

**SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT**

**YICHANG-WANZHOU RAILWAY PROJECT**

**IN THE**

**PEOPLE'S REPUBLIC OF CHINA**

**June 2003**

## CURRENCY EQUIVALENTS

(as of 31 May 2003)

Currency Unit	–	Yuan (CNY)
CNY1.00	=	\$0.1208
\$1.00	=	CNY8.277

## ABBREVIATIONS

ADB	–	Asian Development Bank
CSRC	–	China Securities Regulatory Commission
EIA	–	environmental impact assessment
EPB	–	environmental protection bureau
FABHP	–	Fisheries Administration Bureau of Hubei Province
GDP	–	gross domestic product
HICAS	–	Hydrobiology Institute of China Academy of Sciences
MOR	–	Ministry of Railways
NH	–	National Highway
NO <sub>x</sub>	–	nitrogen oxides
pH	–	measure of acidity/alkalinity
PRC	–	People's Republic of China
SEPA	–	State Environmental Protection Agency
YNCZCS	–	Yichang Natural Conservation Zone for Chinese Sturgeon
YWR	–	Yichang-Wanzhou Railway
YRARI	–	Yangtze River Aquaculture Research Institute

## WEIGHTS AND MEASURES

°	–	degrees Celsius
ha	–	hectare
kg	–	kilogram
km	–	kilometer
m	–	meter
mm	–	millimeter
s	–	second
t	–	ton
y	–	year

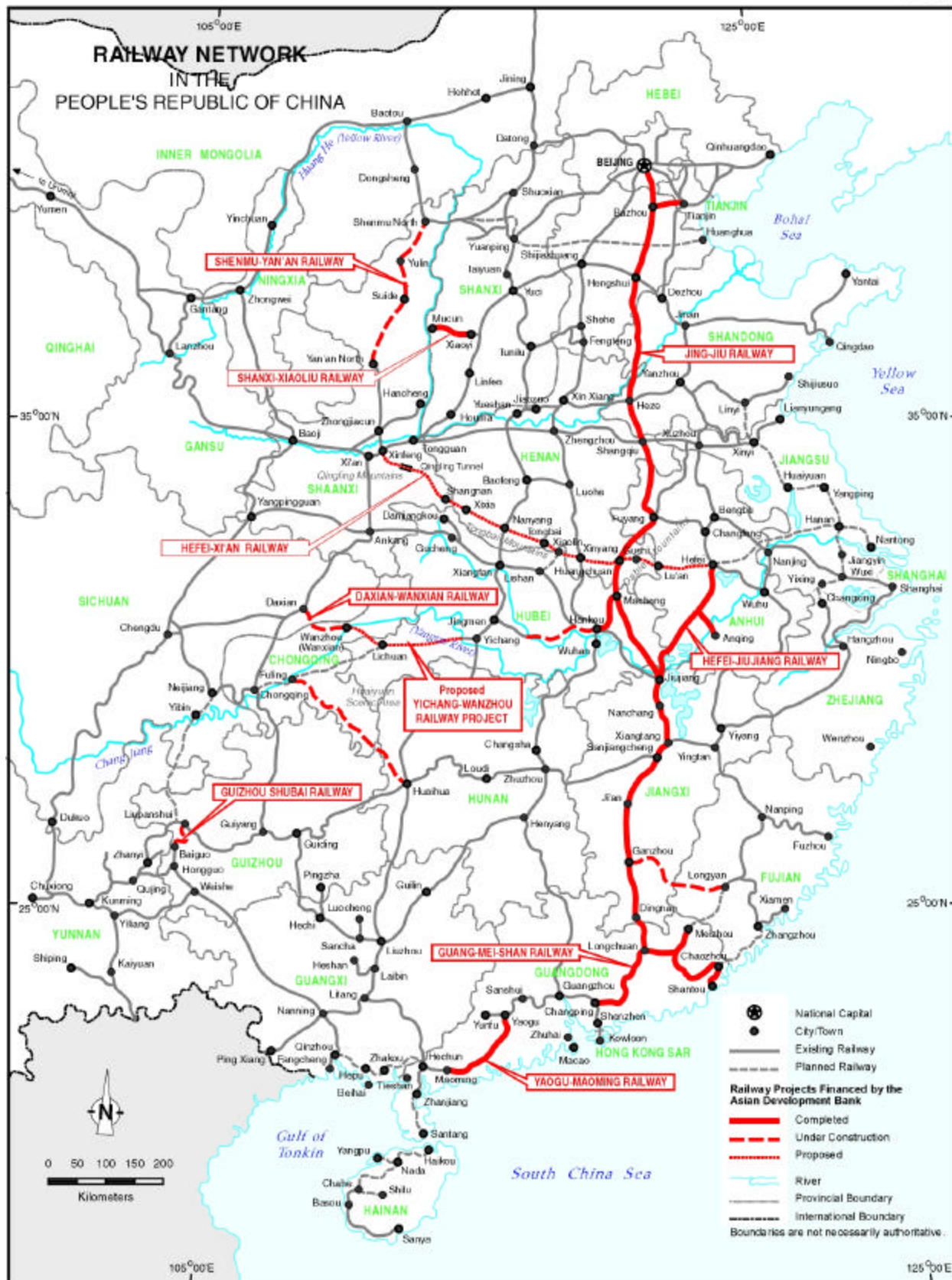
## NOTE

In this report, "\$" refers to US dollars.

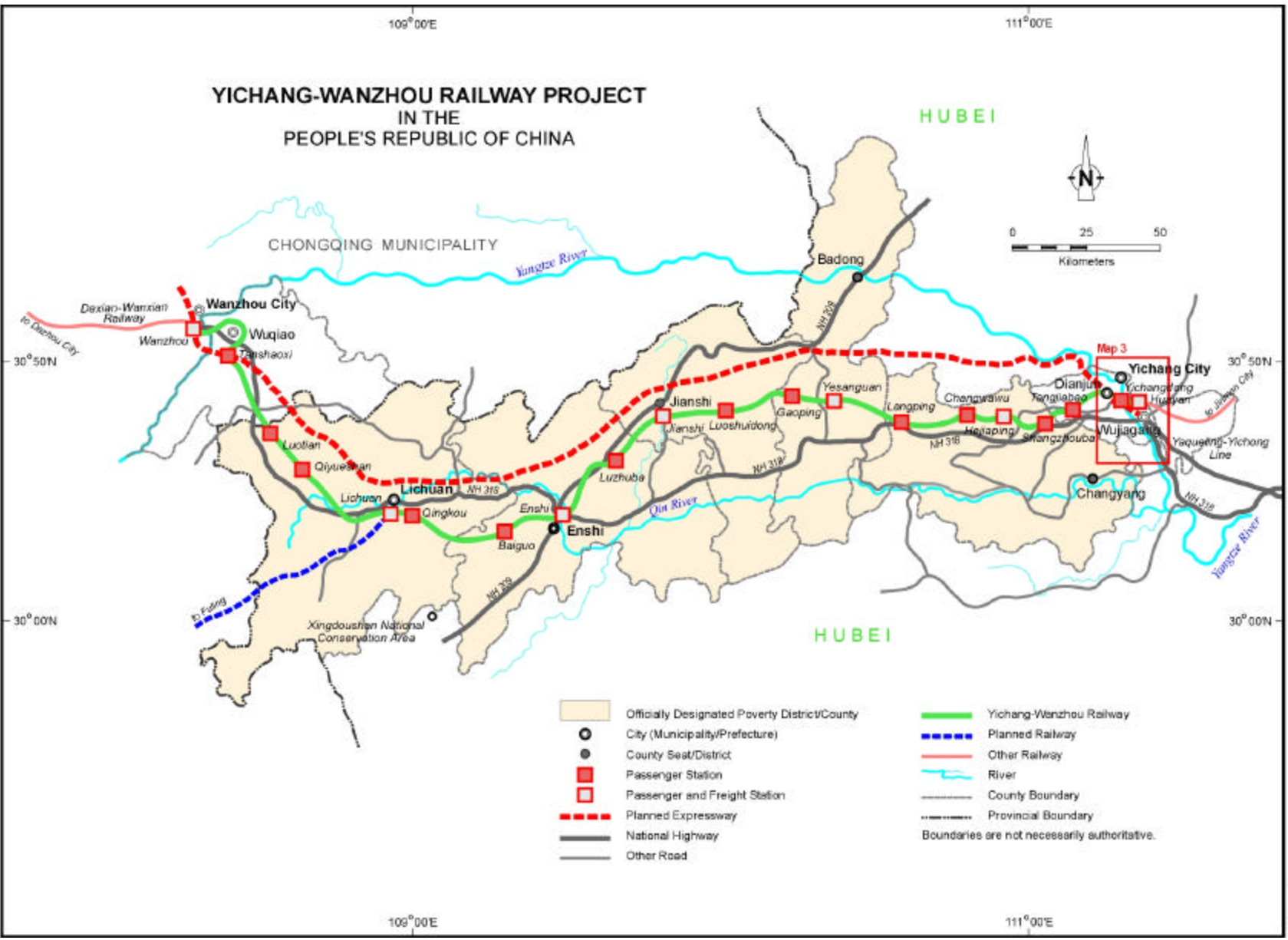
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Map 1



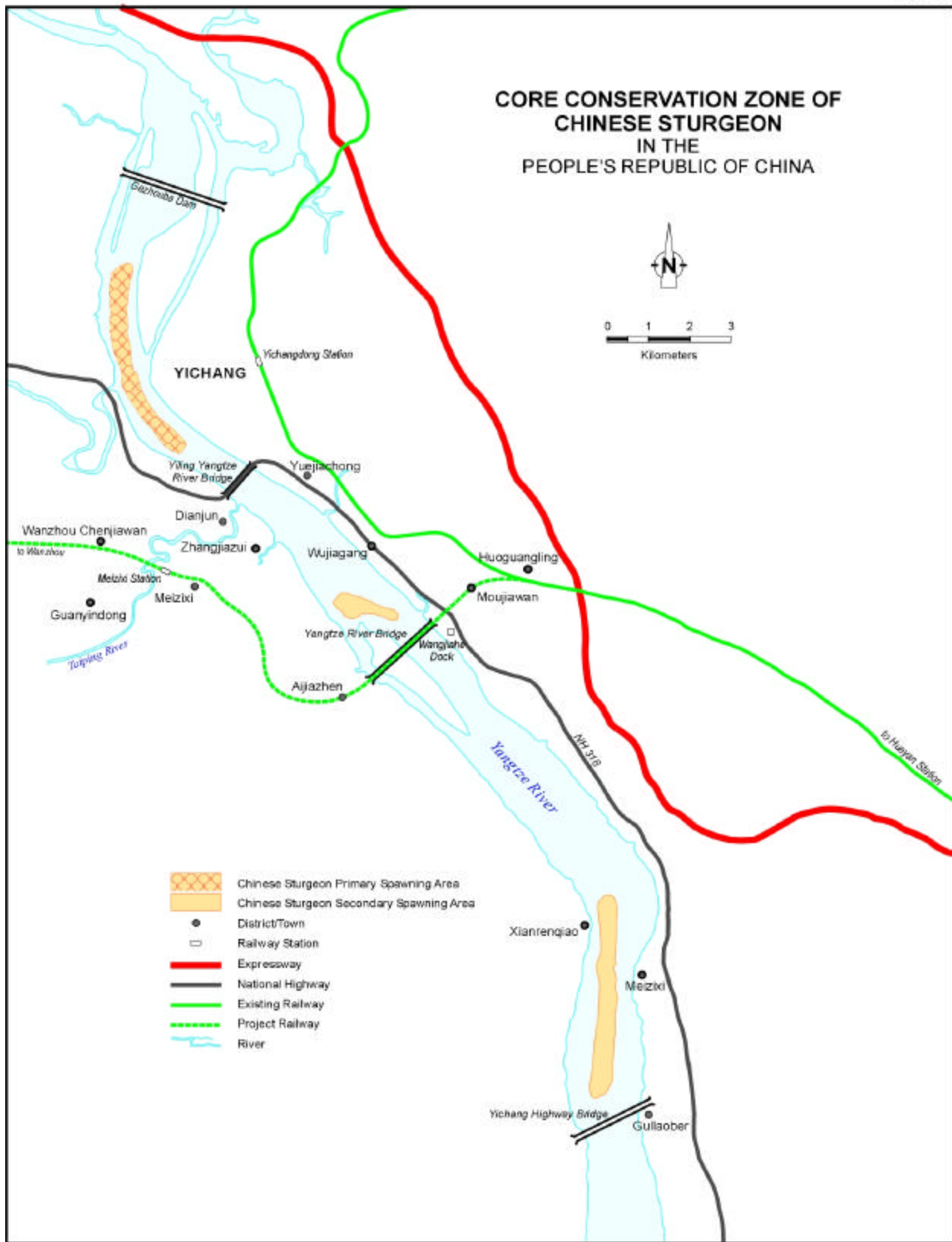
# YICHANG-WANZHOU RAILWAY PROJECT IN THE PEOPLE'S REPUBLIC OF CHINA



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| <span style="display: inline-block; width: 15px; height: 15px; background-color: #f4b084; border: 1px solid black; margin-right: 5px;"></span> Officially Designated Poverty District/County | <span style="display: inline-block; width: 20px; border-bottom: 2px solid green; margin-right: 5px;"></span> Yichang-Wanzhou Railway |
| <span style="display: inline-block; width: 10px; height: 10px; border: 1px solid black; border-radius: 50%; margin-right: 5px;"></span> City (Municipality/Prefecture)                       | <span style="display: inline-block; width: 20px; border-bottom: 2px dashed blue; margin-right: 5px;"></span> Planned Railway         |
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| <span style="display: inline-block; width: 20px; border-bottom: 2px dashed red; margin-right: 5px;"></span> Planned Expressway   | <span style="display: inline-block; width: 20px; border-bottom: 1px dashed black; margin-right: 5px;"></span> Provincial Boundary    |
| <span style="display: inline-block; width: 20px; border-bottom: 2px solid black; margin-right: 5px;"></span> National Highway  | Boundaries are not necessarily authoritative.  |
| <span style="display: inline-block; width: 20px; border-bottom: 1px solid black; margin-right: 5px;"></span> Other Road  |  |

