	198.3	203.8	202.2	197.7

(Note) Figures for 1991 are as of April 1999.

(3) Fiscal Year: January 1 ~ December 31

[Cable-stayed Bridges]

The cable-stayed is one form of long-span bridge, as shown below. It has two towers from which multiple cables extend under diagonal tension to suspend the beams (PC beams in this project) which support the road slab. Of the four bridges, three are cable-stayed bridges. Their central spans are 432m at Tongling, 400m at Wuhan and 444m at Chongqing. The longest cable-stayed bridge in Japan is the Tatara Bridge, at 890m.



[Continuous PC Rigid Frame Bridges]

The form of this bridge, which is a continuous PC rigid frame bridge, is a simple structure on which PC (prestressed concrete) box girders are mounted on a substructure of piers or other elements. It is the most common bridge form. Of the four bridges, the Huangshi Yangtze River Bridge is of this type.

[Grades of Roads in China]

The standards for road structures in China are laid down in the "Public Highways Construction Technology Standards". Roads are divided between automobile-only roads and general roads and subdivided into six grades. Appropriate traffic volumes are specified for each grade. Below expressways, there are public highway standards for grades one, two, three and four. The appropriate standard to apply to a road is determined according to the character of the road, its importance and the volume of traffic using it. The grades are summarized below.

(1) Expressway
Politically and economically important trunk roads constructed with four lanes and a median strip. Entry, exit and turning are restricted.

(2) Grade one public road
This grade is generally applied to roads with daily traffic, averaged over the year, of 25,000 vehicles or more which are of high political and economic significance. They are for automobiles only, with full restrictions on entry and exit.

(3) Grade two public road
Roads linking political and economic centers, large industrial and agricultural centers, ports and stations. This category includes automobile-only roads and general roads. In the case of automobile-only roads, the applicable year-round daily average traffic flow is 4,500~7,000 medium freight vehicles, or equivalent volumes of other vehicles. For ordinary roads the flow is 200~5,000 medium freight vehicles, or equivalent.

(4) Grade three public road
These roads generally carry year-round daily average traffic flows of up to 2,000 vehicles of all types. They are generally the roads that link cities which house district government offices and other facilities.

(5) Grade four public road
These roads generally carry year-round daily average traffic flows of up to 200 vehicles of all types. They are branch roads that interlink districts, villages and hamlets.

Main Design Standards for Roads

Types of roads	Automobile-only roads								General roads					
Road grades	Expressway				Grade 1		Grade 2		Grade 2		Grade 3		Grade 4	
Design speed (km/h)	Level ground	Hills	Mountains		Level ground	Hills Mountains	Level ground	Hills Mountains	Level ground	Hills Mountains	Level ground	Hills Mountains	Level ground	Hills Mountains
Road width, general value (m)	2× 7.5	2× 7.5	2× 7.5	2× 7.0	2× 7.5	2× 7.0	8.0	7.5	9.0	7.0	7.0	6.0	3.5	3.5
Minimum radius of curvature (m)	650	400	250	125	400	125	250	60	250	60	125	30	60	15
Maximum profile gradient (%)	3	4	5	5	4	6	5	7	5	7	6	8	6	9
Bridge design loads	Automobiles exceeding 20 Trailers 120				Automobiles exceeding 20 Trailers 100 Automobiles 20 Trailers 100		Automobiles 20 Trailers 100		Automobiles 20 Trailers 100		Automobiles 20 Trailers 100		Automobiles 20 Caterpillar 50	
Year-round daily average traffic volume (vehicles/ day)	Small-vehicle equivalent of 25,000+.				Small-vehicle equivalent of 10,000～ 25,000		Medium-vehicle equivalent of 4,500～7,000		Medium-vehicle equivalent of 2,000～5,000		Medium-vehicle equivalent of below 2,000		Medium-vehicle equivalent of below 200	
Number of lanes	4				4		2		2		2		2 or 1	

Foreword

This survey compares and analyses the four bridge projects crossing the Yangtze. The four points evaluated were planning, implementation, operation and maintenance, and effects and impacts.

First of all, we analyzed effects and impacts, including the direct impact on bridge users and the ripple effects of bridge construction on the surrounding areas. The points for evaluating ripple effects were set as listed below, based on a consideration of the project objectives of each bridge.

	Project Objective	Key Points of Ripple Effect Evaluation
Hefei-Tongling Highway and Tongling Yangtze River Higyway Bridge Construction Project	To improve the north-south transport network in Anhui province and encourage development of the province's economy.	- Ascertain the traffic and distribution situation in the surrounding area. - Ascertain the state of economic development in the surrounding community.
Huangshi Yangtze River Bridge Construction Project	To accommodate growing demand for cross-river traffic and encourage development of the Yishui district on the opposite bank.	- Ascertain the impact on traffic in the surrounding area. - Ascertain the situation in Yishui district's economic development zone. - Ascertain the state of development in Huangshi.
Second Wuhan Yangtze River Bridge Construciton Project	To alleviate congestion in the city center and make economic activity more efficient.	- Ascertain the changes in the traffic situation in the city. - Ascertain the state of development in communities around the River Bridge.
Second Chongqing Yangtze River Bridge Construction Project	To alleviate congestion in the city center and encourage economic development in the southwest of the city and in southwest China.	- Ascertain the degree of alleviation of traffic congestion in the city center. - Ascertain the state of development in the area around the River Bridge (including the southwest of the city).

I. Project Summary

1. Project Location

Hefei - Tongling River Highway Bridge is located between Hefei, the capital city of Anhui province, and Tongling, the largest mining city in the province. The Second Wuhan River Bridge is located in Wuhan, the capital city of Hubei province. The Huangshi River Bridge is in Huangshi, the second largest city of the same province. The Second Chongqing River Bridge is located in Chongqing, a municipality in Sichuan province. (Refer to the project position map).

2. Project Summary and ODA Loan Portion

The Hefei - Tongling Highway and Tongling Yangtze River Highway Bridge Construction

Project consisted of two projects, the construction of a new 123km-long grade two road between Hefei and Tongling and the construction of PC cable-stayed bridge across the Yangtze (main bridge length 1,152m) to link the road with Tongling. The construction of a north-south trunk road within the province was to provide a base for the economic development of Anhui province by encouraging Tongling's mining industry.

The Huangshi Yangtze River Bridge Construction Project was to build a PC rigid-frame bridge (main bridge length 1,060m) over the Yangtze, which flows through the city, between the West Bank (the Huangshi side) and the East Bank (the Yishui side). The project was intended to meet increased demand for crossings to the Yishui side and help to stimulate economic activity and development along the opposite bank.

The Second Wuhan Yangtze River Bridge Project built a Second Yangtze River Bridge (PC cable-stayed bridge, main bridge length 1,877m) in Wuhan, which is divided into the Hankou and Wuchang districts by the Yangtze River. It was intended to alleviate traffic congestion in the city and make economic development more efficient.

The Second Chongqing Yangtze River Bridge Project built the Second Yangtze River Bridge (PC cable-stayed bridge, main length 888m) in Chongqing, which is divided by two large rivers, the Yangtze and Jialing. The project was intended to create closer traffic links within the city, to promote economic development and a better traffic situation in the southwest of the city, and to reduce traffic pressure in the city center.

The content of the projects consisted of bridge and road construction, land acquisition and technical assistance. The technical assistance only concerned the cable-stayed bridge. The ODA loan covered the entire foreign currency portion of the cost of buying materials (cement, timber, asphalt, steel etc.), construction machinery and technical assistance necessary for the construction of the roads and bridges listed above.

The procurement of materials and equipment covered by foreign currency portions was arranged by international competitive tender through the Chinese Mechanical Equipment Import Export Corporation (a procurement agency).

II. Evaluation on Project Program

1. Objectives

(1) Background and Need for the Project

Since the Third Plenary Session of the Eleventh Central Committee of the Chinese Communist Party adopted openness policies in December 1978, a succession of areas along the Eastern Seaboard have been designated as Special Economic Zones, Free Economic Zones and Free Coastal Zones. The Eastern Seaboard has been the center of rapid growth in foreign trade.

In order to pursue balanced regional development, the Seventh Five-Year National Plan for Economic and Social Development (1986~1990, the "7-5 Plan") proposed regional economic development policies which emphasized creating close linkages between the Eastern Seaboard and the central and western regions. In particular, the central was seen as important for creating an organic link between the coastal and western regions and for gradually propagating coastal development inland. Within the central region, the land along the banks of the Yangtze River was expected to play a vital role as a belt joining the other two regions, and its development was promoted accordingly. The Eighth Five-Year Plan (1991~1995, the "8-5 Plan"), which followed on from the 7-5 Plan, also proposed directing the progress of development in ways which harmonized the coast and the interior. The 8-5 Plan added transport to the list of priority development sectors, alongside agriculture, energy and communications. Construction in the roads sector was to target trunk roads at the provincial level and roads at the district level, in addition to national routes and other trunk routes, expressways and automobile-only roads. Specifically, the priority roads for construction were:

(i) Those linking coastal cities with large cities in the interior.
(ii) Those linking ports to cities.
(iii) Those linking provinces.
(iv) Those linking industrial cities with economic cities.

The 8-5 Plan included the construction of approximately 90,000km of roads and the improvement of approximately 50,000km (comprising 10,000km of expressways and 42,000km of automobile-only roads).

(2) Yangtze River Bridge Construction Under the 8-5 Plan

From the completion of the Wuhan Yangtze River Bridge in 1957 to the start of this project, the Yangtze was bridged in five more places, Nanjing, Zhicheng, Chongqing, Luzhou and Jiujiang, for a total of six bridges.

This project bridged the Yangtze at four more places, Tongling, Huangshi, Wuhan (2nd) and Chongqing (2nd). All of these bridges were designated as key projects under the 8-5 Plan.

The third ODA loan was used in the construction of all four river bridges.

(3) Confirmation of Project Objectives

The purpose of the Hefei-Tongling River Highway Bridge was to construct a road and bridge to link Hefei, the provincial capital, with Tongling, a mining city to the south in order to promote the development of mining in Tongling and, by extension, contribute to the development of Anhui province as a whole.

The purpose of the Huangshi River Bridge was to link Huangshi with the opposite bank of the river. There was no previous bridge in the city, and the ferry link was unable to cope with increasing demand for traffic across the river. The bridge was constructed to improve the situation, and to promote development on the Yishui district side of the river.

The purpose of the Second Wuhan Yangtze River Bridge was to alleviate construction in the city caused by cross-river vehicular traffic exceeding the capacity of the First Wuhan Yangtze River Bridge, to make economic activity more efficient and to accommodate future increases in cross-river traffic demand.

The purpose of the Second Chongqing Yangtze River Bridge was to create closer linkages within the city's traffic system, which is segmented by the Yangtze and Jialing Rivers, and to encourage economic development and traffic improvement in the southwest of the city. The construction of the bridge, which completed a ring road around the city, was also intended to reduce traffic pressure on the city center. By enhancing links with major national-level trunk roads, such as road Nos. 210, 212 and 319, the project was expected to contribute to economic progress in the area around Chongqing, and also, by extension, in southern China as a whole.

Looking at each project objective in turn, the two Ministry of Communications projects (the Hefei-Tongling River Highway Bridge and the Huangshi River Bridge) were remote region development projects intended to promote rural development, while the two Ministry of Construction projects (Second Wuhan and Second Chongqing River Bridges) were bottleneck remedies intended to alleviate traffic congestion.

2. Project Content

Within the Hefei Tongling Yangtze River Highway Bridge Construction Project, the route of the road portion was partially revised at the construction stage, shortening it to 123km from the planned 136km. The river bridge portion of the project was carried out as planned, with no alterations.

