

SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

ZHENGZHOU-XI'AN RAILWAY PROJECT

IN THE

PEOPLE'S REPUBLIC OF CHINA

April 2005

CURRENCY EQUIVALENTS

(as of 12 April 2005)

Currency Unit	–	yuan (CNY)
CNY1.00	=	\$0.1208
\$1.00	=	CNY8.2775

ABBREVIATIONS

ADB	–	Asian Development Bank
BOD	–	biochemical oxygen demand
CO	–	carbon monoxide
COD	–	chemical oxygen demand
dB	–	decibel
EIA	–	environmental impact assessment
EMP	–	environmental management plan
EMU	–	electric motor unit
EPB	–	Local Environmental Protection Bureau
FSDI	–	Fourth Survey and Design Institute of Railways
GDP	–	gross domestic product
JVC	–	joint venture company
MOR	–	Ministry of Railways
MWh	–	megawatt-hour
NGO	–	nongovernment organization
NO _x	–	oxides of nitrogen
NO ₂	–	nitrogen dioxide
PPTA	–	project preparatory technical assistance
PRC	–	People's Republic of China
SBR	–	sequencing batch reactor
SEPA	–	State Environmental Protection Agency
SO ₂	–	sulfur dioxide
SO _x	–	oxides of sulfur
SS	–	suspended solids
TERA	–	Transportation and Economic Research Associates
THC	–	total hydrocarbon
TSP	–	total suspended particulates
VOC	–	volatile organic compound
WWF	–	World Wildlife Federation
ZXR	–	Zhengzhou–Xi'an Railway

WEIGHTS AND MEASURES

C	–	centigrade
cm	–	centimeter
ha	–	hectare
kg	–	kilogram
km	–	kilometer
m	–	meter
mg/l	–	milligram per liter
mg/m ³	–	milligram per cubic meter
m ²	–	square meter
m ³	–	cubic meter
mm	–	millimeter
m/s	–	meter per second
mu	–	a unit of area (=666.7 m ²)
MWh	–	megawatt-hour
ha	–	hectare (1 hectare=15 mu)
nm ³ /a	–	cubic meter (normalized) per annum
t/a	–	ton per annum

NOTE

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

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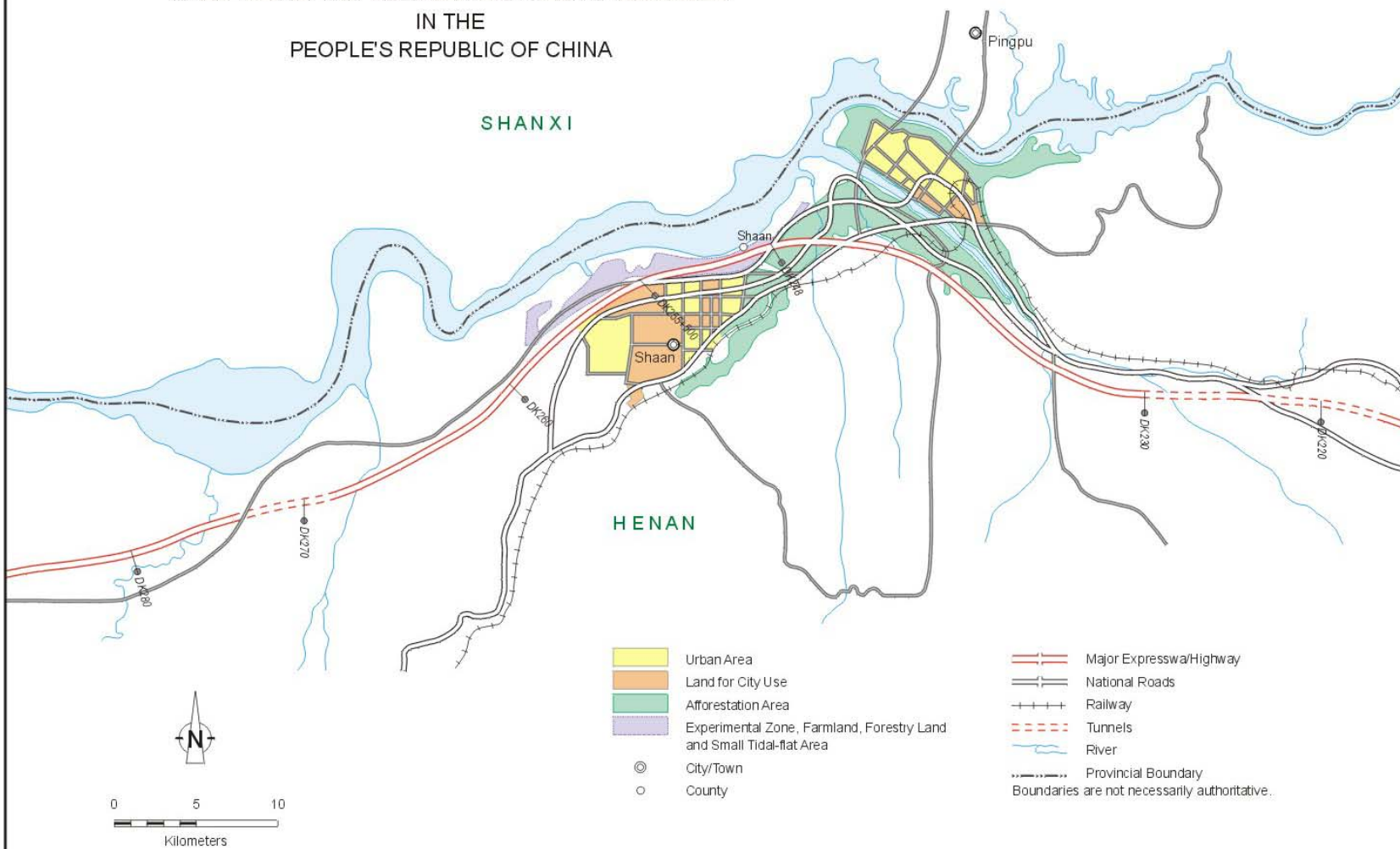
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PROPOSED ALIGNMENT OF
ZHENGZHOU-XI'AN RAILWAY PROJECT
IN THE
PEOPLE'S REPUBLIC OF CHINA



- | | | | |
|---|--------------------------|---|----------------------------------|
| ● | Provincial Capital | — | Existing Railway |
| ⊙ | Prefecture Center | — | Proposed Zhengzhou-Xi'an Railway |
| ○ | County | — | River |
| ● | Village | --- | Prefecture Boundary |
| ■ | New Station | --- | Provincial Boundary |
| — | Major Expressway/Highway | Boundaries are not necessarily authoritative. | |
| — | National Road | | |

PROPOSED ALIGNMENT OF
ZHENGZHOU-XI'AN RAILWAY PROJECT
LAND USE IN THE YELLOW RIVER WETLANDS AREA
IN THE
PEOPLE'S REPUBLIC OF CHINA



Map 2

05-1541bHR

I. INTRODUCTION

1. The Government of the People's Republic of China (PRC) has requested assistance from the Asian Development Bank (ADB) to finance the construction of the proposed Zhengzhou–Xi'an (ZXR) railway project. This summary environmental impact assessment (EIA) was prepared by the pilot project preparatory technical assistance (PPTA) consultants¹ and is based on a comprehensive EIA developed as a joint effort by the First, Second, and Fourth Survey and Design Institutes of Lanzhou, Chengdu, and Wuhan, respectively. The Executing Agency (EA) is the Ministry of Railways (MOR). The terms of reference for the EIA were approved by the Environmental Engineering Appraisal Center of the State Environmental Protection Administration (SEPA) on 11 June 2004.

2. The alignment will be near areas of historic importance, ancient trees, and the Yellow River wetlands. The EIA was designed to identify and evaluate environmental impacts during the construction and operational phases of the project. It was submitted to SEPA for approval in November 2004 and is currently being reviewed. Approval is anticipated by June 2005. The proposed ZXR alignment passes through the "experimental zone"² of the Yellow River Wetlands National Class Natural Protection Area. The Yellow River Wetlands is divided into a core and a buffer zone (where construction is prohibited) and an experimental zone where construction approval is required. The Sanmenxia Office of the Yellow River Wetlands National Class Natural Protection Area approved the construction of the ZXR in the "experimental zone" on 18 November 2004. On 22 December 2004, the Ministry of Water Resources approved the soil and water conservation measures recommended in the EIA.

3. This summary EIA has been prepared in accordance with ADB's requirements and format. It is based on (i) the detailed EIA prepared by the three survey and design institutes in March 2004, and revised in September 2004 following extensive data gathering and evaluation, including the distribution of survey questionnaires to potentially affected persons and officials; (ii) discussions with the authors of the EIA, MOR officials, and international experts; (iii) a 10-day field visit to Zhengzhou, Luoyang, Sanmenxia, Weinan, and Xi'an, for consultative meetings with officials and stakeholders, as well as data collection along the proposed alignment in December 2004; and (iv) findings and discussions from the ADB project interim review meetings in February 2005. It also incorporates comments received from ADB on the PPTA inception report, on the draft summary EIA on January 2005, and during the ADB mission in March 2005.