Map 2

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## I. INTRODUCTION

1. This summary environmental impact assessment (EIA) presents the environmental benefits, adverse effects, and recommended mitigation and monitoring measures related to the construction and operation of the Yichang-Wanzhou Railway (YWR) Project in the People's Republic of China (PRC). In early 2002, Ministry of Railways (MOR) included the EIA of the YWR in MOR's annual environmental impact assessment plan. The outline of the EIA was prepared by the Fourth Survey & Design Institute, as instructed by MOR, and it was reviewed and approved by the State Environmental Protection Bureau in March 2002. A team of international and domestic environmental experts employed by the Asian Development Bank (ADB) assessed the environmental aspect of the Project in September 2002 according to ADB's safeguard policy and the relevant guidelines. The EIA is being finalized by the Fourth Survey & Design Institute and expected to be approved by the SEPA in September 2003.

## II. DESCRIPTION OF THE PROJECT

2. The proposed YWR Project is a class 1, standard gauge, single track electrified railway, which roughly parallels the Yangtze River (Map 1). The YWR Project is a primary component of the railway development plan for a countrywide network, and its alignment has been under study intermittently since 1964. The YWR Project is given high priority under the Tenth Five-Year Plan and is an essential element of the PRC Western Region Development Strategy.

3. The 387-kilometer (km) YWR will link two railways, traversing eight counties and districts of three prefectures in Hubei Province and Chongqing Municipality (Map 2). Starting from an existing freight station at Huayan on the Yaqueling-Yichang line in Hubei Province, the YWR will cross the Yangtze at Yichang on a major bridge (1.8 km). Proceeding westerly from Yichang, the YWR will traverse the hills of west Hubei Province in the greater Yangtze River basin before climbing over the divide into the Qing River watershed. The YWR will then pass through the mountainous Changyang Tujia Autonomous and Badong Counties before arriving at Enshi City. From Enshi, the YWR will ascend along a series of precipitous canyons, to Lichuan, its highest point. The YWR will then descend in a northwesterly direction, recrossing the Yangtze, with a 1.1 km extra-large bridge at Wuqiao, and connecting to the existing West Wanxian Station of the Daxian-Wanxian Railway<sup>1</sup> in Wanzhou District of Chongqing Municipality on the west end.<sup>2</sup> As a result of the steep terrain, and to minimize grade and loss of arable land, the YWR has 127 tunnels with a combined length of approximately 199 km, or 51% of the route's total length. Appendix 1 provides data on tunnels and bridges. The YWR<sup>3</sup> will have 39 stations, with 29 stations to be constructed by 2008 at the initial stage. In the future, Huayan Station will be converted to a district station with a shunting yard, locomotive depot, wagon repair facility, and directing facilities. West Wanzhou will also undergo some expansion. Construction of the YWR will take approximately 6 years and will cost an estimated of \$2.6 billion.<sup>4</sup>

4. The YWR Project will connect two existing railroads (Daxian-Wanxian and Yaqueling-Yichang lines) forming a continuous 2,200 km rail link<sup>5</sup> in the vital east-west Yangtze River

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<sup>1</sup> ADB. 1996. *Report and Recommendation of the President to the Board of Directors on a Proposed Loan to the People's Republic of China for Daxian-Wanxian Railway Project*. Manila.

<sup>2</sup> Chongqing Municipality has the administrative status of a province, and Wanzhou District is equivalent to a prefecture.

<sup>3</sup> Including expansion of two existing stations at both ends of the YWR.

<sup>4</sup> Unless otherwise specified, all costs in this document are expressed in financial costs.

<sup>5</sup> The inclusive link between Wuhan east to Tongling is estimated to be completed in the same time frame as the YWR.

corridor of the PRC. The YWR will carry a variety of local and transit freight, facilitating large-scale movement of foreign grain into the catchment area, enabling farmers to shift to planting vegetables and other cash crops. Secondary industrial development may also be facilitated by reduced transport costs. The direct catchment area has a population of 9.44 million, including 2.82 million of various minority groups. An estimated total of 7.39 million are engaged in agriculture. The population residing in this mountainous area, which has not experienced the improved quality of life now enjoyed in urban and eastern PRC, will benefit from the Project. Farmers and industries will have access to wider markets and obtain better prices for their goods. The YWR Project will improve access to historical and ecotourism sites, generating employment opportunities for the local people.

### **III. DESCRIPTION OF THE ENVIRONMENT**

#### **A. Physical Resources**

5. The project area has a subtropical humid monsoon climate with four distinct seasons and an annual average temperature of 13–17 degrees Celsius (°C). January is the coldest month, with an average temperature of 2–5°C, and July is the warmest with an average of 28°C. The annual rainfall ranges from 1,000–1,700 millimeters, with intense downpours in the summer monsoon season.

6. The geology along the proposed line is characterized by regional uplift with outcropping rocks varying in age from Mesozoic to Paleozoic eras. The entire route poses construction challenges due to extensive folding and fracturing of soft ash and carbonate rocks, potential rockslides, and sudden discharges of water from karst solution cavities.

7. The surface water systems in the project area are the Yangtze River, which is crossed by bridges at each end of the YWR, and the Qing River, which is subject to severe floods during the rainy season, and flows into the Yangtze at Yidu (downstream of Yichang). The Qiyueshan Mountains divide the two watersheds. Freight has been shipped through the Yangtze throughout recorded history. When the Three Gorges Dam is completed and the reservoir has risen to design stage, Wanzhou will become a major port on the Upper Yangtze. The Yangtze River crossing at Wanzhou has been designed to allow passage for up to 10,000 dead weight ton vessels. Of the tributaries to the Yangtze in this area, only the Qing River is open to navigation and only to smaller craft. There are hydropower and flood control facilities on the Qing River and two more under construction.<sup>6</sup>

#### **B. Ecological Resources**

8. The predominant soils in the area formed from siliceous and/or carbonate rocks, and support ample vegetation, but are generally shallow and prone to erosion. The steep terrain limits farming, but all flat areas are cultivated and many slopes are planted or terraced. Overall, less than 20% of the total land is arable. Even this small percentage is subject to continuing depletion due to erosion during the monsoon season. The main crops are tobacco, rice, winter wheat, and rape. Forests largely comprise pine, common fir, elm, sweet oak, cypress, and rattan, and make up approximately 56% of the total land along the line. The proposed alignment generally follows the route of the existing National Highway (NH) 318, where people move about frequently. There is little evidence of large rare animals along the line.

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<sup>6</sup> The Qing River will not be affected by construction of the Three Gorges Project because it joins the Yangtze downstream of the Three Gorges site.



9. A number of important conservation zones are managed by the Provincial Forestry Department in the project area. Table 1 provides brief descriptions of these zones and their proximity to the proposed alignment.

**Table 1: Conservation Zones**

Name	Location (Prefecture/ County)	Regulatory Authority	Threatened Species	Status	Approximate Distance to YWR (km)
Sturgeon Conservation Zone	Yichang City – 80 km zone of Yangtze River downstream of the Gezhouba Dam	Hubei Province Fishery Bureau	Chinese Sturgeon	Endangered species (Appendix 2)	3
Er Dun Yan	Yichang	Hubei Province Forestry Department	Pigeon tree ( <i>Davidia involuciata</i> )	Endangered 28 protected species are present in the zone)	3
Xingdou Mountain Protection Zone	Enshi (Lichuan county)	Hubei Province Forestry Department	Sequoia (dawn redwood, <i>Metasequia glyptostroboides</i> )	A 600 year old tree (species gene bank) is protected; No rare or endangered wildlife	30
Wang Er Bao	Wanzhou	Wanzhou Forestry Department	36 endangered plant species	Study underway to identify rare and endangered insects	3

km = kilometer, YWR = Yichang-Wanzhou Railway.

Source: Asian Development Bank staff estimates.

10. A summary of a special report<sup>7</sup> prepared by the Hydrobiology Institute of the China Academy of Science (HICAS) outlines impacts of the YWR crossing the Yangtze River near the Provincial Conservation Zone for the Chinese sturgeon (Appendix 2). The sturgeon is a large estuary fish that migrates upstream to spawn. Prior to the 1981 construction of the Ge Zhouba dam, just upstream from Yichang, the sturgeon used to spawn upstream, but the fish adapted to the new circumstances and now spawns in three separate areas within a 30 km stretch of the river from the dam on the upstream side to Gu Laobei. Map 3 shows the provincial conservation zone established in 1986 to protect the sturgeon and prohibit any construction activities, particularly blasting under water, in the 30 km core area from the dam to Gu Laobei. The buffer zone, which extends an additional 50 km downstream to the Lu Jiahe shallows, has less stringent conditions. The challenge presented by the proposed bridge at Yichang is that construction of cofferdams and piers is easiest during low flow<sup>8</sup> on the Yangtze—the sturgeon's spawning period.

11. The pigeon tree (Table 1) is largely confined to the Er Dun Yan Conservation Zone, which is 3 km from the approximate position of the line. However, no pigeon tree has been found within the 1 km clearance area on each side of the alignment. 141 old trees were identified in the neighboring villages on the alignment. Among them, there are eight trees ranging from 100–150 years old within 500 meters clearance, but more than 100 meters distant from the alignment. No significant impacts of the project railway on the old trees are perceived. Nevertheless protection measures will be taken for each of the eight trees to ensure no

<sup>7</sup> Summary of Special Research: Impact on Conservation of the Spawning Bed of Chinese Sturgeon by YWR's Yangtze River Crossing (Original Report in Chinese). See summary in Appendix 2 of this document. The report was prepared at the request of the PSD.

<sup>8</sup> Low flow season is September through April.

accidental damage would incur particularly during the construction.

### **C. Human and Economic Development**

12. The YWR will traverse an area with a large minority population. Minorities, largely Tujia, Miao, and Dong, comprise almost 36% of the total population of the catchment area. Arable land capita is only 0.082 hectares (ha) and the land yields only one crop a year (Table 2). Logging and the processing of value-added wood products is a source of employment. In Enshi Prefecture, for example, over 300,000 cubic meters (m<sup>3</sup>) of lumber are harvested annually, and 230 woodworking factories are producing plywood, furniture, and floor covering (parquet), largely for local consumption. Aside from this type of economic forestry, conversion of farmland on steep slopes and reforestation are both ongoing, using volunteer labor brigades and formal organizational efforts. Much of the steeper land in the project area is designated for ecological preservation. Illegal logging is not a serious problem at present.

13. The small-scale production of minerals, primarily for local consumption, includes coal, limestone (for cement), gypsum (building materials), and halite (table salt). Publicly and privately funded explorations have delineated a number of other ore bodies, such as phosphates, iron (pyrite and hematite), and magnesium, some of which may be more economical to develop when the YWR is operational.

14. The tourism industries are profitable in all three prefectures crossed by the YWR Project, largely due to their proximity to the Yangtze River. Tourists on the Three Gorges cruise ships visit numerous impressive cultural and ecologically oriented tourism sites. The number of visitors would be greatly increased if they could reach Enshi by rail instead of the accident-prone NH 318. Wanzhou, which had 1.2 million tourists in 2001, will continue to be a prominent tourism center after the Three Gorges Reservoir is filled. When the Project is completed, westward-bound tourists traveling by rail from the southern PRC or coastal cities will have direct access to the attractions of Wanzhou. A promising foundation of tourist infrastructure is already in place.