The Huangshi River Bridge was altered as follows. Due to geological conditions, the main bridge was moved 27m towards the North Bank, in the direction of the bridge's axis, but the structure of the bridge itself was unchanged. The approach road was altered from 5km of grade two road to 1.5km of grade one road, which was an appropriate alteration due to a change in the route to the connection point.

For the Second Wuhan Yangtze River Bridge, the span sub-divisions and their lengths were altered on the approach bridge on the Wuchang side, and the interchange overpass was lengthened on the Hankou side. These were both appropriate alterations. The specification of

the main bridge was not altered.

For the Second Chongqing Yangtze River Bridge, the approach road on the Lijiatuo side was partially rerouted due to site conditions, increasing its length from the initial 4,130m to 4,411m. The specification of the main bridge was not altered.

Therefore the main bridge sections of the four bridges were built as planned, without alterations to their structures or specifications. Three of the bridges had alterations in the specification of the approach roads and approach bridges, but all the changes were minor and appropriate to the content of the project. All projects achieved their objectives.

3. History

The history of Four-Bridge Construction Project is as follows.

1988	March ~ June	Completion of Feasibility Study in the Chinese side concerning Four-Bridge Construction Project
1989	June	Occurrence of "Tiananmen Incident"
1990	January	Official request of FY 1990 ODA loan projects, including Huangshi Bridge and Second Wuhan Bridge
	July	Government mission
	August	JBIC Appraisal Mission
	September	Prior notification
	November	Exchange of Notes
	November	Loan Agreement signing
1991	January	Official request of FY 1991 ODA loan projects, including Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge(1) and Second Chongqing Bridge
	May	Government mission
	June	JBIC Appraisal Mission
	August	Prior notification
	September	Exchange of Notes
	October	Loan Agreement signing
1992	January	Official request of FY 1992 ODA loan projects, including Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge (2)
	March	Government mission
	April	JBIC Appraisal Mission
	June	Prior notification
	October	Exchange of Notes
	October	Loan Agreement signing

Table II-1 Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge: Comparison of Original Plan and Actual for Project Contents

Item	①Plan	②Actual	Difference (②-①)
(1) Hefei-Tongling Highway			
(a) Main roads			
Section	Fefei – Tongling	Same as left	
Extension	136km	123km	▲13km
Standard	Grade 2 road	Same as left	
Design speed	100km/h	Same as left	
No. of traffic lanes	2	Same as left	
Width	12～15m	Same as left	
Pavement structure			
Lower roadbed	28cm	Same as left	
Upper roadbed	20cm	Same as left	
Outer layer	15cm (Asphalt pavement)	Same as left	
(b) Incidental fabrics			
Bridges	16	17	+1
Multi-level crossing	11 (including 3 interchanges)	5 (including 3 interchanges)	▲6
Grade crossing	31	8	▲23
Toll gate	3	Same as left	
(2) Tongling Yantze River Highway Bridge			
(a) Main bridge			
Type	PC cable-stayed bridge	Same as left	
Length	1,152m	Same as left	
Width	23m	Same as left	
No. of traffic lanes	4	Same as left	
Central span	432m	Same as left	
(b) Approach bridge			
Tongling side	710m	Same as left	
Hefei side	730m	Same as left	
(c) Approach road			
Tongling side	1,856m	1,862m	+6m
Hefei side	313m	Same as left	
Standard	Grade 1 road	Same as left	
Design speed	100km/h	Same as left	

Table II-2 Huangshi Bridge: Comparison of Original Plan and Actual for Project Contents

Item	①Plan	②Actual	Difference (②-①)
(1) Main bridge			
Type	Continuous PC rigid frame bridge	Same as left	
Length	1,060m	Same as left	
Width	20m	21.5m	＋1.5m
No. of traffic lanes	4	Same as left	
Maximum span	245m	Same as left	
(2) Approach bridge			
Huangshi side	814m	841m	＋27m
Yishui side	706m	679m	▲27m
(3) Approach road			
Yishui side	5km	1.5km	▲3.5km
Standard	Grade 2 road	Grade 1 road	

Table II-3 Second Wuhan Bridge: Comparison of Original Plan and Actual for Project Contents

Item	①Plan	②Actual	Difference (②-①)
(1) Main bridge			
Type	PC cable-stayed bridge	Same as left	
Length	1,877m	Same as left	
Width	26.5m	Same as left	
No. of traffic lanes	6	Same as left	
Maximum span	400m	Same as left	
(2) Approach bridge			
Wuchang side	925.4m	861.4m	▲64.0m
Hankou side	425m	Same as left	
(3) Interchange elevated bridge			
Hankou side	603.9m	674.8m	＋70.9m

Table II-4 Second Chongqing Bridge: Comparison of Original Plan and Actual for Project Contents

Item	①Plan	②Actual	Difference (②-①)
(1) Main bridge			
Type	PC cable-stayed bridge	Same as left	
Length	888m	Same as left	
Width	24m	Same as left	
No. of traffic lanes	4	Same as left	
Maximum span	444m	Same as left	
(2) Approach bridge (Lijiatuo side)			
Lijiatuo Length	400m	Same as left	
Width	21.6m	Same as left	
(3) Approach road			
Jiulongpo side	4,774m	Same as left	
Lijiatuo	4,130m	4,411m	＋281m
Bridge	10	5	▲5
Tunnel	2	Same as left	
Interchange	5	Same as left	

III. Evaluation on Project Implementation

1. Implementation Schedule

Work on the Hefei Tongling Yangtze River Highway Bridge began and was completed as scheduled. The road was completed in December 1994 and the river bridge in December 1995.

The start of construction work on the Huangshi River Bridge was delayed for six months due to loan procedures after the Tiananmen Incident and other factors, including design changes. Flooding after the completion of the bridge construction caused a further delay of seven months, meaning the project was completed 13 months later than planned, in December 1995.

The start of work on the Second Wuhan Yangtze River Bridge was delayed for 13 months for similar reasons to the Huangshi River Bridge, but measures taken to accelerate the construction works were successful, and the bridge was finished only six months late in May 1995.

Work on the Second Chongqing Bridge began as planned, but the lack of budgetary allocation to cover the local currency cost overrun slowed its progress, and it was not completed until December 1996, a year late.

Of the three bridges which were completed late, in Huangshi, Wuhan and Chongqing, the Chongqing Bridge was set back by budget allocation delays, and the others were due to acts of God and other unavoidable circumstances beyond the responsibility of the executing agencies. In general, major projects in China are named in honor of events such as the foundation of the Republic, and there is a strong desire to finish on time. The construction of the Wuhan Bridge was an example of this approach, as the delay in beginning construction was covered by efforts to accelerate progress. Completion was delayed, but the delay was kept to a minimum, and it is reasonable to say that performance in connection with construction schedules was good.

2. Project Cost

The ratios of planned to actual project costs in the foreign currency portions were 97.2% for the Hefei-Tongling Highway, 99.5% for the Tongling River Bridge, 99.3% for the Huangshi River Bridge, 99.9% for the Second Wuhan River Bridge and 97.8% for the Second Chongqing River Bridge. Thus the costs were largely as anticipated.

The local currency costs all overran by large margins. The overruns, relative to the planned costs, were 32% for Hefei - Tongling Highway, 60% for the Tongling River Bridge, 310% for the Huangshi River Bridge, 310% for the Second Wuhan River Bridge and 60% for the Second Chongqing River Bridge. The planned values for the projects were based on 1992 prices for the Hefei - Tongling Yangtze River Highway Bridge, 1989 prices for the Huangshi and Wuhan Bridges and 1990 prices for the Chongqing Bridge. The main reason for the cost overruns was price rises triggered by the introduction of market economic. At the time of the appraisal, a local currency inflation rate of 12% per year was predicted, but the prices of major construction-related items leapt up by 2~3 times over the four years between 1990 and 1993.

Item	① 1990 price	② 1993 price	Magnification (②/①)
Labor cost	8 Yuan/day	19.2 Yuan/day	2.4
Timber	482 Yuan/t	1,050 Yuan/t	2.2
Reinforcing rod	836 Yuan/t	1,830 Yuan/t	2.2
Section steel	690 Yuan/t	2,054 Yuan/t	3.0
Cement	181 Yuan/t	280 Yuan/t	1.6
Steel cable	1,858 Yuan/t	4,882 Yuan/t	2.6
Asphalt	365 Yuan/t	1,581 Yuan/t	4.3

Looking at overrun rates for the bridge and the road separately, the rates for the roads are lower than for the bridges, as seen in Hefei - Tongling. The Second Chongqing River Bridge has long approach roads, but the overrun rate for the approach roads is 60%, while the rate for the bridge was 2.7 times. The overrun rate is less for the road than for the bridge, because the road has a higher share of earthworks and low-grade materials (gravel etc.), for which the inflation rate was relatively low.

Now let us examine the funding sources which were used to cover the excess local currency cost. For the Hefei - Tongling Yangtze River Highway Bridge the entire additional cost was covered by government funding. For the Huangshi River Bridge, government funding covered 87% of the required additional funding. Some of the overrun was covered by local borrowing, but as the amount and the interest rate were relatively small, the repayments of interest and principal are not expected to have an adverse effect on the bridge's accounts in operation. For the Second Wuhan River Bridge, government funding provided 82% of the total funds obtained, with the remainder being obtained by borrowing from domestic banks. The interest rate was high (10%), but as the amount was relatively small it is unlikely to push the bridge's accounts into deficit in later years. The situation for the Second Chongqing River Bridge is somewhat different. City bonds issues and domestic bank loans at high interest rates were used to obtain 66% of the required local currency funds. The resulting high capital cost will impose a heavy burden of repayment on the operating company after completion and will put pressure on its balance of income and expenditure. This example demonstrates the large extent to which skill in obtaining local currency funding (how low an interest rate the funds can be obtained at) can control the future balance of income and expenditure for a project.

To compare the costs for the main bridge sections, between the cable-stayed bridges with the PC continuous girder bridge, we calculated the actual construction cost per meter of each bridge, as seen in Table III-1.

Table III-1 Comparison of Actual Construction Costs for the Four Bridges

Name of bridge	Type	Main bridge length①	Central span	No. of traffic lanes	Actual construction cost②	Unit construction cost (②/①)
Second Wuhan	Cable-stayed bridge	1,877m	400m	6	848.05 million Yuan	452,000 Yuan/m
Second Chongqing	〃	888m	444m	4	324.63 million Yuan	366,000 Yuan/m
Tongling	〃	1,152m	432m	4	420.44 million Yuan	365,000 Yuan/m
Huangshi	PC continuous girder	1,060m	245m	4	369.33 million Yuan	348,000 Yuan/m

The unit construction costs for the Second Chongqing and Tongling bridges, which have the same numbers of lanes, are largely the same. These results suggest that the market rate for the construction unit price of the main sections long bridges can be put at 450,000 Yuan/m for a six-lane cable-stayed bridge, 360~370,000 Yuan/m for a four-lane cable-stayed bridge, and 350,000 Yuan/m for a PC continuous girder bridge. Cable-stayed bridges are now the mainstream for long bridges in China. One reason given is that they are not more expensive than the previous form (PC continuous girders), and this example bears that out.

3. Implementation Scheme

The executing agency for the Hefei - Tongling Yangtze River Highway Bridge and the Huangshi River Bridge was the Ministry of Communications. It is a central ministry which carries out policy determination and plan formulation tasks, such as overall planning, plan coordination and selection of projects for application of loan funds. Its remit covers roads and other areas of transport infrastructure. The implementation, maintenance and operation of individual projects are delegated to the provincial level (Communications Office) and municipalities from the feasibility study stage.

