

**World Bank Loan Funded  
Zhengzhou Urban Rail Project  
In Henan, China**

**ENVIRONMENTAL ASSESSMENT  
Executive Summary**

**Prepared by  
The Environmental Protection Center of Ministry of Transport  
Entrusted by:  
Zhengzhou Urban Rail Group Co.**

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## ABBREVIATIONS

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DI	Design Institute
EA	Environmental Assessment
EIA	Environmental Impact Assessment
ESMP	Environmental and Social Management Plan
EPB	Environmental Protection Bureau
EPCMOT	the Environmental Protection Center of Ministry of Transport
FS	Feasibility Study
GDP	gross domestic product
MEP	Ministry of Environmental Protection
OP/BP	Operational Policy/Bank Procedure
PAA	Project Assessment Area
PD	Preliminary Design
PDO	Project Development Objective
PMO	Project Management Office
PRC	The People's Republic of China
RAP	Resettlement Action Plan
STP	Sewage Treatment Plant
URP	utility relocation plan
WB	World Bank
ZMG	Zhengzhou Municipal Government
ZURG	Zhengzhou Urban Rail Group Co.
ZURP	Zhengzhou Urban Rail Project (Line 3)

### CURRENCIES & OTHER UNITS

Mu	Area Unit (1 mu=0.0667 hectare)
RMB	Chinese Yuan (Renminbi)
USD	United States Dollar

Exchange rate    1 US\$=6.06 RMB

### CHEMICAL ABBREVIATIONS

CO	Carbon Monoxide
NO <sub>x</sub>	Nitrogen Oxide
TSP	Total Suspended Particulates

## **1. Project Background**

This document summarizes the environmental impact assessment of the World Bank financed Zhengzhou Urban Rail Project, (ZURP), highlighting the main issues and conclusions of the environmental assessment (EA) and environment and social management plan (ESMP) for this project. According to both the Chinese Environmental Assessment laws and the World Bank's Operational Policy 4.01 Environmental Assessment, the proposed project is classified as Category A for environmental assessment purposes, due to the scale and significance of potential environmental and social impacts. Therefore, a full environmental assessment report was required. The project is estimated to cost about US\$3.0 billion of which the World Bank is to finance US\$ 250 million; the rest will be financed by the Borrower's counterpart funds.

In accordance with Chinese internal review and approval procedures, an environmental impact assessment (EIA) report of the proposed project was prepared by the Environmental Protection Center of Ministry of Transport (EPCMOT) and will be submitted to the Ministry of Environmental Protection (MEP) for approval. This Executive Summary is based on the EA and ESMP in accordance with the World Bank environment policy, as well as feasibility studies carried out for the project.

The EA reports and ESMP were submitted to the World Bank for review and they fully conform to the Bank policy guidelines regarding environmental and social issues. All reports mentioned above will be made available in China and in the Public Information Center (Infoshop) of the World Bank.

## **2. Project Development Objectives**

The proposed project development objective (PDO) is to improve urban mobility for the population of Zhengzhou located along the catchment area of Line 3 from Xin Liu Lu Station to Hang Hai Dong Lu Station.

As with other cities in China, Zhengzhou is experiencing a rapid increase in private motorized travel. In 2007, the percentage of households with access to at least one car was 13 percent, and by the end of 2010, 19 percent. According to the Zhengzhou Public Security Bureau, the city receives as many as 2,000 new vehicle registration requests per day. The rapid increase in car ownership has led to increasing congestion on city streets.

In response to these challenges, the Zhengzhou Municipal Government (ZMG) sees urban rail as the backbone of an integrated public transport system, able to attract passengers with growing expectations in terms of quality and comfort. Zhengzhou Urban Rail Network Construction Plan (2013-2019) outlined an urban rail network consisting of 5 metro lines. As the first stage, construction of Line 1 and Line 2 commenced in 2009 and 2010, and will be completed by 2013 and 2015 respectively. Line 3, proposed to be partly financed by this World Bank loan, will be commenced in 2014 and will be finished by 2016. Line 3 is located on one of the corridors with highest traffic and congestion in the city.

### 3. Environmental Assessment Process and Legal Framework

A full EA was carried out in accordance with Chinese EIA law and relevant regulations and World Bank environmental safeguard policies. The project triggered the following World Bank Policies: Environmental Assessment (OP/BP 4.01), Physical Cultural Resources (OP/BP 4.11), and Involuntary Resettlement (OP/BP 4.12). Compliance with these policies, and the World Bank's disclosure of information policy, is summarized in Table 1. The project is also in full compliance with environmental policies and regulations in China, summarized in Table 2.

**Table 1. Compliance with World Bank Safeguard Policies**

<b>Safeguard Policies</b>	<b>Actions</b>
Environmental Assessment (OP/BP 4.01)	Category A project. Full EIA and ESMP have been prepared.
Physical Cultural Resources (OP/BP 4.11)	<ul style="list-style-type: none"> <li>- Cultural resources survey conducted with consultation of relevant authorities</li> <li>- Alignment tuning to avoid cultural sites</li> <li>- Engineering measures to minimize potential impacts</li> <li>- Chance procedures developed in ESMP</li> </ul>
Involuntary Resettlement (OP/BP 4.12)	- Resettlement Action Plan (RAP) has been prepared.
EHS Guidelines	- The EHS guidelines has been followed and the corresponding measures are included in the ESMP
Consultation	-A combination of opinion surveys and public meetings were held during preparation of the EIA and RAP, and EA and RAP documents disclosed locally and in Infoshop

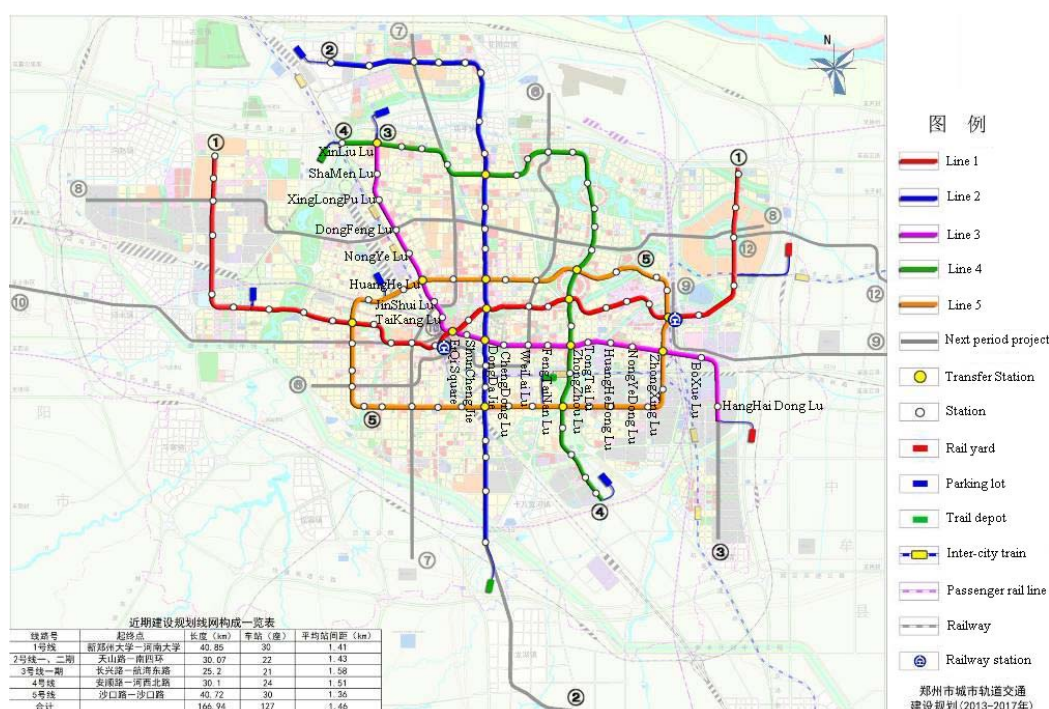
**Table 2. Compliance with Chinese Laws and Regulations**

<b>Chinese Laws and Regulations</b>	<b>Actions</b>
Environmental Protection Law	The EIA is prepared according to relevant laws/regulations and technical guidelines; Mitigation measures are developed in the ESMP and incorporated into the project design, to be implemented and supervised during construction. A final acceptance inspection will be carried out before commissioning.
Environmental Impact Assessment Law	A full EIA report was prepared for ZURP by the EPCMOT. The Chinese EIA report for this project is anticipated to be approved by Henan Provincial Environmental Protection Department by June 2014
Notice on Strengthening EIA Management for Construction Projects Funded by Loans from International Financial Institutions	EIA and ESMP are prepared in compliance with World Bank OP4.01.
Solid Waste Pollution Prevention and Control Law	Solid waste generated from construction must be disposed in the designated spoil disposal sites as planned in the ESMP. The sludge from water treatment plant (WTP) during operation phase will be treated in according with the Chinese regulations.
Water Pollution Prevention and Control Law	Mitigation measures are built into the ESMP. No direct discharge to the surrounding surface water system.
Law of the PRC on Prevention and Control of Atmospheric Pollution	Emission limitations for waste gases (GB16297-1996) were applied in the EIA and mitigation measures are built into the ESMP
Law of the PRC on Prevention and	Noise limits at construction site boundary (GB12523-90) were applied

Control of Pollution From Environmental Noise	in the EIA and mitigation measures were built into the ESMP
Environmental Management on Electromagnetic Radiation	Mitigation measures are incorporated into the project design of the main substations at BoxueLu.
Law of the PRC on Protection of Cultural Relics	Consultations with local authorities of cultural relics were held. Chance finding procedures will be followed.
Tentative Method for Public Participation in EIA	Public consultation was conducted following the tentative method during the preparation of the EIA.