### **D. Quality of Life Values**

15. The contrast between rural and urban residents is illustrated by the wide difference in their per capita incomes. In Hubei Province,<sup>9</sup> per capita rural income is CNY2,277 or approximately 41% of the per capita income for its urban citizens (CNY5,543) in 2000. For Chongqing Municipality,<sup>10</sup> the per capita rural income is CNY1,892, only 30% of the per capita urban income of CNY6,276. Economic indicators in the project catchment area are illustrated in Table 2. Emphasizing the scope of the industrial component of Yichang as compared with those of Enshi Prefecture and Wanzhou District, Table 2 lists the industrial gross domestic product (GDP) of Yichang as CNY41.0 billion in contrast to CNY12.7 billion for Enshi Prefecture and CNY7.3 billion for Wanzhou District. Likewise, the per capita GDP of Yichang is CNY10,323, which is markedly higher than Enshi's (CNY3,354) or Wanzhou's (CNY4,358). The low productivity of the agricultural sector stems from the small size of the areas farmed by each family. In Wanzhou, for example, the arable land per agricultural person is only 0.05 ha.

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<sup>9</sup> Hubei Statistical Yearbook 2001.

<sup>10</sup> Chongqing Statistical Yearbook 2001.

Table 2: Main Economic Indexes, Catchment Area (2000)

ITEM	Unit	Hubei Province		Chongqing	Total/Average
		Yichang City	Enshi Prefecture	Wanzhou	
LAND AREA	1,000ha	2,108	2,394	346	4,848
Total Population	million	3.975	3.802	1.680	9.457
Non-Agricultural Population	million	1.206	0.450	0.406	2.062
Agricultural Population	million	2.769	3.351	1.273	7.394
GDP (Industry & Agriculture)	billion CNY	30.703	14.856	6.671	52.23
GDP (Agriculture)	billion CNY	9.891	7.761	1.765	19.417
GDP (Industry)	billion CNY	20.812	7.098	4.908	32.818
GDP	billion CNY	41.034	12.677	7.319	61.03
Per capita GDP	CNY	10,323	3,335	4,358	6,453
Arable Land	ha	257,700	280,590	65,150	603,440
Arable Land per Agricultural Person	ha	0.093	0.084	0.051	0.082

GDP = gross domestic product, ha = hectare.

Source: *Environmental Impact Assessment on Yichang-Wanzhou Railway*, FSDI.

16. The ADB-financed Daxian-Wanxian railway has satisfactorily complied with the environmental covenants and only treated sewage is discharged at the Wanzhou terminal station. However, there are polluted drainage ditches on both the Yichang East Station and the Huayan Station on the Yaqueling-Yichang Railway. Pollution of existing watercourses is indicated in Appendix 3. Awareness of wastewater management and abatement actions has significantly increased recently along the Yangtze River, where uncontrolled discharge of water has created a tragedy of commons. In Yichang, six new wastewater treatment plants are planned for the Tenth Five-Year Plan period, including treatment capacity for the Yichang East and Huayan stations, while septic tanks continue to have an important role, and latrines or composting toilets furnish wastewater treatment where centralized wastewater treatment plants are not yet in operation. Enshi Prefecture has three conventional water treatment plants in operation, and adjacent counties have seven. Wastewater treatment plants using oxidation ditch technology are scheduled for completion in Badong County with a capacity of 60,000 tons per day (t/d) and Enshi City with a capacity of 120,000 t/d during 2003. A wastewater treatment plant with a capacity of 50,000 t/d will be completed in Lichuan County in 2004. Wanzhou city, investing CNY500 million, is building three wastewater treatment plants, with a combined capacity of 110,000 t/d. A major construction program of 200 km of sanitary sewers is under way.

17. Four rapid sand filter plants are operating to produce potable water in Yichang. Wanzhou is currently treating 210,000 t/d of potable water.<sup>11</sup> However, in small villages in the project area, potable water comes from springs and shallow wells, or is manually hauled from nearby towns.

18. In Yichang City, a landfill with liner and methane collection system financed by the World Bank began operating in 2001. Enshi Prefecture will complete the construction of solid waste treatment plants in Badong with a capacity of 150 t/d, in Enshi with 200 t/d, and in Lichuan with 200 t/d by 2004. Wanzhou Prefecture will complete a solid waste treatment plan in 2003 at CNY200 million of cost.

<sup>11</sup> Some of these facilities must be relocated because they will be inundated by the reservoir of the Three Gorges Dam.

19. Background noise and air quality are both better in rural areas, because of the lack of major industrial facilities. The two terminal stations, Huayan of the Yaqueling-Yichang Railway, and Wanzhou of the Daxian-Wanxian Railway, are presently affected by moderate railroad noise. However, the noise sensitive points on the interior line are mainly in rural villages, where the noise source is attributable to social living, augmented perhaps by vehicular traffic from NH 318.<sup>12</sup>

#### IV. ALTERNATIVES

20. Four alternative modes of transport are available in the project area: air, rail, road, and water. Regional development strategies include development of an integrated transportation network using all four transportation modes.

21. **No-Action Alternative.** Without the project, air, road, and water traffic will continue to increase, with roads travel expected to account for most increases in passenger travel, and with freight transport using road and water routes.

22. **Rail vs. Other Transport Modes.** Dams and locks on the Yangtze River restrict the amount of water traffic, and expansions of the road network will be required to accommodate anticipated increases in car and truck traffic. Air transit will be limited to its niche of lightweight, high-value freight; expansion of air transport to service regional passenger travel demand does not appear feasible. River and road will constitute the alternative modes of traffic through the middle section of the east-west Yangtze Corridor. Given the preference for developing all four transportation modes in the project area, the PRC government designated the YWR Project as a critical link in the east-west rail corridor, and approved the YWR conceptual design. Advantages of the YWR Project include the following:

- (i) River barges primarily connect the port cities (i.e., Yichang and Wanzhou), and cannot directly serve the interior communities of the YWR. Moreover, future barge traffic will be slower and more costly when it must pass through the locks at the Three Gorges Dam.
- (ii) The two highways, NH 318, running east-west, and NH 209, running north-south, comprise the road network of the catchment area between Yichang and Wanzhou. The highways intersect at Enshi. Throughout this mountainous area, both highways are unstable, unsafe two-lane roads with no passing lanes, requiring almost continuous maintenance to correct landslides, cave-ins, and other slope failures.
- (iii) The YWR with electric locomotive traction will be far less injurious to the environment, as both barges and trucks are propelled by diesel engines with carbon dioxide (CO<sub>2</sub>) and nitrogen oxide (NO<sub>x</sub>) emissions.

23. **Alternative Alignments for YWR.** The original alignment considered by MOR was based on a maximum gradient of 2.4%, using double locomotives. To reduce operating costs and ensure safer operation and more traction capacity, the decision was made to reduce the maximum grade to 1.8%, which necessitated a number of reroutings along the line. ADB

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<sup>12</sup> In accordance with the standard PRC procedures, an intensive baseline survey was conducted along the line. Calibrated integral sound level meters were used to continuously measure 10-minute intervals of equivalent sound level to determine the environmental daytime and nighttime background noise levels. One daytime and one night time measurement was recorded at 56 points at 20 sites focusing on housing areas, schools, and clinics.

assessed the alignment options with different gradients and justified the proposed alignment from various aspects including technical and economic.

24. **Alternatives for Yangtze River Crossing at Yichang City.** Two general alternatives were considered in the design of the crossing of the Yangtze River at Yichang: a bridge or a tunnel. Two tunnel options were considered: a bored tunnel constructed by drilling and blasting; or a sunken tube method, constructed by dredging a deep trench across the river into which connected tube sections are sunk and backfilled. Both options would require extensive realignment of the line on both sides of the river. The sunken tube method would be the most disruptive to the sturgeon habitat, while the deeper bored tunnel would also cause extensive vibration of the riverbed. Taking into consideration environmental impacts, engineering design, and total costs, the bridge was selected as the optimum alternative.

## V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

25. Table 3 summarizes major impacts in terms of pollution sources and treatment options. Appendix 4 provides additional details on expected project impacts during construction and operations.

**Table 3: Project Impacts and Mitigation Measures**

Types of Pollution Sources		Pollution Sources	Location of Pollution Sources	Pollutant or Parameter	Treatment Measures	Applicable Standards
Noise	Construction Period	Repair shops & heavy equipment	Construction site and access roads	70 – 100dBA (30m)	Continuing Construction Management	GB 12523-90
	Operational Period	Locomotive, shops, stations	Along the line; marshalling yard; repair depot	Varies	Relocate facility, or erect sound barrier	Meet the standard for functional zones
Wastewater	Construction Period	Domestic and industrial wastewater	Work site, living site	COD, BOD, petroleum, etc.	Primary treatment if needed by larger camps	Good engineering practice
		High density wastewater residue from tunneling	Entrance and exit to tunnel	Mud and sand	Sedimentation	Recyclable after sediment
	Operational Period	Huayan station	Yichang City	SS, COD, BOD, petroleum, etc.	Oil contaminated wastewater filtered then recycled; domestic sewage held in septic tank then sent to urban treatment plant	GB8978–1996 Grade III standards

Types of Pollution Sources		Pollution Sources	Location of Pollution Sources	Pollutant or Parameter	Treatment Measures	Applicable Standards
		Yichang east station		SS, COD, BOD	Domestic sewage held in septic tank then sent to urban sewage treatment plant	GB8978–1996 Grade III standards
		Jianshi station	Jianshi County	SS, COD, BOD	Treatment by bacteria-enhanced septic tank, then discharge	GB8978–1996 Grade III standards
		Enshi station	Enshi City	SS, COD, BOD, Petroleum, etc.	Oil contaminated wastewater filtered then recycled; domestic sewage held in septic tank then sent to urban treatment plant	GB8978–1996 Grade III standards
		Lichuan station	Lichuan City	SS, COD, BOD	Domestic sewage to septic tank then to urban sewage treatment plant	GB8978–1996 Grade III standards
		Wanzhou station	Wanzhou district, Chongqing City	SS, COD, BOD, petroleum, etc.	Oil contaminated wastewater filtered then recycled; domestic sewage held in septic tank then sent to urban treatment plant	GB8978–1996 Grade III
Air Pollution	Construction Period	Dust rising in the air during construction and exhaust gases emitted by construction machinery and vehicles	Construction sites access roads and surrounding areas	Increase TSP, NO <sub>2</sub> , SO <sub>2</sub> . Levels at construction sites, and surrounding areas	Continuous management measures to be imposed at the construction sites	Atmospheric environment will be impacted to some extent during construction period
	Operational Period	Smoke emitted by diesel shunting locomotives and boilers	Relevant Stations, Depots & points	Main pollutants are smoke, dust, SO <sub>2</sub> , Nox, etc.	Smoke from diesel shunting locomotives will be emitted directly; use fuel or gas boiler	Smoke from diesel locomotives exerts moderate impact on surroundings
Solid Wastes	Construction Period	Spoils from earth moving; refuse from construction workers; construction garbage	Construction sites and worker's camps		Spoil to be used as base material for road or station construction; or carefully placed on slopes; garbage buried locally	Good engineering practice

Types of Pollution Sources		Pollution Sources	Location of Pollution Sources	Pollutant or Parameter	Treatment Measures	Applicable Standards
	Operational Period	Garbage from stations and passenger trains; cinders from boiler	Stations along the line		Garbage from stations and passenger trains will be disposed of by local environmental departments	

BOD = biochemical oxygen demand, COD = chemical oxygen demand, dBA = decibel acoustic, GB = *guojia biaozen* (national standard), Grade III = effluent standard from sewage treatment plant, NO<sub>2</sub> = nitrogen dioxide, NO<sub>x</sub> = nitrogen oxides, SO<sub>2</sub> = sulfur dioxide, SS = suspended solids.

## A. Noise

26. During construction, the most noticeable sources of noise will be from machinery in the repair shops; blasting in tunnels and quarries; or from heavy earthmoving equipment. Following standard procedures (e.g., including PRC national standard GB 12523-90), contractors will be required to meet with local officials to schedule operating hours of equipment and to locate machinery away from sensitive areas; local environmental protection bureaus (EPBs) will be notified of construction activity 15 days in advance. Contractors will be encouraged to use new and well-maintained equipment and to mandate that workers use ear protection in areas having high levels of noise.

27. Blasting for tunnel construction will generate noise and vibration, but mainly in relatively remote areas. Appropriate worker protection will be provided. Residents potentially affected will be informed of the construction schedule, and blasting operations will be restricted in accordance with existing PRC standards for noise and vibration.