The implementation scheme used for the Hefei - Tongling Yangtze River Highway Bridge was as follows: For the road, the construction was led by the Anhui High-grade Highways Construction Supervision Section, which has a staff of 172, including 83 engineers. The design was commissioned from the Anhui Road Survey and Design Institute and the Supervision section supervised the construction works. The construction contractors were selected on a competitive tender basis from among the contractors approved by the Ministry of Communications (those with superior qualifications), and worked on an "equipment and materials supplied" basis. The roadbed preparation and the small structures were ordered from two contractors, road paving and large structures from four contractors, for a total of six. The performance of the related parties showed no problems according to the PCR and other sources. However, as will be noted below, many repairs have been needed after completion, which indicates that there may have been problems with construction quality in some areas.

The Anhui High-grade Highways Construction Supervision Section also led the construction of the Tongling Bridge. The design was commissioned from the Ministry of Communications Road Planning and Design Institute and the Ministry of Communications Number One Public

Highways Survey and Design Institute was charged with supervising the construction works. The construction contractors were selected on a competitive tender basis from among the contractors approved by the Ministry of Communications and worked on a "equipment and materials supplied" basis. The selected contractor was the China Road Bridge Construction Corporation. There were no significant problems with the performance of the related parties.

The implementation scheme used for the Huangshi River Bridge was as follows: The main executing body was the Hubei Province Huangshi Yangtze River Bridge Construction Supervision Section and the supervision of the construction works was commissioned from the Ministry of Communications Number One Public Highways Survey and Design Institute. The construction was divided into four zones. The contractor for each zone selected on a competitive tender basis from among the contractors approved by the Ministry of Communications (those with superior qualifications), and worked on an "equipment and materials supplied" basis. The contractor chosen to build the main bridge was China Road Bridge Construction Corporation, which also built the Tongling Bridge. There were no significant problems with the performance of the related parties.

The Ministry of Construction was the executing agency for the Second Wuhan River Bridge and the Second Chongqing River Bridge. The Ministry of Construction is another central ministry which carries out policy determination and plan formulation tasks, such as overall planning, plan coordination and selection of projects for application of loan funds. Its remit covers water supply, gas, roads and other infrastructure in 600 cities throughout China. The implementation, maintenance and operation of individual projects are delegated to the provincial level (Construction Committee) and municipalities from the feasibility study stage.

The implementation scheme used for the Second Wuhan River Bridge was as follows: The main executing body was the Wuhan City Yangtze River Bridge Construction Supervision Section (a staff of 80, including 34 engineers). The design was commissioned from the Ministry of Railways River Bridge Construction Office Institute of Survey and Design. Supervision of the construction works was commissioned from the Ministry of Railways Institute of Bridge Science Supervision Corporation and others. The construction was divided into six zones. The contractor for each zone was selected on a competitive tender basis from among the contractors approved by the Ministry of Communications (those with superior qualifications), and worked on an "equipment and materials supplied" basis. The contractor chosen to build the main bridge was the Ministry of Railways Bridge Construction Office. There were no significant problems with the performance of the related parties.

The implementation scheme used for the Second Chongqing River Bridge was as follows: The main executing body was the Chongqing City Yangtze Second River Bridge Construction Supervision Section (a staff of 80, including 56 engineers). The design was commissioned from the Shanghai Municipal Institute of Design. Supervision of the construction works was commissioned from the Chongqing City Yangtze Second River Bridge Construction Management Section. The construction was divided into five zones. The contractor for each zone was selected on a competitive tender basis from among the contractors approved by the Ministry of Communications (those with superior qualifications), and worked on an "equipment and materials supplied" basis. The contractor chosen to build the main bridge was Chongqing

City Bridge Construction Corporation. There were no significant problems with the performance of the related parties.

In China recently, there have been many cases of shoddy construction of roads and bridges. The most prominent cases are the Kunming-Lufeng Highway in Yunnan province (from Kunming to Lufeng), which required repairs to the entire surface 18 days, and the Qingyang Bridge on the Qinyang-Siping Expressway in Liaoning province (from Qinyang to Siping), where a collapsing road surface caused a fatal accident. The most shocking case was the collapse of the Qijiang River Bridge in Chongqing, which occurred on 4th January 1999, leaving 40 dead and 14 injured. Shoddy construction by unqualified contractors was cited as the cause of the collapse, and there appears to have been a problem with the selection of contractors. When we questioned the Ministries of Communications and Construction as to whether there were any such concerns with the four bridges evaluated here, we were told that in each case the best contractor was chosen from approved contractors (those with superior qualifications) by competitive tender, and that the construction works were supervised by third-party organizations. Therefore, we were told, the kind of accident which affected the Qijiang Bridge would not be possible.

4. Technical Assistance

Three of the four bridges were of the cable-stayed type, which was almost unprecedented in China at the time. ODA loan funds were used to carry out technical assistance for the acquisition of necessary construction and maintenance skills. The technical assistance has been carried out as described below.

For the Tongling River Bridge, two study groups were dispatched during the implementation period to acquire skills for the construction and maintenance of cable-stayed bridges. Eight people were sent to the USA for 15 days, and six were sent to Japan for 14 days. According to those concerned, the study tour to Japan provided valuable information on techniques for protecting main cables and on methods for scenic planning around the bridges.

For the Second Wuhan River Bridge, ten-member study groups were dispatched to Japan as planned, once in 1991 and once in 1992, to acquire skills for the construction and maintenance of long bridges. According to those concerned, the knowledge gained through training in Japan (such as measurement systems for the management of precision in the construction of cable-stayed bridges) was valuable for the construction and maintenance of the bridge.

Technical assistance for the Second Chongqing River Bridge comprised advisory services and the dispatch of study groups to Japan. Advisor employment contracts were signed with TRC, an American long bridge consultant. TRC provided advice on technology for the construction of cable-stayed bridges, and there were no problems with its performance. Study groups visited Japan as scheduled, annually between 1991 and 1993. According to the parties concerned, training in Japan provided valuable knowledge on matters such as Japan's experience of building cable-stayed bridges, advice on environment of construction tenders, and computer-based systems for toll collection.

5. JBIC's Performance

JBIC kept a grasp of the progress of each project and any associated problems through progress reports and other means. In addition, the projects were monitored properly through measures including Interim Monitoring Mission, which was dispatched in November 1992 and October 1993. There were no significant problems in the JBIC's performance.

Figure III-1 Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge: Project Implementation Schedule

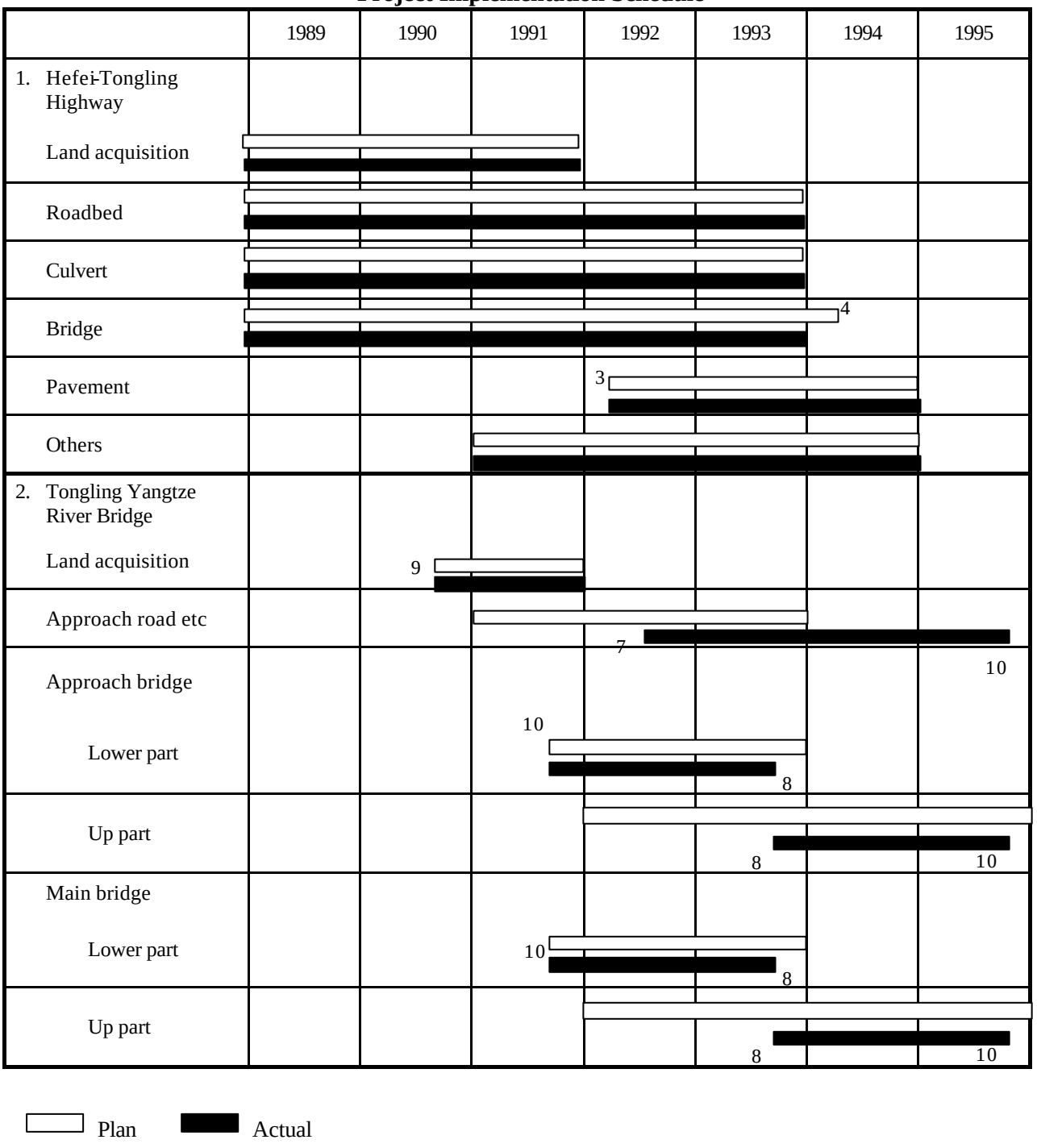


Table III-2 Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge: Comparison of Original Plan and Actual for Project Cost

Units: ¥ 1 million, 10,000 Yuan

Item	① Plan			② Actual			Difference (②－①)		
	Foreign currency (¥ 1 million)		Local currency	Foreign currency (¥ 1 million)		Local currency	Foreign currency (¥ 1 million)		Local currency
	Total	JBIC portion	(10,000 Yuan)	Total	JBIC portion	(10,000 Yuan)	Total	JBIC portion	(10,000 Yuan)
1. Hefei-Tongling Highway									
Roadbed	130	Same as left	7,175	130	Same as left	8,964	0	Same as left	+1,789
Pavement	1,122	〃	3,377	1,122	〃	5,667	0	〃	+2,290
Bridge	356	〃	1,787	356	〃	2,272	0	〃	+485
Culvert	168	〃	579	168	〃	1,379	0	〃	+800
Others (interchange, toll gate etc.)	508	〃	2,553	508	〃	4,128	0	〃	+1,575
Technical assistance	30	〃	0	0	〃	0	▲30	〃	0
Land acquisition	0	〃	2,900	0	〃	3,590	0	〃	+690
Price escalation	35	〃	766	35	〃	—	0	〃	—
Contingency	115	〃	507	77	〃	—	▲38	〃	—
Total	2,464	〃	19,644	2,396	〃	26,000	▲68	〃	+6,356
2. Tongling Yangtze River Bridge									
Main bridge	3,975	Same as left	7,744	3,925	Same as left	14,403	▲50	Same as left	+6,659
Approach bridge	1,317	〃	3,053	1,310	〃	5,679	▲7	〃	+2,626
Approach road etc.	494	〃	1,220	483	〃	1,916	▲11	〃	+696
Technical assistance	30	〃	0	32	〃	1,916	＋20	〃	+800
Land acquisition	0	〃	451	0	〃	355	0	〃	▲96
Price escalation	32	〃	965	69	〃	—	+37	〃	—
Contingency	291	〃	567	290	〃	—	▲1	〃	—
Total	6,139	〃	14,000	6,109	〃	22,353	▲30	〃	+8,353
Grand Total	8,603	〃	33,644	8,505	〃	48,353	▲98	〃	+14,709