## 4. Project Description

According to Zhengzhou Urban Rail Network Construction Plan, five metro lines will be constructed by 2020. Figure 1 shows the geographic location and layout of the five lines including the proposed Zhengzhou Urban Rail of Line 3 (purple line).



**Figure 1. Geographic location and layout of the proposed project**

Line 3 runs through the urban center from northwest to southeast and connects the emerging new districts and the old commercial zones. Line 3 starts in the northwest from Xinliu Road Station near the Provincial Sports Center in Huiji District and ends in the southeast at HangHaiDongLu Station near 17th JingKai Avenue in the Economic and Technological Development District. The total length is about 25.2km with 21 stations, 1 train depot and 1 parking lot, and the whole line is underground. The average distance between two stations is 1.29 km. The proposed route of Line 3 passes

through the core area of the urban center and connects several major commercial areas such as ErQi Square and the Economic and Technological Development District.

The Bank will provide financing for the construction of the Line 3 (US\$250 million in loan financing): The loan will support the construction of 5 stations (TongTaiLu, HuangHeDongLu, NongYeDongLu, BoXueLu and HangHaiDongLu) and connecting tunnels between the five stations, which are all located at the southeast end of the Line 3. The loan also includes US\$ 2.14 million for design, construction management and technical assistance.

The tunnel will be constructed by tunnel boring machine (TBM), while 20 of the metro stations will be built by open-cut method and one (JinShuiLu Station) of them will be constructed by covered-excavation method. It is estimated a total of 3.35 million m<sup>3</sup> of spoil soil will be generated during the construction phase, including 2.37 million m<sup>3</sup> will be generated from metro stations, 0.47 million m<sup>3</sup> produced by shield tunneling and 0.51 million m<sup>3</sup> yielded from the depot and parking lot construction. The designed capacity of Line 3 for 2023 is 129-pair trains/day with a total passengers of 423,800 persons/d.

## **5. Environmental Baseline**

### **5.1 Physical Environment**

#### **Topography and Landscape**

The proposed Zhengzhou Urban Rail Line 3 is located in the urban built-up area of Zhengzhou which is located in the east side of the flat land area. The entire 25.2 km line will be underground, where the surface elevation ranges from 86.70 to 103.10 meters, and will pass through the central urban area, along major commercial streets.

#### **Regional Geology**

The landform of Zhengzhou features loose Quaternary deposit. According to its topographic feature and geotechnical properties, the project area can be divided into two categories: Zone A (K0+0.000~K23+200) is called alluvial plain of the Yellow River; Zone B (K23+200~K31+350.000) is known as aeolian dune microrelief of alluvial plain of the Yellow River.

#### **Groundwater Conditions**

Groundwater in Zhengzhou are mainly clastic rock fissure water and loose rock pore water. According to the survey conducted in July 2008, buried depth of groundwater ranges 5~10 m in the northeast suburb and the north alluvial plain; 10~15m in the urban area of east side of Beijing-Guangzhou Railway; 15~35m in the urban area of west side of Beijing-Guangzhou Railway, and 20~40m in the west suburb.

#### **Climate**



Zhengzhou has a temperate continental climate, with cool, dry winters and hot, humid summers. The annual mean temperature is 14.9 °C with a minimum low of -17.9 °C and maximum high of 43.3 °C. The monthly average temperature ranges from 0.3 °C in January to 27.8 °C in July. Average annual precipitation is 640 mm and most of the rainfall occurs in summer.

## 5.2 Ecological Environment

The project assessment area (PAA) is located within the urban built-up area of Zhengzhou city. The ground vegetation near the end terminals is mainly farmland. There are some secondary forestry near the proposed train depot. However, there is no environmentally sensitive site such as natural habitats, protected areas, scenic spots or forest parks.

## 5.3 Socio-Economic Situation

Zhengzhou is the capital of Henan Province and, in recent years, has emerged as one of the most important comprehensive transport hubs for highways, railway and civil aviation in central China. According to the Zhengzhou City Statistical Yearbook (2012), by the end of 2011, Zhengzhou had a population of 8.85 million, including an urban population of 4.56 million. Zhengzhou's GDP in 2011 reached 498 billion RMB, a 13.8 percentage increase over 2010, of which secondary and tertiary industry accounted for 97.3% of GDP.

Zhengzhou is one of the most over populated cities in China. Traffic congestion can be happened anytime anywhere. It is predicted that the annual users of public transportation will reach to 1.6 billion and 2.13 billion person-time per year by 2015 and 2020, respectively. A total of 209 bus lines are in operation across Zhengzhou city with a total length of 3,230.7 km. The central area (within the third ring road) is well served by the public bus system, but more public transportation service is needed outside of the third ring road. Traffic congestion is a big concern, partially because of the city is divided into sections by major north-south (Beijing-Guangzhou) and east-west (Shanghai-Lanzhou) railways crossing the city. The existing public transportation system is far behind the rapid development. As part of the city development plan and urban transport strategy, the city has planned its rail transit development on corridors that are expected to become the busiest in the city.

## 5.4 Physical Cultural Resources

There are four cultural relics found in the PAA, including Erqi Monument, Shang Dynasty City Ruins, Zhengzhou Confucius' Temple and PengGong Memorial. The Erqi Monument was built in September 1971 to commemorate the Beijing-Hankou Railway Workers Strike, which occurred on February 7, 1923. It is a unique and arched conjoined twin tower of Chinese style architecture. Various historical relics, figures, documents and memorial articles regarding the Strike are displayed in the tower. It is a landmark building of Zhengzhou City. On May 25 of 2006, State Council of People's Republic of China publicized it as national major cultural relic's protection unit. Shang Dynasty City Ruins are the remains of a capital of Shang Dynasty. In 1950, the discovery of a high rammed-earth city wall proved that it is the capital ruins of Shang Dynasty. Historical relics

unearthed from the ruins are mainly earth wares and bronze wares, which provided important reference for fully understanding of the scope, years and importance of Shang Dynasty town site. The ruins were announced as national major cultural relic's protection unit in 1961 by the State Council. Zhengzhou Confucius Temple was initially built during the Eastern Han Dynasty era (25-220 AD) when the Eastern Han Empire had their capital in Luoyang. The Temple is used to worship Confucius and other sages. In the last 2,000 years, it has been destroyed and rebuilt many times. Dacheng Hall of Qing Dynasty survived, and the Colored Glaze art in Dacheng Hall can be called as the masterpiece in existing ancient building arts located in Henan Province. Due to its large historical, artistic and scientific value, it was announced as a provincial Cultural Relic's Protection Unit by Henan Provincial Government in June 1963. PengGong Memorial was built in 1925 to commemorate Mr Peng Xiangqian who was killed in 1922 in the battle of defend Zhengzhou. It was announced as a Municipal Cultural Relic's Protection Unit by Zhengzhou Municipal Government in June 2009. The characteristics of PCRs are summarized in Table 3.

**Table 3 Summary of characteristics of PCRs**

Name	Protection Classification	Present status	Relation with this project position			
			Section or station	Pile No.	Position	Distance (m)
ErQi Monument	National level	Well protected	Erqi Square - Shuncheng Road section	K10+317 - K10+348	Right side	3
Shang Dynasty City Ruins	National level	Underground ruins; only wall reserved; well protected	East Street - Chengdong Road section	K12+500 - K12+579	Left side	31
					Right side	6
Confucius Temple	Henan Province level	In good conditions	East Street - Chengdong Road section	K12+340 - K12+400	Left side	82
PengGong Memorial	Zhengzhou Municipality level	Well protected	Jinshui Road Station - Taikang Road Station section	K10+850 - K10+900	Left side	79

## 5.4 Environmental Quality

### Ambient Acoustic Environment

In 2009, the monitoring results of daytime equivalent continuous sound level ( $L_{eq}$ ) in all the four functional zones<sup>1</sup> meet the Chinese National Environmental Quality Standard for Acoustic Environment. However, some non-compliance was found during nighttime. The regional average noise level was 54.4 dB(A), 1.2 dB(A) lower than that in 2008. The weighted mean of traffic noise was 66.0 dB(A), 1.7 dB(A) lower than that in 2008.

<sup>1</sup> According to the environmental quality standard for noise (GB3096—2008), the Limits of sound level ( $L_{eq}$ ) of four functional zones are: Category 1 (mainly residential area): daytime 55dB, nighttime 45dB; Category 2 (mainly commercial area): daytime 60dB, nighttime 50dB; Category 3 (industrial area): daytime 65dB, nighttime 55dB; Category 4a (traffic artery including main streets in urban area): daytime 70dB, nighttime 55dB; 4b (railways): daytime 70dB, nighttime 60dB

## Vibration Environment

Road traffic and construction machinery are the main contributors to the ambient vibration in Zhengzhou. In general, the vibration intensity is within the acceptable range and satisfy with the Standard of Vibration in Urban Area Environment (GB10070-88)<sup>2</sup>.