II. DESCRIPTION OF THE PROJECT

4. The Project (Figure 1) includes the construction of 458.9 km of an electrified double-track class I passenger railway designed for electric motor units (EMUs) traveling at 140 to 200 kilometers (km) per hour (kph). A total of 61 km of tunnels and 151 km of bridges will be constructed. The Project will expand existing stations at Zhengzhou and Xi'an (which will serve as maintenance depots), and build eight new stations. The ZXR will provide a vital connection within the historic corridor linking east and west PRC, will cross two provinces (Henan and Shaanxi), and will pass through 170 rural villages and 13 urban neighborhoods in 19 counties and urban districts. Roughly 50 million cubic meters (m³) of earth and stone works will be needed during construction. The Project will cost approximately CNY34.5 billion (\$4.2 billion). ADB has

¹ Pilot TA PRC-4340 (ADB, 2004. *Technical Assistance to the People's Republic of China for the Zhengzhou-Xi'an Railway Project*. Manila) contract dated 28 September 2004 between MOR and TERA International Group, Inc. of USA, in association with Tonichi Engineering Consultants, Inc., Japan and Fourth Survey and Design Institute, PRC.

² The experimental zone may be used for various activities such as scientific experimentation, education, tourism, including major construction works as long as appropriate approvals are obtained and mitigation measures are implemented to avoid or minimize damage to the environment. There is currently a national highway, a coal fired power plant and farmland located in the 'experimental zone' in the vicinity of the proposed project.

been asked to provide a loan of \$400 million. Construction is scheduled to begin after August 2005, and will be completed in 5 years.

5. The Project is an essential component in the development of a dedicated passenger railway network that will increase (i) passenger traffic, and specifically in the heavily traveled east–west corridor; and, (ii) the number of freight trains on the existing ZXR line (Longhai Railway), in order to support economic development. The Project will directly benefit the tourism industry in the ZXR region by providing international class service at one-fourth the current journey time. The Project will also directly and indirectly provide employment opportunities for the population along the alignment, with about 60% of the job requirements being for unskilled workers. The Project will substantially reduce the transportation bottleneck that has constrained development in western PRC by substituting freight trains for passenger trains on the existing railway, thus enabling much greater freight volumes to be transported. The economic development of western PRC is an important national policy objective, and is key to alleviating poverty in one of PRC’s poorest regions. Shaanxi Province has historically served as the “gateway to the west”. Table 1 shows the estimated major works for the ZXR project.

Table 1: Major Works

Item	Section	Unit	Total
Construction length		km	458.9
Stonework and earthwork	Main line	m ³	42,622,958
	Stations and yards	m ³	5,896,142
Bridges	Super major bridges	No. and total linear meter	62–130,098.6
	Major bridges	No. and total linear meter	69–18,919.6
	Middle bridges	No. and total linear meter	23–1,897.4
	Minor bridges	No. and total linear meter	3–87.5
Tunnels	L>3000m	No. and total linear meter	8–36,248
	L<3000m	No. and total linear meter	30–24,763
Buildings		m ²	195,142
Land occupation		ha	1,772 596.2 (temporary)
Cost estimate	Total	Billion CNY	34.5

Source: Fourth Survey and Design Institute, Preliminary Design, PRC, September 2004.

III. DESCRIPTION OF THE ENVIRONMENT

A. Physical Environment

6. In the east, the ZXR begins at Zhengzhou, the provincial capital of Henan, and crosses the south-west corner of the north PRC plain in a westerly direction. It then passes through the mountains of western Henan, following the Yellow River valley at elevations rising from 200 m to 1000 m, and enters the Weihe River alluvial plain in south-east Shaanxi. Following a major valley north of the Qinling Mountains, the alignment arrives at Xi’an (Map 1). The climate in the project area is classified as warm subhumid monsoon and warm subhumid continental monsoon. Overall, the region is generally warm, with low to average precipitation (about 700 mm of rainfall per year). It is windy and dry in spring, hot (25-28°C) and rainy in summer, clear and sunny in the fall, and cold (average 0°C) with some snow in the winter.

7. The geological structure through which the ZXR passes belongs to the platform area of north PRC, a tectonic zone associated with the Qinling mountains to the south. The outcroppings in Henan vary from Tertiary to Precambrian, and contain a mixed lithology of argillaceous limestone, mudstone, shale, and some metamorphic rock. From the Qinling mountains north to the Weihe River, fragmented limestones, and quartzose and arkosic sandstones predominate. Soil strata for the Shaanxi-Xi’an region include loess, sandy loess, and clays. Except in the lower

hill areas, the rocks outcroppings above the larger structures are recent in origin, mainly Quaternary in age, with intrusive rocks. Areas with geological problems along the alignment include several seismic zones with soils and loosely consolidated sediments vulnerable to liquefaction. In other areas erosion has led to unstable slopes and steeply bedded rock formations. The ZXR contractors also anticipate local slumping caused by subsurface coal excavations in some areas.

8. The alignment passes through the Yiluohe River and Weihe River water systems in the Huanghe River catchment area, which are part of the Yellow River watershed. The main rivers along the alignment are the Yihe, Luohe, Nanjianhe, Tianchihe, Shiquanhe, Zhaigou, Qinglongjian, Canglongjian, Haoyanghe, Hongnongjian, Shahe, Yangpinghe, Shi'erlihe, Shuangqiaohe, Youhe, Linghe, Xihe, Bahe, and Chahe. The Sanmenxia reservoir (on the Yellow River just above the Sanmenxia urban area) provides water for the city and controls the downstream discharges of the Yellow River. Both surface water and groundwater throughout this region are classified as hard because of their high calcium and magnesium salts content. Many of the rivers in the region are rated class IV or V in terms of water quality, and water from them requires treatment. The current shortfall in wastewater treatment seriously impairs the water quality in the rivers that flow through the densely-populated and industrialized metropolitan areas. The Luoyinhe River, which flows through Luoyang, for example, exceeds the permissible limits for ammonia, nitrogen, petroleum, and biochemical oxygen demand (BOD). Daqing canal in downtown Luoyang City is also heavily polluted. None of the surface water in Sanmenxia City, Lingbao City, Weinan City, and Xi'an meets national water quality standards for the designated use of the water body.

9. After recycling, 50% of solid wastes in Zhengzhou are incinerated and this affects air quality. In general, though, the ambient air quality in the eastern part of the alignment is relatively good because of favorable airflow patterns. In Sanmenxia City, levels of sulfur dioxide (SO₂) exceed standards, whereas in Weinan City and Xi'an the major pollutant is particulate matter. Normally, the rural inhabitants along the western section of the alignment enjoy a higher level of air quality than their urban counterparts. There are occasions, however, when thick yellow-brown fog from industrial areas of the cities blankets the entire countryside, limiting visibility to less than 100 m.

10. Soil erosion is moderate to severe along the alignment. Many areas are subject to wind and water erosion. Some of the gully and break areas in Shaanxi Province have annual soil erosion loss rates that exceed 11,000 tonnes per square kilometer (t/km²), among the highest in PRC. The densely populated cultivated land in the plains and the river terraces at the eastern end of the alignment have moderately productive soil. Moving west towards Luoyang, the rolling loess country becomes crisscrossed with gullies, and erosion is widespread. The Sanmenxia area exhibits extensive destruction of the red and brown-yellow clay topsoils. In mountainous regions, the slopes are steep and the thin layer of topsoil is continuously carried away by the runoff from the rainwater. Erosion is also severe in Shaanxi Province, but major efforts are being expended in control programs to support the tourism and agriculture sectors.

11. Some areas near Zhengzhou City and Xi'an have excessive noise and vibration levels. For example, 35.7% of all roads in Xi'an City and 12.7% in Zhengzhou City are rated as excessively noisy. Areas close to the National Highway 310 and the Lianyungang-Huoguo Expressway have moderately high noise levels but are within national standards. Electromagnetic fields induced by high voltage transmission lines reduce the quality of the television reception in adjacent areas.

B. Ecological Environment

12. At the eastern end of the proposed railway, in the vicinity of Zhengzhou City and Luoyang City in Henan Province, the areas along the alignment are mainly woodlands. The forests are secondary (30–50 years old). In this region, and throughout Henan and Shaanxi provinces, 26 ancient trees, varying in age from 300 years to 1,500 years, have been identified. These trees are under the protection of the local forestry departments, which have dated and certified them. Generally they are found in groups of one or two in village squares or courtyards of temples. Most of the old trees are a safe distance away from the alignment (1–2 km) except for a 300-year-old Japanese pagoda tree located 36 m away from the centerline of a bridge. The forestry officials monitoring the work of the contractors will monitor potential impacts to old trees.

13. Table 2 indicates that woodland account for 29.1% of total land in areas along the alignment, arable land 33.1%, and land covered by water 2.8%. The highest percentages of woodland is in Luoyang (36.8%) and Sanmenxia (36.2%) prefectures. In Luoyang, the percentage of arable land is 30%, but in mountainous Sanmenxia it is only 20%. At the other extreme, in Xi'an municipality, which is located in the fertile valley of the Weihe River, only 3.3% of the area is woodlands and 74.6% is arable land. Map 2 shows land use along the alignment.