28. During the operating phase, passing trains, as well as the operation of equipment in each station, shop, and marshalling yard, will generate noise. In open areas, the noise of the passing trains will be linearly dispersed, and will only have a minor impact. During the field investigation for the EIA, day and night time background noise levels at sensitive sites, such as schools and housing areas, were determined. By using a calibrated analog model to simulate train noises at the rural sensitive sites, and superimposing these noises on the measured background noises, total equivalent noise levels during the operating phase were calculated. Most of the measured sites meet the national standards and no mitigation is needed. Where standards were exceeded, the following mitigation measures will be adopted:

- (i) Yichang River Crossing, north bank: Aijiazui Community—540-meter (m) long, 2-m high noise barrier will be constructed, the bridge deck will be closed and welded long rail will be used;
- (ii) Yichang River Crossing, south bank: Hongqi Cable Factory-Affiliated School—a 200 m long, 2 m high sound barrier will be erected on both sides, the bridge deck will be closed, and welded long rail used;
- (iii) Yichang, north side of Yiling Avenue: residential community—sound-insulating windows will be installed in all houses within 60 m of the proposed railway;
- (iv) Residences of Yitai Rice Co—sound-insulating windows will be installed in houses (40 families) within 60 m of the railway;

- (v) Dayan Middle School, right side—a 150 m long, 3 m high noise barrier will be build;
- (vi) Douhe Primary School—will be relocated; and
- (vii) Maozhenba Primary School, right side—some classrooms and office buildings will be moved (partial relocation).

## **B. Water**

29. The generally small quantities of wastewater discharged during the construction will consist of effluent from the work camps, and washwater from the equipment maintenance shops. The wastewater with oil will be treated before recycling the oil. If construction camps are large (e.g., more than 500 workers), liquid wastes, prior to discharge in a natural watercourse, will be subjected to secondary treatment in an anaerobic pond preceded by a bar screen.

30. Tunnel excavation and construction could increase erosion and cause elevation of suspended solids in local waterways. The best engineering practices (e.g., dikes for run-off control and silt fences) will be employed to minimize erosion and spoils. Tunnel and rail bed construction will not permanently alter waterways, and will not increase flood potential.

31. During the operating phase, domestic wastewater will be generated at each railroad station from offices, waiting rooms, and staff living quarters. Experience from similar-sized stations indicates that the quantities and the chemical/biological characteristics of the wastewater can be forecast for each station. Treatment methods are noted in Table 3. PRC law requires cities with more than 500,000 people to construct centralized wastewater treatment plants, and adequately sized treatment plants using efficient technology (e.g., oxidation ditch), are scheduled for completion in Enshi, Lichuan, Wanzhou, and Yichang by the time the YWR Project is completed. For each town, a comparison<sup>13</sup> will be undertaken, weighing the cost of constructing connecting sewers against the cost of building a small treatment plant, in order to treat the wastewater in an appropriate and cost effective manner for the local community.

## **C. Air**

32. Dust accompanied by minor increases in the levels of NO<sub>x</sub> and SO<sub>x</sub> are the primary atmospheric pollutants during the construction period. The dust will settle on trees and crops, and can cause respiratory problems for nearby residents. Frequent wetting of the roads will be necessary to minimize dust. Overall, with continued control by the contractor, the impact will be temporary and slight.

33. During the operating phase, no air pollution will result from the main line electric locomotives, and only minimal impacts will occur from the five diesel shunting locomotives (Table 4) scheduled for operation at Enshi, Huayan, and Wanzhou. Based on traffic diverted from highway to railway, the EIA concluded that over the project lifetime, CO, HC, and CO<sub>2</sub> will be reduced by 158,849 t, 11,373 t, and 10,488,850 t respectively; but SO<sub>2</sub> and PM would increase by 8,846 t and 1,263 t, respectively.

34. There are a total of 30 one-ton, and 4 half-ton oil-burning boilers designed for specified

<sup>13</sup> If the sewer option is selected, with the exception of oil separation, treatment plants will not be required at any of the stations, as the domestic sewage from the station and its associated living quarters can be conveyed directly to the urban wastewater treatment plant.



stations and residential quarters along the line. The specifications for these boilers call for an allowable maximum of 100 milligrams per cubic meter of smoke and dust discharge, which brings it into conformance with PRC regulations. Yichang, which has been allocated 6 one-ton and 1 half-ton boilers in the Yichang East and Huayan stations (Table 5), has been designated by SEPA as an acid rain control area. This implies that tight controls should be placed on emissions of sulfur dioxide, but the YWR Project will only discharge 2.16 t per annum (0.78 t from the boilers, and 1.38 t from the 2 shunting locomotives), which will result in minimal impact.

**Table 4: Discharge of Atmospheric Pollutants by Shunting Locomotives**

Station	Number of Shunting Locomotives	Oil Consumption	Discharge of Pollutants (tons per year, t/y)			
			NOx	Soot	CO	SO <sub>2</sub>
Huayan	2	436.6	8.26	6.62	3.1	1.38
Enshi	1	217.8	4.13	3.31	1.55	0.69
Wanzhou	2	435.6	8.26	6.62	3.1	1.38
Total	5	1090	20.65	16.55	7.75	3.45

CO = carbon monoxide, NOx = nitrogen oxide, SO<sub>2</sub> = sulfur dioxide, t/y = tons per year.

Source: Adopted from *Environmental Impact Assessment Report on Yichang-Wanzhou Railway, Revised Draft Edition*, FSDI, Wuhan; September 2002. Table E-75, Page 135.

**Table 5: Yichang Area SO<sub>2</sub> Discharge from YWR Boilers (t/y)**

Site	Set x Capacity (t)	SO <sub>2</sub>
Yichang East Passenger Train Servicing Point	2 x 1	0.26
Huayan District Station	1 x 0.5	0.09
Huayan Residential Quarters	2 x 1	0.26
Huayan Locomotive Depot	2 x 1	0.17
Total	6 x1 Ton; 1 x 0.5 Ton	0.78

SO<sub>2</sub> = sulfur dioxide, t = tons, t/y – tons per year.

Source: Adopted from *Environmental Impact Assessment on Yichang-Wanzhou Railway*, FSDI.

#### D. Solid Waste

35. The construction process will generate sizeable quantities of refuse (e.g., discarded packaging, scraps, etc.), most of which will be recycled by the local people. In addition, garbage from the construction camps will be collected and disposed of by the local government. The major element of solid wastes, however, is soil rock and debris from excavation. Table 6 summarizes the estimated earthwork quantities. The total earthwork quantities are estimated at 61.38 million m<sup>3</sup>, including 14.95 million m<sup>3</sup> of tunnel excavation. The excavated material will be reused to the extent and an estimated 2.99 million m<sup>3</sup> of tunnel waste will be used for structural fill. The contractors will be required to follow good engineering practice by:

- (i) using, for structural fill of access roads, stations, and embankments, all wastes, to the extent possible, before resorting to excavating borrow pits;
- (ii) setting aside topsoil after cleaning and stripping borrow pits;
- (iii) spreading and drying wastes from tunnel excavation before using in embankments;
- (iv) ensuring that when wastes are placed (at designated locations) on slope areas

for permanent disposal, they will be stabilized, then covered with topsoil and planted with grass;

- (v) paying special attention to natural waterways to ensure they are not blocked by construction debris, to prevent pollution of local water supplies and fishing grounds;
- (vi) flattening steep cut slopes, and benching to control drainage; and
- (vii) driving anchoring piles or extensive use of shotcreting to stabilize areas prone to landslides.

**Table 6: YWR Earthwork Quantities (Unit: 10<sup>4</sup>m<sup>3</sup>)**

	Item		Line	Station and Yard	Existing Track	Relocation of Roads, Trench and Channel	Total
Hubei	Earthwork	Fill	310.47	586.36	8.20	17.79	922.82
		Excavation	391.75	362.59	8.23	50.66	813.23
	Stonework	Fill	450.79	605.78	3.83		1,060.40
		Excavation	624.44	798.29	11.80		1,434.53
Subtotal			1,777.45	2,353.02	32.06	68.45	4,230.98
Chongqing	Earthwork	Fill	10.79	62.25		3.69	76.73
		Excavation	15.30	31.39		13.33	60.02
	Stonework	Fill	26.64	82.85			109.49
		Excavation	36.59	117.72		11.94	166.25
Subtotal			89.32	294.21		28.96	412.49
Total Earthwork and Stonework			1,866.77	2,647.23	32.06	97.41	4,643.47
Tunnel Construction		Excavation					1,495.0
Tunnel Construction		Fill					299.0
Tunnel Construction		Subtotal					1,794.0
<b>Total</b>			<b>1,866.77</b>	<b>2,647.23</b>	<b>32.06</b>	<b>97.41</b>	<b>6,437.47</b>

m<sup>3</sup> = cubic meters.

Source: Environmental Impact Assessment on Yichang-Wanzhou Railway, FSDI.

## E. Flora and Fauna

36. The YWR will have impacts on plants and trees within and close to the right-of-way. All nearby vegetation will be affected by dust. A total of 831 ha will be taken for the railway roadbed (including tunnel portals) and 485 ha for the station and yard sites. In addition, another 213 ha will be used for disposal of tunnel wastes. Borrow pits and waste disposal sites will cause temporary loss of land. After covering with topsoil and seeding, the sites will gradually return to use as agricultural land. Table 7 lists the loss of forested in areas identified as orchard, forest, windbreaks, and commercial forest. No protected zones of primary forests will be affected by the YWR. After final staking, if some isolated pigeon trees are found to be within the construction zone, they will be protected or relocated. No loss of rare or endangered animals is anticipated. When the tourist zones are developed, employment for the local people will be increased. The adverse impact of tourists will be controlled by proper administration and management.

Table 7: Extent of Tree Damage

Category		Hubei Province				Chongqing Municipality		Total Area (ha)	
		Yichang City		Enshi Prefecture		Wanzhou District			
		Area (ha)	No. of Sites	Area (ha)	No. of Sites	Area (ha)	No. of Sites		
Line	Orchard	26.60	80	0	0	0	0	26.60	
	Forest	50.54	15	36.56	6	10.81	3	97.91	
Station	Orchard	20.26	60	00.07	1	0.90	3	21.23	
	New Stations	Windbreak Trees	12.50	3	30.94	9	12.18	3	55.61
		Commercial Forest	6.25	2	15.47	4	6.09	2	27.81
	Existing Stations	Orchard	2.47	8	0	0	0		2.47
		Windbreak Trees	4.07	2	0	0	0		4.07
Total		122.68	170	83.03	20	29.99	11	235.70	

ha = hectare.

Source: *Environmental Impact Assessment on Yichang-Wanzhou Railway*, FSDI.

37. The special study by sturgeon experts (Appendix 2) concluded that construction, noise, and vibrations from two existing highway bridges in the area have not degraded the sturgeon spawning patterns. The proposed YWR crossing will be farther downstream from the main spawning area than the existing Yiling Bridge. Thus, the environmental challenges to be surmounted are construction methods and appropriate scheduling of the construction period for the bridge substructure. After review of the EIA in late 2002, the Hubei Provincial EPB approved the YWR's Yichang Extra-Large Bridge crossing with three conditions: (i) construction methods must minimize disruption to the riverbed and fish population, (ii) no foundation work is allowed from 15 September through 30 November (the sturgeon spawning season), and (iii) the construction contractor(s) will have strict liability for any ecological damage caused during construction. HICAS and the Yichang EPB will monitor the construction activity.

## F. Historical, Cultural, and Archeological Sites

38. No historical or cultural sites will be adversely impacted by the YWR. When the Project is complete, however, it will provide access for tourists to several noteworthy ruins (e.g., the partially preserved Qing Dynasty architecture at Dashui Jing, some 20 km from the alignment). A recent article in the news identified a promising new archeological site adjacent to the Wu Long Chi Forest Park, Wanzhou District, approximately 10 km from the proposed alignment. A fossil tusk (*Stegodon preorientalis*) was recently found at this site.

## G. Resettlement

39. The YWR design restricts the railway mainly to steeper slopes, requiring numerous bridges and tunnels, to minimize the loss of housing and arable land. However, 449,200 square meter of structures will be affected by the Project. In accordance with PRC regulations, affected people will be provided with compensation adequate to allow them to build new housing of an equivalent standard. Where land must be acquired for the YWR, each family's new income level must not be lower than the original, and farmers will be compensated for all losses of the farm assets (e.g., crops in the field, fish ponds, pasture lands, and wells). The people affected by these resettlement policies can be divided into agricultural and nonagricultural groups. The people who will remain in farming will be resettled on reallocated agricultural land. The rest will be trained to work in manufacturing, transportation, or trade. Summary Resettlement Plan is

attached in Appendix 5.

Table 8 provides statistics on the resettlement impacts and budget.