## Electromagnetic Environment

According to the design, the proposed Line 3 is underground, the train depot and parking lot are surrounded by farmland with no residents in the range of 500m, and the potential impact to TV signals is not of a concern. One electric substation will be built at BoXueLu Station and the power cable to and from the transform will be installed through underground pipe. The electric substation neighbors with storehouses and there is no sensitive objects.

## Water Environment

The surface water system in Zhengzhou includes rivers, reservoirs and lakes. The rivers belong to two water systems, namely the Yellow River and the Huai River. According to 2012 monitoring results, water quality of the Yellow River, runs from west to east through north of Zhengzhou, meets the class III standards<sup>3</sup> of the Chinese National Environmental Quality Standard for Surface Water (GB3838—2002). Jialou River and its tributaries, belong to Huai River drainage, run through the city intermittently and receive sewage from the city. Therefore, water quality in two third of the monitoring sections are worse than the class V standards of the above same standard. Monitoring results of seven groundwater wells indicated groundwater quality satisfied with Class III<sup>4</sup> of the national standard (GB/T14848-93).

## Ambient Air

Based on the routine environmental monitoring, the ambient air quality of the PAA in 2012 was categorized as the Second Class<sup>5</sup> (the annual mean of SO<sub>2</sub>, NO<sub>2</sub>, NO<sub>x</sub>, and TSP complies with 0.06mg/m<sup>3</sup>, 0.04 mg/m<sup>3</sup>, 0.05 mg/m<sup>3</sup>, and 0.2 mg/m<sup>3</sup> respectively) of the Chinese National Environmental Quality Standard for Ambient Air (GB3095-1996). The air quality was stable

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<sup>2</sup> Limits of vibration Residential/educational institution area: daytime 70dB, nighttime 67dB; Commercial and mixed area: daytime 75dB, nighttime 72dB

<sup>3</sup> According to the standard, water qualities are classified as five classes and they are applicable to different water usage. I: source water and natural reserve; II: the first class protection zone of source water that are used for centralized drinking water supply, or habitat for rare aquatic life; III: the secondary class protection zone of source water that are used for centralized drinking water supply, or aquaculture and/or for swimming; IV: industrial water supply or for entertaining where no direct contact; and V: agriculture and landscaping.

<sup>4</sup> Class III groundwater is applicable to sources water for centralized drinking water supply, industrial and agricultural water supply.

<sup>5</sup> Class II air quality standard is applicable to residential, commercial, education, general industry areas and countryside.

comparing to that in 2011. Major pollutants include respirable particulate matter and sulfur dioxide (SO<sub>2</sub>). There was no acid rains in the past two years.

## **6. Analysis of Alternatives**

The project has been subject to intense analysis of alternative options including the project-no project scenarios, various options for rail line alignments, location of metro stations during the feasibility study and designing stages, and alternative construction methods of metro stations during construction phase. The optimal alternatives were selected based on the avoidance of possibility to mitigate adverse social and environmental impacts, as well as other economic, technical, and financial considerations for the least cost solutions.

### **6.1 With and Without-Project Analysis**

With and without-project analysis is conducted based on public transport, urban development and potential positive and negative environmental impacts. Under the “without-project” scenario, the development in Zhengzhou will slow down and living condition of the local people might be get worse, since the traffic jam and air quality deterioration in the downtown of Zhengzhou are becoming increasingly serious. On the other hand, the “with-project” scenario will generate long-lasting social and economic benefits, while the environmental impacts, mainly during construction period and thus temporary, can be avoided or mitigated by using well known environmental protection measures. Environmental benefits clearly outweigh environmental impacts.

### **6.2 Alternative Analyses of Metro Alignments**

ZMG will provide a high capacity mass transit solution as part of an integrated public transport network that also includes bus rapid transit system and an extensive bus network. Compared with an elevated rail transit, an underground urban rail line saves valuable land, minimizes potential traffic noise, improves the city’s esthetics and landscape and avoids many existing obstacles like flyover bridges.

During the feasibility study, seven alignments for three sections were intensively studied, namely, North BeiHuan Section, JinShuiLu Station– ErQi Square Station, and Crossing Highway 107 Section. For each section, at least two optional alignments were compared considering engineering feasibility,

socio-economic impact, environmental impact and cost benefit. The recommended alignments are listed in Table 4 (refer the attached sketch maps for details of the recommended alignments):

**Table 4. Recommended Alignment**

Section	Recommended alignment
North BeiHuan Section	ChangXing Road scheme
JinShuiLu Station– ErQi Square Station	MingGong Road scheme
Crossing Highway 107 Section	Straight crossing scheme

### 6.3 Alternative Analyses of Subway Station's Location

Two alternative locations for JinShuiLu Station were studied because this station is adjacent to the DaShiQiao cloverleaf intersection in the center of the city, where is the main commercial street with busy traffics. Moreover, the complex pile foundation of the cloverleaf intersection restricts the choice metro alignment. The alternative analysis result supports the scheme II (located in east side of DaShiQiao cloverleaf intersection and 30 m to JinShui Road) considering its better ridership and land utilization. The recommended scheme II also has less impact to the traffic of JinShui Road during construction and less noise and vibration impact to the nearby residents during operation.

### 6.4 Alternative Analyses of Construction Methods

For the construction of tunnels between metro stations, basically, two methods have been considered. One is mining excavation method and the other is shield tunneling method. Given the urban context and the geological characteristics of Zhengzhou, the shield tunneling method is recommended due to its high-degree of automation, quality of work and less disturbance to adjacent structures and environment. For the construction of metro stations, two methods will be adopted, namely, open-cut method and covered-excavation method, depending on construction conditions, social and environmental impacts. 20 of the metro stations will be built by open-cut method and one (JinShuiLu Station) of them will be constructed by covered-excavation method.

## **7. Environmental Impacts and Mitigation Measures**

Implementation of ZURP will bring significant positive environmental and socio-economic impact to Zhengzhou by promoting public transportation which in turn alleviating urban traffic, reducing environmental pollution results from vehicle emission and traffic congestion, and improving urban life quality. However, some temporary and manageable negative impacts will be inevitable. The main concerns and mitigation measures are summarized as follows:

### 7.1 Impacts during Construction and Mitigation Measures

#### **Traffic Management**

It is predicted the major impact to traffic will happen at the streets and intersections adjacent to metro station construction sites. Based on the experience of Line 1 of Zhengzhou metro project, the EIA has prepared the Traffic Diversion Scheme for each construction site of Line 3 (refer to EIA, Table 5.10-7). The key means for minimizing traffic congestion include: (a) implementing construction phase by phase to minimize road occupation; (b) open up detours or alternative routes for vehicles; (c) optimizing and prioritizing public transport system; and (d) informing public in a timely manner by radio and electronic display board so that people can choose the best route.

## **Noise and Vibration**

During construction, noise and vibration mainly comes from construction machines and vehicles, such as big excavators, air compressors, drills, hammers, heavy duty trucks, etc. A number of sensitive sites along the construction sites will be affected by the nuisance, especially those residential areas, schools, hospitals and heritage buildings within certain distance. Such impact can be very sensitive during nighttime. To minimize or mitigate noise and vibration impact of construction stage, the following mitigation measures are included in the ESMP:

- Install temporary noise reduction facilities at sensitive sites (refer to Table 5.3-6 of EIA report);
- Place the noisy machinery, such as generators and air compressors, in a closed cabin (sound insulation shed) and away from sensitive sites and keep good maintenance; Minimize usage of portable diesel engine generator without of insulation;
- Use commercial concrete instead of onsite preparation by concrete mixer; Pre-cast reinforced concrete segments off-site and arrange the transportation of construction material with environmental considerations;
- Plan the access roads to the construction sites on the far side of sensitive areas such as hospital, schools, residential and heritage buildings;
- Carefully choose construction methods – for example, use of a static pile driver is better than drilling pile in terms of noise and vibration control. Covered excavation method and subsurface excavation method are usually produce less noise and vibrations than open cut excavation method;
- Optimize construction activities to accommodate the requirements of ESMP related to noise and vibration control; in principle, construction activities which produce high level of noise and vibration such as piling should be operated during daytime. If necessary, such intensive construction activities must be limited during 07:00 – 12:00, and 14:00-22:00 prior to the permission of local environmental protection bureau (EPB).
- Follow the requirements specified in Noise Limits for Construction Site (GB 12523-90) and accept the supervision and inspection of local EPB;

- Monitor and measure vibration of sensitive buildings and the cultural relics along the metro line during construction (refer to Table 5.4-21 of EIA report) and take necessary reinforcement actions as needed;
- Set up a 24-hour hotline to take public grievances and resolve those complaints in a timely manner;
- Include these clauses for noise and vibration control in bidding and contract documents.

### **Physical Cultural Resources**

The EIA identified four cultural relics within the PAA, namely, ErQi Monument, Shang Dynasty City Ruins, Zhengzhou Confucius' Temple and PengGong Memorial. The metro alignment and project design has integrated the reviewing comments of the State Administration of Cultural Heritage and the Ministry of the Environmental Protection regarding physical cultural resources in the proposed project. Some engineering measures such as pre-reinforcement, isolated piles and steel spring floating slab will be applied in where it is necessary to minimize the potential impact (see Table 5).