Table 2: Land Use (ha) along the Alignment

Region	Zhengzhou Municipality		Luoyang Prefecture		Sanmenxia Prefecture		Weinan Prefecture		Xi'an Municipality		Total		
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	
Total Area	753,256	100.0	1,522,983	100.0	1,049,600	100.0	336,366	100.0	113,228	100.0	3,775,434	100.0	
Agriculture Land	Total	456,274	60.6	1,055,321	69.3	667,630	63.6	293,716	87.3	98,965	87.4	2,571,905	68.1
	Arable Land	338,024	44.9	457,667	30.1	209,610	20	161,331	48.0	84,521	74.7	1,251,153	33.1
	Orchard	19,826	2.6	16,315	1.1	35,940	3.4	3,100	0.9	1,478	1.3	76,659	2.0
	Woodland	62,147	8.3	559,931	36.8	380,270	36.2	94,992	28.2	3,744	3.3	1,101,084	29.1
	Pasture	831	0.1	15	0.0	10,690	1	21,353	6.4	4,663	4.1	37,552	1.1
	Water Area	35,445	4.7	21,394	1.4	31,120	3	12,940	3.9	4,559	4.0	105,458	2.8
Developed Land	Total	143,463	19.1	130,822	8.6	97,720	9.3	19,857	5.9	11,039	9.8	402,901	10.7
	Dwellings and Industries	120,035	15.9	104,333	6.9	41,580	4	15,148	4.5	8,466	7.5	289,562	7.7
	Communications Infrastructure	16,580	2.2	20,304	1.3	10,760	1	4,709	1.4	2,279	2.0	546,32.3	1.4
	Other	6,848	0.9	6,185	0.4	45,380	4.3	0		294	0.3	58,707	1.6
Unused	153,519	20.4	336,840	22.1	284,250	27.1	22,793	6.8	3,225	2.9	800,628	21.2	

Source: ZXR Draft Environmental Impact Analysis, Fourth Survey and Design Institute, 2004.

14. The wetlands in the region, as listed in Table 3, are riverine in origin and primarily associated with the downstream reaches of the Yellow and Weihe rivers. With the exception of the Yellow River wetlands, there is adequate separation of at least 2 km between the proposed alignment and protected areas. With respect to the Yellow River wetlands, in the vicinity of DK 248+250 to DK 254+500, the proposed alignment enters the experimental zone and nears the buffer zone. The experimental zone may be used for various activities such as scientific experimentation, education, tourism, and major construction works as long as appropriate approvals are obtained and mitigation measures are implemented to avoid or minimize damage. There is currently a national highway, a coal fired power plant and farmland located in the experimental zone adjacent to the proposed ZXR alignment. The Forestry Survey and Planning Institute of Henan Province has prepared a master plan for the Yellow River Wetlands National Class Natural Protection Area, and the Sanmenxia Preparatory Office of the Yellow River Wetlands National Class Natural Protection Area determined (18 November 2004) that the

proposed alignment passes only within the experimental zone and does not enter the buffer zone, and approved the proposed alignment. Mitigation measures prescribed by SEPA will be implemented in the Project's final design and implementation. It should be noted that the alignment will require the construction of a bridge over Xiliu Lake, a class 1 water source for Zhengzhou City. This is discussed in Section V (B) on anticipated impacts and mitigation measures.

Table 3: Wetlands and Protected Areas Along the Alignment

Province	Prefecture	County	Location	Name	Separation
Henan	Luoyang	Mengjin Jili	Yellow River	Yellow River wetlands	30 km
	Sanmenxia	Shaan	Yellow River	Yellow River wetlands	Test Zone
Shaanxi	Weinan	Tongguan	Confluence of the Yellow River and Weihe River	Three River wetlands	2 km
	Xi'an	Lingtong	Confluence of the Weihe River and Jinhe River	Jinwei River wetlands	8 km

km = kilometer.

Source: Compiled by the project preparatory technical assistance consultant, December 2004.

15. Although no formal surveys of endangered species were undertaken during the EIA, the alignment area has already been developed (e.g., the existing rail line and the national highway are near or adjacent to the ZXR alignment) or evaluated (e.g., the Yellow River Wetlands Master Plan), and officials are knowledgeable about the ecology of the area. The total length of the alignment that will traverse the experimental zone of the Yellow River Wetlands is about 6.25 km. The closest point of the alignment to the buffer and core zones is 300 m and over 2 km, respectively. According to officials, no endangered species of flora or fauna would be impacted by the Project. The EIA indicates that there are no endangered aquatic species that will be negatively impacted by the Project.

C. Human and Economic Resources

16. The average per capita GDP of the districts along the alignment in Shaanxi is CNY7,308 (\$883), and in Henan it is CNY9,118 (\$1,102). The national average is CNY9,074 (\$1,096). School attendance is almost 98% for primary, 99% for middle, and 73% for secondary schools. Shaanxi has 47 institutions of higher learning and Henan Province has 64, including vocational schools. About 64% of high school graduates move on to tertiary education. Both provinces have many health facilities. Shaanxi has 14,369 health institutions (813 hospitals, 1,861 health centers, and 10,924 clinics), and Henan has 13,621 (1,102 hospitals, 2,043 health centers, and 9,308 clinics).

17. Henan, a major agricultural and industrial province, has 6.8 million hectares of arable land, of which 4.6 million are irrigated. The leading agricultural products are grain, cotton, and meat, followed by sesame, jute, oil plants, fruit, and tobacco. Shaanxi Province augments its traditional food crops by raising tobacco, cotton, medicinal materials, and fruit. Both Henan and Shaanxi provinces are rich in minerals, and over 60 different kinds are currently mined, including low-sulfur coal. Both provinces are developing hydroelectric power sites. The main industries in Henan are electronics, machinery, chemicals, food processing, and production of building materials. The main industries in Shaanxi include electronics, machinery, chemicals, and tourism.

18. Tourism is already a major industry in both provinces, and continues to grow rapidly. It will undoubtedly grow further as a result of the ZXR, which will provide an opportunity to expand and upgrade facilities in the project area. Tourism directors along the alignment indicate that tourism is relatively well developed along the alignment area, and further growth can be accommodated. The area to be served by the ZXR project contains some of PRC's most important historic and cultural sites. Xi'an has a history of more than 3,000 years and served as

the capital of 11 dynasties in PRC, extending from the Western Zhou Dynasty (1046–771 BC) to the Tang Dynasty (618–907 AD). The city is the site of the world renowned terracotta army and was the national capital for 1,068 years. Many beautifully designed and maintained museums, particularly the Gong Yi Museum in Henan and the Xi'an Museum in Shaanxi, are located in the region. Local figures played crucial roles in the development of religions in ancient PRC. The Longman Grottoes and the White Horse Temple, both in Luoyang Prefecture, celebrate the advent of Buddhism into PRC, and the Taichu Palace at Hangu Pass in Sanmenxia Prefecture is the site where Lao Zi, some 2,500 years ago, wrote the document which forms the basis for Taoism.

IV. ALTERNATIVES

19. Before the Project was designed, several alternatives were considered. Given that the current transport network is severely overloaded, the “without project” option was not viable. Alternative transport systems were also considered and are discussed below. When it had been determined that an electrified train system as part of a dedicated passenger line provided the best option, other routes were considered. Specific sections of the alignment were assessed on the basis of cost, and environmental, cultural, and socioeconomic factors.

20. Increasing air services as an alternative was not viable because of the greater operating costs and thus higher ticket price. Air transport is not generally preferred in PRC by either domestic or foreign travelers for distances of less than 600–800 km.

21. Increasing the use of roads and expanding the highway system were also considered. However, for distances of more than 200 km, trains are the preferred mode of transport in PRC. Since there are only a few long-range buses with toilets and TV units, the comfort and ease of train travel are preferred. Importantly, increasing road transport by expanding the bus and truck fleets and expanding the road network would require considerably more land than an expanded rail system; consume more petroleum and thus emit more harmful emissions, including volatile organic compounds (VOCs) such as oxides of nitrogen (NO_x) and SO₂, than electric trains; and encourage urban sprawl along the roads. An electrified train system would facilitate concentrating development in existing urban areas. With respect to energy efficiency, the EMU is 6.8 times more fuel efficient than automobiles and many times more fuel-efficient than air travel by jet.

22. During the design stage, the designers examined numerous alternatives. In deciding among these, the following principles were followed:

- (i) destruction or disturbance of the known monuments, relics, tombs, and ruins were avoided;
- (ii) bridges should be preferred to high embankments, and tunnels to deep cuts;
- (iii) less productive land should be used as much as possible; and
- (iv) contractors should use areas designated for future stations, yards, and other facilities for temporary storage of materials and equipment.

23. The specific alignment alternatives that were assessed totaled 150.2 km, or 32.7 % of the total length of the ZXR. Prior to selecting an option, a number of factors were considered, most of which have cost implications. The Provinces place an extremely high value on cultural and heritage sites, and the alignment has been selected to avoid sites of known archaeological significance. The selection of the alignment also attempted to minimize the number of unstable areas such as those near sites that had experienced below-ground excavation of coal, or had sandy soil bases. Mitigating these areas would have added cost to the Project. Similarly, minimizing the dislocation and disruption of people, enterprises and facilities such as schools was given a high priority. Again, resettlement/relocation and other acquisition costs would have added

to overall Project cost. The alignment option selected was done after consultation with local authorities to ensure that existing urban/regional plans and ordinances were followed. While this can be seen in cost terms, it was also done in order to facilitate benefit flows to local populations. Table 4 presents the alternative route alignments but does not include reference to alignment decisions with respect to the Yellow River wetlands or other conservation areas. These are discussed in Section V.