**Table 8: Summary of Land Acquisition and Building Demolition**

<b>Item</b>	<b>Unit</b>	<b>Quantity</b>
Total Land Acquisition	ha	1,087
Land Acquired for Right of Way	ha	625
Land Acquired for Stations and Yards	ha	462
Cultivated Land Acquired	ha	428
Land Borrowed for Temporary Use	ha	203
Total Scale of Demolition of Buildings	square meters (m <sup>2</sup> )	449,169
Demolition Scale over Every Kilometer	m <sup>2</sup> per kilometer	1,146
Number of Affected People, Total	People	20,142
People Affected by Acquisition	People	7,423
People Affected by Demolition	People	17,752
People Affected by Acquisition and Demolition	People	5,033
People Affected per Kilometer	people per kilometer	52
Resettlement Budget (preliminary estimate):		
Cost for Permanent Land Acquisition	thousand yuan (CNY '000)	102,671
Compensation for Standing Crops	CNY '000	3,589
Cost for Temporarily Borrowed Land	CNY '000	960
Compensation for Building Demolition	CNY '000	147,456
Compensation for Infrastructure	CNY '000	81,480

ha = hectares.

Source: Draft Resettlement Plan as of 31 May 2003.

## **H. Safety and Health**

40. Worker health and safety is an important responsibility of the construction contractors. The contractors will ensure that hard hats, dust respirators, goggles, and other safety equipment are worn, and that all workers are given pertinent safety instructions. The construction contractors' safety inspectors will enforce the 1998 Ministry of Labor Force Proclamation on Management Procedures on Safety and Health in Construction Projects and will focus on hazards associated with (i) blasting, (ii) bridge construction, (iii) improper equipment use, and (iv) land slides. Moreover, the contractors will be required to operate small clinics to prevent the spread of contagious diseases in crowded construction work camps.

## **I. Induced Impacts**

41. The YWR Project will induce economic activity within the project area. The government is actively promoting the development of tourism and tertiary (service) industry. Currently, there is little mining and mineral processing in the area.<sup>14</sup> However, improved freight transport may result in expanded exploitation of undeveloped mineral resources and related industries. The mineral resources with economic potential are limestone (cement), coal, and iron. Induced growth is expected in the cement, fertilizer, and pharmaceuticals industries. In all cases, new industrial projects will require an EIA approved by the provincial or prefecture government prior to the start of construction. New project EIAs will be subject to review and approval, and a

<sup>14</sup> A representative of the Hubei EPB stated that there are no known mining and related industrial sites, but acknowledged that some small-scale illegal operations may be occurring. The regional tourism development master plan emphasizes tourism over other industrial activities for economic development.

project normally approved by prefecture government will be subject to provincial approval.<sup>15</sup> Under this more stringent EIA procedure, small and medium scale industrial activities will be subject to at least a county-level review and approval.

## VI. ECONOMIC ASSESSMENT

### A. Environmental Protection Costs

42. The tentative environmental costs for the YWR Project (Table 9) comprise sanitation facilities in construction camps; a third-party environmental monitoring contract; wastewater treatment plants for expanded and new railway stations; noise abatement measures; and erosion control (the major environmental cost factor, including required work in stabilizing slopes, properly disposing of wastes, and regrading, seeding, and afforestation of temporarily occupied areas). The environmental costs (including erosion control, which is normally included in project's civil works) thus constitute 11% of the estimated base cost for the YWR Project.

**Table 9: Environmental Management Costs (Tentative as of June 2003)**

Cost Elements	Estimated Cost (Million Yuan)
Camp Sanitation	1.0
Monitoring Contract	6.0
Station Wastewater	26.9
Noise Abatement	6.0
Erosion Control	1,807.0
<b>Total</b>	<b>1,846.9</b>

Source: *Environmental Impact Assessment on Yichang-Wanzhou Railway, Revised Draft Edition*, FSDI.

### B. Environmental Benefits

43. **Reduction of Air Emissions.** Whereas gasoline and diesel engines continuously emit NO<sub>x</sub> (as well as other pollutants), the main line electric locomotives to be used on the proposed YWR railway will essentially not discharge any NO<sub>x</sub>. A recent study<sup>16</sup> of average NO<sub>x</sub> emission quantities, comparing truck and rail modes, states that railroads emit 0.1 gram per ton-km and trucks 0.25 gram per ton-km. The results of this study were based on a combination of diesel and electric locomotives, and therefore, as applied to YWR, the figure of 0.1 gram per ton-km for the railroad is on the high side and the calculated savings are conservative. Significant environmental benefits compared with road transportation and diesel traction rail transportation will be accrued during the YWR operation.

44. **Erosion Control.** Erosion control to stabilize slopes and provide an orderly scheme for disposition of wastes is the major environmental cost item (97.85% of the total in Table 9). If the proposed engineering procedures (i.e., retaining walls, flattening and benching of hillsides, riprapping, shotcreting, anchoring piles, etc.) were not followed, landslides could cover nearby agricultural land and houses each rainy season, cause loss of life, and disrupt passenger and freight traffic. Although the benefits of eliminating or reducing destructive land slippages and train wrecks due to collapse of whole sections of the roadbed would be undeniably huge, they cannot be quantified because the probabilities of such catastrophes are not known.

<sup>15</sup> PRC State Council Ordinance 253 mandates that all major projects must have an approved EIA (approval will be by SEPA if project costs exceeds Y200 million) before they can start construction.

<sup>16</sup> Chen Zuo, *Ecological Impacts of Urban Rail Traffic*, China Railway Sciences, Vol. 22, (June, 2001), Page 128.

## VII. INSTITUTIONAL REQUIREMENTS AND ENVIRONMENTAL MONITORING PROGRAM

45. Prior to mobilization of equipment, construction management personnel will meet on site with officials of all groups involved. Although the focus will be on protecting the spawning grounds of the Chinese sturgeon, many trained technicians will observe a number of environmental issues. The personnel of the local forestry departments will monitor protection or relocation of protected trees and plants. The fishery administration department will monitor the substructure construction of the bridge crossing the Yangtze River at Yichang. Disposal of spoil will be monitored by the Water Conservation officials. The local EPBs will work with the contractor on controlling noise, air pollution, and the discharge of wastewater and solid wastes. An independent monitoring agency, under contract to MOR, will regularly visit the project sites, collect individual reports and test results, then prepare periodic reports for MOR and ADB.

46. The local EPBs, which are responsible for monitoring new industrial developments as well as other major projects (e.g., civil works), are adequately staffed and their personnel are technically competent. Table 10 gives indicators for the three prefecture-level governments. The EIA document, states a number of conditions and allowable limits of pollutants. Table 11 summarizes impacts, recommended mitigation measures, and applicable PRC standards.

**Table 10: Status of Local Environmental Protection Bureaus**

Location	Technical Personnel	Graduate Engineers	Certified Labs	Vehicles	Projects Being Monitored
Yichang City	100	50	Yes	Yes	150
Enshi Prefecture	40	10	Yes	Yes	100
Wanzhou District	63	15	Yes	Yes	81

Source: Compiled by Consultants from data provided by local Environment Protection Bureau officials.

**Table 11: Summary Of Environmental Impacts And Mitigation Measures**

Environmental Impact	Mitigation Measures	Action by
<b>A. Groundwater Contamination</b>		
Construction: Oil and fuel leaks from vehicle parking and maintenance areas.	Collect and recycle lubricants. Avoid accidental spills through best management practices. <sup>a</sup>	Ministry of Railways (MOR) <sup>a</sup> and civil works contractors
Operation: Potential spills of lubricating oils and hazardous materials from locomotives and freight cars	Covered by existing contingency plans.	
<b>B. Earth Works/Erosion</b>		
Construction: Excavation quantity, 30,864,000 m <sup>3</sup> ; fill quantity 26,866,000 m <sup>3</sup> ; tunnel excavation wastes (spoils and muck), 16,100,000 m <sup>3</sup> .	Careful selection of disposal areas in coordination with local EPBs.	MOR and civil works contractors
Potential soil erosion from	Adhere to good engineering practice and	

Environmental Impact	Mitigation Measures	Action by
spoils and stockpiled material; and landslides, slumps, slips, and other mass movements in open cuts.	specifications, such as subgrade slope to be protected by retaining walls and slope protection in areas with deep excavation or high fill; providing drainage systems (gutters and side ditch); reclaiming areas formerly farmlands; avoiding disposal into forested land, revegetating spoil heaps. Align route to avoid inherently unstable areas.	
Alteration of overland and subsoil drainage (where constructed road bed intercepts perched water table, springs, etc.).	Stabilize open cuts with structures (e.g., concrete or dry masonry walls or retaining walls, gabions, or similar devices). Install adequate drainage works.	
Transmission of communicable diseases from work force to local population.	As part of vigorous public health program, include mandatory lectures on the origin and spread of communicable diseases, conduct periodic health examinations of workers.	MOR, civil works contractors and Public Health Bureaus
Operation: Soil erosion during operation from steep cuts and embankments.	Slope stabilization to include concrete facing and/or landscaping all unstable cuts. Replant embankments and maintain adequate drainage on periodic/as-needed basis.	MOR and civil works contractors
<b>C. Noise</b>		
Construction: Pile driving, blasting, and use of heavy equipment.	Coordinate with local governments to (i) schedule operating hours of equipment areas, (ii) locate all heavy machinery at least 1 km from sensitive areas, (iii) use new and well-maintained equipment, and (iv) equip operators and workers with ear protection. [GB 12523-90]	MOR and civil works contractors
Operation: Noise from passing trains and railway maintenance shop equipment.	Equipment sources to comply with relevant regulations. Sensitive receptors: (i) relocation of Dayan Middle School and partial relocation of Mazhenba Primary School; (ii) construct sound barriers and replace windows at various locations. [GB 12523-90]	MOR
<b>D. Atmospheric Pollution</b>		
Construction: Dust and pollution from borrow pits, excavation areas, and haul roads	Use modern machinery, apply water sprays for dust suppression at earthwork sites and on construction roads, and regularly maintain vehicles. <sup>a</sup>	MOR and civil works contractors
<b>E. Surface Water Quality</b>		
Construction: Contamination of local and downstream water supplies by temporary work camps; and turbid	Wastewater from large (more than 500 workers) camps to be treated by series of stabilization ponds (minimum of 1 anaerobic). [GB 8978-1996, Class III]	MOR

Environmental Impact	Mitigation Measures	Action by
water from tunnel construction..		
Operation: Discharge of domestic and commercial sewage and industrial wastes. Contamination of watercourses by railway personnel or equipment.	Install or upgrade treatment capacity at 6 stations: (i) construction of secondary (biological) treatment plants; (ii) use existing oil separation and aeration plants to treat oily wastes; (iii) discharge into existing municipal activated sludge treatment facility; build sewage lift station and 300 meters of cast-iron main to convey sewage into existing urban systems. [GB 8978-1996, Class III]	MOR
<b>F. Solid Waste</b>		
Construction: Overloading rural dump capability with wastes from large temporary contractor's camps for workers.	Provide adequate storage. Where camps are large (>500 workers), contractor will operate sanitary landfill. <sup>a</sup>	MOR and civil works contractors
Operation: Disposal of solid wastes from passenger trains (estimated at 1,624 tons/year).	Equip passenger trains with garbage cans and bags. The garbage will be sorted at railway stations. Tins and bottles will be recycled, and the remainder landfilled by local sanitation department.	MOR
Domestic refuse.	Domestic refuse from railway residential quarters will be collected and landfilled by local sanitation department.	MOR
<b>G. Plants, Wildlife, and Precious Ecology</b>		
Some clearing of vegetation will be required. The railway line will not cause significant impact on wildlife and its habitat.	The YWR Line will maintain a minimum 3 km distance from old-growth forest; protected tree species will not be removed due to the project. Revegetation program in the project area will offset clearing of vegetation along the railway line. The Project area is generally being converted from farmland to forest (including economic forests, e.g., orchards), in accordance with the PRC Forestry Law. The Project will not impact nature preserve areas.	MOR and civil works contractors, and local governments

EPB = Environmental Protection Bureau, GB = *guojia biaozen* (national standard), MOR = Ministry of Railways, PRC = People's Republic of China.

km = kilometer, m = meter, m<sup>3</sup> = cubic meter.

<sup>a</sup> MOR will include appropriate requirements in the bidding documents and contracts to ensure compliance with the environmental requirements by contractors.

## VIII. PUBLIC PARTICIPATION

47. The construction of a railroad through the mountains linking the numerous rural villages to the cities of Yichang, Enshi, Lichuan, and Wanzhou, has been a topic of interest for many years. The local governments along the line are very supportive of the Project. In February 2002, meetings were held throughout the catchment area and a questionnaire was distributed. Table 13 defines the makeup of the respondents to the questionnaire in terms of occupation,



educational level, and age. Appendix 6 summarizes the public participation activities supporting the EIA and social impact assessment. The typical respondent appears to be a rural farmer, 30 to 40 years of age, who left school after middle school. Of the 200 questionnaires distributed, 197, or 98.5%, were filled out and returned. Analysis of these questionnaires showed that television has become the dominant news medium, and the people are knowledgeable about pollution. A few of the pertinent responses were:

- (i) almost everyone was aware of the YWR Project; almost 90% had learned of it from radio (19.8%), newspaper (20.8%), or television (48.7%);
- (ii) essentially everyone (96.4%) approved of the Project; no individual indicated disapproval, and only 3.6% were indifferent;
- (iii) over 90% of the respondents believe that controlling the environmental impact of such a project is necessary;
- (iv) the present leading environmental problem identified is: sewage (57.3%), followed by solid waste (17.8%), waste gases (16.2%), and noise (13.7); and
- (v) the anticipated major environmental impacts are noise (59.9%), sewage (19.8%), refuse discarded along the line (17.3%), and waste gases (3.0%).