**Table 5. Summary of Mitigation Measures for PCRs**

Physical Culture Resources	Mitigation Measures
ErQi Monument	Pre-reinforcement measures: install an array of bored pile (800 mm in diameter) along axis direction of 3 line to isolate the ground settlement channel during the tunneling. Install steel spring floating slab ballast bed for vibration reduction; process control measures: intensive monitoring and construction practice within the range of 50 m of ErQi Monument.
Shang Dynasty City Ruins	The buried depth of the ruins is about 8 to 13m according to the archaeological exploration, so it is recommended the metro line should be built at the depth of 15 to 20m. Install steel spring floating slab ballast bed for vibration reduction; Strengthen monitoring
Zhengzhou Confucius' Temple	Line 3 will be built underground by shield construction method and the construction distance meets the construction safety requirement. Install steel spring floating slab ballast bed for vibration reduction Strengthen monitoring
PengGong Memorial	It is recommended that the design and construction of metro station, including its auxiliary facilities, near the People's Park where the PengGong Memorial located, must be accommodated to the PCR and the surrounding architectures.





The EIA also prepared chancefindings procedures. If cultural relic is found during the construction, the contractor must stop earth excavation immediately and report to the local cultural authority. Construction is not allowed to restart until competent authorities have investigated and/or explored the site and approved to resumption of construction.

### **Disposal of Waste**

A total of 3.35 million m<sup>3</sup> of spoil soil will be generated during the construction phase, including 2.37 million m<sup>3</sup> will be generated from metro stations, 0.47 million m<sup>3</sup> produced by shield tunneling and 0.51 million m<sup>3</sup> yielded from the depot and parking lot construction. The spoil soil will be removed and disposed in four designated sites, namely HouZhai, HongHuaSi, XiaoLiuCun and ShaWoLiCun (refer Table 6 for detail). The four sites have sufficient capacity to receive all the spoils of the project. Soil conservation measures, such as revetment and drainage ditch, will be applied to control soil erosion at these sites.



**Table 6. Information of the Four Designated Disposal Sites for Spoil Soil**

Name	Land area (Mu)	Capacity (million m <sup>3</sup> )	Lifespan	Approval status	Reclamation measures	Present status
HouZhai	60	1.37	2011-2028	In transaction	Plant cherry after filled up	
HongHuaSi	40	0.80	2010-2025	In transaction	Plant poplar, cherry and grape after filled up	
XiaoLiuCun	40	0.64	2012-2025	In transaction	Plant apple, cherry, grape after filled up	
ShaWoLiCun	60	1.20	2011-2012	In transaction	Plant fruit trees after filled up	
Total	200	4.01	/	/	/	

### Accessibility to Houses and Businesses

Metro construction will inevitably affect the accessibility to houses and businesses and also may affect the existing urban infrastructure such as water mains, gas lines, communication cables, electricity supply, and so on. Any of such interruption could bring a huge impact to people's daily lives. It is required to prepare utility relocation plan (URP) prior to the start of construction. The URP must be reviewed, and approved by the municipal urban utility management bureau and implemented by certified professionals, and the public should be well informed in advance regarding any planned utility interruption. The affected people and householders will be consulted and compensated according to the RAP. Mitigation measures to minimizing impact to accessibility based on the Line 1 have been developed and integrated into the ESMP.

### Water Environment

Surface Water There is no drinking water source along the metro line. The construction activities have no impact to the existing drink water sources which located in the north and south ends of the city. Construction wastewater will be pretreated and reused onsite with no discharge. Sewage and human waste from construction workers will be collected and transported to wastewater treatment plant for disposal.

Groundwater Given the sophisticated technology of shield tunneling method, the impact of tunnel construction to groundwater is minor. However, the open-cut method used in metro station constructions may have impact to groundwater regime. The EIA has calculated the impact range for unwatering of each station and tunnel (refer to Table 5.5-13 of EIA report). Water from the unwatering process will be pumped to ground, pretreated and then discharged into the drains for rainwater. Underground continuous wall and the similar technology will be applied to the foundation construction of metro stations to minimized ground subsidence. Onsite waste will be properly managed through the ESMP to minimize potential pollution of groundwater. The EIA concluded that groundwater regime will be recovered soon after the completion of the project.

## **Air Environment**

Construction activities, such as excavations, backfilling, sand and stone processing and movement of construction vehicles will generate air-borne dust, which is one of the main air pollutants in many Chinese cities. Tail gas emissions from construction machines and vehicles are also predicted. Air-borne dust and emissions may degrade air quality in Zhengzhou during the construction period. The negative impacts can be adequately mitigated through good management measures, including:

- Have full time staff on site to responsible for the implementation of ESMP including dust control and emission reduction;
- Pave the access roads and keep the road clean and damp by sprinkling recycled water;
- Clean up and remove the construction waste and spoil soil in a timely and environmental friendly manner. The truck wheels must be washed before leaving construction sites. Ensure that all trucks carrying excavated material or spoil soil are covered during transportation in a manner that prevents the inadvertent release of such material in the urban environment.
- Schedule the transport vehicles carefully, avoiding rush-hour, busy streets and bad weather conditions such as heavy rain and wind.
- Regularly check and maintain the construction vehicles and machineries to ensure emission are compliance with the national standards.

## **Ecological Environment**

Potential impacts on terrestrial ecology would be mainly caused by land occupation, including 52.4 ha of agricultural land for car depot and parking lot, and 2.9 ha of urban landscape land for metro stations. The impact to aquatic ecology is negligible because there is no direct effluent discharging to the rivers. The impact on urban ecology will be mitigated or minimized by implementation of well planned ESMP at all construction sites. The basic principles include minimizing land occupation, maximizing protection of green space, compensation and recovering. For cases where transplanting is optional, the transplanting scheme must be made in consultation with the city garden department. For temporarily land occupation, the recovery of farming crops and local indigenous vegetation are expected after the construction.

## 7.2 Impacts during Operation and Mitigation Measures

The completion of Zhengzhou Metro Line 3 will significantly improve the quality of life in the city. Traffic congestion will be relieved. Commuting in the city will be easier and smoother. It is estimated, at the initial stage of operation, the metro system will reduce vehicle emission of CO 111.6 t and NOx 30.9 t per year<sup>6</sup>, which in turn slow down the air quality degradation. The negative impact will be mainly noise, vibration, electromagnetic radiation, solids waste, wastewater and those potential impacts can be reduced to an acceptable level with the implementation of ESMP.

### **Noise**

The EIA predicted that 44 sensitive areas along the metro line will be affected by the operational noise of the metro system. The affected population is 10,101. Noises are mainly from ventilation and air-conditioning systems serving the metro system. A set of mitigation measures for noise control has been developed with an extra budget of RMB 6.26 million. Parts of the measures include:

- Integrate the EIA findings and mitigation measures into city planning and project engineering design to reduce the noise sources from its origin and cut or decline its route of transmission, such as placing fans and cooling towers away from sensitive sites;
- Use of low-noise equipment such as fans and cooling towers where is technically feasible and economically affordable;
- Relocate the affected residents in where the control distance for environmental protection is not satisfied with the requirements specified in Code for Design of Metro, for instance, the residents live within 15 m of the fan system;
- Install mufflers at the fan systems of 16 metro stations (refer to table 5.3-19 of EIA report).

### **Vibration**

Metro operation will inevitably bring vibrations due to the interaction between wheels and rails. The intensity and propagation of vibration depends on a number of factors. The EIA predication model concluded that 172 sensitive sites and two heritage buildings will be affected by vibration generated by the metro operation. Corresponding mitigation measures include:

- Select and purchase trains and rail with environmental considerations, with priority given to the products with low vibration and noise levels, as well as ergonomic design, while meeting other key specifications;
- Install 576 m of track shock absorber fastener (GJ-III), 8,871 m of elastic support monolithic track bed, 9,294 m of steel spring floating slab track bed for the corresponding sensitive areas, and resettle of 10 residential buildings that will be affected by the metro operation (refer to Table 5.4-20, 5.4-21 of EIA). The total cost for vibration mitigation will be 287.905 million RMB;

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<sup>6</sup> Environmental Impact Assessment Report of Zhengzhou Urban Rail Project, 2013, EPCMOT

- Keep good maintenance of the metro system and conduct regular vibration monitoring of the concerned heritage buildings;
- Provide city planning agency with the EIA conclusion, including the vibration impact ranges, so that the city planning agency can integrate the EIA recommendations into the future city planning.

## Impacts on Land Use

The construction of Line 3 will permanently occupy 5.98 ha of land and temporarily use of 30.08 ha. Meanwhile, the project will stimulate and promote the implementation of the Land Utilization Plan and speed up the urbanization along the proposed Line 3. The land utilization along the metro line will be changed substantially. Some of the farmland and forest land will be converted into land for residential, commercial or educational purpose. The land zoning along Line 3 is illustrated in Figure 2.