Table 4: Alternative Route Alignments

Alternative Schemes	Recommended Alignment
Louyang Station - Length 25.4 km <ul style="list-style-type: none"> • South route • North route 	North route was selected due to compatibility with town planning, ease of construction, and better configuration of the rail line.
Jiaokou-Hanguguan Length 36.5 km <ul style="list-style-type: none"> • South route • North route 	South route was selected due to lesser disruption of urban areas (industries, schools, and residences), and would not necessitate further engineering to mitigate liquefying sandy soil base, caves and other geologic issues.
Caijiapo Landslides Length 15.1 km <ul style="list-style-type: none"> • Subgrade scheme • Bridge scheme • Tunnel scheme 	Subgrade scheme was selected since in terms of engineering and slope, the recommended stabilization and drainage improvements under this scheme are considered to be effective measures to ensure slope stability. The bridge scheme would still require considerable slope stabilization, hence its higher cost while the tunnel would not be a cost-effective option.
Fushui-Weinan Length 73.2 km <ul style="list-style-type: none"> • North route • South route 	North route was selected since it has better geologic conditions such that it would require lesser engineering measures, and it would cause lesser disruption/displacement of buildings, roads, pipelines, and occupied land.

Source: Compiled by the project preparatory technical assistance consultants, 2005.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

24. The alignment was selected to minimize overall environmental and socioeconomic impacts. Early in the design process, a decision was made to avoid disrupting important historic and ecological sites. The impacts of the construction phase have been identified and steps will be taken to ensure that these are short-term and reversible. Apart from the construction of the rail line and the resettling of people following land acquisition for the railway, long-term and irreversible impacts have been minimized and mitigation measures developed. MOR has established procedures to implement mitigation measures and monitor impacts. All contractors will be required to coordinate with appropriate local officials and monitoring agencies before and during construction. They will be required to inform workers of the need to adhere to appropriate standards and to use best practice. Applicable laws, regulations and standards are presented in the supplementary EIA.

A. Air Quality

25. As noted in para. 9, air quality in and around the urban areas along the alignment is already poor. The EMU will produce less pollution than that produced by an expansion in road transport, leading to substantial socioeconomic and health benefits. During construction, there will be a moderate and temporary deterioration in air quality, caused mainly by dust accompanied by minor increases in the level of NO_x and SO_x (from construction equipment). The dust will settle on trees and crops, and will cause some degree of respiratory stress for nearby residents. Frequent use of water spray trucks to wet down the roads to suppress dust emission will be mandatory. Contractors will use low-sulfur gasoline and diesel fuel, and the exhaust fumes of the equipment will meet emission standards.

26. During the operational phase, there will be no immediate mobile sources of air pollution because ZXR will use only electric locomotives. There are 24 boilers (20 diesel-fired, 2 gas-fired, and 2 coal-burning) scheduled for installation at various repair shops, stations, and depots along

the line. Table 5 shows annual emissions of pollutants and applicable standards for these boilers. As the table indicates, all of the ZXR boilers conform to emissions standards. Boiler and station locations will not have an impact on agricultural land or forests as they will be located in urban or developed areas. Boilers will be regularly inspected to ensure that they are operating efficiently and standards are met.

Table 5: Annual Boiler Air Emissions and Standards (mg/Nm³)

Type	Discharged Pollutant Concentration			Emissions Standards (Class II under GB13271-2001)		
	Smoke/dust	SO ₂	NO _x	Smoke dust	SO ₂	NO _x
Fuel-fired boiler	45–75	360–425	320-375	100	500	400
Coal-burning boiler	187.5	729.1	-	200	900	-
Gas-fired boiler	12.3	51.2	276.2	50	100	400

Source: The Fourth Survey and Design Institute, PRC. 2004.

27. If the projected atmospheric emissions from electric trains (and from the power grid) are compared with those from the buses needed to transport the same number of passengers, it is clear that an expansion of road transport at the expense of rail would have very negative impacts. For example, in 2020 171 pairs of trains are scheduled to be operational and are projected to consume 2,359,410 megawatt-hours (MWh) of electricity and to require an installed capacity of 393.2 MW. This would represent an estimated saving of 6,200 t per year of carbon monoxide emissions, 2,500 t per year of hydrocarbons, and 8,000 t of nitrous oxide, compared with the buses needed to transport the same number of passengers.

B. Water Quality

28. Construction of tunnels in mountainous areas may discharge water under pressure in sufficient quantities to cause changes in water flows of surrounding watercourses. Settling ponds will be constructed to prevent deterioration of local watercourses. Preliminary investigations indicate that none of the proposed ZXR tunnels are constructed beneath existing water supply reservoirs. In addition to the tunnel water, the generally small quantities of wastewater discharged during the construction phase will consist of washwater from the equipment maintenance shops or effluent from the work camps. The oily washwater wastes will undergo treatment in an oil separator before the oil is recycled. Construction camps will be provided with sanitary latrines so surface water is not polluted. If more than 150 people live in the camps, before it is discharged into a natural watercourse, sewage will receive primary-equivalent treatment in an anaerobic pond preceded by a bar screen.

29. Specific water source points for the construction phase have not yet been identified. However, it should be noted that, of the ten stations, five will connect to urban systems and five will use new groundwater sources. These connections and sources will be used to provide water whenever possible, together with other urban systems along the route. When other sources are used, there will be coordination with local officials. Particular attention will be given to Xiliu Lake, which is to be crossed by a bridge. The lake is a Class 1 water source that provides drinking water for Zhengzhou City. The contractor will be required to ensure construction debris and wastes do not enter the lake. A specific water quality monitoring program will be established for Xiliu lake to monitor impact from the project. All contractors activities will be monitored by local authorities. If, as a result of an accident, any wastes enter the lake, the Zhengzhou Municipal Public Utility and the local EPB will be notified immediately, so appropriate remedial measures can be taken.

30. Wastewater produced during the operational phase will be generated from maintenance facilities and stations. If necessary, wastewater will be treated until it conforms to applicable discharge standards. At the Wulibao Passenger Car Servicing Point, wastewater from the washing of passenger cars will be treated by the reuse facility incorporated into the washing equipment; wastewater from the battery room will undergo electro dialysis and electrolytes will be recycled; and the sewage from toilets will be treated by sedimentation and sequencing batch reactor (SBR) units. Wastewater from the passenger terminals is essentially domestic in character and will be treated by trickling filters or equivalent. Wherever existing sewers and treatment facilities are available, the station sewers will be connected to them. The discharge points for sewage from passenger cars will be connected to urban systems that include treatment facilities.

31. The alignment near the Yellow River wetlands just west of the Sanmenxia urban area was selected in order to avoid the buffer zone of the Natural Protection Area. As discussed in Section III (B), the Forestry Survey and Planning Institute of Henan Province prepared the master plan for the Yellow River Wetlands National Class Natural Protection Area, and the Sanmenxia Preparatory Office of the Yellow River Wetlands National Class Natural Protection Area determined that the alignment did not enter the buffer zone, and was thus acceptable for major public works. In addition, the alignment will generally be elevated in this area, and will be constructed using culverts, piers, and other structures to minimize impact to the local hydrology.

C. Solid Wastes

32. Three types of solid waste will be generated during construction: (i) domestic garbage from work camps, (ii) construction scraps and refuse from work sites, and (iii) spoil and muck from the cuts and tunnels. While the first two types of wastes will be small in volume, the contractor will be required to dispose them daily in an efficient, and hygienic way (existing public landfill sites will be used wherever possible). The third element is more voluminous and its disposal is discussed in para. 37. During the operational phase, the treatment and disposal of garbage from stations and the industrial wastes from service facilities will use existing landfills under the authority of local officials. Collection and disposal of toxic and hazardous wastes will be conducted in accordance with PRC regulations (para. 44).

D. Noise and Vibration

33. There is already considerable noise and vibration along the alignment, caused by the existing railway, the national highway and other roads, and a range of industrial, commercial, and agricultural activities in the area. During construction, the most noticeable sources of noise will be from machinery in the repair shops; from blasting in tunnels or quarries; or from heavy earthmoving equipment. The standard procedure for MOR contractors is to meet with local officials and, on a case-by-case basis, to schedule operating hours for blasting and equipment and to arrange for machinery to be located away from facilities and areas, such as schools and hospitals. Contractors will be encouraged to use new and well-maintained equipment, and ensure workers use ear protection in areas with high noise levels. Construction noise on large public works in populated areas is strictly limited by the Noise Criteria for Boundary of Construction Sites (GB 12523-90), although some flexibility is provided by the local Environmental Protection Bureau (EPB), which has a monitoring role. It is not anticipated that construction noise on the ZXR will be a serious problem in either the urban sites or the sparsely settled rural areas.

34. During the operational phase, passing trains, as well as the hum and screech of equipment in each station, shop, and marshalling yard, are sources of noise. High-speed trains produce more noise and vibration than slower passenger or freight trains. However, recent technologies have greatly reduced the noise and vibration impacts of EMUs. Furthermore, the noise and vibration produced by EMUs does not last as long as that caused by slower trains.

During the EIA field investigation, noise monitoring equipment was used to measure daytime and nighttime ambient noise levels at potentially affected sites such as schools and housing areas. Then, by using a calibrated analog model to simulate train noises, and superimposing these noises on the measured background noises, total equivalent noise levels at the selected sites were calculated. It should be stressed, however, that the EIA field tests did not reflect some of the latest noise and vibration technologies. For example, recent Japanese technology allows trains traveling at speeds of 230 kph to operate below 72 decibels (dB) for noise and 65 dB for vibration (the PRC standards are 75 dB for noise and 70 dB for vibration). Thus, the number of affected areas could be lower than estimated in the EIA.