(Note) Exchange Rate: At the time of appraisal (April 1992) 1 Yuan = ¥23.4
Actual 1 Yuan = ¥14.2 (average between 1993 and 1995)

Figure III-2 Huangshi River Bridge: Project Implementation Schedule

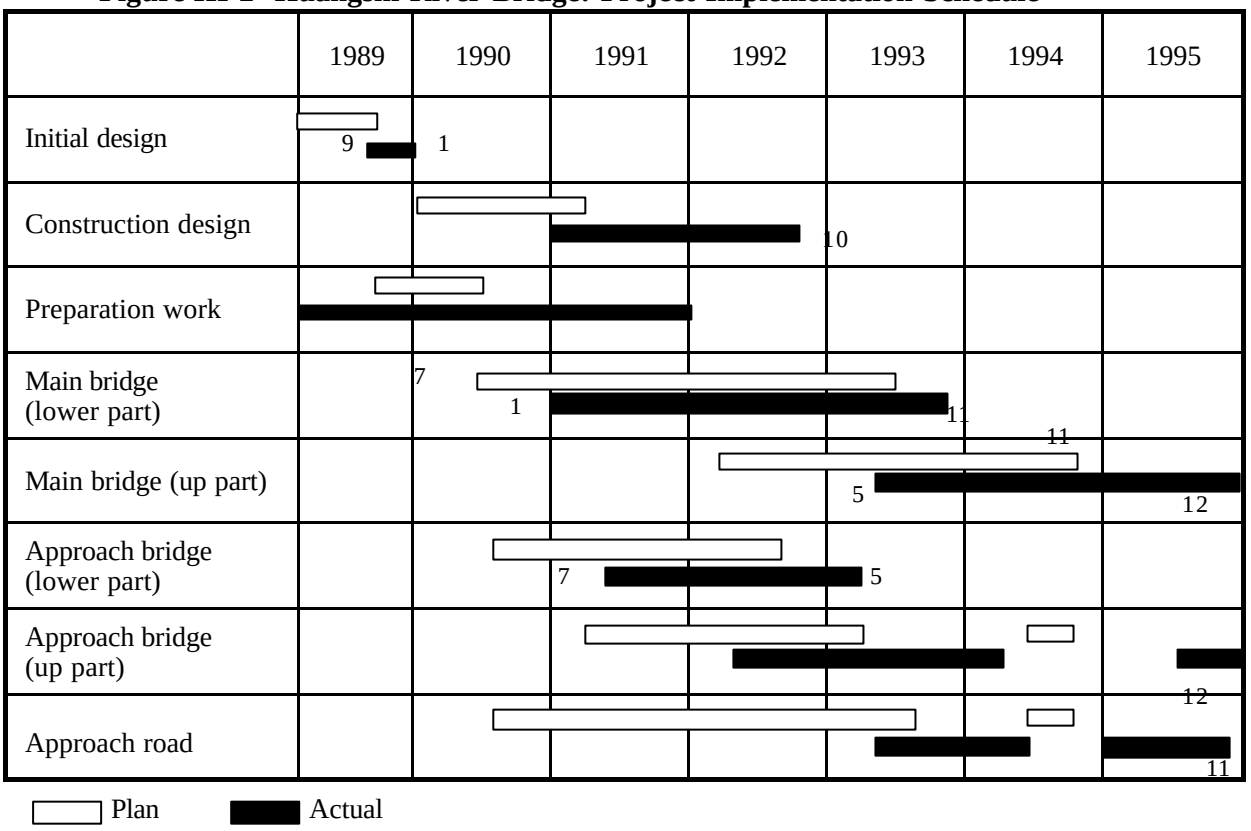


Table III-3 Huangshi River Bridge: Comparison of Original Plan and Actual for Project Cost

Units: ¥ 1 million, 10,000 Yuan

Item	① Plan			② Actual			Difference (②−①)		
	Foreign currency (¥ 1 million)		Local currency (10,000 Yuan)	Foreign currency (¥ 1 million)		Local currency (10,000 Yuan)	Foreign currency (¥ 1 million)		Local currency (10,000 Yuan)
	Total	JBIC portion		Total	JBIC portion		Total	JBIC portion	
Preparation work	-	-	560	-	-	1,789	-	-	+1,229
Main bridge (lower part)	1,406	Same as left	2,900	1,456	Same as left	18,022	+50	Same as left	+15,122
Main bridge (up part)	1,017	〃	2,746	1,053	〃	5,125	+36	〃	+2,379
Approach bridge (lower part)	371	〃	781	384	〃	2,596	+13	〃	+1,815
Approach bridge (up part)	645	〃	1,203	668	〃	2,996	+23	〃	+1,793
Approach road	108	〃	228	112	〃	3,587	+4	〃	+3,359
Price escalation	-	-	2,344	-	-	-	-	-	▲2,344
Contingency	153	Same as left	528	-	Same as left	-	▲153	〃	▲528
Land acquisition	-	-	113	-	-	1,015	-	-	+903
Total	3,700	Same as left	11,403	3,674	Same as left	35,130	▲26	Same as left	+23,727

(Note) Exchange Rate: At the time of appraisal (1989) 1 Yuan = ¥34.4
Actual 1 Yuan = ¥18.2 (average between 1991 and 1995)

Figure III-3 Second Wuhan River Bridge: Project Implementation Schedule

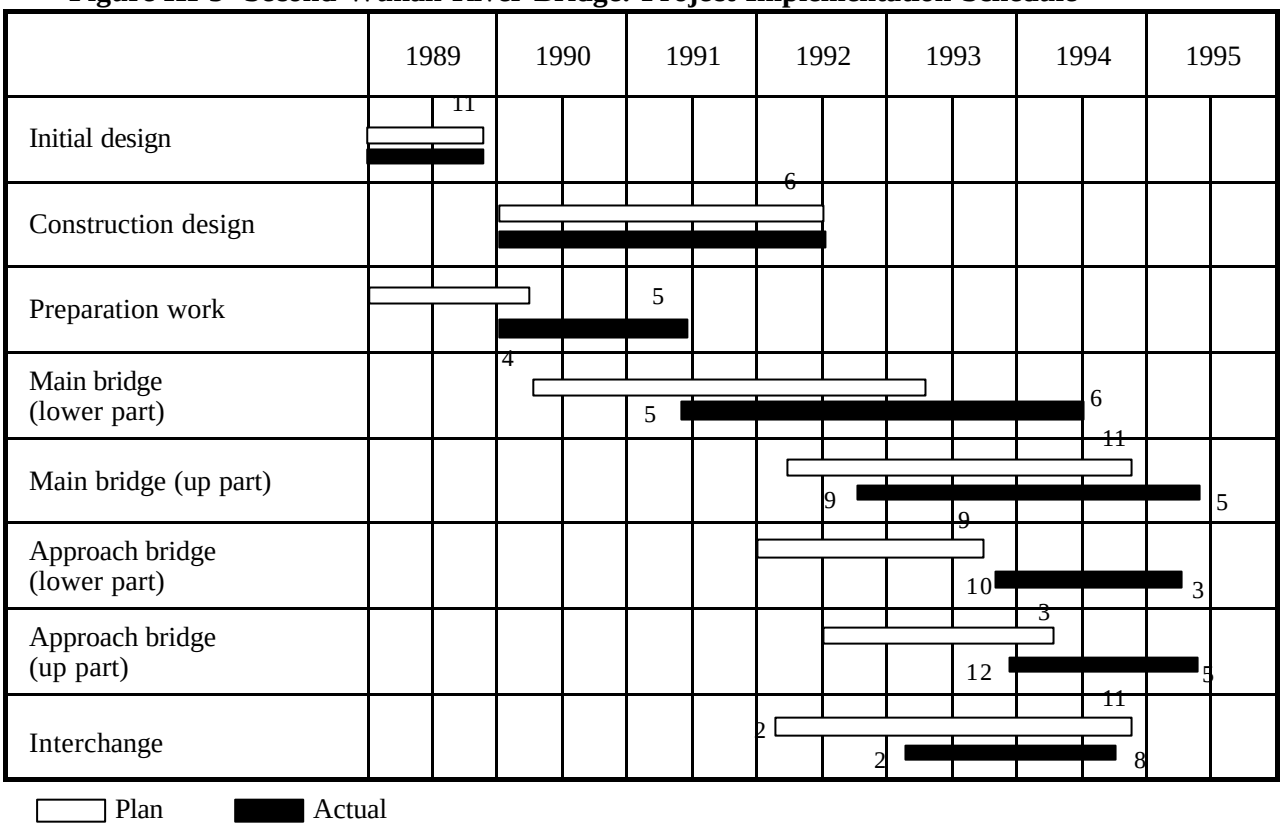


Table III-4 Second Wuhan River Bridge: Comparison of Original Plan and Actual for Project Cost

Units: ¥ 1 million, 10,000 Yuan

Item	① Plan			② Actual			Difference (②−①)		
	Foreign currency (¥ 1 million)		Local currency (10,000 Yuan)	Foreign currency (¥ 1 million)		Local currency (10,000 Yuan)	Foreign currency (¥ 1 million)		Local currency (10,000 Yuan)
	Total	JBIC portion		Total	JBIC portion		Total	JBIC portion	
Preparation work	-	-	2,700	-	-	4,881	-	-	+2,181
Main bridge (lower part)	1,264	Same as left	8,908	1,340	Same as left	50,386	+76	Same as left	+41,478
Main bridge (up part)	1,670	〃	3,072	1,769	〃	17,337	+99	〃	+14,265
Approach bridge (lower part)	190	〃	3,153	198	〃	5,011	+8	〃	+1,858
Approach bridge (up part)	524	〃	3,274	545	〃	5,195	+21	〃	+1,921
Interchange	865	〃	3,881	885	〃	6,743	+20	〃	+2,862
Land acquisition	-	〃	5,442	-	〃	21,407	-	-	+15,965
Housing development of resettled residents	-	〃	-	-	〃	8,023	-	-	+8,023
Technical assistance	20	〃	-	20	〃	-	0	〃	-
Price escalation	-	-	6,557	-	-	-	-	-	▲6,557
Contingency	227	Same as left	1,841	-	Same as left	-	▲227	〃	▲227
Total	4,760	Same as left	38,836	4,757	Same as left	118,983	▲3	Same as left	+80,147

(Note) Exchange Rate: At the time of appraisal (1989) 1 Yuan = ¥34.4
Actual 1 Yuan = ¥18.2 (average between 1991 and 1995)