**Table 13: Questionnaire Respondents**

Item	Description	Number of Responses	Proportion (%)
Occupation	Farmer	114	57.9
	Worker	40	20.3
	Cadre <sup>a</sup>	43	21.8
Education	Primary School	36	18.3
	Middle School (Secondary Vocational School)	118	59.9
	Higher Vocational School	22	11.2
	Undergraduate	21	10.7
Age Structure	<30	36	18.3
	30-40	86	43.7
	40-50	48	24.3
	>50	27	13.7

<sup>a</sup> Includes members of the military and police plus officials and employees of all levels of the governments.

Source: Environmental Impact Assessment on Yichang-Wanzhou Railway, Revised Draft Edition, FSDI.

## IX. CONCLUSIONS

48. The YWR Project will have environmental benefits primarily through reduced air pollution and soil erosion. Numerous tourism sites within the project area will be available to large volumes of tourists when the YWR is operational. Remedial infrastructure (e.g., new access roads) is currently under construction to enhance the attraction of these sites. In addition, certain industries will enjoy induced development from the YWR, and jobs will increase income opportunities for rural residents.

49. Potential environmental impacts arise from tunnel waste disposal, soil erosion, air pollution, degradation of water quality, noise pollution, disposition of solid wastes, and effects on

plants, aquatic resources, and wildlife. Each environmental problem area was investigated and the magnitude of the impacts on the affected people and/or ecosystem determined. Wherever adverse impacts were identified, rational and comprehensive mitigation measures were specified.

50. The bridge crossing at Yichang City near the provincial conservation zone for the Chinese sturgeon has undergone considerable study. The feasibility studies have evaluated routing and alignment options, engineering design, social costs, and environmental impacts, and concluded that the proposed bridge crossing is an optimum location for the Yichang area service infrastructure. The HICAS scientists noted that the Chinese sturgeon has adapted to an upstream dam reducing the size of its spawning area, and two highway bridges close to Yichang. They conclude that the process of spawning by the sturgeon will not be seriously affected by the operation of the railroad bridge, but that significant impacts could result from constructing the bridge foundation. The HEPB has approved the bridge construction, with stringent restrictions on construction design, scheduling, and monitoring. These conditions will be detailed in the contract documents and monitoring will be the responsibility of the local EPBs and the fishery administration department, with periodic oversight by HEPB and Yichang EPBs.

51. With the exception of the bridge crossing at Yichang, the alignment of the proposed railway does will not impinge directly on any conservation zone, and endangered plants or animals will not be negatively impacted by the YWR Project.

52. A detailed environmental monitoring program will be rigorously implemented to ensure compliance with the EIA. An independent monitoring agency will prepare the monitoring reports to be submitted to MOR and ADB. The environmental impacts of the Project will be minimized to acceptable levels through adequately funded mitigation measures and monitoring programs.

## PROJECT TUNNELS AND BRIDGES

Table A1.1: YWR Tunnels

Section	Beginning And Ending Location	Length of Route (km)	Quantity/Length of Tunnels (number-km)					Length of Tunnels to Total Route Length (%)
			0.5km or less	3km or less	10km or less	Over 10km	Total	
Hubei Province	CK000+000~CK380+680	334.07	46 11.132	45 53.319	10 55.938	3 35.797	104 156.186	46.75
Chongqing Municipality	CK380+680~CK423+902	52.555	3 0.726	15 22.249	5 20.104		23 43.079	81.87

Source: Environmental Impact Assessment on Yichang-Wanzhou Railway, Revised Draft Edition, FSDI.

Table A1.2: YWR Bridges and Culverts

Category	Item	Unit	Hubei Province	Chongqing City	Total
Railroad Bridges	Extra Large	no., linear meters	13, 10,411.9	3, 2,317.8	16, 12,729.7
	Major	no., linear meters	164, 34,286.13	17, 3,095.45	181, 37,381.58
	Total	no., linear meters	177, 44,698.03	20, 5,413.25	197, 50,111.28
Culverts		no., linear meters	584, 23,683.79	38, 1,715.35	622, 25,399.14
Highway Bridges		no., linear meters	9, 761.42	1, 60	10, 821.42

Source: Environmental Impact Assessment on Yichang-Wanzhou Railway, Revised Draft Edition, FSDI.

## **SUMMARY OF SPECIAL RESEARCH ON IMPACT ON CONSERVATION OF THE SPAWNING BED OF CHINESE STURGEON BY YWR'S YANGTZE RIVER CROSSING<sup>1</sup>**

### **A. Background**

1. Starting from Huayan Station, the Yichang-Wanzhou Railway (YWR) goes southwest and crosses the Yangtze River by bridge 13 kilometer downstream from Ge Zhouba Dam. Since the selected location of the bridge is within the Yichang Natural Conservation Zone for Chinese Sturgeon (YNCZCS), the construction and operation of the YWR are likely to have some impact on the Chinese sturgeon and other rare aquatic species. The Hydrobiology Institute of the China Academy of Sciences (HICAS, in Wuhan) was engaged to identify the potential impacts on the sturgeon and subsequently clarify the requirements for mitigation measures or any management considerations during the construction and operation of the YWR.

2. HICAS established a task force of experienced hydrobiologists to study in depth the data and survey records accumulated for more than 20 years regarding the Chinese sturgeon, including a series of pertinent experiments. On 22 June 2002, HICAS submitted a draft report to the Fishery Administration Bureau of Hubei Province (FABHP), which is the direct administrative authority of YNCZCS, and the FSDI. Reflecting the comments from FABHP, FSDI, and other specialists or consultants, HICAS revised and expanded the draft report, completing the study on 30 July 2002. This appendix summarizes the significant findings, recommendations of HICAS's final report.

### **B. Brief Introduction to Project**

#### **1. Features of Project River Section**

3. The river section where the proposed bridge is to be located is on a slight curve and features a transition from mountainous to flatter surrounding terrain. The main part of Yichang City is on the north bank of the Yangtze River and Dianjun District and Aijia Township occupy the south bank. A elongated sand bar, Yan Shouba, divides the river into two branches, a main course near the bank and an offshoot on the other side where the flow dries up when it is less than 8,000 m<sup>3</sup> per second (s). The towhead stretches about 4.5 Km and exhibits its shape at low flow, whereas it is completely immersed under water if the flow measures more than 30,000 m<sup>3</sup> per second (s). During high flow season, the river section, in the area of the project, varies in width from 700 m to 1,500 m, with a width of about 1,000 m at the upstream and downstream ends of Yan Shouba.

4. The river section has its high flow from May to October, with an average flow rate of 21,700 m<sup>3</sup> per second (s). Low flow averaging 5800 m<sup>3</sup> per second (s) occurs from January to April and November to December. Monitoring records of several decades show the average sand content of the river water as 1.19 kilograms (kg) per cubic meter (m<sup>3</sup>).

#### **2. Design of the Bridge**

5. At the recommended location, the railway bridge will cross the upstream or middle part of Yan Shouba. Two other large bridges cross the Yangtze River near the YWR Project: the Yiling Bridge, approximately 6 km upstream of the proposed bridge, and the Yichang Highway

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<sup>1</sup> This document is an abstract in English of the original documents in Chinese prepared by HICAS.

Bridge, approximately 10 km downstream. The Yiling Bridge has three piers, one on each bank and one in the approximate middle of the river. The Yichang Bridge is a large suspension bridge with no piers in the river.<sup>2</sup>

6. The total length of the railway bridge is 1,807.15 m, with a combination structure of continuous rigid arch girder, spanning 120-m + 2×275-m + 120-m. The main bridge opening will be double spans of 275-m. There are 13 piers within the river; among them piers No.1 to No.4 near the north bank; piers No.9 to No.11 will be located on Yan Shouba towhead which will be completely above water when the elevation of the water level drops to 39.21-m above the Yellow Sea Datum Plane.

7. The piers are based on bored pile foundations and will be constructed by sinking caissons within cofferdams. Construction contractors and/or the local water resources management agency will take responsibility under contract to clean and remove the muck from pile boring or other construction activities within the watercourse. After completion of the construction, contractors will be responsible for demolishing and removing of the cofferdams and other temporary structures in the watercourse.

8. Construction of the railway bridge is estimated to last 42 months. The construction of the substructures (e.g., piers) will be scheduled for low flow season, between September and April.

### **C. Profile of Conservation Zone for Chinese Sturgeon**

#### **1. Outline of Conservation Zone and Spawning**

9. The Chinese sturgeon is a large estuary fish that migrates upstream to spawn. It matures in coastal waters near the People's Republic of China and Japan, and used to spawn at the upper reach of the Yangtze River (about 3,050 km upstream from the estuary), or in the Zhujiang River. The sturgeon population in the Yangtze River spawn from mid-October to mid-November. This differs from the spawning season (March to April) of the related Zhujiang sturgeon, which is reported to be dwindling rapidly and is nearly extinct. Before 1981, the sturgeon had its spawning bed distributed along an 800-km long upper reach of the Yangtze River. Then, in 1981 the Ge Zhouba Dam Hydroelectric Complex began to dam off the migrant passage and the sturgeon was forced to stay downstream of the dam, establishing its new spawning beds, as well as its main habitat, in the approximately 30 km river section between Ge Zhouba Dam and Gu Laobei.

10. As one of the oldest vertebrates still living, the Chinese sturgeon is very valuable with regard to biodiversity and scientific research. To protect this rare living fossil, commercial fishing of the sturgeon has been strictly forbidden since 1983 (under the Wildlife Protection Law and Fishery law of the PRC).<sup>3</sup> In April of 1996, the Hubei Provincial Government approved the establishment of YNCZCS an 80 km river section from Ge Zhouba Dam to Lu Jiahe shallows, covering approximately 80 kilometer (km<sup>2</sup>). Furthermore, FABHP defined the section from Ge Zhouba Dam to Gu Laobei as the core area, and downstream of Gu Laobei as the buffer area.

<sup>2</sup> The environmental impact assessment for the YWR Project noted that some impacts on sturgeon might have accrued from construction of the upstream Yiling Bridge, but that the impacts are not considered significant. The downstream Yichang Highway Bridge was considered not to have any significant impact.

<sup>3</sup> Various government agencies are empowered to enforce the ban on fishing. Illegal fishing of sturgeon has essentially been eliminated because: (i) the fish population has declined, and it is no longer an economically attractive catch; (ii) the spawning grounds are in a highly visible urban area, making it relatively easy to police fishing activities; and (iii) the unique size and characteristics of the fish make it difficult to conceal.

The approval publication allows passage of vessels in principle but excludes any construction activities, particularly blasting under water. Sand excavation is allowed but only under special license available only in the nonspawning season for the river section downstream of Yun Chi.

11. Currently, YNCZCS is managed by the Yichang Fishery Administration Division (YFAD, a city-level agency with 25 employees). Moreover, Ge Zhouba Dam Group Company has set up a sturgeon research and breeding center with equipment and qualified personnel to help maintain the sturgeon's habitat and population. The division's main responsibilities include: (i) salvage and care of injured Chinese sturgeon, paddlefish, mullet, and other rare and endangered fish; (ii) scientific study and monitoring of the sturgeon's population, spawning beds, and habitat; (iii) artificial insemination and domestication of the sturgeon; and (iv) popularizing science education, information dissemination, and pertinent training.

12. Constant tracing and monitoring for more than 20 years have proven that the Chinese Sturgeon can become sexually mature and spawn downstream of Ge Zhouba Dam, although its habitat and suitable spawning bed have been greatly decreased. The Chinese sturgeon favors a deep and turbulent watercourse or underwater depression with a rugged riverbed of gravel, cobblestone, rock, and coarse sand, but higher turbidity or sand concentration, and too rapid a flow are unfavorable for the development of the eggs. Fortunately, the hydrologic characteristics and underwater landforms from Ge Zhouba Dam to Gu Laobei can satisfy the needs of the fish. After Ge Zhouba Dam began to impound water, three spawning beds gradually formed between Ge Zhouba Dam and Gu Laobei.

- (i) Principal Spawning Bed: In about 4.8 km from the river of Ge Zhouba Dam to Zhen Jiangge, fish normally converge to spawn each year.
- (ii) Minor Spawning Bed: From Mo Jishan to the upper end of Yan Shouba towhead, about 2.2 km, small groups of fish spawn.
- (iii) Occasional Spawning Bed: Fish were occasionally found spawning in a river section of 5.5 km from Xian Renqiao to the upper reach of Yichang Yangtze River Highway Bridge, 10 km downstream of the proposed railway bridge.