35. There are some areas where field tests indicate that the Project will exceed regulatory limits. Along the alignment in Zhengzhou Prefecture, an art institute, a primary school, and a middle school will require ventilating and soundproof windows to be installed. Along the alignment in Luoyang and Sanmenxia prefectures, five primary schools and various structures in 43 villages will need remedial construction to meet the Environmental Noise Standards for Urban Areas (GB 3096-93). Along the alignment in Shaanxi Province, another 41 sites, including schools, villages, and military camps, will need remedial construction.

36. During construction, vibration will increase temporarily because of the operations of pile drivers, jackhammers, vibrating rollers, and explosives, but proper coordination between the contractor and the local officials will minimize difficulties. Some of the sites affected by the noise of passenger trains will also be affected by excessive vibration. The striking force of the steel train wheel on the steel rail is transferred to the subgrade via a sleeper and ballast bed (or concrete slab), and then is transferred to adjacent earth and structures. In the area close to Zhengzhou, the border of the Jinshui Road residential area is only 20 m from the right-of-way of the ZXR. The computed value of the vibration indicates that vibrations from the trains will exceed the permissible maximum unless mitigating measures are taken. In the same area, the dormitories for both the electric power plant and the Petroleum Construction Corporation will be affected. Along the line, a number of villages also have high computed values for vibration. Efforts to reduce the impact of vibration will focus on both rolling stock and the construction of special tracks in areas of anticipated high vibration. Rolling stock will be procured through international bidding and the focus will be on acquiring the latest technology from each supplier. In areas of high anticipated vibration, track construction will use techniques pioneered by German, French, and Japanese railroad builders, including resilient fasteners, resiliently-supported ties, and rubber-bearing pads under the ballast or under a concrete slab.

E. Soil Erosion

37. The contractor will move approximately 44 million m³ of soil and rock in the construction of the rail line, the stations, the access roads, temporary storage sites, and the yards. This will include tunnel muck 1.6 million m³, subgrade earthwork 26.2 million m³ (of which 6.5 million m³ is cut excluding tunnel muck, and 12.7 million m³ is fill), graded crushed stone 1.9 million m³, rock work 1.6 million m³ and improved/good quality soil (including top soil) 12.3 million m³.

38. Along the alignment, the contractor will encounter many severely eroded areas, particularly the deep gullies in the loess country and the mountainous regions in the western and central sections. During project construction, contractors will follow best engineering practices in order to minimize the permanent disfigurement of the terrain as well as to control the erosion.

39. Table 6 lists potential causes of soil erosion and mitigation measures based on the soil and water conservation measures recommended in the EIA and approved by the Ministry of Water Resources. Specific sites and final quantities for quarrying, gravel and sand have not been identified. However, all excavations and mining will conform to established standards and

regulations, and operators will be monitored. The table does not include the grass seeding (approximately 300,000 m²) and green zones planted with seedlings along the alignment (see Section V. (F) below). Soil and water conservation measures have been estimated to cost around CNY1.2 million (\$0.14 million) and a further CNY10.4 million (\$1.26 million) has been set aside for tree planting.

Table 6: Soil Conservation Management Framework

Potential Erosion Problem	Mitigation Measure
Use of spoil/borrow pits	All available spoil will be used for structural fill for access roads, stations, and embankments before borrow pits are excavated.
Locating borrow pits	Borrow pits will be centrally located wherever possible in order so they can serve more than one site.
Location of spoil/borrow pits	Sites for spoil and borrow pits will be a long way from industrial, agricultural, residential, historic, and ecological sites. Officials have specified that they should be at least 1 km from historic relics.
Topsoil from borrow pits	Topsoil from the borrow pits will be removed and set aside. When the project is completed, the areas will be regraded, the topsoil replaced, and the area reseeded. Intercepting ditches will be constructed on the high side of the restored pit to prohibit surface scouring by storm runoff.
Tunnel muck	Muck (approximately 1.6 million m ³) will be spread and dried before it is used for embankments.
Spoil disposal	Spoil will be spread on the lowest yield/least productive land available.
Soil disposal	When soil is spread on slopes for permanent disposal, it will be buttressed at the toe by a retaining wall. The surface of the slopes, if necessary, will be stabilized by shotcreting, riprapping, or laid rubble prior to seeding.
Steep cuts	All steep cuts will be flattened and benched.
Natural watercourses	Special attention will be given to ensuring that watercourses are not blocked and temporary soil and rock stockpiles will be designed so runoff will not induce sedimentation of waterways.

F. Flora and Fauna

40. About 1,772 ha of land will be permanently acquired by the ZXR, and about 596 ha will be needed for temporary occupancy. Of the 1,772 ha, 100 ha (5.6%) is covered with forest or planted trees. Wildlife along the alignment is generally sparse because of the existing infrastructure, population density, and industrial activity. Local officials report that there are no endangered species of flora or fauna in the vicinity of the project. During construction, nearby vegetation will be covered by a layer of dust. Within the right-of-way, and in the areas temporarily occupied for construction, the secondary growth trees will be cleared at an average rate of 526 trees per km. Roughly half of these have trunk diameters greater than 10 cm, and have some potential commercial value.

41. To ensure minimal Project impacts of the Yellow River Wetlands, the following mitigation measures will be implemented:

- (i) No spoil sites, borrow pits and work camps will be allowed in the Yellow River Wetlands Protection Area.
- (ii) Construction contracts will include provisions stating that workers may not trap or hunt, log, take crops/foilage, or otherwise damage any areas along the alignment that passes through the experimental (test) zone of the Yellow River Wetlands.
- (iii) A written code of conduct and environmental impact prevention training will be given to each person when hired for work in this area. Fines, according to PRC legislation on poaching, will be explained and imposed for hunting, wild

food harvesting, tree cutting for fuel, and wandering into off-limits areas without permission from the supervising engineer. All permission and violations will be documented in writing and will be available for inspection by environmental inspectors and Environmental Protection Bureau officials

42. When the civil works have been completed, the contractor will develop, on nonagricultural land, a greenbelt (30 m width) on both sides of the railway. Trees will be planted at station and depot areas (PRC regulations require trees to be planted on an average of 70% of the land). The trees to be planted will be suited to the local soil and climate. Along the alignment, an additional 300,000 m² of land will be seeded for grass, and intercepting drainage systems on grasslands will be constructed to prevent excessive scouring due to rainstorms.

G. Historical, Cultural, and Archaeological Sites

43. As discussed in Section III. (C), the alignment will pass through some areas of historic significance which may contain archaeological sites. The alignment has been chosen to avoid previously identified sites of archeological significance. For example, the railroad was routed around the restored grade AAA scenic spot at Hangu Pass by using the Hanguan Major Bridge and the 4.7-km Hanguan Tunnel. Given the level of development along the alignment, including an existing rail line and a national highway, considerable resources have already been devoted to identifying and assessing cultural/heritage sites in the vicinity of the ZXR. Further, construction contracts will include clauses specifying actions that must be taken in the event of the discovery of objects or sites, and the EA, County Relics and Antiquities Bureaus (RAB) and EPBs, and other agencies will monitor adherence to the contract clauses. The following mitigating measures for the protection of cultural sites will be included in the SEIA:

- (i) For sites that cannot be avoided or sites that will be found during earth works, relocation will be undertaken under the supervision of the County RABs.
- (ii) Vibration attenuation rubber matting between the rail and subsurface will be installed to minimize or avoid impacts to sites that are close to the alignment. This measure has been successfully used in Japan's Shinkansen where structures directly attached to the railway line (above the track, including hotels, offices, residences) experience no vibration from train operations.
- (iii) No borrow pits, spoils dumps and work camps will be located within a kilometer of a known historic/cultural/ archaeological site.
- (iv) In the event relics are unearthed during construction, excavation will immediately cease and the County RAB will be notified immediately for appropriate action. From this point, the local official will work with the contractor to ensure objects and or sites are preserved. Local officials have experience in applying the regulations and best practices for historic and cultural sites, and these will be strictly followed during construction. Funds amounting to CNY 11 million have been allocated for surveys of potential historic/cultural/ archaeological site that may be unearthed during construction.

H. Toxic and Hazardous Chemicals

44. As noted in the discussion of water impacts, there have been significant efforts to control toxic and hazardous chemicals at maintenance facilities. These include the installation of water reuse and oil recycling facilities, and electrodialysis for recycling electrolytes. As it will be a

passenger line, the ZXR will not be used to transport toxic or hazardous chemicals. Thus, there is little or no risk of toxic or hazardous chemical spills along the alignment.

I. Land Acquisition and Resettlement

45. There are 8.3 million people living in counties or districts included in the Project impact area. The ZXR will pass through or encroach on 170 villages and 13 urban street committees, with a total population of 331,597. Of this population, 36,737 people (0.44% of the affected counties total population) will be directly affected by the Project. Of these, 29,774 will have to be relocated. It is estimated that 1,772 ha will be acquired, of which 1,119 ha are currently cultivated. Nearly 1.3 million m² of buildings will be demolished. Table 7 summarizes land acquisition and building demolition under the project. The progress of the resettlement will be governed by a specific contract and monitored to ensure that affected people are receiving adequate compensation, and that they are receive priority with respect to project construction job opportunities. A summary of the resettlement plan is provided in Appendix 1.