Figure III-4 Second Chongqing River Bridge: Project Implementation Schedule

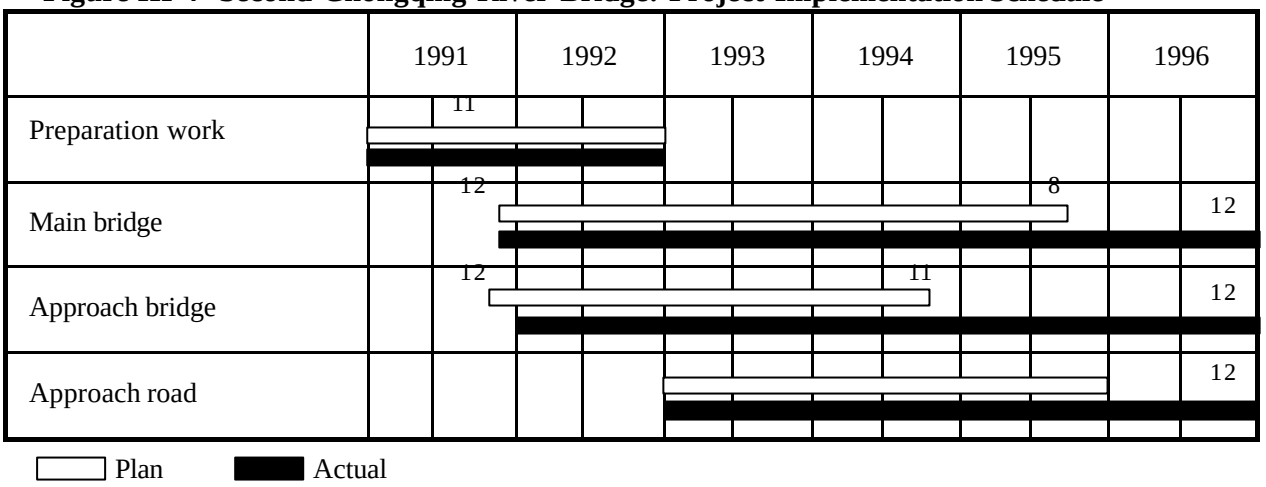


Table III-5 Second Chongqing River Bridge: Comparison of Original Plan and Actual for Project Cost

Units: ¥ 1 million, 10,000 Yuan

Item	① Plan			② Actual			Difference (②−①)		
	Foreign currency (¥ 1 million)		Local currency	Foreign currency (¥ 1 million)		Local currency	Foreign currency (¥ 1 million)		Local currency
	Total	JBIC portion	(10,000 Yuan)	Total	JBIC portion	(10,000 Yuan)	Total	JBIC portion	(10,000 Yuan)
Preparation work and construction of housing for resettled residents	1,256	Same as left	133	654	Same as left	0	▲602	Same as left	▲133
Main bridge	1,888	〃	7,700	2,207	〃	19,706	＋319	〃	+12,006
Approach bridge	282	〃	1,158	162	〃	3,962	▲120	〃	+2,804
Approach road	824	〃	13,565	1,552	〃	22,506	+728	〃	+8,941
Land acquisition	-	〃	2,490	-	〃	8,337	-	-	+5,847
Technical assistance	85	〃	-	85	〃	-	0	〃	-
Price escalation	205	〃	7,435	-	〃	-	▲205	〃	▲7,435
Contingency	224	〃	1,625	-	〃	-	▲224	〃	▲1,625
Total	4,764	Same as left	34,209	4,660	Same as left	54,672	▲104	Same as left	+20,463

(Note) Exchange Rate: At the time of appraisal (1990) 1 Yuan = ¥26.2
Actual 1 Yuan = ¥17.3 (average between 1991 and 1996)

IV. Evaluation on Operation and Maintenance

1. Operations and Maintenance Scheme

The Ministry of Communications projects, the Hefei - Tongling Yangtze River Highway Bridge and the Huangshi River Bridge, were placed under direct management schemes organized by the province or city. The operation and maintenance (O&M) of the Ministry of Construction projects, the Second Wuhan River Bridge and the Second Chongqing River Bridge, was placed in the hands of corporations established for the purpose under the management of the cities. In each case, the bridge is supposed to operate on the basis of independent profitability, but it is easier for the corporations to earn money from sources other than tolls (such as advertising and land development).

The operation and maintenance costs reflect the organizational differences. The Second Wuhan River Bridge is managed by a joint venture with Hong Kong company, which might be expected to be more efficient than a state-owned enterprise or direct management by a government agency. In fact, its operation costs are higher than those for the other bridges. The reasons are as follows:

(i) The traffic volume is higher, resulting in higher personnel costs.
(ii) Additional expenses are incurred which are unnecessary in the case of direct management (offices, taxation, gratuities for security etc.).

The Second Chongqing River Bridge is also managed by a corporation, but its operation costs are relatively low. It is fully funded by the government and it has relatively low overhead costs for office expenses ad cooperation fees to related agencies. All the O&M staff are on annual contracts, and accordingly rational maintenance is being applied thoroughly.

2. Tolls

Past policy on the setting of charges by public-interest corporations in China emphasized the public interest, with profitability viewed as an irrelevance. With the shift to market economics, the central government's policy has changed, and the idea of placing the burden on the beneficiaries has been taking root. The management offices for each river bridge are asked to operate them on the basis of independent profitability, but the price settings are finally approved by Pricing Office and the Government after comparison of charges with those of other transport agencies and other provinces.

Comparing the levels of tolls for the four bridges, the Tongling and Huangshi River Bridges have tolls of approximately six Yuan per ton, while the Second Wuhan and Second Chongqing Bridges have lower tolls of approximately five Yuan per ton. On the Chongqing Bridge, tolls are only collected in one direction, and they are very cheap for larger vehicles, making it no more than half the price of tolls on the Wuhan Bridge. However, both the Wuhan and Chongqing Bridges are used by relatively large numbers of passenger automobiles because they are located in large cities.

Table IV-1 shows average tolls per vehicle for 1998, derived from traffic volumes and toll revenues. The Huangshi River Bridge has the highest tolls, at 27.5 Yuan per vehicle. This is

probably because the Huangshi Bridge forms part of the Shanghai - Chengdu Expressway, and has a high proportion of large vehicles. The Wuhan and Chongqing Bridges have higher proportion of passenger vehicles, which lower the average toll per vehicle. The Wuhan Bridge has the lowest average toll, at 3.6 Yuan per vehicle (the average is the toll revenue divided by traffic in both directions), because it only collects tolls in one direction.

Tolls charged in Wuhan were revised in June 1999, bringing the average toll per vehicle to approximately ten Yuan, double the 1998 level.

Table IV-1 Comparison of Crossing Toll per Vehicle

Unit: Yuan/vehicle

		Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge	Tongling River Bridge	Haungshi Yangtze River Bridge	Second Wuhan Yangtze River Bridge	Second Chongqing Yangtze River Bridge
Toll system	Small car	25 (Below 2.5t)	20 (1.5～4t)	20 (Below 2t)	2～10 (Below 2t)	3～10 (Below 5t)
	Medium car	50 (2.5～7t)	50 (4～8t)	40～50 (2～10t)	20～30 (2～8t)	15 (5～8t)
	Large car	75 (7t or more)	80 (8t or more)	60 (10t or more)	50 (8t or more)	20 (8t or more)
Average toll per vehicle (Actual results in 1998)		23.8	24.5	27.5	5.0	3.6

3. Traffic Volumes

As Table IV-2 shows, the actual traffic volumes on each of the Ministry of Communications projects (the Hefei Tongling Highway, the Tongling River Bridge and the Huangshi River Bridge) were lower than those predicted at the time of the appraisal. On the Chongqing River Bridge, traffic volume reached 85% of the predicted volume. In Wuhan, the actual traffic exceeded the predicted volume. In general, traffic volume is thought to vary in line with the toll for crossing the bridge, but for the Tongling and Huangshi Bridges the level of crossing tolls does not seem to have much impact. In Tongling, the ferry crossing was closed, leaving the bridge as the only way of making the crossing, meaning that there is little price elasticity. In Huangshi the ferry fare is five Yuan per ton, and the average charge of six Yuan per ton for crossing the bridge does not seem particularly high in comparison. Therefore, the likely reasons for the gap between predicted and actual include the following:

1) Wuhan and Chongqing are large cities and they are growing extremely rapidly, but the pace of growth in regional cities such as Tongling and Huangshi is relatively slow.
2) After the bridges were opened, there was little change in the volumes of traffic using ferries in outlying areas, which indicates that the volume of traffic transferring from ferries in outlying areas was small.
3) The building of peripheral roads in Huangshi and Tongling is overdue.

After the bridges opened, the growth rates in traffic crossing the Tongling and Huangshi Bridges were large (around 20% and 40% per year, respectively) and there is potential for greater growth as progress is made in the development of peripheral roads.

Table IV-2 Comparison of Traffic Volumes

(Unit: vehicle/day)

	Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge	Tongling River Bridge	Haungshi Yangtze River Bridge	Second Wuhan Yangtze River Bridge	Second Chongqing Yangtze River Bridge
Predicted traffic volumes at the time of appraisal	6,677 [1)]	8,649 [2)]	7,795 [3)]	77,420	14,737
Actual traffic volumes (1998)	2,249	2,425	3,534	116,863 (47,151)	12,572
Notes	Average traffic volumes over the three zones. 1) is estimated from traffic volumes in 1995 and 2000	2) is estimated from traffic volumes in 1995 and 2000	3) is estimated from traffic volumes in 1995 and 2000	Traffic volumes crossing the Yangtze River (including First Bridge). Figures in ( ) are for the Second River Bridge	

4. Operations and Maintenance

Maintenance problems have appeared on the Hefei-Tongling Highway and the Second Wuhan Yangtze River Bridge. There are no significant problems with the other bridges.

The Hefei-Tongling Highway already suffers from subsidence and surface cracking in many areas, only four years after completion, and an embankment collapsed in one area. There are many possible causes, of which these are the two main candidates.

(i) When the road was built, the countermeasures taken to prepare weak ground and to protect against groundwater in cuttings were inadequate.

(ii) Despite the fact that the project area has high humidity and rainfall, the drainage facilities, such as ditches and drainage pipes, were inadequate.

It is doubtful whether adequate care was taken in matters such as route selection, appropriate design for the ground and climatic conditions and quality control checks during construction.

The Second Wuhan River Bridge has severe damage to the road surface, including cracking in some places. The following problems are potential causes:

(i) Inadequate curing of the surfacing concrete during construction.

(ii) The thickness of the surface may have been slightly inadequate.

(iii) Drainage facilities (drainage pipes, buried pipes etc.) may be lacking or damaged.

The maintenance problems described above can be traced back to problems with the design and with supervision at the construction stage. The problem probably lies in whether or not experts were employed in designing the road surface to prevent defects and breakage and in managing the construction work. Urgent measures are being taken to repair the damaged road surface, and there are no problems with the maintenance system.

5. Income and Expenditure

Table IV-3 shows the income and expenditure for each project in 1998. Of the four bridges, the Tongling River Bridge and the Second Chongqing River Bridge have incomes which fall short of their expenditures. Their common problems are that they both have large amounts of borrowing against relative small incomes. The Tongling River Bridge used the largest amount of foreign currency borrowing of the five projects, and the problem in its accounts surfaced as soon as repayments on that borrowing began. The Second Chongqing River Bridge used large amounts of local currency borrowing, and the high interest (10% p.a.) increased the bridge's deficit in 1998.

The Second Wuhan River Bridge also used large amounts of local currency borrowing and suffered a deficit in 1998, but its toll income is already large and rising, and it is expected to achieve a surplus in 1999.

Table IV-3 Comparison of Income and Expenditure for Each Project in 1998

(Unit: 10,000 Yuan)

	Hefei-Tongling Highway	Tongling Tangtze River Bridge	Huangshi Yangtze River Bridge	Second Wuhan Yangtze River Bridge	Second Chongqing Yangtze River Bridge
Toll income	1,953	2,165	3,551	8,804	1,532
Maintenance cost	1,576	820	400	2,000	400
ODA loan interest	399	1,005	661	752	766
Local currency borrowing Interest Repayment of principal	None	Repayment status unclear	320	1,342 5,440	3,813 7,252
Single-year balance of income and expenditure	▲22	340	2,170	▲731	▲10,699
Total borrowings Foreign currency portion (¥1 million) Local currency portion (10,000 Yuan)	2,396 0	6,109 4,320	3,674 5,385	4,757 27,200	4,660 39,178
Notes		Income/ expenditure problems			Income/ expenditure problems

The repayment status of local currency borrowing for the Tongling River Bridge is unclear, so it is not included in the single-year balance of income and expenditure.