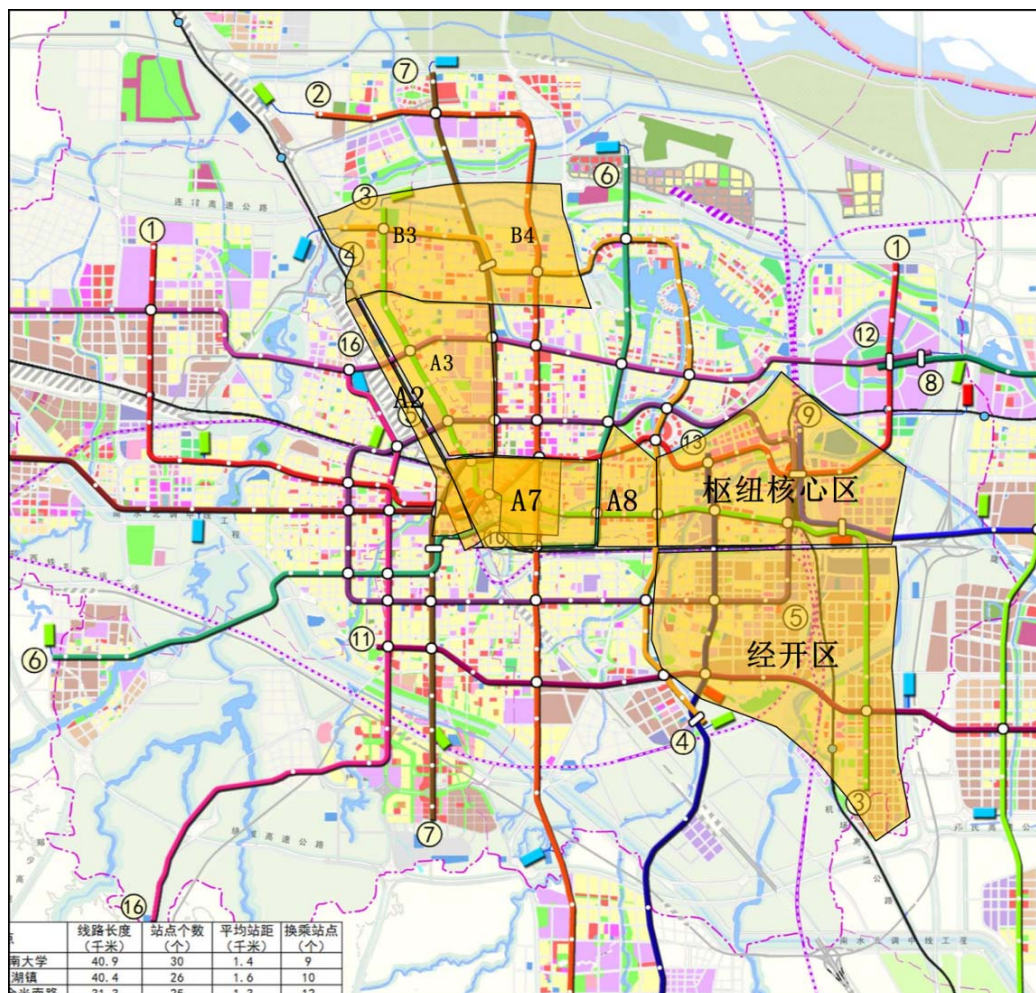


Figure 2. Land zoning along the metro Line 3

The construction of the project will affect the local land utilization in positive and favorable ways, especially for the adjacent area of the 21 metro stations and Nanyang Road. The EIA report suggest that the noise and vibration preventing distance generated from this report should be fully considered when developing the land utilization plan of the above areas to minimize impact to existing residences and planned sensitive spots.

## **Social Impacts**

The design, construction and operation of Line 3 has given a considerable thoughts to the vulnerable population, which include (1) fair and affordable ticket price, (2) access to handicapped people such as elevator for wheelchairs, path for blind, and (3) rational ratio of toilets for men and women.

## **Water Environment**

It is estimated that the metro system of Line 3 will produce 1,722 m<sup>3</sup> of wastewater daily, including 205 m<sup>3</sup>/d from the train depot and parking lot, and 1,517 m<sup>3</sup>/d from 21 metro stations. The wastewater and sewage will be pretreated onsite prior to discharging into the municipal sewer system. The three receiving sewage treatment plants (STP) are MaTouGang STP, WangXinZhuang STP and GengZhuang STP. Therefore, wastewater from the metro operation will not affect either surface water or groundwater environment.

## **Solid Waste**

The EIA predicted there are three major types of solid wastes during metro operation, i.e., 568 - 969 ton/year of trash, about 1000 used train batteries per year and some sludge from septic tanks along the metro line. Trash will be collected and sorted on site and transported to the municipal landfill site for disposal on a timely manner. Used batteries and sludge are classified as hazardous waste according to the Chinese environmental regulations. Therefore, ZURG will contract certified agencies to handle and dispose the used batteries and sludge on a regular basis.

## **Electromagnetic Environment**

Two potential electromagnetic impacts may be subjected to the operation of the proposed project. One is the interference with TV signal and another is the electromagnetic radiation generating from the main substations at BoXueLu. The EIA concludes that the project will have no interference with TV signal because the whole Line 3 is underground and there is no residents within the range of 200 m around the train depot and parking lot. Although the analogical analysis indicated the electromagnetic radiation generating from the main substation is satisfy with the limits of Technical Guidelines for Environment Impact Assessment of Urban Rail Transit (HJ453-2008), the EIA advice keeping at least 50 m distance between the main substation and the nearest residences.

### 7.3 Cumulative Impacts

Cumulative impacts of Line 3 and other related projects that are under construction or will be constructed in foreseeable future are reviewed and evaluated during the EIA, which included the rail network Line 1, Line 2 and Line 5. The cumulative factors covered environmental and social impacts during both construction and operation stage.

#### **Construction Waste**

According to ZURG, Line 1 has finished most of civil work, Line 2, Line 3 and Line 5 will be constructed in approximately same time, from 2011-2018. Spoil soil from Line 3 alone will be about 3.35 million m<sup>3</sup> and will be disposed in 4 designated disposal sites. However, the total spoil soil from all the three lines will reach 8 million m<sup>3</sup>. The potential impacts of spoil soil disposal have attracted attention of the municipal waste management office. Some measures will be put in place, such as contract certified waste remover, monitor the whole process from transportation to disposal, and strengthen on-site management. The EIA suggests that disposal site should be selected with environmental consideration and approved by waste management authority, prior to be used, drainage system must be installed, and soil erosion and reclamation measures must be taken after the site is closed.

#### **Traffic Congestion**

Cumulative traffic congestion is predicted in the overlapped construction sites, like HuangHeLu Station and ZhongXingLu Station where Line 3 and Line 5 will be connected. ZhongXingLu Station is located at the intersection of Shangdu Road and Zhongxing Road, which is a newly developed wider road with less traffic, therefore, simultaneously construction activities is acceptable. However, HuangHeLu Station is located at the very busy intersection of Nanyang Road and Huanghe Road. Therefore, the EIA suggests the construction activities should be limited to the relatively wider Huanghe Road and implemented at one side at a time, to avoid occupying both sides at one time. In addition, public transport system around the concerned construction sites will be further optimized and prioritized. Detours and temporary bypasses will be established to mitigate any possible blockage. The contractors from different projects will be required to work collaboratively and to implement construction in a timesaving and environmental friendly way to minimize traffic jam caused by the construction activities.

#### **Vibration and Physical Cultural Resources**

ErQi Square Station, will be built underneath the ErQi Monument that is the landmark of Zhengzhou City, is the interchange station for Line 1 and Line 3. The construction of the metro station and operation of Line 1 and Line 3 will potentially threaten the safety of the Monument. To address this issue, a special study and engineering design has been conducted to protect ErQi Monument, the protective scheme including advanced reinforcement and continuous monitoring and engineering measures will be taken during construction.

#### **Positive Cumulative Impacts**

Implementation of the Zhengzhou Urban Rail Network combine with the existing BRT will fundamentally improve the public transportation in Zhengzhou and provide people with an efficient and comfortable ride in a long run. Moreover, the urban rail network will greatly increase the land utilization and provide a substitute for bus transport along the alignment and private automobiles. The reduction of vehicles' emission from the three Lines is predicated. As a result, the air quality will be improved.

#### 7.4 Risk Analysis

From the environmental impact point of view, the EIA reviewed the international and national wide incidents that happened during metro construction and operation, identified potential risks of this project and their potential impact. During construction phase, the cause and consequences include (1) improper construction method caused differential settlement, ground subsidence or upheaval; (2) inadequate protective measures caused collapses, roof falling, sand/water gushing, flooding; (3) cut of drainage by mistake and resulted in building cracking or collapse. The EIA predicated that most difficult and risky parts are the construction of metro stations due to the poor geologic stability and relatively high water tables in Zhengzhou. For the tunnel construction, the risky portions are the crossing segments at three interchange bridges (BeiHuan/NanYangLu, NanYangLu/JinShuiLu and ZhongZhouDaDao/ShangDuLu) and two railways (Long-Hai Railway, and Shi-Wu High Speed Railway). During operation phase, the risks may include arson, terrorist attacks, mechanical failure caused by improper operation. Risk analysis was performed as part of the risk management process for the project. As per the EIA recommendation, the following risk management measures to be taken during construction phase and operation phase, respectively:

During construction phase;

- Conduct risk source screening and fine tune design prior to construction;
- Establish environmental security classification system;
- Adopt new construction technologies and processes;
- Strengthen on-site monitoring and engineering supervision;
- Prepare construction phase contingency plan.