46. All resettlement activities will conform to the laws of PRC and ADB's *Policy on Involuntary Resettlement*. In 2004, the State Council issued a Decision on Further Reform to Strictly Implement Land Administration (State Document 28). This requires public consultation with affected people before projects are approved, maintenance of the living standards of affected people, strengthened monitoring procedures, public accounting of the receipt and distribution of resettlement funds, and distribution of compensation for land loss to affected people. MOR and provincial and local authorities prepared the resettlement plan with the assistance of the PPTA consultants. A compensation information package will be distributed to affected people and enterprises as part of the consultation and disclosure process. The resettlement plan stipulates eligibility and entitlement provisions for affected people. Permanent land losses will be compensated by land reallocation or by cash payments at rates of 8-10 times the average annual output value (AAOV) of the land (these rates are still under discussion). In general, a resettlement subsidy is calculated at 4-6 times AAOV. Compensation for temporary land loss will be paid directly to affected people and the land will be restored to its original state after use. Compensation for rural housing losses will be paid directly to the affected people at replacement cost, free of demolition expenses and salvaged materials. The objective for rural households will be to rebuild their houses within the same village. Crop and tree losses will be paid directly to affected people. Urban households, factories, schools and other institutions and enterprises will be paid compensation at market rates for relocation and reconstruction.

47. Special attention has been given to poor households, who are particularly vulnerable to hardships caused by resettlement. Sample surveys were conducted for 2,265 households in the affected villages and urban districts and 18% were designated as poor households. Roughly one half (17 out of 39) of households are headed by females and five out of six households with a disabled member were poor households. The ZXR will increase employment and income-generating opportunities and the poverty and social analysis has developed recommendations to assist with poverty alleviation through preferential employment opportunities and other measures.

48. In the villages in the project area, about 1% of the population (4,130 people in total) are indigenous peoples or members of ethnic minorities, including Hui (4,083 total), Mongols, Koreans, and Uygurs. Most of members of ethnic minorities live in or near urban areas. For example, 3,084 Hui live in or near Zhengzhou. Minority households surveyed had per capita incomes above the poverty level.

Table 7: Summary of Land Acquisition and Building Demolition

Item	Unit	Quantity
Total permanent land acquisition	ha	1,772
Land acquired for right of way	ha	1,539
Land acquired for stations and yards	ha	233
Cultivated land acquired	ha	1,119
Land acquired for temporary use	ha	596
Total area of demolition of buildings	m ²	1,682,392
Demolition area per kilometer	m ² /km	3,666
Population affected by acquisition (assuming 100% loss)	people	36,736
Population to be relocated	people	29,774

Source: ADB Pilot TA PRC-4340. *Resettlement Plan Report*. 2005

J. Public Safety and Health

49. During construction, there may be an increased risk of work crews spreading sexually transmitted infections, such as HIV/AIDS. Henan Province has a higher incidence of HIV/AIDS than some other areas in PRC as the virus was transmitted to a number of people selling blood roughly a decade ago. However, a strong public education program already exists and it will be used to as the basis for providing information to work crews. A public health officer will regularly inspect work camps and disseminate information.

50. Construction safety will be addressed by MOR, contractors and monitoring officials. The contractors will be required to appoint safety inspectors who will conduct regular safety inspections. Remedial actions consistent with national and local standards will be taken immediately when safety violations are discovered. Hard hats and other safety equipment will be required at all sites. Workers will be provided with safety information. Contractors will establish on-site clinics for larger camps (300 or more persons) if they are a long way from local health care facilities.

51. Given that a railroad already exists near the ZXR route, the public generally understands railroad safety issues. However, the ZXR is much faster than previous trains, and the local population will have to be warned of potential dangers and the need to keep livestock well away from the tracks. The alignment will be fenced and there will be no intersections with roads or level crossings (underpasses or by-passes will be used). Regular monitoring of fencing will be undertaken. MOR will coordinate with local schools, clinics and other public information outlets, and provide information on high-speed trains.

K. Induced Impacts

52. The ZXR will facilitate the growth of tourism along the alignment. Although there are already a number of facilities and the capacity to accommodate substantial number of visitors, the ZXR will result in the construction of more facilities as well as upgrading of existing ones. Henan and Shaanxi provinces, in common with the rest of PRC, place a high priority on developing the tourism sector, both in terms of increasing the numbers and also in a qualitative sense. There is a recognition that preservation of historic and ecological sites is an essential component of tourism. These sites provide increased employment opportunities and help promote local cultural traditions.

53. The ZXR will also facilitate the expansion of freight traffic along the route, as passengers switch from the existing route to the ZXR, thus enabling more freight to be transported. This will allow existing industries along the corridor to increase production and new industries to be developed.

54. Collectively, these two economic benefits of the Project will provide a basis and momentum for further development in the region. The additional tourists and the expanded and new industries will require more agricultural and services inputs, benefiting farmers, taxis, freight haulers, and computer technicians in the region. Economic opportunities will increase, which will lead to further demands on infrastructure and other services.

VI. ECONOMIC ASSESSMENT

55. The current cost estimate for the Project is CNY34.5 billion (USD4.17 billion). The environmental protection elements constitute 4.8% of the total estimated cost of the fixed infrastructure (Table 8). Vibration attenuation is a new field of study for MOR, and a number of new techniques adopted from Europe and Japan will be tested on the ZXR. These include heavy, continuously welded track, resilient fasteners, and insertion of rubber mats under either the concrete slab or the sleeper. A common method of vibration attenuation is rubber matting between the fastener and the rail. The budget for vibration damping is estimated at CNY40 million (USD4.84 million).

Table 8: Environmental Protection Investment

Cost Elements	Estimated Cost (CNY million)
Camp Sanitation	1
Monitoring Contract	6
Station Wastewater	36.4
Noise Abatement	246.4
Dust Control (use of water trucks)	0.4
Tree Planting	10.4
Historical/Relics Survey	11
Vibration Attenuation	40
Soil and Water Conservation	1,246.9
Electromagnetic Compensation	1.6
Garbage Collecting and Pre-treatment	0.9
Total	1,601

Source: Compiled by the project preparatory technical assistance consultant, 2004.

56. The environmental benefits directly associated with the Project includes growth in passenger transportation (electric railway) that has a relative advantage in air pollution and energy conservation compared to the alternative transportation alternatives (bus, car and air transport).

VII. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

A. Environmental Management Plan

57. The pollution impacts during the construction and operating periods of the Project are shown in Table 9, together with mitigation measures and applicable standards. The table shows that project impacts can be mitigated through the use of appropriate technologies and good engineering practices. Costs for the mitigation measures have been summarized in Table 8. Detailed information on applicable laws, regulations, and standards are provided in the supplementary EIA.

58. MOR will be the Executing Agency for the Project, and thus has overall responsibility for ensuring that all standards and procedures are followed. MOR also has responsibility for ensuring that all monitoring requirements, including reporting, are fulfilled. MOR plans to establish a joint venture company (JVC) under PRC law to build the railway, and, on completion of construction, to operate and manage the Project. The JVC will be the implementing agency (IA)

and will be responsible for all project management aspects, including oversight of environmental pollution, mitigation, and monitoring. Agencies such as the Ministry of Water Resources, provincial and local EPBs, local Bureaus of Relics and Antiquities, and health officials will monitor, for example, pollution, health and safety, and the implementation of mitigation measures. The IA will prepare an EMP execution schedule for the contractors. The IA will also ensure that the contractors comply with the provisions of the EMP and will monitor compliance with mitigation measures defined in the EMP during the operation phase.

59. The IA will work directly with national and local government agencies and with contractors to ensure compliance with standards and the implementation of mitigation measures. However, MOR will have the ultimate responsibility for the Project. The MOR and IA will ensure that the EMP is updated during the detailed design stage and that environmental clauses of the contract Terms and Conditions and the EMP are included in all bidding documents and operating contracts (the EMP may be attached as an executable item). The IA will establish an environmental and social monitoring unit that will ensure implementation of the social/environmental management and monitoring plan during construction and operation phases of the project. Independent monitors will verify implementation of appropriate mitigation measures and reporting schedules.