V. Evaluation of Project Effects and Impacts

1. Classification and Examination of Project Effects and Impacts

In general, the effects and impacts of road and bridge projects consist of effects due to the projects' inherent functions (direct effects) and derivative ripple effects (indirect effects).

The direct effects are as follows:
(1) Savings in driving costs.
(2) Effects of time savings (shorter transport times).
(3) Effects of reduced ferry costs.
(4) Alleviation of congestion on related roads.
(5) Enhanced comfort (reduced driver fatigue).
(6) Enhanced safety (less accidents).
(7) Reduced cargo damage and savings in packaging costs.

The ripple effects include the following:
(1) Regional development effects (industrial development, market development, population increase, promotion of roadside land use etc.).
(2) Influence on prices due to reduced shipping costs.
(3) Effects expanding production capacity.
(4) Expanded living radius.

Other effects and impacts include the following:
(1) Impact on the natural environment.
(2) Impact on the social environment.
(3) Transfer of technology effects.

Of the above effects, the three studied as project effects for the appraisal of the four bridges were as follows:
(1) The total benefit yielded by direct effects (1)~(3).
(2) EIRR and FIRR based on the above benefit and toll income.
(3) Environmental impact.

In addition to the direct effects listed above that were studied at the time of the appraisal, we have now examined two ripple effects: "Impact on the transport situation in the surrounding region" and "Regional development effects".

2. Direct Effects

In order to compare direct effects, we recalculated EIRR and FIRR on the basis of the actual recorded values of construction costs, maintenance costs, traffic volumes and toll income. Table V-1 compares the recalculated values with the values estimated for the appraisal.

EIRR values estimated now are lower than those for the appraisal for all projects. The EIRR shortfall is relatively small for the two Ministry of Construction projects (the Second Wuhan River Bridge and the Second Chongqing River Bridge), but it is large for the other three projects. The decline is closely related to the actual traffic volumes using the projects, compared to the

volumes predicted for the appraisal. The Ministry of Communications projects (the Hefei-Tongling Highway, the Tongling River Bridge and the Huangshi River Bridge) have less than half the traffic predicted at the time of the appraisal, while the volumes of traffic on the Ministry of Construction projects exceed the forecast or are only slightly below.

The local currency portion of the construction cost overran in every project, which also drove the EIRR values down. The local currency cost overrun was particularly large on the Second Wuhan River Bridge, but the overrun was offset by the traffic volume, which is 50% higher than forecast for the appraisal. Overall the EIRR for this project was only slightly less than expected.

For all projects other than the Huangshi River Bridge, the values of FIRR recalculated for this project were lower than those calculated for the appraisal. The reasons include the following:

(i) The increased local currency cost of construction.
(ii) Changes in the exchange rates for the foreign currency portion of the construction cost.
(iii) Increased operation and maintenance costs.

Furthermore, in the case of the Tongling River Bridge, the actual traffic volume is only around 30% of that forecast for the appraisal, which is one factor behind the large drop in FIRR, even after future growth in traffic volume are included in the calculation. On the Second Chongqing River Bridge, charges are only collected in one crossing direction. This arrangement reduces the average charge per vehicle and is one factor reducing FIRR.

The Huangshi River Bridge has only half the traffic volume predicted for the appraisal, and the local currency portion of its construction cost tripled, but its FIRR was unchanged because the charge was set at 3.7 times more than was anticipated at the time of the appraisal.

Table V-1 Comparison of EIRR and FIRR

(Unit: %)

		Hefei-Tongling Highway	Tongling Tangtze River Bridge	Huangshi Yangtze River Bridge	Second Wuhan Yangtze River Bridge	Second Chongqing Yangtze River Bridge
At the time of appraisal	EIRR	16.8	8.7	11.6	9.4	19.5
	FIRR	7.9	11.1	11.1	4.0	2.7
At the time of evaluation (recalculated value)	EIRR	6.4	3.7	5.6	8.0	16.6
	FIRR	2.3	0.8	11.1	3.6	0.4

3. Ripple Effects

The ripple effects of transport infrastructure such as roads and bridges are manifested as increased private-sector building of facilities and increased freight movement due to improved transport conditions in the project area. They extend to the stimulation of production activity in the area. In this case we examined two ripple effects: "impact on transport conditions in the surrounding area" and "regional development effects".

[Hefei - Tongling Highway and Tongling River Bridge]

(1) Impact on transport conditions in the surrounding area

The road linking Tongling, one of the most important industrial cities in Anhui province, and Hefei, the provincial capital, was largely unpaved. As a result the journey between the two cities took seven or eight hours, including the time for the ferry crossing of the Yangtze. After the road and bridge opened, the journey time over the same distance was cut to around two and a half hours, a saving of 4.5~5.5 hours.

The proportion of medium-sized (5t) or larger vehicles within the total traffic volume on the bridge and road is 65%, which suggests that the road and bridge play an important role in the north-south transport of goods in Anhui province.

(2) Regional development effects

1) The establishment of new development zones
After the implementation of the project, eight development zones were established along the Hefei - Tongling Highway, and their development is under way. Plans are also under way for an agricultural development zone on the south side of the bridge, and the necessary land is being acquired.

2) New industrial siting
This project has made transport in the surrounding area more convenient and encouraged the establishment of development zones, making the area an attractive site for industry. As a result, new industrial operations have started in the area and some older ones have expanded their operations. In addition, a commercial zone has been built at the south end of the bridge, and is operated by the Anhui Tongling Yangtze River Highway Bridge Management Office. It has a filling station, a food service business, an automobile repair workshop and other businesses, and is an example of regional development effects.

3) GDP growth rates in surrounding areas.
Table V-2 compares growth rates for the country as a whole and for the project regions between 1994 and 1997 (before and after the implementation of the project). It shows that, with the exception of the Feixi district, the areas around the projects achieved far higher GDP growth rates than either Anhui province or the country as a whole. In particular, the cities of Hefei, Zongyang and Tongling exceeded the national growth rate by over 70 points and the provincial growth rate by 50 points. The high growth rates in these areas cannot be attributed entirely to the road and bridge built under this project, but they certainly made a large contribution.

Table V-2 GDP Growth Rate in the Surrounding Area

	1994	1997	Growth rate
National	4,675,940	7,477,240	160%
Anhui	148,847	26,995	179%
Hefei	8,590	24,899	290%
Feixi	1,837	2,957	161%
Lujiang	2,278	4,680	205%
Zongyang	1,050	2,520	240%
Tongling	2,514	5,801	231%
Tongling	999	2,091	209%

Note: Each fiscal year prices (unit: Yuan)

4) Effect on rural people along the road route
Besides affecting workers in secondary and tertiary industries along the route, the construction of the road also had a positive impact on workers in primary industries. Many rural people along the route had opportunities for non-agricultural employment during the road construction period, and after the road's completion the greater convenience of travel enabled them to find other jobs beyond forestry and agriculture.

(3) Summary of the ripple effects of the Tongling Highway and Tongling River Bridge

This road and bridge enable smooth north - south transport through Anhui province. The resulting increase in movement and exchange of people and goods due to increased north-south traffic contributed to the development of the province.

The GDP growth rate of the area around the project has greatly exceeded the national average growth rate since the road and bridge were opened. The construction of the road and bridge also made the area more accessible, prompting the designation of eight development zones along the road, the siting of new industries there, and the expansion of some existing ones. These developments helped to create more employment opportunities for the local people.

[Huangshi Yangtze River Bridge]

(1) Impact on transport conditions in the surrounding area

This road forms part of the expressway linking Shanghai with Chongqing. The bridge serves as an important artery linking western cities such as Wuhan and Chongqing with cities in eastern and coastal areas, such as Shanghai and Nanjing. Around 90% of the vehicles crossing the bridge are through traffic on that route, which indicates that the bridge is a very significant part of a national trunk route.

Since the bridge opened, a number of new bus routes have opened between Huangshi and large cities to the east (Shanghai, Hangzhou, Hefei, Anqing, Jiujiang and Susong). Clearly the opening of the bridge has stimulated exchanges between Huangshi and areas to the east.

Apart from stimulating east-west traffic, the bridge has boosted traffic across the Huangshi to Yangtze district and other areas on the North Bank. Before the bridge, the ferry was the only way to reach Yishui, but there was a wait averaging two hours to board the ferry, rising to four hours in peak times. In addition, the ferry service was forced to close for up to two months a year by fog, flooding and typhoons.

After the bridge opened, the crossing time was greatly reduced. As a result, new bus services began running to Tuanpo on the North Bank between Huangshi and Yangtze. Bus services to Yishui district increased dramatically, from two a day before the bridge to one every ten minutes.

The ferry jetty is located in the center of Huangshi, which meant that vehicles waiting to board the ferry caused severe congestion in the city center. The bridge has eliminated that source of congestion. Traffic over the bridge is expected to increase greatly in future, but as the bridge is

situated to the north of the city, there is no risk of congestion in the city due to the through traffic.

(2) Regional development effects

1) Changes in the GDP of Huangshi

Table V-3 shows the year-on-year GDP growth rates for Huangshi between 1985 and 1997. Before the bridge was built, Huangshi's growth rate was not much different from the national growth rate. After the bridge opened, in 1995 and 1996, the city grew very rapidly.

Immediately after the bridge was built, the growth in GDP might have been far above the national growth rate for reasons other than the opening of the bridge, but there is no doubt that the completion of the bridge has made a great contribution to the economic development of Huangshi.

Table V-3 Year-on-year GDP growth rates (%)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
National	13.2	8.5	11.5	11.3	4.2	4.2	9.1	14.1	13.1	12.6	9.0	9.8	8.5
Huangshi	8.1	13.5	10.5	19.4	14.5	9.8	7.5	25.5	19.4	23.1	58.0	36.7	17.6
Primary	17.3	8.8	5.5	14.9	20.0	10.2	-3.7	7.4	15.1	29.8	113.4	53.1	12.4
Secondary	11.5	09.3	7.6	19.0	12.1	-3.5	6.6	27.2	20.6	22.9	42.6	29.9	18.5
Tertiary	-8.1	33.6	23.4	23.0	17.7	43.7	13.8	29.4	18.6	21.4	66.1	39.8	18.2

Note: Growth rates are calculated on the basis of the each fiscal year prices.

2) Development in Yishui district

Huangshi is expected to achieve further growth, but its hinterlands are surrounded by mountains, with almost no scope for further development, which places a major restriction on economic activity. Therefore one of the objectives of this project was the development of Yishui district, which is an agricultural area of flat land on the opposite bank of the Yangtze.

Development of Yishui is proceeding, following the opening of the bridge. In particular, Sanhua Zhen has been designated as an economic development zone, and its development is under way. The Sanhua Zhen Economic Zone has a spacious land area of 68km^2 where various industries are situated, including economic and trade-related service industries, agricultural machinery factories, spinning and small-scale shipbuilding. The population of the zone is now 40~50,000. Houses are now being built for workers from the economic zone and for others who commute across the river to Huangshi. The population is expected to rise to 500~800,000 in future.

(3) Summary of the ripple effects of the Huangshi Yangtze River Bridge

Considering the fact that the ferry, which was the only means of crossing the river before the

bridge was built, was forced to suspend its operations for up to two months due to problems such as fog and flooding, the bridge must have made a great contribution to improving the traffic situation, thereby aiding the economic development of Huangshi and of Yishui district. The bridge also serves as part of one of China's main expressways, which links Shanghai with Chongqing. Therefore the bridge's impact can be assumed to spread beyond the project area to affect the country as a whole. As around 90% of the current traffic volume is through traffic, the bridge is clearly important as part of the east - west trunk road that links nearby regions. Some parts of the Shanghai - Chongqing expressway within Anhui have not yet been completed, but once they are, the volume of traffic using the bridge will increase further, and the development of Huangshi and Yishui can be expected to make more progress.