13. Surveys and monitoring since 1997 reveal that the sturgeon is gradually restricting its spawning to the principal bed in the 4.8 km river section, although the other two spawning beds are still infrequently used.

14. The Chinese sturgeon usually reaches the river section at Yichang City in September or October of the first year and stay until the November of the following year, when spawning is finished. After spawning the sturgeon return to the sea. During each spawning season from the middle of October to the middle of November, the sturgeon normally spawn twice within about 17 days. The duration from spawning to impregnation, and until completion of fecundation is 6-7 days.

## 2. Briefing of Sturgeon's Population and Habitat

15. Beginning in 1980s, HICAS and many researchers conducted surveys and research on the habitat and population of the Chinese sturgeon.<sup>4</sup> The estimates of the sturgeon population and breeding supplement are shown in Tables A2.1, A2.2, and A2.3.

**Table A2.1: Annual Supplement to Chinese Sturgeon's Population in 1980s**

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Supplement	1002	887	1279	1363	1388	1334	1013	822	1272	1650

Source: *Original Report*, Table 3-2, Page 13.

**Table A2.2: Estimated Population of Chinese Sturgeon in 1980s**

Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Population (Estimated based on survey)	1158	1022	1609	2547	2718	2678	2313	1800	2065	2879
Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	
Population (Estimated based on survey)	2404	2357	2273	2153	2009	1854	1700	1551	1406	

Source: *Original Report*, Table 3-3, Page 14.

16. HICAS estimates the population of the Chinese sturgeon varied between 1,022 and 2,879, with an average number of 2,079. The increased population after 1983 is attributed to the ban on sturgeon harvesting. In 1998–2001, HICAS evaluated the Chinese sturgeon's population in the river section from Ge Zhouba Dam to Gu Laobei by sonar detection equipment.<sup>5</sup> Based on surveys, HICAS extrapolated the sturgeon's population each year during the next 20 years.

**Table A2.3: Estimation of Chinese Sturgeon's Population, Year 2000 to Year 2009**

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Estimated Population	1263	1125	993	872	764	674	600	543	499	468
Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Estimated Population	446	431	420	414	409	406	405	403	403	402

Source: *Original Report*, Table 3-5, Page 19.

17. The sonar survey shows that the average distribution density of the Chinese sturgeon in the principal spawning bed was 41.5/km<sup>2</sup> before spawning and 17.6km<sup>2</sup> after spawning. Average distribution density in other river sections within the conservation zone is about 19/km<sup>2</sup>.

<sup>4</sup> Estimates of fish population prior to construction of the Ge Zhouba Dam are based on unofficial fisheries records and other surveys and studies, but are not considered definitive. The population estimates for 1981 and 1982 are considered representative of the conditions prior to completion of the Ge Zhouba Dam.

<sup>5</sup> About 40–60 sturgeon are captured each year for scientific purposes, including harvesting of eggs for the artificial breeding program; most are tagged and released back to the river. About 1,700 sturgeon have been caught or killed since 1983.

The water layer the sturgeon inhabits ranges in depth from 8 to 24 m. Ninety percent of sightings were in the layer between 9 m and 21 m in depth.

18. Obviously, the population of the Chinese sturgeon has sharply decreased since the Ge Zhouba Dam was put into service. In addition, other human activities such as ship travel in the river, wharf and dock operation, sand excavation, building of bridges, and illegal fishing, have adversely affected the Chinese sturgeon. According to incomplete statistics, about 250 sturgeon have been mortally wounded by propellers or lost to illegal fishing since 1984, not counting permitted catching for scientific research purposes. Natural enemies are another threat to the sturgeon's spawn: 11 species of benthic fish eat the spawn, eliminating 90% of the younger sturgeon during the spawning season.

### **3. Artificial Breeding**

19. Before Ge Zhouba Dam Project, local aquatic experts had successfully bred the Chinese sturgeon. In 1983, the Chinese Sturgeon Research Center (CSRC) of Ge Zhouba Dam Group Company successfully induced breeding of the fish. Since 1984, CSRC has been breeding the sturgeon and releasing small fry into the Yangtze River. By 1998, CSRC had distributed 63.2 million sturgeon fingerlings and kept improving techniques and performance in breeding as well as survival of the fry and young sturgeon. In 1989, the Yangtze River Aquaculture Research Institute (YRARI, a subordinate of the China Aquaculture Sciences and Research Academy<sup>6</sup>) joined the effort by dropping 400,000 fingerlings into the river per year.

20. Benefiting from all these efforts, the Chinese sturgeon can maintain its population. Monitoring at the estuary of the Yangtze River in recent years convincingly justifies the artificial fecundation. The number of young sturgeon is increasing year by year and is nearly equivalent to the level before construction of Ge Zhouba Dam.

### **4. Other Rare Fish in Conservation Zone**

21. Recent research reveals that YNCZCS is also a main spawning bed of the longnose sucker, another rare species in the Yangtze River. Hydrobiologists and scholars found traces of paddlefish also, which are even more rare than the Chinese sturgeon and have similar spawning characteristics.

## **D. Conclusion of Potential Impacts by Railway Bridge**

### **1. Experiments on Sturgeon's Response to Noise**

22. Using CSRC's breeding pond and two female sturgeons in Yichang, HICAS's specialists conducted a series of experiments to learn the response of the sturgeon to noises and vibrations. The experiments confirmed that the Chinese sturgeon evades loud noise and high vibrations, but, when exposed to a steady noisy environment, its sensitivity to noise declines.

### **2. Comprehensive Assessment of Impacts**

23. Construction of the proposed railway bridge could change the riverbed morphology if muck from boring and concrete debris spills into the river during pile construction. In addition to

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<sup>6</sup> YRARI is an academic institution with 146 staff, including about 80 mid- and senior-level experts. It is similar to HICAS, but is related to the Ministry of Agriculture, while HICAS is related to the Ministry of Science and Technology.



raising turbidity, concrete change the acidity of the water. After construction, the scour of water flow will change the transverse river section. These effects will change the sturgeon's habitat to a certain extent.

24. During construction, the muck, concrete, and wastewater discharged into the watercourse could pollute the sturgeon's habitat. Even construction above the riverbank instead of in the water can induce soil erosion and turbidity in the river. Loud noise and strong vibration produced by boring of piles, vibrating of concrete, striking of metal structures, etc. could alarm the sturgeon. Since the railway bridge is in the access passage of the sturgeon to its principal spawning bed, adjacent to the minor spawning bed near Yan Shouba towhead, some sturgeon going up to the principal spawning bed may be disturbed, and the minor spawning bed may shrink or even fade out.

25. Any environmentally unfavorable impacts resulting from the proposed bridge will also most likely have ill effects on other aquatic creatures within the YNCZCS, such as grass carp, bighead, herring, chub, etc.

26. Nevertheless, the earlier built highway bridges are both within the conservation zone and the Yiling Yangtze River Highway Bridge is closer to the core area. No convincing evidence exists that these two older bridges have caused any prominent impacts on the Chinese sturgeon. Because the proposed railway bridge further from the principal spawning bed is likely to have less significant influence on the Chinese sturgeon than previous project. When the YWR is operating, the Chinese sturgeon will not be deterred on its long march to maintain and develop its population.<sup>7</sup>

## **E. Mitigation Measures**

### **1. Legal Considerations**

27. Article No. 18 of the PRC's Natural Conservation Zone Ordinance states that corporations and individuals are prohibited from entering the core area of the conservation zone; except for special permission, scientific researchers are also not allowed within the core area; and only scientific research and observation activities can be allowed in the buffer area.

28. The Hubei Provincial EPB approved the construction of the Yichang Extra-Large Bridge crossing providing the special permission under three conditions: (i) construction methods must minimize disruption to the riverbed and fish population, (ii) no foundation work is allowed from 15 September through 30 November (the sturgeon spawning season), and (iii) the construction contractor(s) will have strict liability for any ecological damage caused during construction.

### **2. Mitigation Measures**

29. Based on abundant data from surveys and research, as well as from this special focused study, HICAS believes the proposed railway bridge will impacts on the Chinese sturgeon, although they are not sure what level or extent the potential impacts will be. To minimize any adverse impacts and keep the habitat and spawning bed in an acceptable condition, HICAS prescribes mitigation measures as follows:

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<sup>7</sup> The Yiling and Yichang Highway Bridges were constructed beginning in 1997 and completed in 2001. Project EIA approvals were granted by the environmental departments of the Ministry of Construction and Ministry of Communication, and by SEPA.

- (i) The proponent and the contractors should prevent muck and concrete debris from entering into the river and to maintain the present landform of the riverbed around the bridge. This is needed so the sturgeon's habitat and spawning bed can remain a stable and functional environment. If any foreign matter falls into the water, the administration agency of the watercourse will get rid of it and avoid increases of the pH value or turbidity of the water.
- (ii) Blast operations will not be allowed.
- (iii) The aural perception of fish may be impaired if they are exposed to loud and constant underwater noise. However, the loss may be revised when the fish returns to a tranquil environment for a period of time usually proportional to the time of exposure to the high noise. HICAS suggests minimizing construction activities during night, to provide a long quiet interval and increase the time for the sturgeon to recover from noise due to construction.
- (iv) The sturgeon is lives at depths between 9 m and 25 m, and the south canal of Yan Shouba is much shallow than 9 m during this season, pier construction at the sandbar and its south-flanking canal can be acceptable. For the piers in the main course, however, any underwater activity with loud noise and/or constructing high vibration is not allowed from 1 September to 30 November to secure an undisturbed habitat and propagation cycle for the sturgeon.
- (v) Vibration-absorbing materials or structures will be required so the noise and vibration from the trains can be damped significantly.
- (vi) During the construction, there is a possibility of incidental injury to rare fish. Therefore, a mechanism must be provided to rescue and treat injured fish. HICAS suggests that a qualified institute be nominated to supervise, coordinate, and implement a rescue operation. The institute will also help to deal with relevant legal procedures.

## POLLUTION OF EXISTING WATERCOURSES

**Table A3.1: Yichang East**

Monitoring Point	Item	PH	COD <sub>Cr</sub> (mg/l)	BOD <sub>5</sub> (mg/l)	SS (mg/l)	Petroleum (mg/l)	Flow (m <sup>3</sup> /h)	
Anqi drainage ditch at proposed Yichang East Station to the small culvert at Anqi Group	GB5084-92Class1	5.5~8.5	= 200	= 80	= 150	= 5.0	/	
	Monitoring Value	0.1.12.27	7.14	157	50.65 57.23	58	1.0	62.37
		0.1.12.28	7.18	39	12.45 9.60	119	0.35	6.72
		0.1.12.29	6.93	27.5	17.06 15.70	31	0.6	4.75
	Mean Value		7.13	137.9	47.6	61.8	0.92	24.61
	Conforms to Standard		100%	100%	100%	100%	/	
Sewage outlet from Anqi Group to downstream railway bridge	GB5084-92Class1	5.5~8.5	= 200	= 80	= 150	= 5.0	/	
	Monitoring Value	0.1.12.27	7.38	3765	600.1 325.7	1699	4.15	240.66
		0.1.12.28	7.05	4675	2574.2 1308.7	2746.5	2.6	231.97
		0.1.12.29	7.34	4650	1979.7 1991.2	1054.5	3.5	304.49
	Mean Value		7.24	4383.3	1500.8	1759	3.43	259.04
	Conforms to Standard		100%	N	N	N	100%	/
Entance to Changjing River by Anqi Drainage ditch	GB5084-92Class1	5.5~8.5	= 200	= 80	= 150	= 5.0	/	
	Monitoring Value	0.1.12.27	7.33	1036	236.2 329.2	169	3.55	2,620.8
		0.1.12.28	7.39	2015	620.0 506.6	151.5	9.45	1,528.8
		0.1.12.29	7.30	3835	971.9 409.7	185	7.2	3276
	Mean Value		7.33	2472.	520.5	172	6.38	2,475.20
	Conforms To Standard		100%	N	N	N	100%	/

Source: *Environmental Impact Assessment Report on Yichang-Wanzhou Railway, Revised Draft Edition*, FSDI, Wuhan: September 2002. Table D-9, Page 51.

1. The results (Table A3.1) of the monitoring of an existing drainage ditch at Yichang East Station show that effluent quality, which meets COD, BOD and SS standards for irrigation water quality, gets progressively worse away from the station and the ditch collects sewage from adjoining unsewered communities.

2. The quality of the water in this ditch is very poor, and exceeds both BOD and COD allowable limits, but meets the SS standard.