Table 9: Environmental Management Plan

Types of Impact		Source if Impact	Location	Parameters	Mitigation Measures	Applicable Standards
Soil Erosion	Construction and Operational Periods	Borrow pits, spoil disposal areas, steep cuts, natural water sources	Throughout the alignment		Soil erosion protection plan. This will be updated to match the detailed design	PRC legal requirement
	Construction Period	Powered mechanical equipment and vehicle	Construction sites and access roads	70-100dBA (30m)	Continuous construction management	GB12523-90
Noise	Operational Period	Train and/or track noise, stationary EMU noise in station, equipment noise in EMU depot	Along the line; EMU maintenance depots	Varies	Relocate schools, install noise barriers; sound proof windows	GB12525-90; GB3096-93; GB12348-90
	Construction Period	Powered mechanical equipment and vehicle	Construction sites and access roads	70-83dB	Continuous construction management	GB10070-88
Vibration	Operational Period	Train and/or track vibration	Along the line	Varies	Install low-vibration slab track and continuous weld rail	GB10070-88
	Operational Period	Electromagnetic field jams radios and TVs adjacent to rail	Along the line	Varies	Compensate for non-cable TV user within 50 m of the line	Signal-noise ratio less than 35 dB, stated by CCIR
Waste Water	Construction Period	Wastewater from washing construction equipment and vehicles; domestic wastewater from construction workers	Work sites; living sites	COD, BOD, petroleum, etc	Provision of sanitary latrines. Primary treatment if needed by larger camps	Good engineering practice
		High level of SS from tunneling	Entrance and exit to tunnel	Mud and sand	Sedimentation ponds	GB5084-92 or GB8978-1996
	Operational Period	Feces from train's tank	Passenger servicing depot, EMU maintenance depots	COD, BOD, SS	Treat by SBR or septic tank	GB8978-1996 Grade or standard (G/S)
		Wastewater from washing of train		COD, SS	Recycled after treatment by coagulation, sedimentation, filtration	
		Oily wastewater from repair facility		Floating oil	Primary treatment by oil separator	
Domestic wastewater	Stations and depots	COD, BOD, SS	Treat by septic tank, biological filter or SBR	GB8978-1996 G/S		
Air Pollution	Construction Period	Dust from the earthwork, emission from construction vehicles	Construction sites and access roads	TSP, NO _x , SO ₂	Continuous management measures	Ambient Air Quality and Vehicle Emission Standards
	Operational Period	Emission from diesel or gas or coal boiler	Stations and depots	TSP, SO ₂ , NO _x	Preferred diesel or gas boiler	GB13271 - 2002
Solid wastes	Construction Period	Spoil earthwork; garbage from camp; debris from building demolition	Construction sites and camps		Spoil to be used in embankment, garbage and debris buried in landfill	Good engineering practice
	Operational Period	Garbage from station and train, cinder from boiler	Stations and depots		Garbage disposed of by local sanitary departments, cinder used as road material	

Types of Impact		Source of Impact	Location	Parameters	Mitigation Measures	Applicable Standards
Cultural, Historical, Archaeological Sites	Construction Period	Earthworks and various Project activities	Along the line		Borrow pits, spoils dumps and work camps will not be located within a 1 km of known sites. If relics are unearthed , excavation will cease immediately and officials will be notified .	
	Operational Period	Vibration	Along the line		Vibration attenuation rubber matting will be installed	

Source: Environmental Impact Assessment, Revised Draft Edition, FSDI, Wuhan, September 2004.

B. Environmental Monitoring Program

60. The EA will establish an environmental protection and management office (EPMO), led by the project manager and consisting of at least 3 staff members with relevant qualifications and experience, to be responsible for ensuring that the overall environmental targets are achieved and that the environmental responsibilities and obligations of the EA are satisfied during project implementation. The EPMO will coordinate the day-to-day monitoring of local government agencies responsible for relics, environment, forestry, and water conservation. The County EPBs and other agencies will monitor adherence of contractors to the contract clauses. Staff from local forestry departments will monitor protection of wetlands or relocation of protected trees. Officials from local relics and antiquities bureaus will monitor the excavation in critical areas. Spoil disposal and temporary storage will be monitored by water conservation officials. The local EPBs will work with the contractors to monitor and control noise, air and water pollution, and the discharge of wastewater and solid wastes.

61. An external monitoring agency will be hired to monitor the implementation of the Environmental Monitoring Program. The external monitoring agency will regularly visit work areas, collect individual reports and test results, and provide periodic reports for MOR and SEPA. During the construction phase, the reports will be prepared quarterly and during the operational phase according to agreed upon schedules. Twice annual reports presenting monitoring results and analysis will be presented to ADB during the construction period and for two years after provisional acceptance. A final project completion report will then be submitted to ADB.

62. Table 10 presents the environmental monitoring parameters, frequencies and responsibilities. Appendix 2 presents the estimated cost for annual environmental monitoring. Monitoring during the operating phase will be handled by the responsible agencies and the IA with MOR oversight. A detailed EMP will be prepared and implemented by the IA prior to commencement of construction activities. Environmental baseline monitoring will be conducted as required.

Table 10: Environmental Monitoring Framework

Area to Be monitored	Competent Authority	Risks	Mitigation Measures in EIA	Accountability	Reporting requirements	Reporting Frequency
Ancient trees	Forestry department (provincial)	Damage to ancient trees	Monitoring	MOR	To SEPA	Upon relocation
Cultural Relics, Historic Sites	Relics Bureau	Destruction/contamination of artifacts/ sites	Relocation/preventive measures	MOR	To SEPA, Relics B.	Q/A
Wetlands, Ecological Sites	District authorities (e.g., Sanmenxia Yellow River Wetlands)	Contamination	Identified in EIA	MOR	To SEPA	Q/A
Xiliu Lake	EPB	Impacted Water Supply	Separate Water Quality Monitoring Plan for Construction Phase	MOR	To SEPA	Q/A
Areas Prone to Erosion/Spoil and Muck Disposal Areas	Water conservation	Loss of arable land, impairment of visual quality	Identified in EIA	MOR	To SEPA	Q/A
Noise Abatement	EPB	Disturb residents, permanently impair hearing	Change windows, construct acoustic barriers, relocate buildings	EPB	To SEPA	Q/A
Vibration Abatement	EPB	Disturb residents	Use latest technologies	MOR	To SEPA	Q/A
Air Quality	EPB	Acid rain, respiratory problems	Install treatment facilities	EPB	To SEPA	Q/A
Wastewater and Surface Water	EPB	Spread disease	Utilize appropriate treatment practices and technologies	MOR	To SEPA	Q/A
Overall Project Environmental Impact	Various	Identified in EIA	Indicated in EIA	MOR	To SEPA, ADB	Twice Annually

Note: Q/A denotes quarterly during construction period and annually during operational period.

Source: Compiled by the project preparatory technical assistance consultants, 2004.

VIII. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

A. Stakeholder Consultation

63. From December 2001 to December 2004, there were numerous meetings with national, provincial, and local authorities during the ZXR project planning period. Meetings were also held with representatives of enterprises that could provide inputs for the construction and operational phases of ZXR. Most importantly, villages and urban districts likely to be affected have been identified, and meetings have been held with involved residents as well as representatives of schools and other agencies that could be affected. These have been followed up by a range of surveys in order to assess the number of affected persons, agencies, schools and enterprises, as well as the type and magnitude of the impacts. A total of 2,354 of the most seriously affected households have been surveyed. An additional 721 households in neighboring areas that could benefit from ZXR employment and help alleviate poverty, have been surveyed. Passengers (1,600), and truck and bus drivers (1,000) have also been interviewed. 487 representatives from villages and agencies, and officials who will be affected by the ZXR have been consulted on environmental issues. Details of the various public meetings and surveys are in Table 11.

Table 11: Stakeholder Meetings and Surveys

Date	Region	Agency	Participants	Number of Persons	Main Topics
Dec 2001–July 2002	Project region	1st and 4th Survey and Design Institutes	Local government and railway officials,	80	Opinions of local government and railway authorities on ZXR
March–July 2003	Project region	1st, 2nd and 4th Survey and Design Institutes	Local government, officials, and passengers	300	Opinions of local government and railway authorities on ZXR
Sep–Nov 2003	Project region	1st, 2nd and 4th Survey and Design Institutes	Local government and railway officials, potential passengers	300	Opinions of local government, railway authorities and potential passengers on ZXR
Nov 2003–Jan 2004	Project region	1st, 2nd and 4th Survey and Design Institutes	Local government and railway officials, potential passengers	300	Opinions of local government, railway authorities and potential passengers on ZXR
Feb 2004	Shaan County, 2 villages	2nd Survey and Design Institute	Village leaders and representatives	20	Situation in village, opinion about future demolition and ZXR
March 2004	Luoyang Longmen township	Fourth Survey and Design Institute	Township and village leaders, village representatives	20	Local demolition policy, resettlement framework, public participation, attitude towards ZXR
March 2004	Hua County, Baqiao - 2 Villages	First Survey and Design Institute	Village leaders, representatives of the village	20	Local demolition policy, resettlement framework, public participation, attitude towards ZXR
Feb-March 2004	Project region	First Design Institute	Farmers	7	Situation in village, opinion about future demolition and ZXR
Feb-March 2004	Project region	First, Second and Fourth Survey and Design Institutes	Households that may experience impact	Survey of 600 households	Discussion of infrastructure location, environmental impacts, potential mitigation measures
June-July 2004	Project Region	First, Second and Fourth Survey and Design Institutes	Households, small businesses, farmers, teachers and students	487	Attitudes towards construction of ZXR, environmental issues and potential mitigation measures.
Dec 2004	Project region	PPTA and local consultants	Local government officials	221	Basic situation of local society and economics, attitudes towards ZXR
Dec 2004	Project region	PPTA and local consultants	Tourists at main tourist sites	17	Attitudes towards ZXR
Dec 2004	Project region	PPTA and local consultants	Passengers at train, long-distance bus station, airport	Survey of 1600 passengers	Origin and destination, aim of travel, reasons for choosing mode of transport, frequency of travel, occupation, income.
Dec 2004	Project region	PPTA and local consultants	Drivers at long-distance bus stations, drivers of trucks and buses at highway tolls	Survey of 1000 drivers	Model and owner of the vehicle, number of years in use, origin and destination, operating fee, goods transported, number of tonnes, frequency of trips.
Dec 2004	Project region	PPTA and local consultants	Villages along the line that will sustain potential resettlement impact	Survey of 1198 households	Basic household situation, opinions about future demolition, attitudes towards ZXR
Dec 2004	Project region	PPTA and local consultants	Households that are not on alignment but which may be affected	Survey of 721 households	Basic household situation, opinions about future demolition, attitudes towards ZXR
Dec 2004	Project region	PPTA and local consultants	Large enterprises along the line	Survey of 163 enterprises	Type and quantity of the production, raw material consumption, number of employees, total wages.
December 2004	Project region	PPTA and local consultants	Impacted households, small businesses, farmers, teachers and students	200 surveys	Discussion of anticipated environmental impacts, proposed mitigation measures, opinions regarding environmental issues
March 2005	Project region	ADB, MOU, PPTA Consultants	Provincial, Households, city, county and village officials	350 officials	Discussion of proposed development, social impacts, environmental impacts and resettlement issues.