[The Second Wuhan Yangtze River Bridge]

(1) Impact on transport conditions in the surrounding area

Wuhan is divided by the Yangtze River, and the only bridge linking the two parts was the First River Bridge built in 1957. The number of vehicles crossing the old bridge was increasing every year , reaching nearly double the bridge's design flow by 1995. Areas around the bridge suffered chronic congestion. The only other way of crossing the river was a ferry, but at peak times there was a wait of an hour or more for boarding.

The construction of the Second River Bridge completed a ring road around Wuhan, and divided the traffic that had been concentrated on one bridge between two. Immediately after the bridge opened, the second bridge took a 30% share of the total traffic over the two bridges, rising to a 40% share by June 1999. Thus the second bridge has fulfilled its role of sharing the traffic load, which was previously concentrated on the first bridge. However, as Table V-4 shows, cross-river traffic demand is growing extremely rapidly, and the problem of traffic congestion around the first bridge, though alleviated by the construction of the second bridge, has still not been solved.

Table V-4 Traffic Volume of First and Second Yangtrze River Bridges

(Vehicles/day)

	May 1995	October 1995	May 1998	June 1999
First Yangtze River Bridge	70,880	64,676	66,991	85,000
Second Yangtze River Bridge	—	27,645	47,151	56,000
Total	70,880	92,321	116,863	141,000

Before the second bridge opened, all cross-river traffic was concentrated on the first bridge, leading to extreme congestion in rush hours, which made the crossing take a long time. Also, traffic in the northeast of the city had to make a major diversion to cross the river at the first bridge.

The opening of the second bridge shortened the crossing route from the northeast of the city, and allowed crossing routes from other parts of the city to avoid the congested area around the first bridge, greatly shortening journey times between different parts of the city. The opening of

this bridge improved the cross-river traffic situation for the whole of Wuhan, with the northeast of the city enjoying a particularly marked increase in accessibility.

(2) Regional development effects

Before the second bridge was built, the area where it reaches the East Bank was mainly used as farmland. After the second bridge opened, development of the area made gradual progress. House building is proceeding rapidly in the Shafu residential zone and elsewhere, and another zone is being planned to attract consulates. Using the improved accessibility yielded by the second bridge, a new wholesaler has been established to handle fresh produce shipped from the surrounding area. A residential area is also being built near the western end of the second bridge.

(3) Summary of the ripple effects of the Second Wuhan Yangtze River Bridge

Wuhan is divided by the Yangtze River, between the Hanyang and Hankou districts and the Wuchang district. The only bridge linking the two parts was the First River Bridge built in 1957. The number of vehicles crossing the river has been growing every year since the first bridge was built, and both it and the ferry had reached the limits of their transport capacity.

The construction of the Second River Bridge completed a ring road around Wuhan, and divided the traffic that had been concentrated on one bridge between two. The second bridge now takes a 40% share of the total traffic over the two bridges, which indicates that the second bridge has fulfilled its role of sharing the traffic load which was previously concentrated on the first bridge.

Using the improved accessibility yielded by the second bridge, the land around the second bridge, which was previously used as farmland, is being developed in various ways, including the construction of housing and a new fresh produce wholesaler. The construction of the second bridge has achieved the dispersion of traffic, population and commercial activity, which were previously concentrated around the first bridge. This dispersion will contribute to more balanced urban development in the future.

[The Second Chongqing Yangtze River Bridge]

(1) Impact on transport conditions in the surrounding area

Chongqing has a population of approximately 16 million, of whom over three million are concentrated in the town center, which is surrounded by the Yangtze and Jialing Rivers. As a major industrial city, Chongqing has many freight vehicles, which cause congestion in the city center. Congestion was particularly severe in the city center area, which is bounded by the First Yangtze River Bridge, the Jialing River Bridge, the Shimen River Bridge and Chongqing Railway Station.

One cause of the congestion was the fact that through traffic on national routes Nos. 210, 212 and 319, which are all national trunk routes, had to pass through the center of the city. These vehicles had to pass through the city center and the first bridge to cross the Yangtze on the way to their destinations to the south and east.

The opening of the second bridge altered the path of route 210, which previously passed through the city center of Chongqing and its south bank district. The new route crossed the Jialing River Bridge and passed through the Jiulongpo district to cross the second bridge. Vehicles which used No. 212 to reach the north and east and No. 319 to reach the south and west were able to cross the river without detouring to the first bridge.

According to the Chongqing Lijiatuo River Bridge Limited-liability Corporation, a large proportion of the vehicles using the second bridge are freight vehicles, and most of them are through traffic. This indicates that the second bridge is serving as a bypass route, allowing through traffic to avoid the first bridge.

(2) Regional development effects

1) Siting of housing estates and new industrial operations at both ends of the second bridge

The Jiulongpo district to the north of the second bridge and the Dadukou district to the northwest are industrial areas with large numbers of factories, while the Banan district to the south of the second bridge was mainly used as farmland, and had not been developed. After the bridge was built, a new residential area was built in the Banan district. Of the five new residential and development zones, four are situated in the Banan district. The other is a residential zone in Jiulong.

The construction of the second bridge helped to improve the accessibility of the previously underdeveloped southern area, and had a great impact on development around both ends of the bridge, particularly in the Banan district.

New industrial businesses have been established and old ones expanded along the approach roads to the bridge. These include a motorcycle factory, a cement factory jointly funded with Hong Kong investors, and a ceramics factory. Lijiatuo in the Banan district was the relocation area for residents displaced by the bridge construction. It is the site for a number of small new cottage industry businesses founded with local capital, including a car workshop and a motorcycle components factory.

Thus development has been proceeding in the area around the bridge, and particularly in Banan, since its construction. The improved accessibility available since the bridge opened has made a great contribution to these developments.

2) Changes in gross production value

Table V-5 shows the rate of growth in gross industrial production value in the area around the project. While there was considerable growth in 1991~1993, and in 1993~1995, most areas saw much lower growth in 1995~1997, following the impact of the Asian economic crisis. The Jiulongpo zone to the north of the bridge showed largely the same trends as the other zones, and does not appear to have been strongly influenced by the construction of the second bridge.

On the other hand, the Banan district on the south bank had growth rates below the

national average in 1991~1993 and 1993~1995, before the second bridge was built. After the bridge was built, in 1995~1997, Banan showed a growth rate of over 50%, which demonstrates the large impact of the second bridge on the area.

Table V-5 Growth Rate of Gross Industrial Production

	1991～1993	1993～1995	199519～97
National	81.8%	89.9%	23.8%
Sichuan	83.2%	50.9%	26.4%
Jiangbei	71.0%	45.4%	36.5%
Yuzhong	-0.3%	14.9%	-8.3%
Shapingjian	79.0%	57.3%	-20.0%
South Side District	53.3%	51.8%	25.2%
Dadukou	95.8%	15.6%	22.9%
Banan	45.9%	54.3%	52.2%
Jiulongpo	56.0%	90.4%	26.5%

(3) Summary of the ripple effects of the Second Chongqing River Bridge

Chongqing is the junction for national routes Nos. 210, 212 and 319, which are major national trunk routes. Vehicles using these roads had to use the first bridge, located in the center of the city, to cross the Yangtze. As a result, the city center was plagued by chronic traffic congestion.

While the construction of the second bridge did not help to disperse traffic moving within city center near the first bridge, it took a share of the load from through traffic, which had previously been concentrated on the first bridge. The construction of the second bridge reduced the volume of through traffic using the first bridge, temporarily easing its traffic flow, but the flow is again rising in line with the overall growth of traffic in the city. If the second bridge had not been built, the situation would certainly have been much worse.

The bridge also helped to improve the traffic situation in the southern and southwestern areas, which were relatively inaccessible before, and had a great effect on the areas at both ends of the bridge. The impact on Banan district was particularly strong. The construction of the bridge has assisted the economic development of the south of the city and contributed to balanced development with the north of the city, which is expected to grow strongly in future.

[Classification and Examination of Ripple Effects]

As described above, each of these projects yielded major ripple effects. Table V-6 examines these effects, classifying them as "impact on traffic in the surrounding area" and "regional development effects".

Table V-6 Examination of Ripple Effects

		Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge	Haungshi Yangtze River Bridge	Second Wuhan Yangtze River Bridge	Second Chongqing Yangtze River Bridge
Impact on transport in the area	Alleviation of traffic congestion in the cities	- No particular changes in Hefei or Tongling.	- Cars waiting for ferries, which caused congestion in Huangshi city center, disappeared, solving the congestion problem.	- The opening of the Second River Bridge completed the city's ring road. - Cross-river traffic, which had been concentrated on one bridge, was split between two, making transport within the city smoother. - Growth in cross-river traffic is rapid and the area around the First River Bridge is still congested.	- The Second River Bridge takes a share of the through traffic which previously passed through the center and caused congestion. - Growth in cross-river traffic is rapid, and the areas around the First River Bridge and the city center are still congested.
	Impact on inter-regional transport	- The project contributed to smoother north-south travel in Anhui province.	- The project formed a part of China's East - West expressway. - Travel to Yishui district, on the opposite bank from Huangshi, was stimulated.	- Travel time for through traffic is reduced because it no longer has to pass through the busy streets around the First River Bridge.	- Travel time for through traffic is reduced because it no longer has to pass through the busy streets around the center of Chongqing.
Regional development impact	Industry location and expansion of business scale	- Businesses have been established along the Hefei - Tongling road, including plastics factories, pharmaceuticals factories and sawmills. - Existing industries along the route of the road have been encouraged to expand.	- Cement factories using the bridge to ship their products have expanded their operations. - A Sino-Japanese joint venture textile factory has been established. It uses the bridge to ship its products to Shanghai.	- A fresh fruit wholesale market has been established to take advantage of the improved accessibility afforded by the construction of the Second River Bridge.	- Industries using local capital, such as factories for motor cycles, cement and ceramics have opened since the Second River Bridge opened.
	Establishment of economic development zones	- Eight economic development zones have been established along the road. - Plans are under way for an agricultural development zone on the south side of the bridge.	- A new economic development zone with an area of 680,000km^2 has been established in Sanhua Zhen.	—	- The new Huaxi economic and technical development zone has been established on the south side of the bridge.
	House construction	- Small-scale housing construction is going on along the road.	- Houses are being built for people who work in the development zone in Yishang and for those who commute to Huangshi.	- Construction of housing estates is proceeding rapidly in the Heinihu and Shahu residential zones and elsewhere on both banks.	- Residential zones have been set at one point on the south bank and four points at the north bank. Rapid residential construction can be anticipated.
	Impact on the regional economy	- The project has had a favorable economic effect on the cities of Hefei and Tongling at the ends of the road, and development is proceeding in regions along the road.	- The project contributes to the economic development of Huangshi. - The development of Yishang district, where the new economic development zone has been established, is not making much progress.	- Development of the Second River Bridge, which was overdue. - Traffic and population were concentrated around the First River Bridge, but now they can be more dispersed, contributing to city development.	- The project made a great contribution to development on both sides of the river, particularly in the Banan zone on the south bank.

To summarize the ripple effects, we classify the projects below as "projects for overcoming urban bottlenecks", "projects for linking cities" and "projects for trunk route formation", with reference to the characteristics of each type and points to consider in planning future projects of the same types.

[Projects for Overcoming Urban Bottlenecks]

…… Second Wuhan Yangtze River Bridge, Chongqing Yangtze River Bridge

Wuhan and Chongqing are large cities with vigorous industrial and commercial activity. Therefore they are on intersections of China's major trunk routes and have large amounts of through traffic. However, each city had only one bridge (the First Bridge) to cross the Yangtze. These first bridges were unable to keep up with constantly increasing cross-river traffic, and the areas around them suffered from constant congestion. This situation necessitated the construction of a second bridge in each city.