During operation phase:

- Prepare contingency plan and conduct simulation exercises;
- Equip with the state-of-the-art monitoring and alarm system;
- Conduct public awareness education.

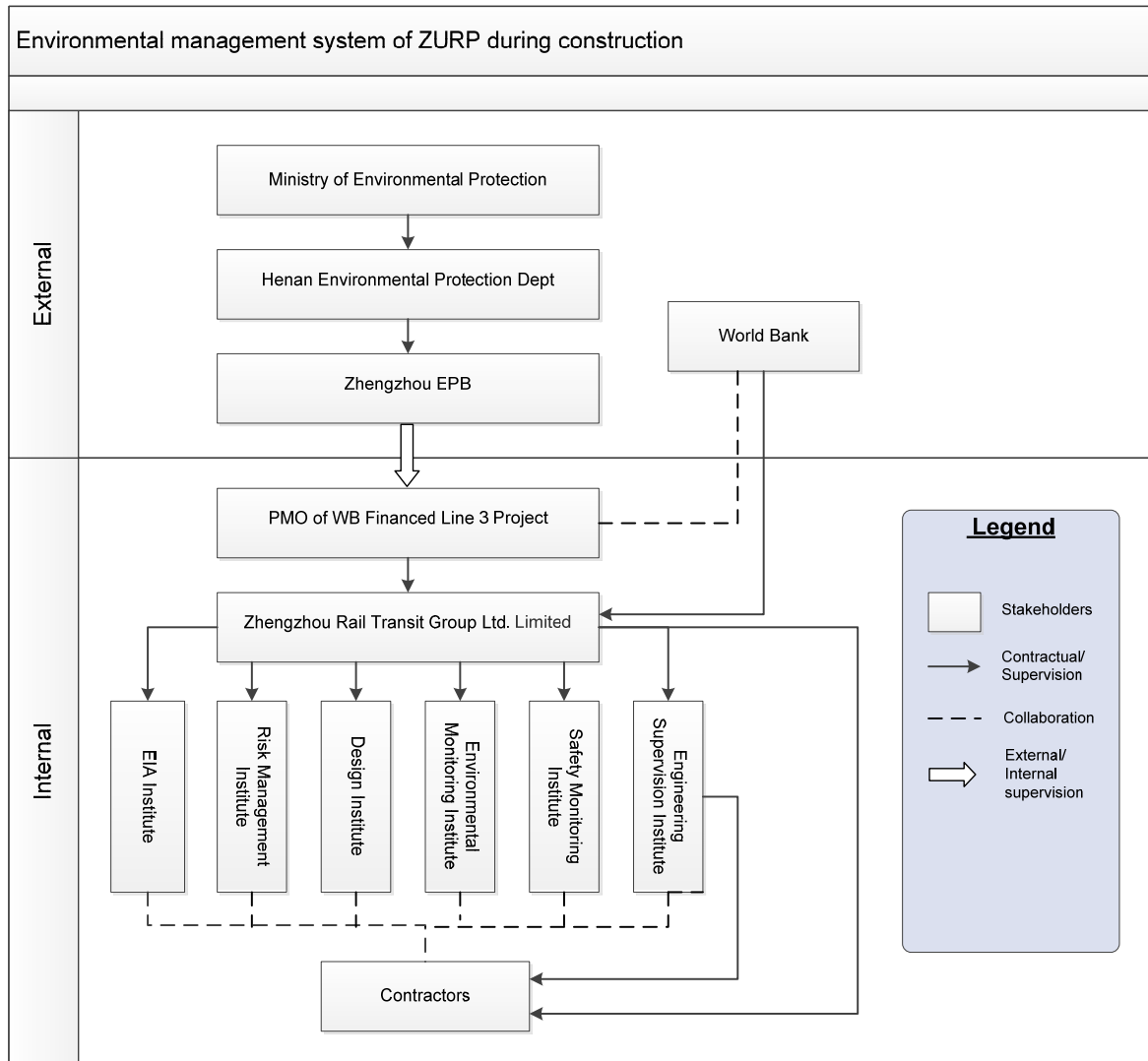
## **8. Environmental and Social Management Plan**

The EIA report of ZURP recommends the implementation of an Environmental and Social Management Plan (ESMP). The ESMP established the environmental and social management organizational structure and responsibilities, proposed a number of measures to mitigate environmental and social impacts during the pre-construction, construction and operation of the proposed project, identified a set of environmental monitoring activities, developed a capacity building and training plan, estimated the budget to implement activities under the ESMP to ensure achievement of the project's environmental objectives.

### **Management Organization and Responsibilities**

Environmental management of the proposed project includes two parts, internal and external, throughout three stages, i.e., project preparation stage, construction stage and operation stage. During preparation stage, Zhengzhou Rail Transit Group Ltd. (ZRTG) is responsible for (1) preparing environmental impact assessment and environmental management plan; (2) implementing the National and World Bank policies during land acquisition and resettlement, and (3) evaluating and selecting contractors with environmental considerations. Environmental management during construction is illustrated in Figure 3.



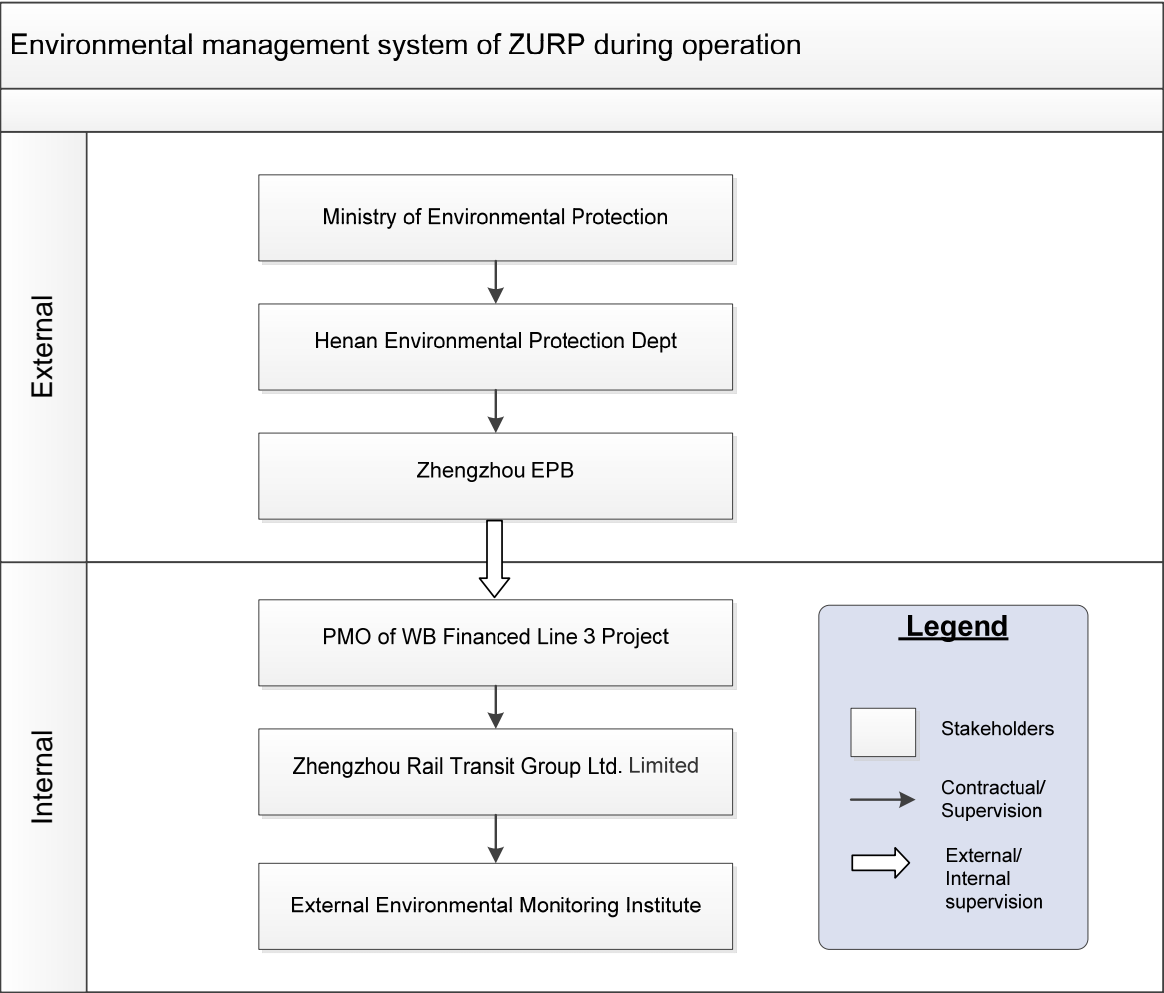


**Figure 3. Environmental management system during construction phase**

As the project implementing agency, ZRTG is responsible for overall environmental and social management during construction. Internal environmental management involves three parties, i.e. project owner, supervision institutes including engineering supervision and risk management supervision, and contractors. The contractors are crucial for implementation of various environmental protection measures specified in the ESMP. Consultant institutions, including EIA, design and risk management, will provide timely professional services. Meanwhile, the proposed project accepts supervision and inspection of national, provincial and municipal environmental authorities, as well as inspection missions from the World Bank.