HH=households.

Source: Compiled by the project preparatory technical assistance consultants, 2005.

64. As detailed in Table 11, extensive public consultation has been undertaken regarding the environmental impact of the proposed development. In particular, in February and March 2004 during preparation of the project terms of reference, FSDI conducted initial public consultation with impacted people along the alignment. This included 600 questionnaires received from effected households covering environmental issues and conducting individual discussions with residents on environmental concerns. Additionally, in June/July 2004 to provide input to the Draft EIA, 600 impacted residents were surveyed along the alignment and 487 questionnaires were received from effected residents regarding environmental issues associated with the proposed development. In August 2004, after finalization of the Draft EIA, the document was placed in local libraries and government offices in impacted areas for public review. Subsequently, in December 2004, FSDI and the PPTA consultants conducted a further round of public consultation to obtain public input for inclusion into the SEIA and to obtain feedback on the Draft EIA. This included conducting interviews with 200 effected people (households, officials, enterprises) along the alignment as well as completion of 145 environmental questionnaires from people interviewed.

65. Based on the 487 questionnaires covering environmental issues conducted in June and July 2004, the following project perceptions were gathered (i) 99% of respondents were aware of the Project, and the source for this information in 90% of the cases was the media; (ii) 97% of those surveyed approved of the ZXR; (iii) 92% believed that environmental impacts should be controlled; (iv) in terms of current environmental issues, 56% of the respondents identified sewage as the leading environmental problem, 20% solid waste disposal, 16% air emissions, and 13% noise; and (v) 64% of respondents identified noise as the major likely environmental impact of the ZXR, 18% sewage, 15% refuse discharged along the line, and 3% air emissions.

66. Future consultations will establish a complete database on affected persons, agencies and enterprises in order to determine compensation amounts and monitor the implementation of the resettlement plan. Funds have been allocated for these activities under the resettlement plan for both the construction and operational phases of the project. A compensation program is being developed jointly by MOR and the provincial authorities, who will have responsibility for implementing the resettlement plan. This will include a grievance mechanism. In addition, under the environmental management plan and the environmental monitoring plan, local authorities, residents, and agency and enterprise representatives will be consulted before and during construction as well as during the operational phase, and will be involved in the monitoring process. Funds have also been allocated for these activities.

IX. CONCLUSIONS

67. The ZXR project area is part of the main corridor between east and west PRC. The corridor includes the Yellow River and its tributaries, and a considerable number of PRC's most important historic sites. The western terminus of the ZXR alignment, Xi'an, and the eastern terminus, Zhengzhou, have developed into major industrial, administrative, and distribution centers. Industry and agriculture are the principal economic activities along the alignment. Tourism is becoming increasingly important, and is projected to grow substantially following the ZXR's construction. Over time, the flow of goods and passengers will greatly increase as the national objective of developing and thus alleviating poverty in the PRC's western provinces gains momentum. ZXR will serve a vital role in furthering economic development and offering employment opportunities in both Henan and Shaanxi provinces, and ultimately in the PRC's western provinces. The ZXR is the PRC's first high-speed dedicated passenger line and will be a test case for similar projects. The total cost of the Project is substantial, and further investment in high-speed dedicated passenger lines will depend on its performance. As a result, considerable attention and resources have been provided for both the engineering and the EIA. Successful

implementation of measures to minimize environmental impacts is a priority for MOR and for the local authorities along the alignment.

68. The potential adverse environmental impacts include soil erosion, spoil disposal, air pollution, water pollution, noise and vibration, solid wastes, disturbance or contamination of historic and ecological sites, public safety, land acquisition and altered land use patterns, population resettlement, and induced impacts. Alternatives have been assessed, as have alternative alignments. Detailed mitigation measures for each of the potential adverse impacts have been developed within the context of environmental management and monitoring plans. Investment in environmental protection and mitigation measures accounts for 4.8% of the estimated cost of the fixed infrastructure (total project cost less cost for rolling stock). Roughly 75% of the environmental investments will be for soil and water conservation, which is especially important in areas subject to high rates of soil erosion. Other important mitigation measures for noise and vibration from the high-speed train have been designed for the populations, agencies, and enterprises along the alignment.

69. The EIA concluded that project impacts from both construction and operations will be minimal, and can be mitigated through the use of best practices and appropriate technologies. With the implementation of the EMP and the monitoring plan, the Project is not expected to have significant environmental impacts. Internal and external monitoring and audits will be conducted to ensure that standards and regulations are being followed, and if they are not, that they are immediately corrected.

SUMMARY RESETTLEMENT PLAN

1. The Ministry of Railways (MOR) in consultation with provincial and local governments has prepared a draft Resettlement Plan (RP) based on the preliminary design study, village surveys of all 170 rural villages and all 13 village-level urban neighborhoods, 2,354 household surveys, provincial, prefecture and local government statistics, and consultations with local officials, village leaders, and affected households. The resettlement objective is to ensure that compensation and entitlements provided to affected people are adequate to at least maintain their "without-project" standard of living, with prospects of improvement, in line with the Land Administration Law (1998) and with ADB's *Policy on Involuntary Resettlement* (1995). People losing land, housing, other assets, or other means of production will be compensated at replacement cost and assisted in restoring their incomes and living standards. In 2004, the PRC Constitution was amended to ensure that people are compensated according to law for land expropriated for public projects, and the State Council issued Decree No. 28 on "Further Reform to Strictly Implement Land Administration", which requires public consultation with affected people prior to approval of projects, maintenance of the living standard of affected people, strengthened monitoring procedures, public accounting of the receipt and distribution of resettlement funds, and distribution of compensation for land loss principally to affected people. The RP will be updated by local governments in conformity with Decree No. 28, particularly with respect to compensation standards. The updated RP will be disclosed to affected people, and submitted to ADB for approval.

2. The RP stipulates eligibility/entitlement provisions for affected people. Permanent land losses will be compensated by land reallocation or by cash payments. Each rural village will utilize the land compensation and resettlement subsidy for income restoration. Compensation for temporary land loss will be paid directly to the affected people and the land will be restored to its original state after use. Compensation for rural housing losses will be paid directly to the affected people at replacement cost, free of demolition expenses and salvaged materials; rural households will rebuild their own houses within the same village. Crop and tree losses will be directly paid to the affected people. Urban households, factories, schools and other institutions and enterprises will be paid compensation at market rates for relocation and reconstruction.

3. In most of the affected villages, investigations showed that income loss from land acquisition is less severe because this corridor is developing rapidly and at least 70% of net income for more than half of rural households came from non-agricultural employment and for developing small businesses. Nonetheless, special assistance will be provided to vulnerable households that include the poor, widows, and the disabled. Special measures will also be provided for any affected ethnic minority households. Ethnic minorities account for 0.65% of the population of affected villages and village-level urban units on the alignment, most of whom are Hui people.

4. Local government land administration bureaus will be responsible for implementing resettlement; many activities will be carried out by township officials and village committees. The estimated resettlement cost is US\$ 181.4 million, excluding the costs for enterprise relocation and infrastructure to be relocated. In December 2004, agreements were signed between MOR and Henan and Shaanxi provincial governments whereby the local governments will fund 100% of the cost of land acquisition and resettlement which in turn will be an equity contribution to the Project. The resettlement budget will be adjusted based on the actual measurement of physical losses and market prices.

5. Affected people will be informed and consulted about the likely impacts of the Project at various stages. During the preliminary design stage, stakeholders consulted include heads of affected households, village heads and representatives, local government agencies and departments, and vulnerable groups, including women and ethnic minorities. Resettlement

information booklets will be distributed to affected villages by 15 April 2005 and the endorsed RP will be sent to ADB by 30 April 2005. Affected households will also be further consulted and can participate in resettlement activities, including the detailed measurement survey, location of underpasses, new housing sites, and grievance redress.

6. MOR and municipal-level land acquisition and resettlement offices, in collaboration with the county resettlement offices, will be responsible for internal supervision and monitoring of compensation payments, house rebuilding/relocation for affected people, land redistribution, and grievance redress. Progress reports will be prepared by MOR and submitted to ADB on a quarterly basis, until resettlement is completed. MOR will then prepare a resettlement completion report for submission to ADB. In addition, an independent monitor will be contracted by MOR to carry out the external monitoring and evaluation. The tasks include: (i) conduct baseline survey; (ii) review and verification of the compensation payments, status of land acquisition and compensation payments; (iii) assessment of grievance redress procedures, affected people's reaction/satisfaction, restoration of livelihoods; and (iv) drawing lessons learned for future resettlement planning. The external monitor will prepare monitoring reports for submission to MOR and ADB every 6 months until the completion of resettlement activities; thereafter, annual evaluation investigations will be conducted for at least 2 years and reported to MOR and ADB.