After the second bridge was built in each city, traffic volume for each bridge grew steadily. The cross-river traffic had previously been concentrated on the first bridges, but the Second Wuhan River Bridge succeeded in sharing through traffic, and the Second Chongqing River Bridge succeeded in sharing internal city traffic and through traffic. However, traffic volumes are growing very rapidly in each city, and congestion around the first bridges has not been solved. Multiple bridge construction plans are under way in each city.

When this kind of rapid growth in demand for river crossing in large cities leads to bottlenecks around existing bridges, the position of new bridges must be considered carefully to achieve proper linkages with city traffic and inter-city roads, if pockets of congestion are to be alleviated effectively. For this type of effect, there does not appear to be any significant problem with traffic demand.

In both cities, urban functions, traffic and population are concentrated into the areas around the first bridges because of their superior accessibility. Therefore, with a view to regional development effects, plans for the construction of new river bridges should take into account the appropriate dispersal of urban functions and population, which are now clustered around existing bridges.

[Projects for Linking Cities]

…… Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge

Projects of this type are mainly intended to create links between pairs of cities. The main purpose of the Hefei - Tongling River Highway Bridge was to construct a road and bridge to link Hefei, the provincial capital of Anhui, with Tongling, an industrial city to the south. The construction of the road and bridge was intended to make north-south travel, which had been interrupted by the Yangtze, easier and more efficient. This was intended to stimulate traffic and increase interchange of people and goods, thus contributing to the development of Anhui province. However, the two cities at the ends of the roads, and particularly Tongling, lack roads extending beyond them to other destinations. At present the traffic on the road consists largely

of vehicles traveling back and forth between Hefei and Tongling, and the volume of traffic is not growing.

Ripple effects of the road include the designation of eight new development zones, the siting of new industrial operations in the area, and the expansion of some existing ones. There is a beneficial impact on the economies of Hefei and Tongling, the cities at the ends of the road.

In projects such as this, where the main objective is building a link between two cities, one of the underlying assumptions is that there is a large latent demand for transport between the two cities to be linked. It became clear that if connections with other roads are inadequate, the traffic volume will not grow adequately.

Regional development effects of the project are expected to include development along the route of the road, as well as in the two cities. Therefore a positive approach should be taken to measures such as the designation of development zones along the route.

[Projects for Trunk Route Formation]

…… Huangshi Yangtze River Bridge

In this type of project, the bridge forms part of a trunk road. In the case of the Huangshi Yangtze River Bridge, it forms part of the Shanghai-Chengdu expressway, which is one of China's east -west trunk routes. Some parts of the expressway have not yet been completed, and the traffic volume on it is somewhat low, but when the entire route is open, the volume can be expected to increase. The construction of the bridge made other cities more accessible, which helps the development of Huangshi. Furthermore, new development zones have been established in Yishui district, on the opposite bank from Huangshi, and traffic to Yishui is growing.

In this type of project, the cross-river traffic volume from the surrounding area can be expected to be at least adequate if the use of the connected trunk roads is promoted. Through traffic was expected to form the majority of the traffic volume, and the route that passes over the bridge must be directed away from the city center.

This kind of project makes multiple cities more accessible, which means it can be expected to yield considerable regional development effects.

4. Environmental Impact

None of these projects has caused any serious environmental deterioration due to its construction. At the time of the appraisal, the environmental check points set included atmospheric pollution, noise, water pollution, and the relocation of residents. These points are summarized in Table V-7.

The Hefei - Tongling Highway and the Tongling River Bridge do not have high volumes of traffic, and they cause no environmental problems such as air pollution or noise. The Huangshi River Bridge exceeds environmental standards for NOx (nitrogen oxides) and TSP (Total Suspended Particulates), but only by a small margin in each case, and the situation does not appear to have worsened significantly, relative to other measurement stations. At monitoring

stations near the heavily-trafficked Second Wuhan and Second Chongqing River Bridges, some measurement results for air pollution exceed environmental standards. In both cities the background environment is very bad, and the river bridges are not the sole causes. According to the bridge management offices in the two cities, the construction of the bridges has actually improved overall air quality by alleviating traffic congestion in the city centers. At present, moves are under way to implement city-wide measures, such as the prohibition of leaded gasoline.

Continuing attention will have to be paid to the atmospheric pollution situation around the Huangshi River Bridge, the Second Wuhan River Bridge and the Second Chongqing River Bridge.

Table V-7 Summary of Environmental Impact

Environmental aspect	Hefei-Tongling Highway	Tongling Tangtze River Bridge	Huangshi Yangtze River Bridge	Second Wuhan Yangtze River Bridge	Second Chongqing Yangtze River Bridge
Air pollution	Below standard values	Below standard values	NOx and TSP exceed standard values	NOx and TSP exceed standard values	NOx and TSP exceed standard values *1
Noise	Small villages are at least 20m away, so there is no problem	Below standard values	Below standard values	Exceeding standard values	Exceeding standard values
Impact on water quality	Nothing significant	Nothing significant	Nothing significant	Nothing significant	Nothing significant
Relocation of residents	Settled by compensation for land and houses	Same as left	Same as left	Same as left	Same as left
Environmental measures*2	Ban on the use of leaded gasoline Ban on the use of poorly-maintained cars	Planting of green belts Planting in service areas	Planting of green belts Controls on roadside development Ban on claxon horns Ban on the use of poorly-maintained cars	Planting of green belts Ban on claxon horns Noise-baffling barriers under consideration	Planting of green belts Ban on the use of leaded gasoline Exhaust gas standards under consideration

*1: Probably influenced by a nearby thermal power station.
*2: Prepared on the basis of discussions with the bridge management office for each bridge.

VI. Overall Evaluation

Based on the above four evaluation points, our overall evaluation of each project is as follows.

1. Hefei-Tongling Highway and Tongling Yangtze River Highway Bridge

[Hefei-Tongling Highway]

The content of the projects was appropriate and the objectives were attained. While the implementation of the project incurred a local currency cost overrun, it was completed largely without problems. A system for O&M is in place, but in some places problems remain, such as areas where repair works, apparently due to poor quality control of construction, are urgently required.

In terms of project effects, the actual volume of traffic is lower than forecast and, while there are development effects in the surrounding area, the direct targets of toll income and increased traffic between Hefei and Tongling have not been achieved as yet.

Overall, the EIRR and FIRR of this project were both lower than initially planned, and these targets have yet to be attained. For the effects to be realized, consideration will have to be given to measures such as a radical road surface improvement program, a better network of connecting roads and encouragement for development along the road, followed by the urgent implementation of a program of such measures.

[Tongling Yangtze River Highway Bridge]

The content of the project was as planned and was appropriate to attaining its objectives. While the implementation of the project incurred a local currency cost overrun, it was completed as planned and without significant problems. At present there are no problems with the O&M system, but in the future the repair system will have to be enhanced and the maintenance equipment and materials expanded. As for the effects of the project, the actual traffic volume is lower than planned and, while there are some development effects, the direct targets of toll income and increased traffic between Hefei and Tongling have not been achieved as yet.

As an overall judgement, the EIRR and FIRR for the project are lower than initially planned and its targets have yet to be achieved. In order to increase the impact of building the road and improve its balance of income and expenditure, measures will have to be considered to increase the traffic volume using the project, such as a better network of connecting roads and encouragement for development along the road, followed by the urgent implementation of a program of such measures.

2. Huangshi Yangtze River Bridge

Part of the content of the project was changed, but the changes were appropriate to the attainment of project goals. The implementation suffered a delay of 13 months before completion, and the local currency cost inflated considerably, but these problems were due to

unavoidable external factors. The project is sustainable, with no significant O&M problems. While traffic is still below planned levels, it is expected to grow rapidly once the related expressway opens and other factors take effect, and the development effect on the surrounding area also appears large.

Overall, this project can be expected to achieve results through its own independent development. Therefore it can be described as a success.

3. Second Wuhan Yangtze River Bridge

Part of the content of the project was changed, but the changes were appropriate and the project was successful. The implementation suffered a delay of six months before completion, and the local currency cost inflated considerably, but these problems were mainly due to unavoidable external factors.

Although the road surface is severely damaged and requires repairs, the project's O&M situation is largely sustainable. As for project effects, the actual traffic on the bridge has grown far more than expected. The bridge has also improved the road network in the area, delivering strong regional development effects.

The maintenance of the road surface needs to be carefully monitored, but overall this is a successful project which has more than achieved its goals.

4. Second Chongqing Yangtze River Bridge

Part of the content of the project was changed, but the changes were appropriate to the attainment of project goals. The implementation suffered a delay of one year before completion, and the local currency cost overran by 60%, but these problems were due to unavoidable external factors. There is no technical problem with O&M, but the bridge is in a severe financial position.

As for effects, the traffic volume is now around 80% of the planned level, but increases in induced and through traffic volumes can be expected due to development along the road route and better linkage with trunk roads.

Overall the bridge has not made a great contribution to its initial goal of alleviating traffic pressure in the city center, but it can be expected to yield effects in future due to growth in through and induced traffic.

VII. Lessons Learned

Based on the evaluation findings, we can raise the following points which should be used as feedback for future operations.

(1) Local currency cost overruns

The final local currency cost of each of the four projects was far higher than the planned amount. The main reason for the cost overruns was that domestic prices rose more than expected due to the introduction of market economics. In a transition economy such as China's, it should be remembered that the introduction of market economics can cause domestic price increases which lead to major local currency cost overruns.

In the case of the Second Chongqing River Bridge, the budgetary allocations to cover the extra costs were delayed, which caused further delays in the construction. Attention must be paid to the local currency budget allocation situation during implementation.

(2) The importance of preparation for weak ground and groundwater countermeasures in cuttings

The construction of the Hefei - Tongling Highway did not include adequate preparation of weak ground or countermeasures against groundwater in cuttings. Even though the project area is damp, with high rainfall, which makes the road surface vulnerable to damage, not enough attention was given to drainage facilities. Therefore the road has already suffered surface cracking and subsidence in many areas only four years after completion, necessitating repair works. This problem may be related to the change of road route and the fixed-price order placed for the road. It is important to enhance checking performed by consultants during construction by putting more specialist staff on site for longer.

If road construction projects require treatment for weak ground and countermeasures against groundwater in cuttings, experts in those fields should be placed on site, and special attention should be paid to the design conditions employed at the design stage, and to supervision at the construction stage to avoid problems of the kind seen in this project. The executing agency should be advised to take such steps.

(3) Close examination of traffic predictions

Both the Hefei - Tongling Highway and the Tongling Yangtze River Bridge have actual traffic volumes considerably lower than those predicted at the time of the appraisal. At the planning stage there were many unknown variables, such as improvements to nearby road networks and traffic transfer from ferries, which made it difficult to produce a more precise prediction, but as traffic volume is an important factor which affects EIRR and FIRR, it would be desirable to give more careful consideration to demand prediction.

(4) Confirmation of toll collection methods

At the time of the appraisal for the Second Wuhan River Bridge, the predicted traffic volume (return crossings) was multiplied by the crossing toll per vehicle to calculate future revenue from crossing tolls. However, in practice tolls are only collected for one crossing direction. This arrangement does not pose an obstacle to loan repayment, bridge repair or other needs, and the bridge is delivering its effects as a bridge construction project, but the matter of toll collection should have been checked more carefully, as far as possible, at the appraisal stage.

(5) Confirmation of the role of second river bridges

At the appraisal for the Second Chongqing River Bridge the necessity of the second bridge was argued based on the projection that the demand for traffic across the Yangtze would exceed the capacity of the First River Bridge and the ferry. However, most of the traffic on the First River Bridge was for journeys within the city, while the Second River Bridge was mainly used for intercity traffic. Thus the natures of the two bridges were very different. From the point of view of the Second River Bridge, there is a problem with handling cross-river traffic as a single homogenous volume. It should have been considered in more detail to confirm the role of the second bridge.