**Table A3.2: Huayan Station**

Item	pH	COD <sub>Cr</sub> (mg/l)	BOD <sub>5</sub> (mg/l)	SS (mg/l)	Petroleum (mg/l)	Flow (m <sup>3</sup> /h)	
GB5084-92Class1	5.5~8.5	= 200	= 80	= 150	= 5.0		
Monitoring Value	0.1.12.27	6.71	472	349.11 113.01	116.5	1.95	10.62
	0.1.12.28	6.55	997.5	343.59 710.40	38.5	9.9	6.08
	0.1.12.29	6.70	731.5	233.98 617.00	127	7.25	3.08
Mean value		6.66	673.8	352	94	5.22	6.59
Standard reaching rate		100%	N	N	100%	33%	

Source: *Environmental Impact Assessment Report on Yichang-Wanzhou Railway, Revised Draft Edition*, FSDI, Wuhan: September 2002. Table D-10, Page 52.

### ANTICIPATED ENVIRONMENTAL IMPACTS DURING CONSTRUCTION AND OPERATION

Impacts During Construction	Direct/ Indirect	Primary/ Secondary	Temporary/ Cumulative	Reversible/ Irreversible	Short-Term/ Long-Term	Likelihood of not Meeting Applicable Standard
Land Acquisition & Relocation/Resettlement	Direct	Primary	Temporary	Irreversible	Long-Term	Low
Soil erosion and dust emissions from building access roads and other temporary utilities	Direct	Secondary	Temporary	Partially Reversible	Short-Term	Medium
Soil erosion, water pollution, and impacts on groundwater caused by bridges and tunnels construction	Direct	Primary	Part temporary and part cumulative	Partially Reversible	Partially Long-Term	Medium
Soil erosion and water pollution from spoil banks & borrow pits	Direct	Primary	Temporary	Partially Reversible	Short-Term	Medium
Vegetation loss owing to permanent/temporary facilities	Direct	Primary	Part temporary and part cumulative	Reversible	Partially Long-Term	N/A
Landscape impairment	Direct and Indirect	Secondary	Part temporary and part cumulative	Partially Reversible	Long-Term	N/A
Noise & vibration from construction sites and access roads	Direct	Secondary	Temporary	Reversible	Short-Term	Low
Impacts on Chinese Sturgeon by construction of Yangtze River crossing at Yichang	Direct	Primary	Cumulative	Irreversible	Long-Term	N/A
Wastewater and garbage from construction sites & camps	Direct	Secondary	Temporary	Reversible	Short-Term	Low
Construction related job creation, social & economic development due to YWR	Direct and Indirect	Primary	Cumulative	Irreversible	Long-Term	Low
Impacts on Chinese Sturgeon by Yangtze River crossing at Yichang	Direct	Primary	Cumulative	Irreversible	Long-Term	N/A
Soil erosion and water pollution from embankment/cut slope	Direct	Secondary	Temporary	Reversible	Short-Term	Low
Noise & vibration from trains and stations, depots	Direct	Primary	Cumulative	Partially Reversible	Long-Term	Medium
Wastewater from stations, depots and living quarters	Direct	Secondary	Cumulative	Reversible	Long-Term	Low
Air pollution from shunting locomotives and boilers	Direct	Secondary	Cumulative	Basically Reversible	Long-Term	Low
Garbage from trains, stations, depots, and living quarters	Direct	Secondary	Cumulative	Mostly Reversible	Long-Term	Low
Job creation, social & economic development due to YWR	Direct and Indirect	Primary	Cumulative	Irreversible	Long-Term	Low
Environmental stresses from induced development	Indirect	Primary	Cumulative	Partially Reversible	Long-Term	Medium

YWR = Yichang Wanzhou Railway.

## SUMMARY RESETTLEMENT PLAN

1. The Yichang-Wanzhou railway line and stations will affect 38 townships and 204 administrative villages in Enshi Prefecture, Wanzhou Municipality and Yichang Municipality. The Project will permanently occupy about 1,087 hectares (ha), of which 39% is cultivated land, 10% is orchards, 23% is forest, 24% is wasteland, and the remainder is ponds or homesteads. The loss of cultivated land and orchards will require the equivalent of full economic rehabilitation of 7,420 people (2,120 households); on average, each farmer will lose 0.25 ha per household. About 450,000 square meters of mainly residential structures will be affected, requiring relocation of 17,750 people (5,100 households). Many of the same people will be affected by both loss of land and loss of housing, so the total impact is estimated to affect 20,140 people (5,750 households). The Project will also temporarily occupy of 200 ha of land, but most will be non-agricultural land. Very few enterprises will be affected by land acquisition and these are mainly next to the railway terminus in Yichang City and are primarily transportation warehouses. These will be rebuilt next to the expanded railway station.

2. Land acquisition and resettlement impacts were minimized by aligning the railway away from areas with high population densities. The new railway stations are on the outskirts the towns, so no major urban displacement is required. Also, 55% of the alignment is tunnels and bridges, so the requirement for land acquisition is much less than for other railways. In the urban sections of Yichang Municipality, some residential buildings and enterprises will be affected, but the value of affected property is not very high because these are older industrial sections of the city. In Wanzhou Municipality, the urban areas have undergone significant change due the resettlement for the Three Gorges Project. Consequently, the railway alignment has been included in the redevelopment plan, so urban impacts will not be very large.

3. The Fourth Survey and Design Institute in close collaboration with local governments have prepared a resettlement plan. In late 2001, the institute conducted a socioeconomic survey of 525 households in 88 villages. Based on this socioeconomic survey and the preliminary alignment survey, an initial resettlement plan was formulated. Between July and September 2002, international consultants carried out an additional 249 household surveys, 33 village surveys, and consultations with affected villages and households, and then revised the resettlement plan following Asian Development Bank (ADB) guidelines. Subsequently, design standard changed, so the institute carried out a staking survey for the adjusted alignment and collected social impact data at the same time, which now forms the basis for the resettlement plan. In early 2003, additional household surveys and village consultations were conducted for the three largest new railway stations, in order to formulate village rehabilitation plans. All the affected prefectures and counties have reviewed the resettlement plan and their concerns have been incorporated. The precise project impacts will be determined by the detailed measurement survey, reported in an updated resettlement plan (including cost implications) and submitted to ADB for approval prior to the commencement of civil works.

4. For people unavoidably affected by the Project, the resettlement objective is to ensure attainment of equal or better livelihoods and living standards in accordance with the Land Administration Law (1998) of the People's Republic of China (PRC) and ADB's *Policy on Involuntary Resettlement* (1995). The resettlement plan is based on the Land Administration Regulations of Hubei province and Chongqing municipality. The Ministry of Railways and the local governments will ensure that any people losing land, housing, other assets or other means of production will be assisted in restoring their incomes and living standards. Lost assets will either be replaced or owners will be compensated at replacement cost. The estimated

resettlement budget to be financed by MOR is \$45 million equivalent (CNY 370 million). Local governments will provide additional funds to combine resettlement with development.

5. A socioeconomic investigation of the population along the railway alignment estimated that 18% to the people are poor, with high poverty incidence mainly in Enshi Prefecture. Also, 35% are ethnic minorities, primarily Tujia and some Miao. In 96 of the 204 affected villages, ethnic minorities comprise more than half of the population. Investigations showed that ethnic minorities have a higher poverty incidence because they are in remote areas with low economic development. However, the Han population in these areas were no better off. Additional support will be given to the ethnic minorities, the poor, women and other vulnerable groups (the elderly, children, and disabled), including preference for (i) housing based on traditional styles, (ii) setting up shops along streets near the railway station, (iii) terracing of sloping land to increase agricultural output and decrease soil erosion, (iv) employment in project construction and operations, (v) access to micro-credit, (vi) skills training, and (vii) improved social services and infrastructure.

6. Land compensation payments are calculated at 6 times the annual average output value of the land over the past 3 years. A resettlement subsidy is calculated at 4 to 6 times the annual average output value, depending upon the size of landholding. The collective compensation is used to reclaim agricultural land, construct irrigation facilities, build village roads, expand water supply, upgrade schools, and improve village offices. Any households that are heavily affected by loss of land will be provided replacement land within the village. For temporary use of land during construction, if farmland is occupied, farmers will be compensated for the lost of crops for the entire period of occupation and the contractor will restore the land to farmland after use.

7. People losing houses will receive direct compensation according to the size, class, and type of house. The amount is based on the floor area, building materials, and attachments. There will be no depreciation of housing values and the affected people will be allowed to salvage materials from their former houses without deduction from their compensation. Along the railway alignment, farmers will reconstruct housing in a scattered manner. At the sites for new railway stations, the county will arrange development sites for clustered housing. In most cases, the new house will be constructed and the family relocated before the old dwelling is demolished. If households require temporary accommodation, they will receive compensation for up to 3 months. For private shops, compensation will be paid for relocation and reconstruction, including transfer costs, and compensation for damaged assets. Other compensation and mitigation measures for the affected people are specified in the resettlement plan.

8. The leading groups at the municipal and county levels will supervise the resettlement program, with assistance from MOR. The eight affected counties and districts have established railway construction support offices (RCSOs) to facilitate land acquisition, compensation, disbursement of compensation, and relocation and rehabilitation activities. The county land and natural resources bureau is in charge of land acquisition, surveying and recording the amount of land involved, and categorizing land into quality levels. The bureau will work jointly with the county RCSOs to set specific compensation levels. The county government will be responsible for developing resettlement sites and implementing village rehabilitation plans. Village committees will help implement land acquisition and resettlement, with guidance from township officials.

9. Local officials have carried out public awareness campaigns in townships and villages along the alignment. In many places, local inputs altered the alignment of the line and location

of stations. Information about the resettlement program has been disseminated through public media such as newspapers, radio, public notices, and meetings at township and village levels to promote understanding and support from all communities in the project area. During implementation, affected households will participate in discussions on village rehabilitation plans and implementation issues. Local units of the All China Women's Federation (ACWF) will participate in this process to insure that the needs of women, and particularly of households headed by women, are understood and met at all stages of the process. Avenues for redress of grievances are available to affected people under PRC law and a system will be available for registering grievances at the village level.

10. The resettlement implementation is designed so that (i) all affected households will be provided with means of livelihood before they are removed, (ii) households will be relocated before removal, and (iii) relocation and the project construction schedules will be synchronized to achieve these objectives. Land acquisition will commence in the later half of 2003 and most will be completed by the end of 2004. Rehabilitation will commence right after relocation and will continue to the end of 2005, or until all affected households have been adequately restored.

11. Resettlement implementation will have both internal and external monitoring. The RCsOs will be responsible for quarterly progress reporting under the supervision of MOR. MOR will engage an external monitoring agency to conduct a socioeconomic baseline survey, investigate resettlement implementation progress, and prepare monitoring and evaluation reports for submission to MOR and ADB every 6 months. After the completion of resettlement, annual investigations will be carried for 2 years to assess whether rehabilitation measures have fully restored incomes and livelihoods of all affected people. Annual evaluation reports will be prepared by the external monitor and submitted to MOR and ADB.

**PUBLIC CONSULTATION FOR THE PROJECT IN THE PROJECT AREA**

Year	Agency	Meeting Location	Participants	Discussion Agenda And Type Of Issues				
				Project Railway Alignment, Alternative Design And Transportation	Land Acquisition And Resettlement	Environment	Local Economy, Employment And Investment	Other Social Impact (Including Poverty, Ethnic Minorities, Gender)
12/2001 - 02/2002	FSDI	Various in the project area	Local government and agency officials Affected people	X	X	X	X	X
	FSDI	Various			Households Survey (950 households)			
	FSDI	Various			Passenger Survey (1,643 passengers at bus station, motorboat wharf, port, railway stations)			
	FSDI	Various			Environment Survey (200 households)			
	FSDI	Various			Industry Survey (97 companies in Wujiagang, Dianjun, Changyang, Badong, Jianshi, Enshi, Lichuan, Wuquao)			
	FSDI	Various			Village Survey (171 villages)			
02/2002	ADB Mission	Yichang City	Local government and agency officials	X	X	X	X	X
		Wanzhou District	Local government and agency officials	X	X	X	X	X
		Enshi City		X	X	X	X	X
08/2002	Consultants	Various			Households Survey (249 households)			
	Consultants	Various			Village Survey (33 villages)			
09/2002		Yichang City		X	X	X	X	X
		Wanzhou District	Local government and agency officials	X	X	X	X	X
	Consultants	Enshi City	Local government and agency officials	X	X	X	X	X
11/2002	ADB Mission	Yichang City	Local government and agency officials	X	X	X	X	X
		Wanzhou District	Local government and agency officials	X	X	X	X	X
		Enshi City	Affected people	X	X	X	X	X
		Lichuan City		X	X	X	X	X
01/2003-03/2003	Consultants	Mainly Enshi Prefecture			X		X	X

ADB: Asian Development Bank, FSDI: Fourth Survey and Design Institute.