ZRTG will carry over its responsibilities in environmental management during operational stage. The main responsibilities include public environmental awareness, implementation of ESMP in operational phase, maintenance of environmental facilities such sewage/wastewater treatment and

noise control. Meanwhile, ZRTG is responsible for monitoring noise, vibration, wastewater and other environmental impacts generated from the operation of Line 3 and handling environmental complains and accidents. Environmental management structure during operation is illustrated in Figure 4.



**Figure 4. Environmental management system during operational phase**

**Mitigation Measures**

The ESMP addresses all issues identified in the EIA, and includes a detailed description of all activities, the institutional responsibilities for implementation, and defines a budget and source of financing for each one of the activities included in the ESMP. The mitigation measures are divided in two categories, i.e., generic mitigation measures and site specific mitigation measures. The former are mainly those measures of good management practice for pollution prevention, which need to be followed by the construction companies and construction workers in a daily basis. However, site

specific mitigation measures are the measures applying to specific sites for reducing or mitigating negative environmental impact, which may involve engineering means such as acoustic barrier and track shock absorber fastener. As a key component of the ESMP, mitigation measures for social environment impact, such as impact to traffic, public health, infrastructures and resettlement, have been included in both generic mitigation measures and site specific mitigation measures. Most mitigation measures have already been included in project design and included in project costs.

### **Monitoring of ESMP Implementation**

To ensure the implementation of the ESMP, a qualified professional environmental/social supervision agency will be hired and working onsite to monitor the implementation of mitigation measures, and reporting to PMO, local EPBs and the World Bank. Comprehensive environmental monitoring programs have been designed for both construction and operation phases of the project. Monitoring parameters during construction include environmental quality of air, noise, vibration, surface water and groundwater in the PAA. Environmental monitoring during operation phase will focus on noise, vibration, electromagnetic radiation and wastewater from the metro depot. Social environmental monitoring will be part of the responsibilities of external monitoring. The external environmental monitoring will be conducted by certificated environmental monitoring institutions.

### **Capacity Building and Training**

To ensure effective implementation of the ESMP, environmental training will be provided to staff involved in the project management, engineering supervision, and construction workers. The training during construction phase will be conducted before commencement of the construction and focus on: (1) national and local regulations on environmental protection; (2) good management practice related to minimize environmental impact; (3) related requirements of environment, health and, safety (EHS); and (4) environmental mitigation measures included in the ESMP. During operation stage, ZRTG will incorporate environmental protection into its management system.

### **Budget Estimates**

The ESMP planned a total of RMB 241.06 million for implementing the mitigation measure and other related environmental activities. The breakdown is listed in Table 7.

**Table 7. Budget for Mitigation Measure and Related Environmental Activities**

Items	Description	Cost (RMB 10,000)	Cost (US\$ million)
Noise	Lengthen the mufflers at 16 ventilating stations	240	0.4
	Install 3 cross-flow ultra-low noise cooling towers	90	0.1
	Install 3 cross-flow low noise cooling towers	100	0.2
	10-m width green belt around the parking lot in JialouHe	60.9	0.1
	Install acoustic barrier around the car depot in HangHaiDongLu	135	0.2
	Temporary sound insulation devices during construction	225	0.4
	Sub total	850.9	1.4
Vibration	Install 620 m of steel spring floating slab track bed to protect the three heritage buildings	930	1.5
	Install 8674 m of steel spring floating slab track bed to protect 20 sensitive areas including schools, hospitals and residential buildings	13011	21.5
	Install 8701 m of elastic support monolithic track bed to protect 24 sensitive spots along the metro line;	8701	14.4
	Install 576 m of track shock absorber fastener (GJ-III)	288	0.5
	Sub total	22930	37.8
Electromagnetic interference	Install cable TV and optimization for the two main substations		
Wastewater	Treatment and disposal of wastewater generated during construction	50	0.1
Environmental Monitoring	Construction phase: Noise, vibration, air, water, groundwater level and ground subsidence	275	0.5
	Operation phase: Noise, vibration, electromagnetic radiation and water	90	0.1
Total		24105.9	39.8

## 9. Public Consultation and Information Disclosure

A variety of methods of public participation, including project general information announcement, questionnaires, public hearing, experts panel meetings, and meetings with key stakeholders, have been implemented during preparation of the EIA. The public has been well informed about the project, its potential environmental impacts and the corresponding mitigation measures. Most of the

public concerns have been incorporated either in project design, project management or in the environmental and social management plan.

Two-round public consultations have been conducted with those affected by the proposed project and included persons from different groups, gender, socioeconomic and educational backgrounds, and occupations. The first round questionnaires (Dec, 2012) included 267 individual respondents. The consultation results indicated the ZURP has been well known among the public in Zhengzhou and 92% of respondents support the project and hope the current traffic congestion and related environmental issue can be resolved, though they knew they are go to suffer some temporary environmental impact during the construction period. The major public concerns were construction caused traffic jam, noise, dust, vibration and water pollution. All these concerns were addressed in the EIA/ESMP. In addition, intensive consultations have been conducted with 19 sensitive communities and institutions respectively. The participants include village/community committees, hospitals and schools. All the stakeholders have been well informed about the project impact and expressed their understanding and support. The public also concerns of noise impact and traffic congestion. The project owner promised to strictly follow the requirements of ESMP to minimize the impact to an acceptable level.

The second round public survey (Aug, 2013) covered 714 individual respondents. Comparing with the first round consultation, the second one targeted the most likely affected population with larger questionnaire samples. The result showed that 89% of interviewees support the implementation of the project. Public feedback and concerns have been considered in the modification of EIA and ESMP and will be well implemented.

Information about the project has been disclosed through public announcements at local communities and major local media, and websites (Table 8). Telephone hotline has been established for the public to access relevant documents and offer comments. The EA/ ESMP/EA Summary, and RAP will be available at the PMO. The reports will also be disclosed at the website of the Bank's Beijing office and at the Infoshop in Washington, DC.

**Table 8. Summary of Information Disclosure**

Time	Document	Media
May 17, 2012	General information about the project and its environmental impact	ZURP official website: <a href="http://www.zzdrc.gov.cn">http://www.zzdrc.gov.cn</a>
July. 8, 2013	General information about the project and its environmental impact	DongFangJingBo Newspaper (local Chinese newspaper)
Aug. 19, 2013	Full EIA of ZURP	ZURP official website: <a href="http://www.zzdrc.gov.cn">http://www.zzdrc.gov.cn</a>

## 10. Resettlement Action Plan

### Involuntary Resettlement

While bringing benefits to local population, these project activities would also cause some land acquisition and involuntary resettlement of local community. The details of resettlement are summarized in Table 9.

**Table 9. Details of Resettlement Surveyed**

Affected by permanent land occupation, (area in mu)			Affected by demolition of houses/shops (area in m <sup>2</sup> )					
Collective land			private owner			collective owner or private shops		
Land	family	population	area	family	population	number	area	population
786	239	767	35347	449	1038	264	66313	1026

### Considerations for Resettlement

Based on fully informed and extensive consultation among these communities, a Resettlement Action Plan (RAP) has been prepared by Wuhan University. Appropriate and practicable measures were planned for compensation and rehabilitation of the affected peoples' livelihoods, as agreed and satisfied by them. Policies and entitlements included in the RAP are based on national, provincial and municipal regulations, as well as requirements in the World Bank's OP 4.12. The following key considerations were applied in project planning and design and in RAP preparation:

- Minimizing the extent of land acquisition and resettlement by optimizing project design, and minimizing the impact to the local communities if land occupation and resettlement is inevitable.
- Surveying socio-economic baseline conditions, and identifying all displaced persons (DPs) in households, enterprises and others at the project preparation stage.

- Determining compensation for land, structures, and other fixed assets at replacement cost, and guarantee their incomes and living standards can be improved or at least restored.
- Consulting with DPs on arrangements for compensation and assistance.
- Establishing mechanism to address complaints and grievances for the DPs including discussions, negotiations, arbitration, and legal proceedings.
- Arranging supervision and monitoring to ensure the RAP compliance and to address other issues that may arise during RAP implementation

## **Organizational Management**

The PMO of ZURP and concerned district have set up resettlement offices as outlined in the RAP. The staff of the offices will be trained to develop management capacity. The RAP sets out training and resource requirements for these offices. The PMO of ZURP will coordinate implementation of the RAP by the district governments via its resettlement office.

## **Resettlement Monitoring**

Internal and external monitoring mechanisms for RAP implementation will be set up prior to project implementation. Internal monitoring is to be conducted by the PMO of ZURP resettlement office and the district resettlement offices. An external monitoring agency will be engaged to report resettlement progress every six months. External monitoring reports will assess household relocation and livelihood restoration as well as transitional measures for communities and people. The RAP describes monitoring purposes, responsibilities, indicators, methodology, procedures and reporting requirements.

# **11.Conclusions**

The World Bank financed Zhengzhou Urban Rail Project (Line 3) is an essential component of the Urban Rail Transit Network Plan of Zhengzhou City. The implementation of this proposed project will substantially upgrade the city's public transit system and benefit the city's sustainable development. The electricity powered metro system will not only make smooth, comfortable ride, better land utilization but also relieve air pollution by reducing vehicles' emission resulted from the substitution of some ground transit buses and private automobiles. As an affordable public transit, the social vulnerable groups will also benefit from the project.

Due to the nature of the project, metro construction will be carried out in the built-up urban and busy commercial area of Zhengzhou. Therefore, it will inevitably bring some temporary adverse impacts such as local traffic jam, noise, vibration and affect some small business adjacent to the construction sites. However, these negative impacts are temporary and localized, and will be reduced and mitigated to an acceptable level by implementing the ESMP and RAP. The environmental

assessment concludes that the ZURP is environmentally feasible and in line with the trinity principle of social, economic and environmental benefits.



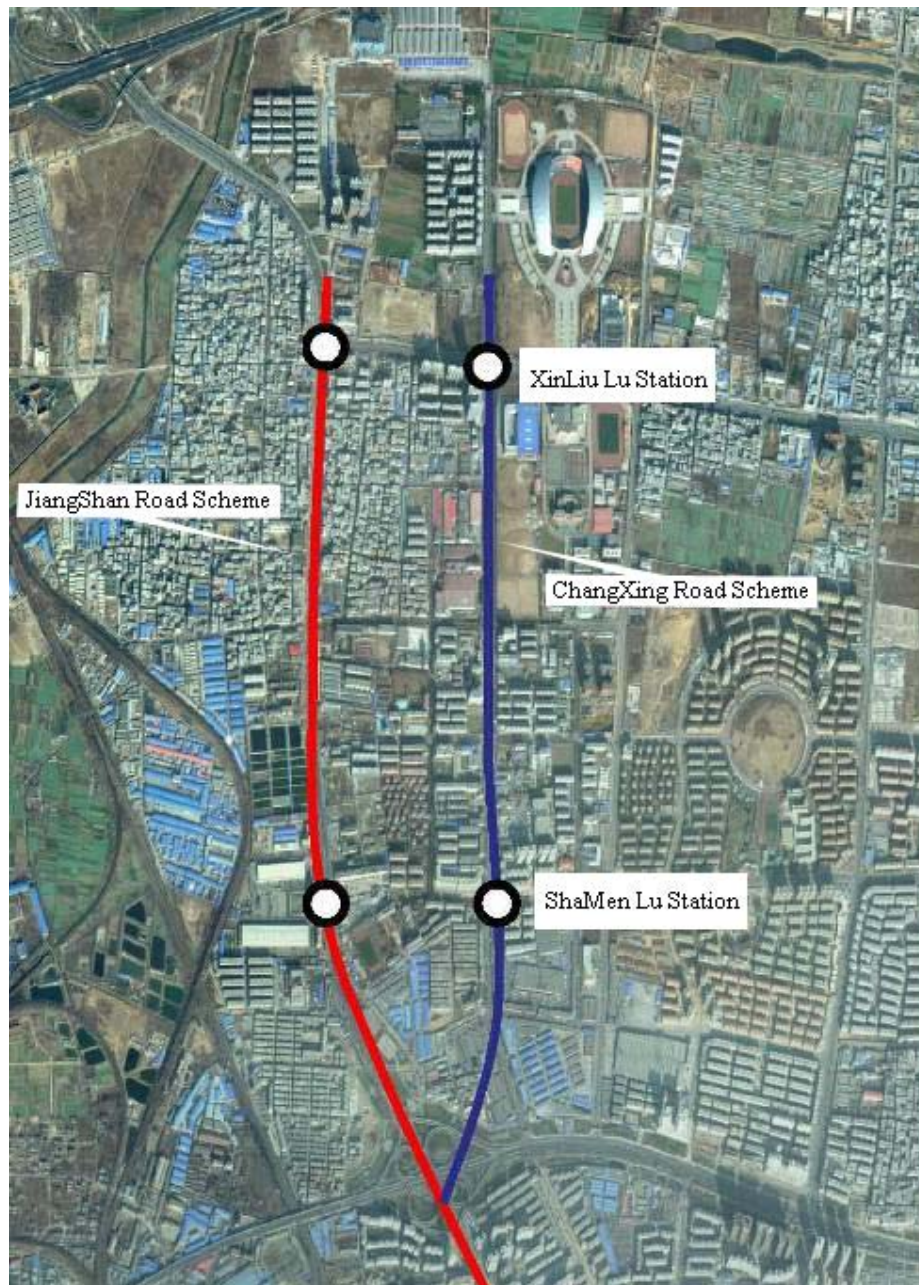
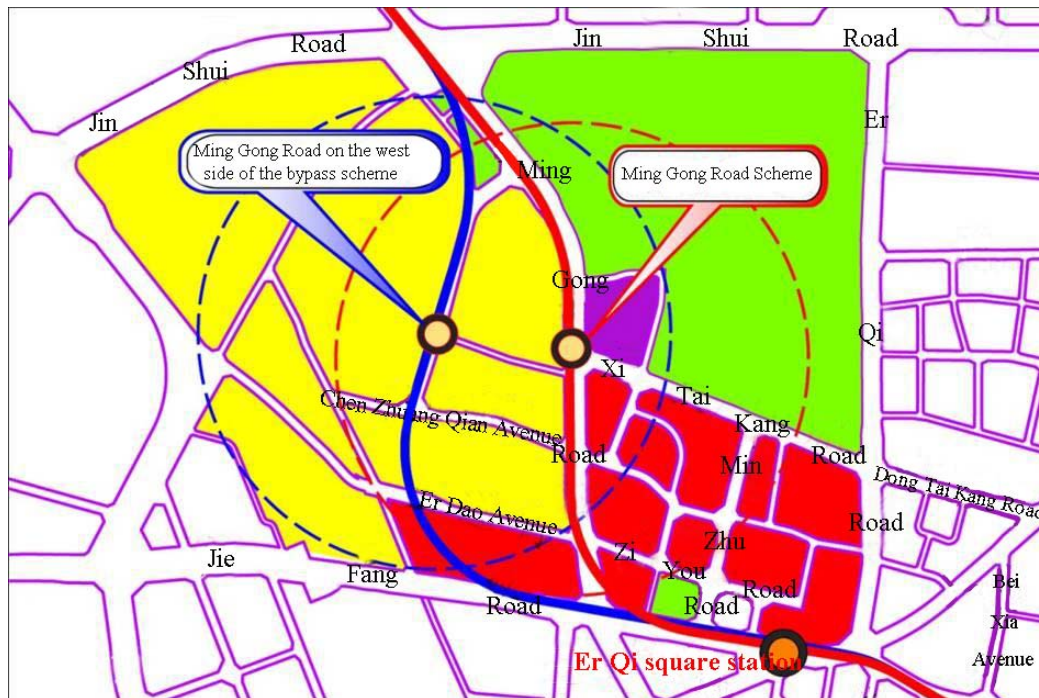
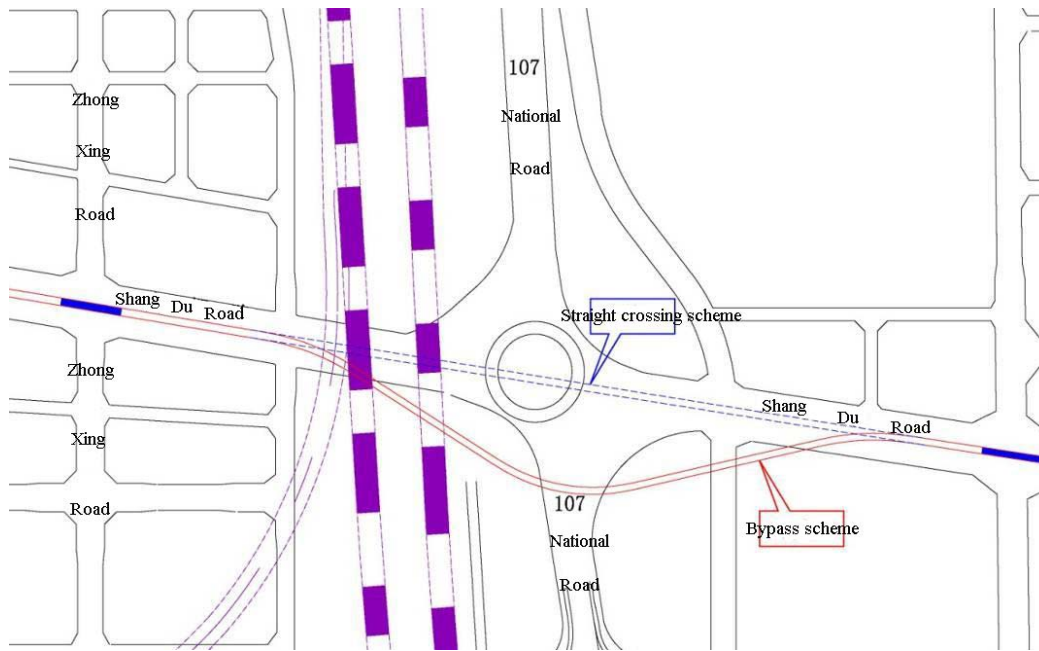


Figure 5. Sketch Map of Alternative Alignment for North BeiHuan Section



**Figure 6. Sketch Map of Alternative Alignment  
between JinShuiLu Station and ErQi Square Station**



**Figure 7. Sketch Map for Crossing Highway 107 Section**